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San Luis Valley, California Water Table

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Dry Southern California Takes Step Toward Desalinated Sea Water

By Jay Mathews
Washington Post Staff Writer

LOS ANGELES, July 10—An unprecedented surge of interest in taking drinking water from the sea along the drought-stricken California coast culminated today with initial approval of what would be the nation's largest distillation plant. It could produce 5 million gallons of water daily to ease Southern California's chronic shortage.

The board of the Metropolitan Water District (MWD), the region's largest water agency, unanimously agreed to a \$500,000 study to determine the best site for the \$30 million plant.

The action came as several California cities, caught in the state's worst drought in 60 years, indicated interest in new desalination methods being used in the Middle East and south Florida. "At some point in time, I don't know when that is going to be, desalination will be the answer to our water problems in Southern California," said Gary M. Snyder, MWD's assistant chief engineer.

Most cities have declined to use desali-

nated water because of its great cost. Water from the proposed MWD plant, although powered by waste heat from an existing power plant, would cost \$1,000 per acre foot or 0.4 cent per gallon, four times the current cost of water from rivers and runoff from the Sierra Nevada mountain range.

But new demands on those traditional water sources are expected to increase their cost, and many California businesses and developers appear willing to pay a premium for a steady supply of desalinated sea water.

On tinder-dry Catalina Island, 26 miles off the Southern California coast, a development company named Hamilton Cove Associates has agreed to build a \$3 million desalination plant producing 132,000 gallons daily to win permission to complete a condominium project on the island.

The city of Santa Barbara, where drought police are ticketing people who water lawns and some homeowners are painting dried grass green, is considering more than 20 proposals to purify ocean water. North of San Francisco, Marin County is beginning a three-month test of a device that could make brackish Bay water drinkable. Several

other water districts are collecting information on desalination.

Water engineers here said they expect California to join Saudi Arabia, Kuwait and some parts of south Florida on the growing list of rich coastal areas that have more money than water and are willing to invest millions to keep taps flowing and economic growth continuing.

Oil-rich Saudi Arabia has 22 desalination plants capable of producing 550 million gallons of water each day, about one-fourth of the total world production of desalinated water. Japanese companies have built many Middle Eastern plants, although Israel constructed one of the first major sea water distillation plants in the desert town of Eilat in 1965.

In the United States, much research on desalination has been driven by the need to meet new water-quality standards and provide pure distilled water for the electronics industry. But residential booms in areas of Florida and California with few remaining water sources have brought the technology to municipal water departments.

Jack Jorgensen, executive director of the National Water Supply Improvement Asso-

ciation in St. Leonard, Md., said Florida's current daily production of 50 million gallons of desalinated water will jump to 250 million gallons in 1992 when several projects are completed.

Despite the cost, communities are finding the converted sea water convenient, particularly since "you can locate the plants at close proximity to the potential users," rather than arrange for pipeline transport from mountains and rivers hundreds of miles away.

Most plants separate salt and other impurities from water in one of two ways. One method, sometimes called "reverse osmosis," forces sea water through a special membrane that filters all but water molecules. The other method, distillation, heats sea water to create unadulterated steam, which cools to become distilled water.

The membrane method is used in the electronics industry, most south Florida plants and the Marin County experiment and works best with bay water or waste water not as salty as sea water. Larger plants, such as those in the Middle East and the proposed MWD plant, find the distillation method more efficient.

Jorgensen said membrane research has produced advances. In 1992, the nation's largest desalination plant is to open in Yuma, Ariz., using the membrane method to purify 72 million gallons daily of brackish irrigation water for shipment to Mexico under an agreement on use of the Colorado River.

If work proceeds as planned, Snyder said, MWD could open its desalination plant in three years and use it as a guide to building much larger plants. The plant would take in 25 million gallons of ocean water daily, remove 5 million gallons of fresh water and return the rest to the sea with its salt content increased from 3.4 percent to 6.4 percent and its temperature raised from 61 to 74 degrees.

Snyder said studies indicate no significant environmental damage from the process. Eventual construction of a much larger plant, capable of producing 100 million gallons daily, probably would require a new power plant fueled by oil, coal or nuclear energy, which MWD officials acknowledge might be opposed by nearby residents and environmentalists.



Congressional Research Service
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June 28, 1990

Washington, D.C. 20540

To : Honorable Albert Gore, Jr.
Attention: Rick Adcock

From : Betsy A. Cody
Analyst in Natural Resource Policy
Environment and Natural Resources Policy Division

Subject : Central Valley Aquifer System

I am sending the attached summary sheet in response to your request for information on the Central Valley Aquifer System in California. Please let me know if you need any thing else (7-7229).

CENTRAL VALLEY AQUIFER SYSTEM

Size:	20,000 square miles
Volume:	800 million acre feet (maf) in upper 1,000 feet of aquifer. (1987 estimate of what was economically feasible to recover.)
Annual withdrawal:	USGS estimates an average of 12 maf during the mid-1970s; an average of 11 maf per year 1961-1977, with a high of 15 maf during the drought year of 1977. (64 maf have been permanently withdrawn since development nearly 100 years ago.) Water levels have dropped nearly 400 feet in some areas. Storage capacity has declined in some areas due to sediment compression. USGS estimates that total storage capacity has been reduced by 15 maf.
Annual recharge rate:	USGS estimates that nearly 11 maf are returned to the aquifer each year, resulting in an average annual overdraft of .8 - 1.3 maf. (Irrigation runoff and seepage accounts for 80% of this recharge, according to USGS.) Artificial recharge of aquifer has been taking place since the 1920s and is still practiced in some areas. The Central Valley Aquifer system is made up of a series of aquifers. It varies in thickness (water mixed with gravel and sand deposits) and distance from the surface. As with the Ogallala, recharge rates vary significantly throughout Central Valley. Overall, recharge rates are much higher than the Ogallala.
Water use:	Primarily used for irrigation (88.4% in 1985); 8.6% used for public supply; 2.4% used for industrial and mining purposes; .5% used for domestic and commercial; and .1 percent thermoelectric power. One source estimates that nearly 10 million acres are irrigated with Central Valley groundwater. ¹

¹ Mohamed T. El-Ashry and Diana C. Gibbons, eds. *Water and arid lands of the western United States*. "The Central Valley of California," by Charles V. Moore and Richard E. Howitt. A World Resources Institute Book. New York: Cambridge University Press, 1988. pp. 85-105.

Water Quality: The water quality in the Central Valley aquifer is suitable for most purposes. However, salinity and contamination from agricultural and other sources are growing problems in some areas. Selenium contamination is especially a problem in portions of the San Joaquin Valley. (See related articles on Kesterson Reservoir contamination).

Other: Land subsidence is widespread due to groundwater pumping in the Central Valley. Nearly 5,000 square miles have dropped by one foot or more since subsidence was noticed in the mid-1920s. In addition to shrinking the carrying capacity of the aquifer, land subsidence is damaging irrigation canals, roads and buildings.

Sources: U.S. Department of Interior, U.S. Geological Survey. *National Water Survey 1984*. Washington DC: U.S. Govt. Printing Office, 1985.

U.S. Department of Interior, U.S. Geological Survey. *National Water Survey 1987*. Washington DC: U.S. Govt. Printing Office, 1990.

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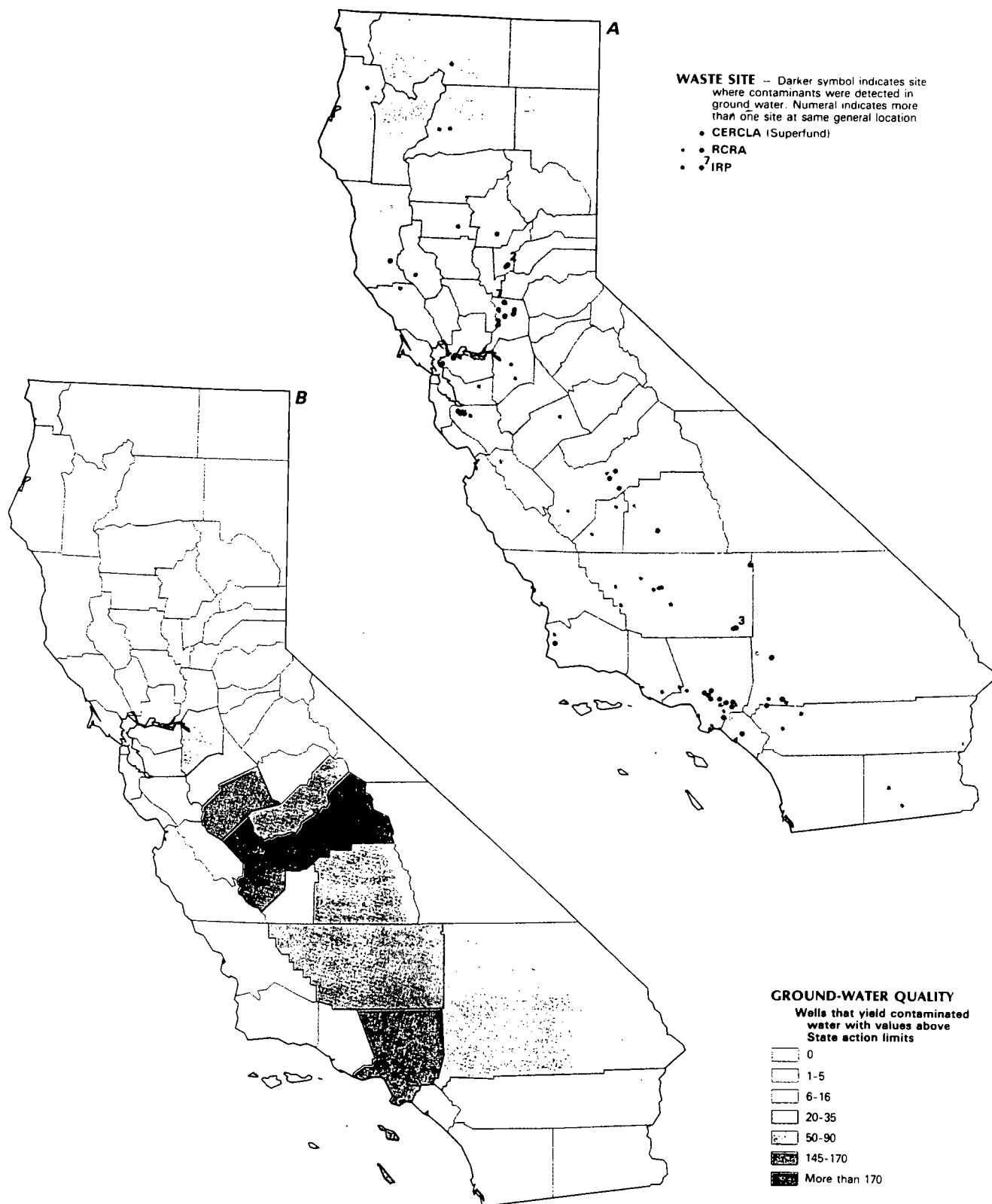


Figure 3. Selected waste sites and ground-water-quality information in California. *A*, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites, as of 1986; Resource Conservation and Recovery Act (RCRA) sites, as of 1986; and Department of Defense Installation Restoration Program (IRP) sites, as of 1985. *B*, Distribution of wells that yield contaminated water, as of 1986. *C*, County or municipal landfills, as of 1986. (Sources: *A*, U.S. Department of Defense, 1986; information from Environmental Protection Agency and California State Water Resources Control Board. *B*, Cohen and Bowes, 1984; California Department of Health Services, 1986; and information from California Regional Water Quality Control Boards. *C*, information from California Waste Management Board.)

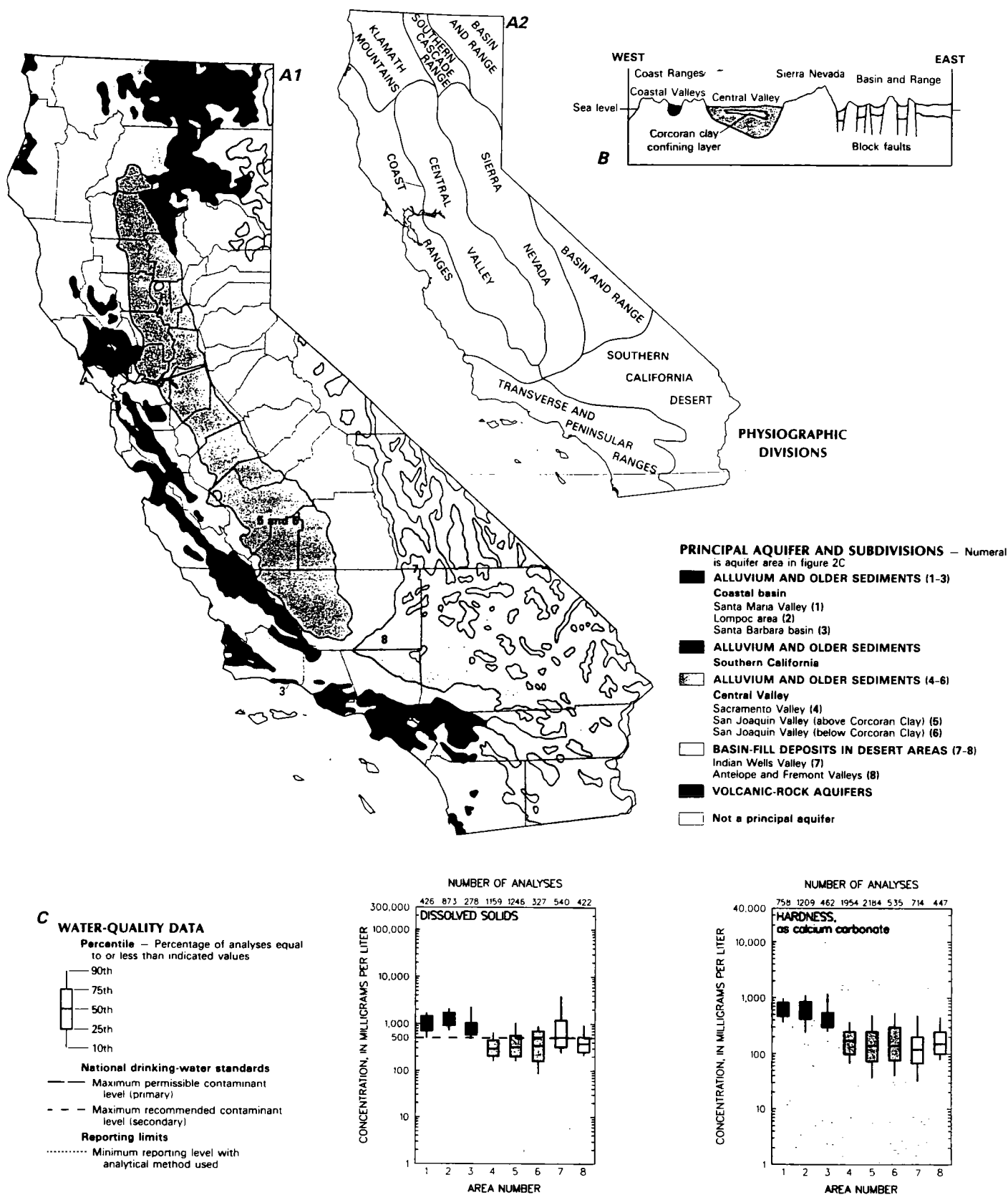


Figure 2. Principal aquifers and related water-quality data in California. **A1.** Principal aquifers. **A2.** Physiographic provinces. **B.** Generalized geologic section. **C.** Selected water-quality constituents and properties, as of 1986. (Sources. **A1.** California Department of Water Resources, 1975c, 1980a. **A2.** Fennerman, 1946. **B.** Compiled by A.M. Spieker from U.S. Geological Survey files. **C.** Analyses compiled from U.S. Geological Survey files; national drinking-water standards from U.S. Environmental Protection Agency, 1986a,b.)

Selenium Poisons Refuge, California Politics

Drainage from the San Joaquin Valley has dumped selenium into a wildlife refuge and pitted two federal agencies against each other

Palo Alto, Calif. Four years ago, the San Luis Drain began to carry undiluted sump water from farms in the San Joaquin Valley northward to a marsh about 130 miles below San Francisco. The place at the end of the drain is called the Kesterson National Wildlife Refuge. Overnight, it was transformed from a refuge into a death trap for several species of fish and migratory birds.

The toxic agent is selenium, an element that abounds in the soil of the Central Valley. A small amount of selenium in the diet is beneficial, but high levels have caused cancers in laboratory animals and other problems in farm animals.

It is clear now that the drainwater threatens wildlife over a broad area, the wintering ground for migratory birds in the Pacific flyway. In addition, it has raised the possibility that selenium and heavy metals may have leaked into the Central Valley's deep aquifer.

The crisis came to a head on 15 March at an emotional hearing near Kesterson chaired by Representative George Miller (D-Calif.), the pro-environment chairman of the House subcommittee on water and power resources. At that meeting, the regional Department of Interior chief, Carol Hallet, acting on instructions from Secretary Donald Hodel, promised that the drainage would be stopped immediately.

Farmers of 42,000 affected acres claimed they would be driven out of business. Ultimately the problem could affect several hundred thousand acres of highly profitable (and federally subsidized) farms in the San Joaquin Valley.

Two weeks after the Miller hearing, the department signed a compromise with farm interests that gives them until 1986 to stop the pollution. It also promised to supply irrigation water indefinitely "into the future."

Interior sits at the center of the problem because it helped build the drain. The Environmental Protection Agency has not been involved because an amendment to the Clean Water Act backed by farmers in 1977 exempts agricultural runoff.

Everyone is waiting to see what will happen. The first federal deadline (20 percent less drainwater by 30 September) will come at the end of the summer irrigation season. Reductions of 20 percent will be made every 2 months until total stoppage is reached by 30 June 1986.

Meanwhile, the Interior Department has promised to have ready by 5 July a plan for cleaning Kesterson. The Westlands Water District, which is dumping the toxic water, has pledged to modify its system and send the waste water into yet-unbuilt evaporation ponds further south. Critics call it the "mini-Kestersons" option. But Westlands officials say they will make the new ponds sterile so that birds will not get toxic food from them.

There is no evidence that drinking water has been affected, but children and pregnant women have been warned not to eat birds from the polluted area. Most severely at risk, according to one observer, are Southeast Asian highlanders (the Hmong) who settled near Kesterson after fleeing the communist takeover in Vietnam.

Three key players are sister agencies in the U.S. Department of the Interior: the Bureau of Reclamation (BUREC), builder of the irrigation and drain systems; the Fish and Wildlife Service (FWS), entrusted with protecting the wildlife and comanager of Kesterson with BUREC; and the Geological Survey (USGS), which has been called upon to settle points disputed by the others. The disagreement between BUREC and FWS has been acrimonious, and several FWS officials accused BUREC and its agribusiness clients of trying to quash dissent and bury data.

One retired 33-year FWS veteran, former California area manager William Sweeney, gave a blistering talk on this subject last fall. He charged that the Central Valley Water Project has brought about "unparalleled destruction" of migratory birds and fish and "turned the San Joaquin River into the lower colon of California—a stinking sewer contaminated with salts, heavy metals, trace elements, and the residue from the annual applications of hundreds of tons of insecticides, herbicides, and fertilizers."

Sweeney mentioned the plight of the salmon in the San Joaquin. Their numbers have declined in 30 years from 100,000 to 5,000 or 10,000, "mostly supported by hatcheries, with no natural spawning in the San Joaquin itself." Other species standing in the way of development may have the same fate, Sweeney said, unless citizens sue to make federal agencies enforce wildlife protection laws.

This is just what happened at Kesterson. A local rancher and duck club owner, R. James Claus, tipped the first domino in the cascading legal actions that forced the Interior Department's hand. Claus knew that his cattle were sick and, when he learned of the selenium problems at Kesterson, he began to file appeals to stop the waste water dumping. He accused the Interior Department of violating the Migratory Bird Treaty Act, which forbids the killing of migratory birds. The state water board was persuaded to intervene (after the regional board would not) on grounds that Kesterson qualified as an unregulated toxic dump. Both Claus and Lloyd Carter, a reporter who has covered Kesterson in the Fresno Bee, say they have received



San Luis Drain

July 12, 1985

anonymous threats, presumably from local farmers who fear the loss of BUREC water.

BUREC and California farmers planned the San Luis Drain in the 1950's as a small but necessary part of a new water supply leg in the Central Valley, called the San Luis Unit. As early as 1951, farmers knew that the irrigation wells they had drilled in the west side of the valley were running dry. They also knew the San Luis water project would have to include a drain to carry off minerals that were collecting in the root beds. Underlying the west valley is a thick zone of clay that effectively creates a bathtub beneath the fields. A steady flow of fresh water is needed to flush out harmful sediments (mainly salt). Gravity takes the drainwater north toward San Francisco Bay.

In recent testimony, BUREC officials have said they were not aware that irrigating the valley's west side would create any long-term problems other than the buildup of common salt. They expected to build the San Luis Drain all the way to the head of the San Francisco Bay, in the delta at Chubbs Island, and dump the brine there without controversy.

However, Claus and USGS officials cite several documents suggesting that the irrigators ought to have been aware of the problems they were creating. For example, they quote a paper by U.S. Department of Agriculture scientists H. W. Lakin and H. G. Byers, "Selenium occurrence in certain soils in the United States," published in 1939, pointing out a "definite relationship" between selenium-loaded geologic formations and soils that produce disease in animals. The highest selenium concentration Lakin and Byers reported after sampling areas in seven states came from a spot in San Joaquin County called Hospital Creek, about 50 miles from Kesterson.

It now appears that selenium compounds are washed down from the edges of the valley and concentrated by irrigation in the "bathtub" beneath the fields. In the alkaline environment peculiar to this area, the selenium is mobilized in the water, taken up by algae, and bioaccumulated in the fish and waterfowl that eat the algae, magnifying the concentration 50 to 100 times.

None of this was known to BUREC, which built the San Luis irrigation unit and began delivering water in 1967 as planned. Construction of the drain did not begin until 8 years later. A segment 85 miles long ending near Kesterson had been completed by 1976 when funds ran out. Farmers to the north where the

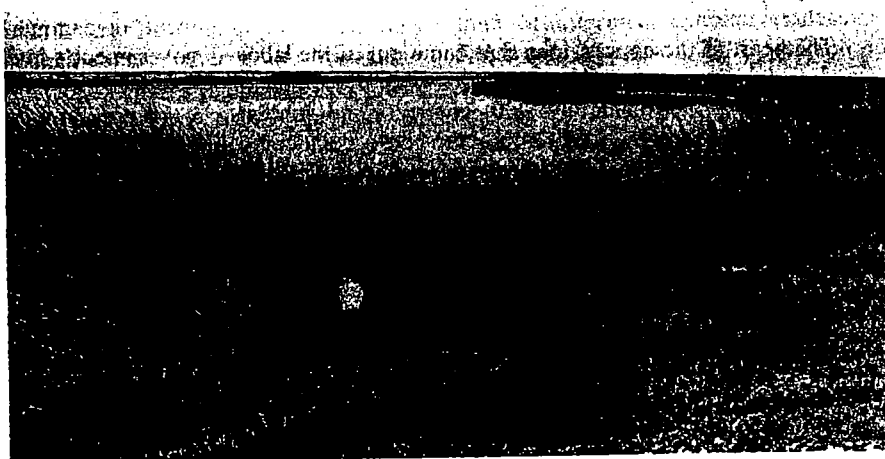
drain would end—in the U.S. congressional district of George Miller—were not eager to have the project finished. Environmentalists were opposed. Land and tax reformers described the drain as a subsidy to agribusiness. Congress never voted funds to complete the drain.

BUREC and the Westlands Water District, which had promised farmers it would ship the waste water out of their fields, decided to convert a "controlling reservoir" at Kesterson to a drain terminus and wildlife refuge. The drainwater began flowing in 1978. It was initially mostly surface runoff, but by 1981 farmers had connected their underground sump systems to the drain and the flow entering the refuge was undiluted bottom water, loaded with salt and selenium.

When the soup came to Kesterson, it

how big is the selenium problem outside Kesterson? (ii) what will it cost and what is the best way to clean up the refuge? (iii) how should drainwater be disposed of if it continues to flow? and (iv) how much irrigation is tolerable in the San Joaquin Valley? The last question is the most controversial and the furthest from solution. But it will be affected by answers to all the others, and particularly by still unpublished FWS and USGS data which suggest that the selenium problem may be widespread in the northern San Joaquin Valley. For this reason, BUREC is not signing new long-term water delivery contracts at this time.

Another little-studied point is the possibility that chemicals other than selenium may be causing toxic effects. The state water board noted that the Kester-



The Kesterson reservoir

came with a vengeance. By 1982, the striped and largemouth bass, catfish, and carp were gone. In 1983 the FWS saw a high incidence of death and deformities among newborn coots, grebes, stilts, and ducks, including embryos with twisted beaks, no eyes or wings, and brains protruding from the skull. The mosquito fish—the only fish left—contained the highest levels of selenium ever recorded by the FWS in live fish, 53 parts per million (ppm).

"We were alerted to the high levels of selenium in the water sometime in 1983," says Lawrence Hancock, assistant regional director of BUREC in Sacramento. He and director David Houston were installed last year and do not personally carry the burden of the San Luis decisions. Hancock considers it being a "Monday morning quarterback" to argue that BUREC should have known of the selenium hazard. "I've spent a lot of time reading through the records, and I cannot truthfully say I would have done anything differently."

The unresolved questions today are (i)

son water contained high levels of arsenic, boron, cadmium, chromium, and copper. Among the many groups investigating this pollution is a committee of the National Academy of Sciences; it has specifically expressed an interest in the heavy metals.

Felix Smith, an environmental analyst for FWS in Sacramento, estimated in a memo of 16 April that the volume of selenium-laden runoff in the Grasslands Water District—which surrounds Kesterson—could be much larger than the amount in the San Luis Drain. This wastewater has never been measured because farmers in Grasslands have the longstanding privilege of draining directly into the San Joaquin River. Water samples taken in the area indicate a high level of selenium, and one USGS sample taken from a Grasslands sump registered 4700 ppm, four times the level needed to qualify as a toxic dump. Birds in the area have shown high levels of selenium as well. "The entire Grasslands could become another Kesterson-type situation," Smith wrote.

"Kesterson was our canary in the cave," says William Davoren, another ex-official of the FWS who runs the one-man San Francisco Bay Institute. "Now the canary is dead, and the question is: are we going to do something about it, or keep on with business as usual?" Every big interest in the area has a right to fresh water, Davoren says, but not the Bay.

Because it lacks a claim to "beneficial use" in California's complex water code, it could become a common dumping ground.

Davoren sees Kesterson as a symbol of all that has gone wrong in 30 years of aggressive land and water exploitation in California. He thinks that big-scale farming in the San Joaquin Valley has

reached a turning point from which it may not recover.

These are the terms of a water contest that will preoccupy California's resource managers for a decade or more as they try to resolve the competing claims of a powerful farm lobby and an increasingly effective environmental movement.

—ELIOT MARSHALL

Polish Universities Face Crackdown

Despite protests at home and from abroad, the Polish government's drive to take control of the country's 99 universities is proceeding at a rapid pace. On the verge of abolishment are broad self-governing powers that were wrung from the government in 1980 in negotiations with Solidarity, the Independent Students' Union, and the teachers' union.

The heart of the concessions that came out of the labor and social unrest of the early 1980's was a system of elected university senates, faculty councils, and student groups. The government aims to scrap these democratic forums as early as this summer, sources say. Tiers of appointed officials whose political views mirror those of government leaders would take the place of elected university leaders. What remains to be seen is how harsh the government will be in tightening its grip on the academic community.

Polish officials are justifying their actions on the grounds that the management freedoms allowed university community are being abused. The political activism that has been permitted is incompatible with the goals of the socialist state, officials charge.

Not only are academic freedoms slated to be curtailed but the futures of at least several thousand academics and university staff members are at risk. The proposed changes in the university management system were unveiled by the Socio-Political Committee of the Council of Ministers in January. These proposals, which the Sejm (Poland's parliament) likely will enact this month, appear to impose tougher restraints on academia than were in place during the 1970's.

The Main Council for Higher Education and Research, the highest self-governing academic body in Poland, is expected to be rendered ineffective in influencing Polish education policy and university operations. Although the government's Minister of Higher Education, Benon Mikiewicz, has held a voting position on the council comprised of elected university professors, he not been able to dominate its affairs. Now his ability to dictate university policy will be fundamentally strengthened under the proposed changes.

University rectors, vice rectors, deans, and department heads currently are elected and report to university senates and department councils. The new rules, which amend the 1982 Law of Higher Education, empower the minister of education to select management personnel throughout the university system. This expanded authority extends to the review of university research projects, teacher selection, retention of tenure, and student organizations that until now have had a say in university affairs.

With the Polish government being the sole employer in the university arena, the clear implication is that academics must buckle under or lose their jobs, notes Letitia Rydjeski, a spokeswoman for the New York-based Committee In Support of Solidarity. But for those faculty members that are identified as sympathizers of the Solidarity movement, or campus activists, falling in step with the Polish government's latest dictates may not save their careers.

Indeed, there are ominous signs that the government wants to purge campuses of faculty and student activists. For example, State Department officials note that since October 1984 the number of political internees has risen from 22 to an estimated 185. There are reports of increasing numbers of professors, researchers, and other university faculty members being detained by Polish police for questioning, or arrested. During the height of the state's crackdown on the Solidarity movement in 1982, as many as 2000 Poles were jailed for political offenses. By last summer, all but 22 had been released by the government.

The number of scientists and university faculty who fail to pass the Polish government's litmus test for loyalty could run into the thousands. This may be best measured by what happens at four larger universities that are strongholds of resistance to the clampdown on academic and civil freedoms in Poland: Adam Mickiewicz University in Poznan, the University of Warsaw, Jagielonian University in Krakow, and Boleslaw Beirut University in Wroclaw. A poll conducted by *Pygodnik Mazowsze*, an underground newspaper at Adam Mickiewicz University, indicates that only 20 percent of the faculty support the government's sweeping changes.

At this point there appears to be little chance of dissuading the Polish government from instituting its plan. The Main Council for Higher Education and Research has protested the changes, 2000 students in Warsaw have openly demonstrated against it, and 150 academics in the United States have written the Polish government. But there are no signs of any moderation in course. "The government does not seem to be taking the West's opinion into regard," says Rydjeski.

The prospect of the U.S. government having any influence on the outcome is even bleaker, State Department officials concede. "We don't really have very much leverage," says one official, noting that U.S.-Polish relations are at an all time low. In the meantime, should the coming crackdown on academic freedoms produce a flood of refugees from the Polish university community, State Department officials say they will try to adjust immigration ceilings to accommodate those who seek to come to the United States. —MARK CRAWFORD

Crisis at Kesterson

*Away, birds, away!
Take a little and leave a little,
And do not come again;
For if you do,
I will shoot you through,
And there will be an end to you.*
—Mother Goose

by Keith Schneider

Until two years ago, few Californians paid much attention to the Kesterson National Wildlife Refuge—5,900 acres of tangled tule reeds and dark lagoons just north of the tiny farm community of Los Banos—except hunters. Like California's nine other waterfowl refuges, Kesterson served as a stopover and wintering ground for swarms of migrating ducks and geese on the Pacific Flyway. Every autumn, members from neighboring duck clubs hid in the marsh grass, waiting to shoot down fat mallards and pintail ducks swooping in from Canada.

Now Kesterson is a regular source of front-page news across California. The refuge, fed by drainage water from thousands of acres of cropland west of the San Joaquin River, has been transformed into a lethal experiment, testing the tolerance of wildlife to dangerous metals and toxic salts. And the only live rounds fired at the contaminated refuge come from the guns of the U.S. Fish and Wildlife Service employees who regularly sacrifice black and white coots that are too sick to fly.

Since last October, a team of rangers has patrolled Kesterson, armed with live ammunition, shell crackers, and propane exploders in a dawn-to-dusk mission to scare waterfowl from 1,200 acres of evaporation ponds located along the refuge's southern perimeter. From afar, the steady pounding of the exploders and shotgun concussions sounds like a scene from "Apocalypse Now."

Keith Schneider is editor of *News West*, an independent news service in Sacramento, and a regular contributor to THE AMICUS JOURNAL.

"I know veterans around here must think they're reliving Khe Sanh," says Walt Hammond, the 31-year-old supervisor of the hazing project.

Indeed, Kesterson has turned into an ugly and unusual biological battlefield. But it is by no means an isolated skirmish. State lawmakers, federal researchers, and leading environmentalists agree that Kesterson has become a prominent symbol of a huge government-financed irrigation project and a system of industrialized farming that has gone awry. Further, these authorities agree that the choices for solving the toxic crisis will be difficult and costly.

Kesterson represents the end of an era when the government encouraged unlimited growth for irrigated farming. It is a turning point as significant to agriculture as Three Mile Island was to nuclear power, or Love Canal was to hazardous wastes. Across California, and the rest of the arid West, the water that helped deserts bloom during the last three decades is now threatening to make much of the land worthless again. The crisis at Kesterson has forced the Interior Department and the U.S. Fish and Wildlife Service to send teams of researchers into the field in ten states to look for evidence that migratory birds are suffering the same sort of poisoning at other refuges.

Last March, Interior Secretary Donald Hodel ordered the Bureau of Reclamation to stop supplying irrigation water by July 1986 to fifty-three huge farms that drain into Kesterson. Hodel said the poisoning of ducks and geese violated terms of the Migratory Bird Treaty Act that the United States has signed with Mexico and Canada. Said James Bartonek, a U.S. Fish and Wildlife Service official, "California is the key winter habitat for birds on the Pacific Flyway. And it has

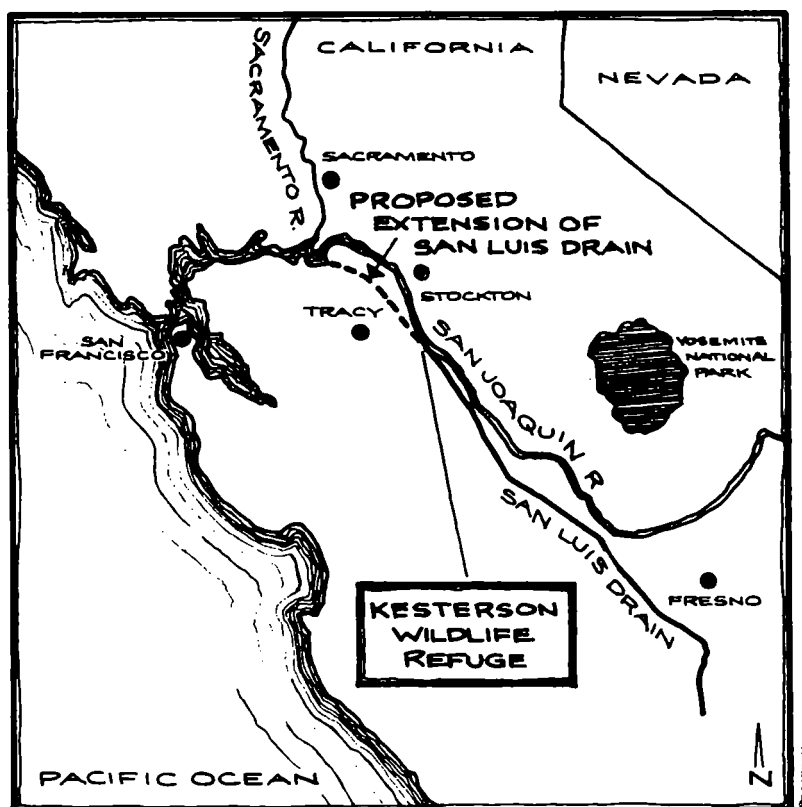
ronmental emergency that threatens to become much worse.

The Kesterson crisis has its roots in geologic time. When the High Sierra and Coast Ranges formed some 60 million years ago, the Pacific Ocean evaporated, and the San Joaquin Valley basin slowly dried. East of the San Joaquin River, erosion from the Sierras brought clean soil. East side farmers had little trouble earning a living as they diverted Sierra streams and produced record harvests on some of the planet's most fertile soil.

But on the west side of the valley, the Coast Range emerged from the sea floor leaving huge deposits of salts and minerals in the soil. Nature further hindered development of the west side by placing a thick, impermeable layer of clay beneath the surface. Much of the region receives less than ten inches of rain each year, not nearly enough to flush away toxic elements, or to cause the clay barrier to begin trapping water. From the beginnings of this century, hardy farm families have eeked livings from the parched soil by raising cattle and growing crops that required little water. Some drilled wells, but by the early 1930s the underground aquifers yielded only brackish water unfit for irrigation.

If farmers were to continue farming the west side, they would need help. Fifty years ago, during the height of the New Deal construction boom, the Bureau of Reclamation authorized the start of one of the most ambitious engineering projects in history—California's Central Valley Project. More than \$2.5 billion later, the project's sixteen dams, eight major canals, two tunnels, and six generating stations trap water that first fell as snow in northern California's High Sierra and transport it hundreds of miles south where it is sprayed across the fields by huge wheeled sprinklers.

Though the project brought wealth, it also created hydrologic headaches. First, the irrigation water dissolved salts and minerals. Secondly, the clay barrier acted like the bottom of an immense tub, trapping billions of gallons applied to the surface. In many areas, it would be only a matter of years before the water would rise to the



root zones and drown crops. What was needed was a primary drainage system.

In the mid-sixties, Interior officials proposed building a 207-mile-long canal to carry waste water from the San Joaquin Valley north to the Sacramento River Delta where it would eventually empty into San Francisco Bay. Federal scientists argued that sea water would render the waste water harmless.

In 1970 construction began on the master San Luis Drain, which would sweep away subsurface drainage water from nearly one million acres. But by 1975, with only 82 miles of the project completed, the money ran out. The canal now would drain directly into the Kesterson Refuge, where engineers had designed a dozen 100-acre evaporation ponds to regulate the flow.

For six years there were no problems at Kesterson. The refuge was fed small amounts of drain water diluted by larger doses of fresh surface water. In 1981, however, the fresh water supply was turned off as farmers required larger quantities, and the refuge's sole source of water came from subsurface runoff from 8,000 acres just south of Los Banos. It was not long before strange biological events began to occur.

Since 1919 federal scientists have been aware

changed more drastically than any other place on the West Coast. Once there were 5 million acres of wetlands in the state. Now there are less than 300,000. I don't think anything has had the long-term effect on waterfowl that can compare with the loss of wetlands in California."

Farmers reacted bitterly, warning that Hodel's decision would leave them in ruins. Leaders from farming communities in Merced and Fresno counties complained that idling thousands of acres would triple unemployment in their areas and lead to widespread business bankruptcies. Bank officials feared that farmers would stop paying back their loans, possibly causing lending institution failures in the San Joaquin Val-

multi-billion dollar bill to pay for a Kesterson cleanup or to build a system for purifying agricultural drainage water. "Requiring taxpayers to finance the cleanup would be a terrible precedent," said Albert Meyerhoff, an attorney with the Natural Resources Defense Council in San Francisco. "The contamination was caused by private farm interests and any cleanup should be paid for by private farm interests." In February, NRDC filed suit with the Consumers Union and California Rural Legal Assistance Foundation against the California State Water Resources Control Board seeking closure and immediate cleanup of Kesterson Reservoir.

For months, the blame for the Kesterson crisis



Kesterson Wildlife Refuge. (Insert) U.S. Fish and Wildlife Service ranger scaring waterfowl from the refuge.

ley. "We're all hanging way out there right now," said Ken Billings, president of the Federal Land Bank Association of Fresno.

So far the Interior Department has stuck to its decision and may extend it to tens of thousands of additional acres. California farmers may be forced to stop growing \$500 million worth of vegetables, grain, and cotton on a Rhode Island-sized stretch of salt- and mineral-laden cropland requiring drainage. "Never in my wildest dreams did I ever imagine that one day we would be considering taking half a million acres of some of the richest land on earth out of production," said Congressman Tony Coelho.

Moreover, taxpayers may be asked to foot the

has ricocheted between Sacramento and Washington. The Interior Department has pledged \$43 million for studies proposing solutions. The California Legislature is considering a bill that would provide up to \$17 million for state studies. Most observers expect farmers whose land drains into Kesterson to seek an extension on the Interior Department's July 1986 deadline. Few believe an extension will not be granted.

Still, all the hand-wringing does nothing to reduce the threat to wildlife, public health, or California farmers. The truth is that a sizeable portion of California's farmland is loaded with dangerous salts and minerals. Kesterson is simply the first dramatic indication of an envi-

that farming the west side of the San Joaquin Valley would result in toxic contamination. Yet the issue received scant bureaucratic attention until the spring of 1983 when biologists with the U. S. Fish and Wildlife Service checked 350 nests of coots, grebes, and other ducks at Kesterson and discovered the refuge had become an avian death trap. Says Harry Ohlendorf, a federal biologist who led the nesting survey, "We were looking into eggs and seeing things we'd never seen before."

Scientists found hatchlings and embryos without eyes, feet, or wings. Many were missing all or parts of their beaks. In some chicks, brains had pushed through the skulls. In birds the natural deformity rate is 1 percent. In Kesterson, the deformity rate in some species was 42 percent. The breeding failures were without precedent in the nation's 90-million-acre refuge system.

Adult birds suffered as well. Each day dozens of bloated carcasses were found floating in the

refuge's tea-colored waters. And crayfish, snakes, muskrats, and raccoons that once flourished here had vanished. In short, the Kesterson Refuge had become a place that killed the animals it was supposed to protect.

Further research identified the principal culprit. It was the element selenium, a salt that had leached from the fields and drained into Kesterson. A necessary dietary constituent at levels in the parts-per-billion range, selenium becomes a murderous toxic contaminant at higher levels. (Breast tissues from adult coots tested at Kesterson contained selenium levels between 3 and 9.5 parts per million.) Scientists believe selenium causes deformities and death by interfering with the ability to synthesize oxygen. In developing chicks, selenium poisoning causes the growth systems to shut down, while in adult birds, the primary symptom is muscle cell deterioration.

Faced with a degree of widespread contamination not seen since the DDT emergencies of

The end of the San Luis Drain that brings agricultural water to Kesterson.



the 1960s, decision makers have been huddling with scientists for months to come up with workable solutions. Most show little promise. The Bureau of Reclamation, for instance, still wants to add the 125 missing miles to the San Luis Drain at a cost of at least \$1 billion. The project requires the approval of the state Water Quality Control Board. Political opposition from powerful Bay Area lawmakers, who fear the drain water's toxicity will threaten declining aquatic life in San Francisco Bay, will almost certainly prevent the federal government from moving ahead with the plan. "I can assure you that we will join in manning the barricades if the drain goes into San Francisco Bay," state Senator Milton Marks told a Bureau of Reclamation official in hearings late last year.

U.S. Senator Pete Wilson, a Republican from San Diego, has proposed building a pipeline from the San Joaquin Valley to oil development lands in southern California, where the drain water would be converted to steam and used to help oil companies extract crude from older wells. Studies are underway to assess the feasibility of the idea. Again, state lawmakers are not enthusiastic. They see no sense in transporting one area's problem to another region.

POEM OF THE TOWHEE

by Brendan Galvin

Peripheral leaf-shufflers,
they're a black stroke of
the Japanese brush
over a reddish, quietly
passionate streak.
This one has bunted the window
all spring, baffled by glass,
and now, over my head,
a gray, humped spider has set up
like a text creeper
before the poem the towhee
printed there in accents
grave and acute, in characters
beyond any translation.



Dudley Silveira of Mendota whose land drains into the Kesterson Refuge.

The state is busy experimenting with a small purification plant near Los Banos, and the federal government is building a similar plant in Arizona. But the purification system has proven to be unreliable. The semipermeable membranes used to extract minerals and salts are still too fragile to be of much use. Moreover, the cost of building plants big enough to handle waste water draining from more than 500,000 acres will run into the billions of dollars.

Some of the wealthier farmers and agribusiness corporations would like to build drainage ponds on their land. State water authorities are not promoting this approach. Last year the Legislature enacted a new toxic waste cleanup law requiring hazardous waste pits to be double-lined and continuously monitored for leakage. The state Water Resources Control Board, in a draft study, has classified the Kesterson drainage ponds as hazardous waste pits, and would put private drainage ponds under the same heading. In addition, the state Department of Fish and Game and the U.S. Fish and Wildlife Service fear that the ponds would attract waterfowl and become mini-Kestersons.

Researchers at California's three major agricultural universities have been urged to step up their work in developing new varieties of salt-

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resistant crops that can be grown with minimal moisture. But plant geneticists and biologists say this work is still years away from field testing.

In effect, no feasible solution has yet appeared, except for taking cropland out of production. This approach has incensed farm interests, one of California's most powerful political lobbies. As a result, state and federal agencies are adopting a wait-and-see attitude. They are waiting for new studies. And they are seeing if the contamination will spread beyond Kesterson. There are strong indications, however, that the poison has moved into other areas. Near Kesterson, in an even larger refuge known as the Grasslands, scientists have identified worrisome levels of selenium and heavy metals in water draining into the area. Similar examples of birth deformities and adult waterfowl deaths have recently begun to occur.

Should the Interior Department abide by its deadline for halting the flow of irrigation water and plugging the drains leading to Kesterson, farmers say they would continue to work the land until they were forced to abandon it. This pattern may be repeated across the San Joaquin Valley as heavily irrigated land causes more salts and metals to leach away, forcing the govern-

The Interior Department has begun drilling wells around the refuge to monitor for leakage from drainage ponds.



Keith Schneider



Keith Schneider

Ranger examining dead coot.

ment to shut off the water supply. An Interior Department study published last year says that between 500,000 and 900,000 acres of west side farmland will need drainage, most of it within the next two decades. If the government turns its irrigation channels into empty ditches, almost \$2 billion worth of acreage would be rendered worthless for farming, between \$500 million and \$1 billion in annual farm income would vanish, and 20,000 workers would be out of jobs. The massive economic dislocation would swamp banks that have billions of dollars in outstanding farm loans, and strike with equal devastation everything from grocery stores to seed merchants to farm machinery outlets.

That prospect has alarmed many San Joaquin Valley residents. But it may be the only way to halt the spread of even more dangerous toxic contamination. The Kesterson crisis represents the first time the government has decided to reduce the irrigated land base, perhaps ultimately by hundreds of thousands of acres. Agricultural decline, not growth, is going to become a much more familiar process in California and throughout the West. It is going to take some time before state lawmakers get used to this new reality. And it may take years before they can come up with sensible plans to lessen the dramatic economic dislocations that will occur. □



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June 27, 1990

Washington, D.C. 20540

To : Honorable Albert Gore, Jr.
Attention: Rick Adcock

From : Betsy A. Cody
Analyst in Natural Resource Policy
Environment and Natural Resources Policy Division

Subject : Central Valley Aquifer System

I am sending the attached summary sheet in response to your request for information on the Central Valley Aquifer System in California. Please let me know if you need any thing else (7-7229).

**PHOTOCOPY
PRESERVATION**

CRS-2

*Update
coming*

CENTRAL VALLEY AQUIFER SYSTEM

Size: 20,000 square miles

Volume: *800,000,000 acre-feet*

Annual withdrawal: USGS estimates an average of 12 million acre feet (maf) during the mid-1970s; an average of 11 maf per year 1961-1977, with a high of 15 maf during the drought year of 1977. (64 maf have been permanently withdrawn since development nearly 100 years ago.)

PHOTOCOPY
PRESERVATION

Water levels have dropped nearly 400 feet in some areas. Additionally, storage capacity has declined in some areas. As water is withdrawn, sediments are compressed, limiting the aquifer's carrying capacity.

Annual recharge rate: USGS estimates that nearly 11 maf are returned to the aquifer each year, resulting in an average annual overdraft of approximately 1 maf. (Irrigation runoff and seepage accounts for 80% of this recharge, according to USGS.) Another source estimates that the overdraft may be as large as 20%. A factor that makes such estimates difficult is that some entities have been artificially recharging the aquifer since the 1920s.

The Central Valley Aquifer system is made up of a series of aquifers. It varies in thickness (water mixed with gravel and sand deposits) and distance from the surface. As with the Ogallala, recharge rates vary significantly throughout Central Valley. Overall, recharge rates are much higher than the Ogallala.

Water use: Primarily used for irrigation (88.4% in 1985); 8.6% used for public supply; 2.4% used for industrial and mining purposes; .5% used for domestic and commercial; and .1 percent thermoelectric power. One source estimates that nearly 10 million acres are irrigated with Central Valley groundwater.¹

¹ Mohamed T. El-Ashry and Diana C. Gibbons, eds. *Water and arid lands of the western United States*. "The Central Valley of California," by Charles V. Moore and Richard E. Howitt. A World Resources Institute Book. New York: Cambridge University Press, 1988. pp. 85-105.

CRS-3

Water Quality: The water quality in the Central Valley aquifer is suitable for most purposes. However, salinity and contamination from agricultural and other sources are growing problems in some areas. Selenium contamination is especially a problem in portions of the San Joaquin Valley. (See related articles on Kesterson Reservoir contamination).

Other: Land subsidence is widespread due to groundwater pumping in the Central Valley. Nearly 5,000 square miles have dropped by one foot or more since subsidence was noticed in the mid-1920s. In addition to shrinking the carrying capacity of the aquifer, land subsidence is damaging irrigation canals, roads and buildings.

Sources: U.S. Department of Interior, U.S. Geological Survey. *National Water Survey 1984*. Washington DC: U.S. Govt. Printing Office, 1985; U.S. Department of Interior, U.S. Geological Survey. *National Water Survey 1987*. Washington DC: U.S. Govt. Printing Office, 1990; and Mohamed T. El-Ashry and Diana C. Gibbons, eds. *Water and arid lands of the western United States*. "The Central Valley of California," by Charles V. Moore and Richard E. Howitt. A World Resources Institute Book. New York: Cambridge University Press, 1988. pp. 85-105.

PHOTOCOPY
PRESERVATION

Urban, Rural Interests at Odds as California Thirsts for Water

By Jay Mathews
Washington Post Staff Writer

LOS ANGELES—California's worst drought in 60 years has cut water use in so many neighborhoods that officials have begun to fear a new political war between grimy suburbanites, irritated by brown lawns and short showers, and the agricultural industry, which uses more than 80 percent of available water.

In a period of rapidly changing attitudes toward water's role in the Southwest's economic and population boom, some urban politicians are demanding cuts in agricultural use. Southern California's leading water agency has signed a landmark agreement to pay for conservation measures in one farming district and send water saved to urban customers.

"If all the urban areas and all the business areas cut water use by 25 percent, it would be equal to agriculture cutting use by only 3 percent," said Assemblyman Phillip Isenberg (D-Sacramento), advocating an urban uprising against rural water waste.

"This may be one of the few issues in life where, if the public understood that simple fact, the dynamics of the situation would radically change."

Such talk enrages and sometimes frightens farmers and professional water managers who see California's \$16 billion annual agricultural production as proof of the wisdom of multibillion-dollar water projects that have turned deserts such as the Imperial Valley into huge fruit and vegetable gardens.



Irrigation ditches feed California's Imperial Valley, but a water shortage has caused some urban politicians to demand cuts in agriculture's large share of water.

Lois Krieger is chairman, as her father was, of southern California's principal water agency, the Metropolitan Water District (MWD). She said she sees "tremendous potential" for demagoguery in arousing urban residents against farmers. "There are people who, if it is possible to divide the state politically on this, would be most happy to do so."

The MWD has moved to ease the pressure by signing a \$220 million conservation agreement with the Imperial Irrigation District, responsible for the now-fertile desert valley near the Mexican border.

The MWD agreed to finance new flow-regulating reservoirs and improved canal lining, and provide more flow monitors, in return for the 106,000 acre-feet of water that would be saved annually. That is

enough to meet residential water needs of more than 200,000 families.

Water managers throughout the state have applauded the agreement. Some expressed fear that, without such measures, water-short cities in the future may be forced to buy up farmland for water allotments, reducing the crop acreage and sending food prices up.

Bob L. Vice, president of the 85,000-member California Farm Bureau Federation, said growers are conserving water. "Every year, we have more places using low-flow and drip irrigation," he said. Federal water price subsidies are about to expire in many parts of the San Joaquin Valley and farmers such as Vice, who pays 10 times the average California water price to irrigate his citrus and avocado ranch

near San Diego, said they cannot profit unless they conserve.

Many urban and suburban skeptics remain. "Irrigated pasture land has very little value," said Tim Brick, an MWD board member who lives in thickly populated Pasadena, "yet we use as much water for pasture land as we use in the homes of all the people in the state."

Few experts have expressed doubt about the seriousness of the current drought, although its full impact has yet to be felt in southern California because water remains in MWD's many reservoirs.

A spokesman for the state drought center said that, with the rainy season ended, the state has received only 65 percent of average precipitation, making this the driest of the four consecutive drought years. Al-

ready 400 local water agencies have imposed restrictions, and more are expected if abundant rain and snow do not come this fall and winter.

Water allotments to agriculture from the state aqueduct have been reduced severely, but many can make up the difference by pumping more ground water at higher cost.

Hardest-hit residential areas have been first to complain that agriculture is hogging the water. In Santa Barbara, where some homeowners are having their dry lawns painted green, a Santa Barbara News-Press editorial called for more water restrictions on local farms, saying:

"It is simply in the best interests of the entire county—and therefore incumbent upon the board of supervisors to insist—that farmers and ranchers come under the same

scrutiny as do the rest of the country's water consumers."

Isenberg, representing northern Californians, forecast a healing of the longtime north-south split on water issues. In an article in the San Diego Union, he told southern California readers that he would not mount the usual northern attack on southerners "for taking water from the north only to wash [their] cars, hose down [their] sidewalks and fill [their] swimming pools" because "I know better: Very little of the water that's diverted from the north ends up in southern California; most goes to agriculture in the San Joaquin Valley."

He went on to recite provocative statistics from Marc Reisner, author of the book "Cadillac Desert." "Alfalfa . . . uses the same amount of water that is used by all of the people in both the Los Angeles area and the San Francisco Bay area," Isenberg said. "Two other crops, cotton and rice, use enough water for 25 million people," more than 80 percent of the state's population.

To water officials who have spent their careers helping agriculture to grow, such reasoning ignores the intermingling of residential and farm interests. "They sit there wearing a cotton shirt and complain about agriculture using all the water," said Cliff Trotter, engineer-manager of the Arvin-Edison Water Storage District in the San Joaquin Valley.

Many farmers and water managers want the state to spend more on reservoirs and pumps to capture and divert the northern California runoff that still flows unused into the ocean.

But to do that, many acknowledge, they must convince skeptical city dwellers that they have not wasted what they have. "Conservation has to become our lifestyle in this state," Krieger said.

Reform Branch of J. C. A. I. S. Welcomes Gay, Lesbian, & Ceroy

CENTRAL VALLEY AQUIFER SYSTEM

Size:	20,000 square miles
Volume:	800 million acre feet (maf) in upper 1,000 feet of aquifer. (1987 estimate of what was economically feasible to recover.)
Annual withdrawal:	USGS estimates an average of 12 maf during the mid-1970s; an average of 11 maf per year 1961-1977, with a high of 15 maf during the drought year of 1977. (64 maf have been permanently withdrawn since development nearly 100 years ago.) Water levels have dropped nearly 400 feet in some areas. Storage capacity has declined in some areas due to sediment compression. USGS estimates that total storage capacity has been reduced by 15 maf.
Annual recharge rate:	USGS estimates that nearly 11 maf are returned to the aquifer each year, resulting in an average annual overdraft of .8 - 1.3 maf. (Irrigation runoff and seepage accounts for 80% of this recharge, according to USGS.) Artificial recharge of aquifer has been taking place since the 1920s and is still practiced in some areas. The Central Valley Aquifer system is made up of a series of aquifers. It varies in thickness (water mixed with gravel and sand deposits) and distance from the surface. As with the Ogallala, recharge rates vary significantly throughout Central Valley. Overall, recharge rates are much higher than the Ogallala.
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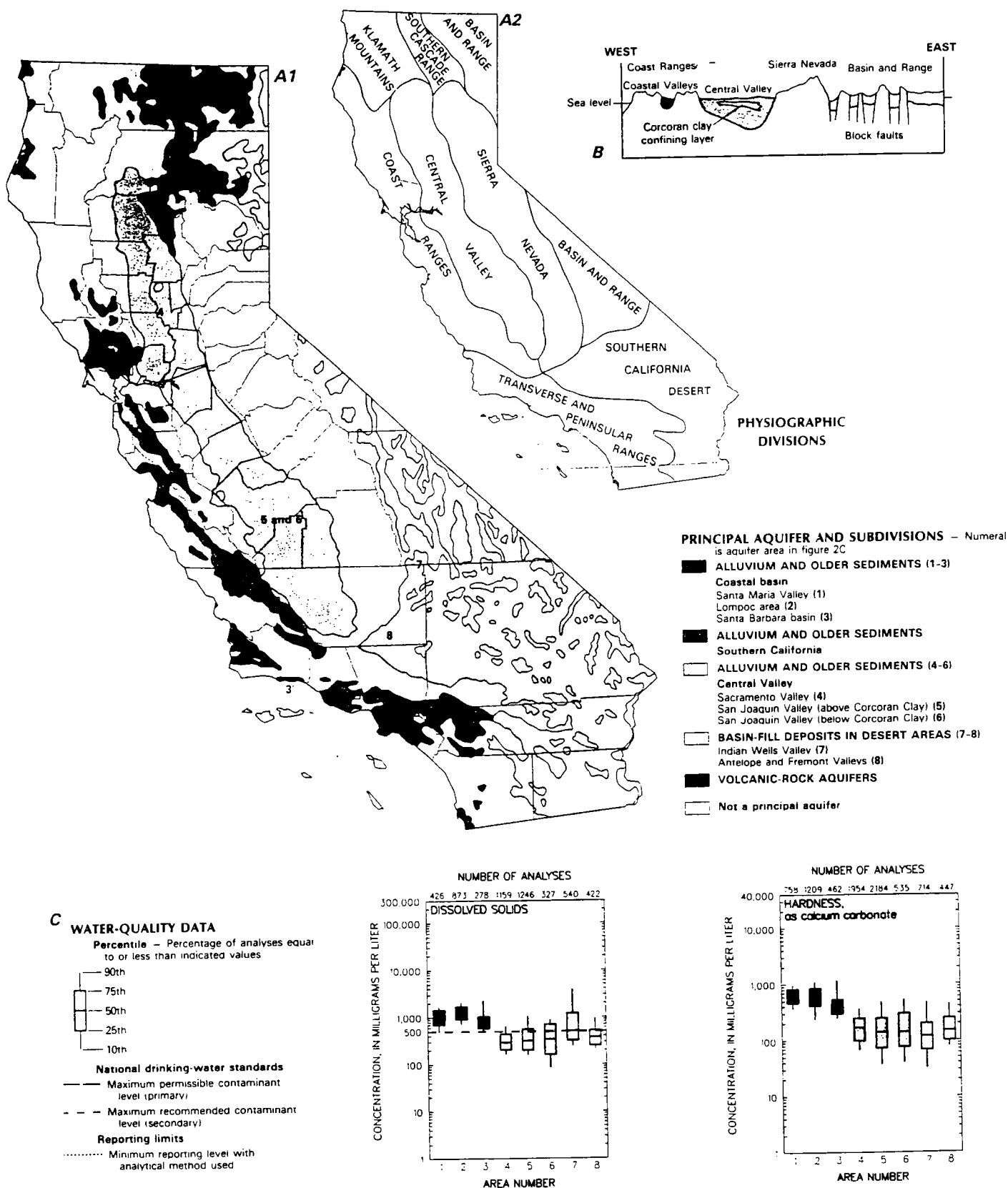


Figure 2. Principal aquifers and related water-quality data in California. A1, Principal aquifers; A2, Physiographic provinces. B, Generalized geologic section. C, Selected water-quality constituents and properties, as of 1986. (Sources. A1, California Department of Water Resources, 1975c, 1980a. A2, Fenneman, 1946. B, Compiled by A.M. Speiker from U.S. Geological Survey files. C, Analyses compiled from U.S. Geological Survey files; national drinking-water standards from U.S. Environmental Protection Agency, 1986a,b.)

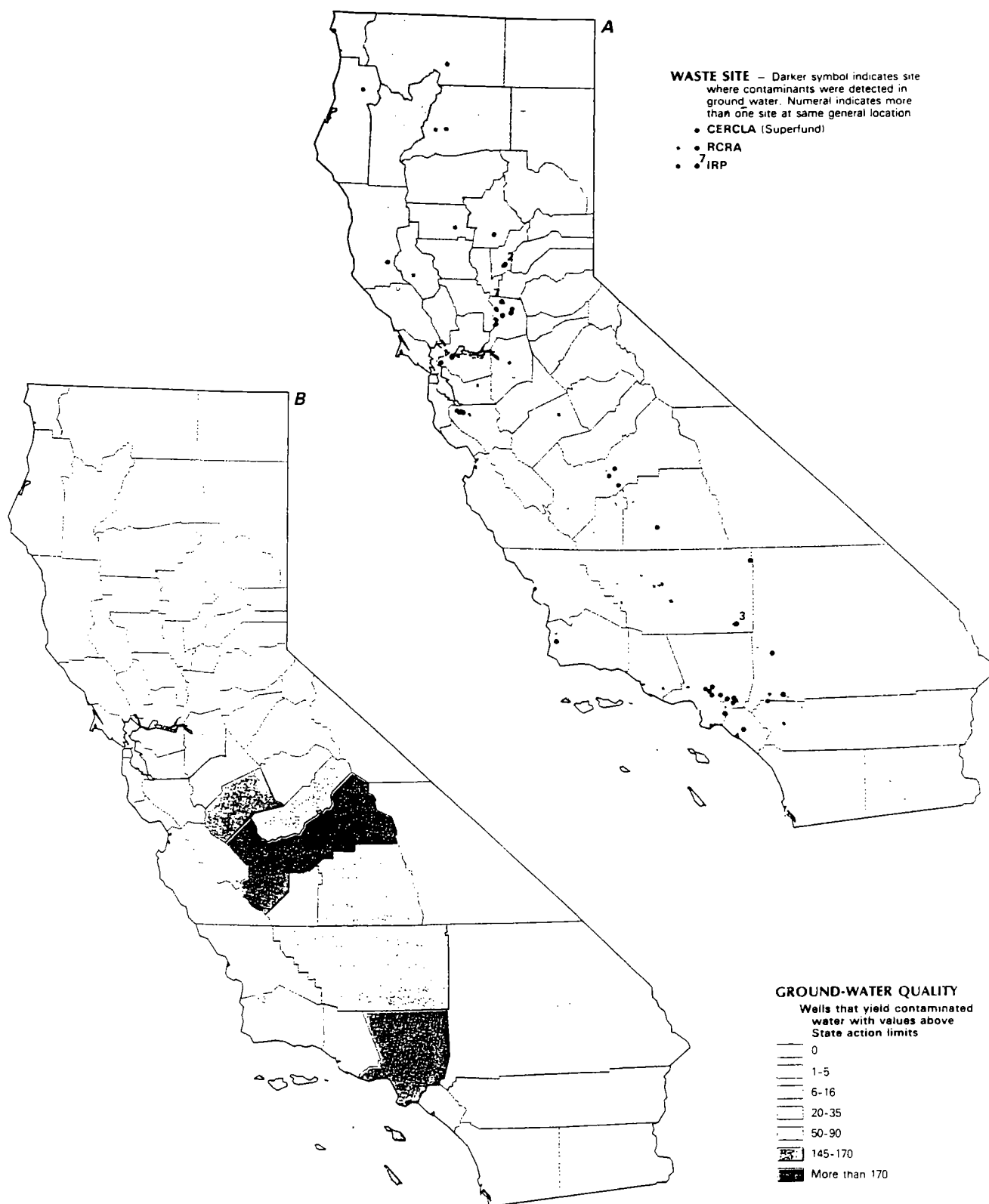


Figure 3. Selected waste sites and ground-water-quality information in California. A. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites, as of 1986; Resource Conservation and Recovery Act (RCRA) sites, as of 1986; and Department of Defense installation Restoration Program (IRP) sites, as of 1985. B. Distribution of wells that yield contaminated water, as of 1986. C. County or municipal landfills, as of 1986. (Sources: A, U.S. Department of Defense, 1986; information from Environmental Protection Agency and California State Water Resources Control Board. B, Cohen and Bowes, 1984; California Department of Health Services, 1986; and information from California Regional Water Quality Control Boards. C, information from California Waste Management Board.)

Selenium Poisons Refuge, California Politics

Drainage from the San Joaquin Valley has dumped selenium into a wildlife refuge and pitted two federal agencies against each other

Palo Alto, Calif. Four years ago, the San Luis Drain began to carry undiluted sump water from farms in the San Joaquin Valley northward to a marsh about 130 miles below San Francisco. The place at the end of the drain is called the Kesterson National Wildlife Refuge. Overnight, it was transformed from a refuge into a death trap for several species of fish and migratory birds.

The toxic agent is selenium, an element that abounds in the soil of the Central Valley. A small amount of selenium in the diet is beneficial, but high levels have caused cancers in laboratory animals and other problems in farm animals.

It is clear now that the drainwater threatens wildlife over a broad area, the wintering ground for migratory birds in the Pacific flyway. In addition, it has raised the possibility that selenium and heavy metals may have leaked into the Central Valley's deep aquifer.

The crisis came to a head on 15 March at an emotional hearing near Kesterson chaired by Representative George Miller (D-Calif.), the pro-environment chairman of the House subcommittee on water and power resources. At that meeting, the regional Department of Interior chief, Carol Hallet, acting on instructions from Secretary Donald Hodel, promised that the drainage would be stopped immediately.

Farmers of 42,000 affected acres claimed they would be driven out of business. Ultimately the problem could affect several hundred thousand acres of highly profitable (and federally subsidized) farms in the San Joaquin Valley.

Two weeks after the Miller hearing, the department signed a compromise with farm interests that gives them until 1986 to stop the pollution. It also promised to supply irrigation water indefinitely "into the future."

Interior sits at the center of the problem because it helped build the drain. The Environmental Protection Agency has not been involved because an amendment to the Clean Water Act backed by farmers in 1977 exempts agricultural runoff.

Everyone is waiting to see what will happen. The first federal deadline (20 percent less drainwater by 30 September) will come at the end of the summer irrigation season. Reductions of 20 percent will be made every 2 months until total stoppage is reached by 30 June 1986.

Meanwhile, the Interior Department has promised to have ready by 5 July a plan for cleaning Kesterson. The Westlands Water District, which is dumping the toxic water, has pledged to modify its system and send the waste water into yet-unbuilt evaporation ponds further south. Critics call it the "mini-Kestersons" option. But Westlands officials say they will make the new ponds sterile so that birds will not get toxic food from them.

There is no evidence that drinking water has been affected, but children and pregnant women have been warned not to eat birds from the polluted area. Most severely at risk, according to one observer, are Southeast Asian highlanders (the Hmong) who settled near Kesterson after fleeing the communist takeover in Vietnam.

Three key players are sister agencies in the U.S. Department of the Interior: the Bureau of Reclamation (BUREC), builder of the irrigation and drain systems; the Fish and Wildlife Service (FWS), entrusted with protecting the wildlife and comanager of Kesterson with BUREC; and the Geological Survey (USGS), which has been called upon to settle points disputed by the others. The disagreement between BUREC and FWS has been acrimonious, and several FWS officials accused BUREC and its agribusiness clients of trying to quash dissent and bury data.

One retired 33-year FWS veteran, former California area manager William Sweeney, gave a blistering talk on this subject last fall. He charged that the Central Valley Water Project has brought about "unparalleled destruction" of migratory birds and fish and "turned the San Joaquin River into the lower colon of California—a stinking sewer contaminated with salts, heavy metals, trace elements, and the residue from the annual applications of hundreds of tons of insecticides, herbicides, and fertilizers."

Sweeney mentioned the plight of the salmon in the San Joaquin. Their numbers have declined in 30 years from 100,000 to 5,000 or 10,000, "mostly supported by hatcheries, with no natural spawning in the San Joaquin itself." Other species standing in the way of development may have the same fate. Sweeney said, unless citizens sue to make federal agencies enforce wildlife protection laws.

This is just what happened at Kesterson. A local rancher and duck club owner, R. James Claus, tipped the first domino in the cascading legal actions that forced the Interior Department's hand. Claus knew that his cattle were sick and, when he learned of the selenium problems at Kesterson, he began to file appeals to stop the waste water dumping. He accused the Interior Department of violating the Migratory Bird Treaty Act, which forbids the killing of migratory birds. The state water board was persuaded to intervene (after the regional board would not) on grounds that Kesterson qualified as an unregulated toxic dump. Both Claus and Lloyd Carter, a reporter who has covered Kesterson in the *Fresno Bee*, say they have received



San Luis Drain

anonymous threats, presumably from local farmers who fear the loss of BUREC water.

BUREC and California farmers planned the San Luis Drain in the 1950's as a small but necessary part of a new water supply leg in the Central Valley, called the San Luis Unit. As early as 1951, farmers knew that the irrigation wells they had drilled in the west side of the valley were running dry. They also knew the San Luis water project would have to include a drain to carry off minerals that were collecting in the root beds. Underlying the west valley is a thick zone of clay that effectively creates a bathtub beneath the fields. A steady flow of fresh water is needed to flush out harmful sediments (mainly salt). Gravity takes the drainwater north toward San Francisco Bay.

In recent testimony, BUREC officials have said they were not aware that irrigating the valley's west side would create any long-term problems other than the buildup of common salt. They expected to build the San Luis Drain all the way to the head of the San Francisco Bay, in the delta at Chubb's Island, and dump the brine there without controversy.

However, Claus and USGS officials cite several documents suggesting that the irrigators ought to have been aware of the problems they were creating. For example, they quote a paper by U.S. Department of Agriculture scientists H. W. Lakin and H. G. Byers. "Selenium occurrence in certain soils in the United States," published in 1939, pointing out a "definite relationship" between selenium-loaded geologic formations and soils that produce disease in animals. The highest selenium concentration Lakin and Byers reported after sampling areas in seven states came from a spot in San Joaquin County called Hospital Creek, about 50 miles from Kesterson.

It now appears that selenium compounds are washed down from the edges of the valley and concentrated by irrigation in the "bathtub" beneath the fields. In the alkaline environment peculiar to this area, the selenium is mobilized in the water, taken up by algae, and bioaccumulated in the fish and waterfowl that eat the algae, magnifying the concentration 50 to 100 times.

None of this was known to BUREC, which built the San Luis irrigation unit and began delivering water in 1967 as planned. Construction of the drain did not begin until 8 years later. A segment 85 miles long ending near Kesterson had been completed by 1976 when funds ran out. Farmers to the north where the

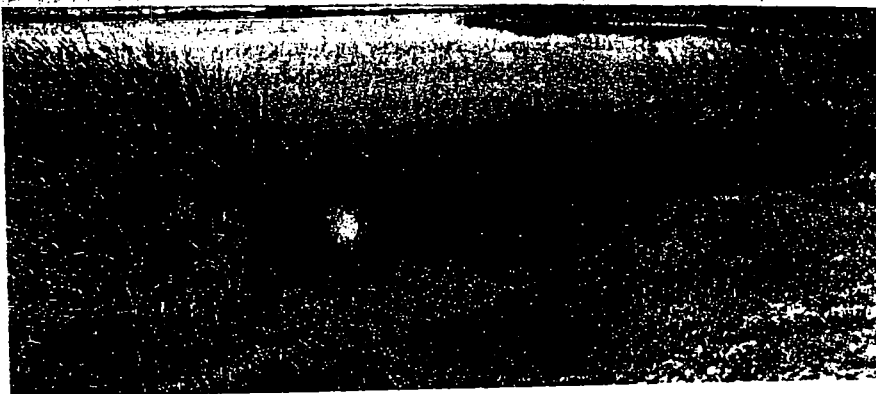
drain would end—in the U.S. congressional district of George Miller—were not eager to have the project finished. Environmentalists were opposed. Land and tax reformers described the drain as a subsidy to agribusiness. Congress never voted funds to complete the drain.

BUREC and the Westlands Water District, which had promised farmers it would ship the waste water out of their fields, decided to convert a "controlling reservoir" at Kesterson to a drain terminus and wildlife refuge. The drainwater began flowing in 1978. It was initially mostly surface runoff, but by 1981 farmers had connected their underground sump systems to the drain and the flow entering the refuge was undiluted bottom water, loaded with salt and selenium.

When the soup came to Kesterson, it

how big is the selenium problem outside Kesterson? (ii) what will it cost and what is the best way to clean up the refuge? (iii) how should drainwater be disposed of if it continues to flow? and (iv) how much irrigation is tolerable in the San Joaquin Valley? The last question is the most controversial and the furthest from solution. But it will be affected by answers to all the others, and particularly by still unpublished FWS and USGS data which suggest that the selenium problem may be widespread in the northern San Joaquin Valley. For this reason, BUREC is not signing new long-term water delivery contracts at this time.

Another little-studied point is the possibility that chemicals other than selenium may be causing toxic effects. The state water board noted that the Kester-



The Kesterson reservoir

came with a vengeance. By 1982, the striped and largemouth bass, catfish, and carp were gone. In 1983 the FWS saw a high incidence of death and deformities among newborn coots, grebes, stilts, and ducks, including embryos with twisted beaks, no eyes or wings, and brains protruding from the skull. The mosquito fish—the only fish left—contained the highest levels of selenium ever recorded by the FWS in live fish, 53 parts per million (ppm).

"We were alerted to the high levels of selenium in the water sometime in 1983," says Lawrence Hancock, assistant regional director of BUREC in Sacramento. He and director David Houston were installed last year and do not personally carry the burden of the San Luis decisions. Hancock considers it being a "Monday morning quarterback" to argue that BUREC should have known of the selenium hazard. "I've spent a lot of time reading through the records, and I cannot truthfully say I would have done anything differently."

The unresolved questions today are (i)

son water contained high levels of arsenic, boron, cadmium, chromium, and copper. Among the many groups investigating this pollution is a committee of the National Academy of Sciences; it has specifically expressed an interest in the heavy metals.

Felix Smith, an environmental analyst for FWS in Sacramento, estimated in a memo of 16 April that the volume of selenium-laden runoff in the Grasslands Water District—which surrounds Kesterson—could be much larger than the amount in the San Luis Drain. This wastewater has never been measured because farmers in Grasslands have the longstanding privilege of draining directly into the San Joaquin River. Water samples taken in the area indicate a high level of selenium, and one USGS sample taken from a Grasslands sump registered 4700 ppm, four times the level needed to qualify as a toxic dump. Birds in the area have shown high levels of selenium as well. "The entire Grasslands could become another Kesterson-type situation," Smith wrote.

"Kesterson was our canary in the cave," says William Davoren, another ex-official of the FWS who runs the one-man San Francisco Bay Institute. "Now the canary is dead, and the question is: are we going to do something about it, or keep on with business as usual?" Every big interest in the area has a right to fresh water, Davoren says, but not the Bay.

Because it lacks a claim to "beneficial use" in California's complex water code, it could become a common dumping ground.

Davoren sees Kesterson as a symbol of all that has gone wrong in 30 years of aggressive land and water exploitation in California. He thinks that big-scale farming in the San Joaquin Valley has

reached a turning point from which it may not recover.

These are the terms of a water contest that will preoccupy California's resource managers for a decade or more as they try to resolve the competing claims of a powerful farm lobby and an increasingly effective environmental movement.

—ELIOT MARSHALL

Polish Universities Face Crackdown

Despite protests at home and from abroad, the Polish government's drive to take control of the country's 99 universities is proceeding at a rapid pace. On the verge of abolishment are broad self-governing powers that were wrung from the government in 1980 in negotiations with Solidarity, the Independent Students' Union, and the teachers' union.

The heart of the concessions that came out of the labor and social unrest of the early 1980's was a system of elected university senates, faculty councils, and student groups. The government aims to scrap these democratic forums as early as this summer, sources say. Tiers of appointed officials whose political views mirror those of government leaders would take the place of elected university leaders. What remains to be seen is how harsh the government will be in tightening its grip on the academic community.

Polish officials are justifying their actions on the grounds that the management freedoms allowed university community are being abused. The political activism that has been permitted is incompatible with the goals of the socialist state, officials charge.

Not only are academic freedoms slated to be curtailed but the futures of at least several thousand academics and university staff members are at risk. The proposed changes in the university management system were unveiled by the Socio-Political Committee of the Council of Ministers in January. These proposals, which the Sejm (Poland's parliament) likely will enact this month, appear to impose tougher restraints on academia than were in place during the 1970's.

The Main Council for Higher Education and Research, the highest self-governing academic body in Poland, is expected to be rendered ineffective in influencing Polish education policy and university operations. Although the government's Minister of Higher Education, Benon Miskiewicz, has held a voting position on the council comprised of elected university professors, he not been able to dominate its affairs. Now his ability to dictate university policy will be fundamentally strengthened under the proposed changes.

University rectors, vice rectors, deans, and department heads currently are elected and report to university senates and department councils. The new rules, which amend the 1982 Law of Higher Education, empower the minister of education to select management personnel throughout the university system. This expanded authority extends to the review of university research projects, teacher selection, retention of tenure, and student organizations that until now have had a say in university affairs.

With the Polish government being the sole employer in the university arena, the clear implication is that academics must buckle under or lose their jobs, notes Letitia Rydjeski, a spokeswoman for the New York-based Committee In Support of Solidarity. But for those faculty members that are identified as sympathizers of the Solidarity movement, or campus activists, falling in step with the Polish government's latest dictates may not save their careers.

Indeed, there are ominous signs that the government wants to purge campuses of faculty and student activists. For example, State Department officials note that since October 1984 the number of political internees has risen from 22 to an estimated 185. There are reports of increasing numbers of professors, researchers, and other university faculty members being detained by Polish police for questioning, or arrested. During the height of the state's crackdown on the Solidarity movement in 1982, as many as 2000 Poles were jailed for political offenses. By last summer, all but 22 had been released by the government.

The number of scientists and university faculty who fail to pass the Polish government's litmus test for loyalty could run into the thousands. This may be best measured by what happens at four larger universities that are strongholds of resistance to the clampdown on academic and civil freedoms in Poland: Adam Mickiewicz University in Poznan, the University of Warsaw, Jagielonian University in Krakow, and Boleslaw Beirut University in Wroclaw. A poll conducted by *Pygodnik Mazowsze*, an underground newspaper at Adam Mickiewicz University, indicates that only 20 percent of the faculty support the government's sweeping changes.

At this point there appears to be little chance of dissuading the Polish government from instituting its plan. The Main Council for Higher Education and Research has protested the changes, 2000 students in Warsaw have openly demonstrated against it, and 150 academics in the United States have written the Polish government. But there are no signs of any moderation in course. "The government does not seem to be taking the West's opinion into regard," says Rydjeski.

The prospect of the U.S. government having any influence on the outcome is even bleaker, State Department officials concede. "We don't really have very much leverage," says one official, noting that U.S.-Polish relations are at an all time low. In the meantime, should the coming crackdown on academic freedoms produce a flood of refugees from the Polish university community, State Department officials say they will try to adjust immigration ceilings to accommodate those who seek to come to the United States. —MARK CRAWFORD

Crisis at Kesterson

*Away, birds, away!
Take a little and leave a little,
And do not come again;
For if you do,
I will shoot you through,
And there will be an end to you.*
—Mother Goose

by Keith Schneider

Until two years ago, few Californians paid much attention to the Kesterson National Wildlife Refuge—5,900 acres of tangled tule reeds and dark lagoons just north of the tiny farm community of Los Banos—except hunters. Like California's nine other waterfowl refuges, Kesterson served as a stopover and wintering ground for swarms of migrating ducks and geese on the Pacific Flyway. Every autumn, members from neighboring duck clubs hid in the marsh grass, waiting to shoot down fat mallards and pintail ducks swooping in from Canada.

Now Kesterson is a regular source of front-page news across California. The refuge, fed by drainage water from thousands of acres of cropland west of the San Joaquin River, has been transformed into a lethal experiment, testing the tolerance of wildlife to dangerous metals and toxic salts. And the only live rounds fired at the contaminated refuge come from the guns of the U.S. Fish and Wildlife Service employees who regularly sacrifice black and white coots that are too sick to fly.

Since last October, a team of rangers has patrolled Kesterson, armed with live ammunition, shell crackers, and propane exploders in a dawn-to-dusk mission to scare waterfowl from 1,200 acres of evaporation ponds located along the refuge's southern perimeter. From afar, the steady pounding of the exploders and shotgun concussions sounds like a scene from "Apocalypse Now."

Keith Schneider is editor of *News West*, an independent news service in Sacramento, and a regular contributor to THE AMICUS JOURNAL.

"I know veterans around here must think they're reliving Khe Sanh," says Walt Hammond, the 31-year-old supervisor of the hazing project.

Indeed, Kesterson has turned into an ugly and unusual biological battlefield. But it is by no means an isolated skirmish. State lawmakers, federal researchers, and leading environmentalists agree that Kesterson has become a prominent symbol of a huge government-financed irrigation project and a system of industrialized farming that has gone awry. Further, these authorities agree that the choices for solving the toxic crisis will be difficult and costly.

Kesterson represents the end of an era when the government encouraged unlimited growth for irrigated farming. It is a turning point as significant to agriculture as Three Mile Island was to nuclear power, or Love Canal was to hazardous wastes. Across California, and the rest of the arid West, the water that helped deserts bloom during the last three decades is now threatening to make much of the land worthless again. The crisis at Kesterson has forced the Interior Department and the U.S. Fish and Wildlife Service to send teams of researchers into the field in ten states to look for evidence that migratory birds are suffering the same sort of poisoning at other refuges.

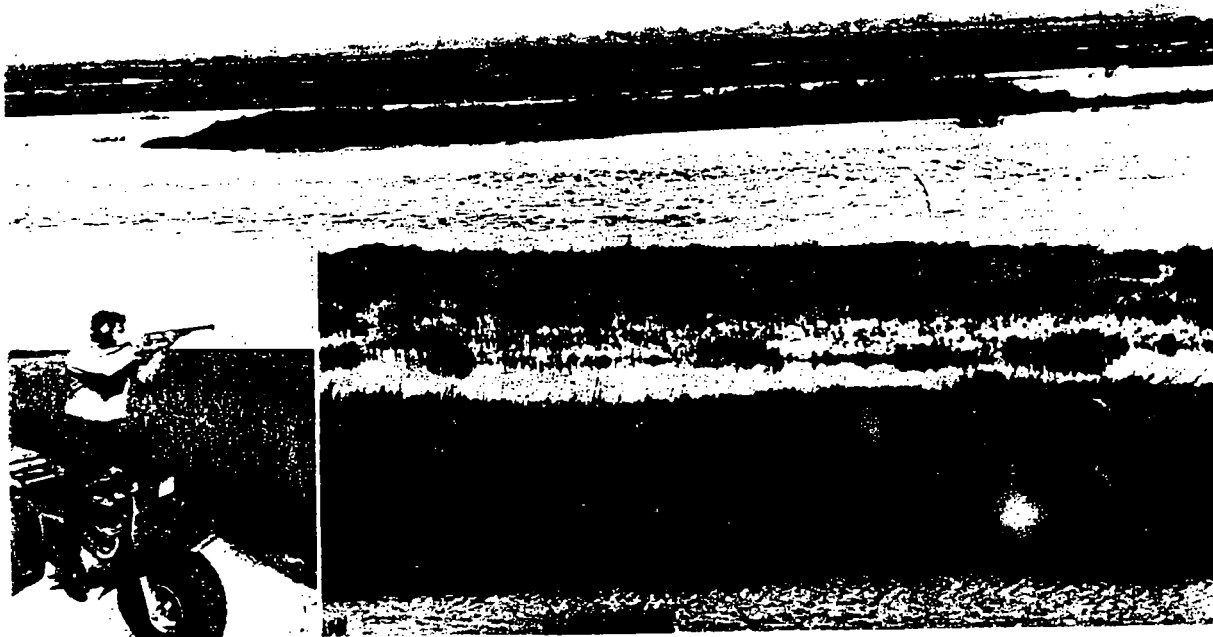
Last March, Interior Secretary Donald Hodel ordered the Bureau of Reclamation to stop supplying irrigation water by July 1986 to fifty-three huge farms that drain into Kesterson. Hodel said the poisoning of ducks and geese violated terms of the Migratory Bird Treaty Act that the United States has signed with Mexico and Canada. Said James Bartonek, a U.S. Fish and Wildlife Service official, "California is the key winter habitat for birds on the Pacific Flyway. And it has

changed more drastically than any other place on the West Coast. Once there were 5 million acres of wetlands in the state. Now there are less than 300,000. I don't think anything has had the long-term effect on waterfowl that can compare with the loss of wetlands in California."

Farmers reacted bitterly, warning that Hodel's decision would leave them in ruins. Leaders from farming communities in Merced and Fresno counties complained that idling thousands of acres would triple unemployment in their areas and lead to widespread business bankruptcies. Bank officials feared that farmers would stop paying back their loans, possibly causing lending institution failures in the San Joaquin Val-

multi-billion dollar bill to pay for a Kesterson cleanup or to build a system for purifying agricultural drainage water. "Requiring taxpayers to finance the cleanup would be a terrible precedent," said Albert Meyerhoff, an attorney with the Natural Resources Defense Council in San Francisco. "The contamination was caused by private farm interests and any cleanup should be paid for by private farm interests." In February, NRDC filed suit with the Consumers Union and California Rural Legal Assistance Foundation against the California State Water Resources Control Board seeking closure and immediate cleanup of Kesterson Reservoir.

For months, the blame for the Kesterson crisis



Kesterson Wildlife Refuge. (Insert) U.S. Fish and Wildlife Service ranger scaring waterfowl from the refuge.

ley. "We're all hanging way out there right now," said Ken Billings, president of the Federal Land Bank Association of Fresno.

So far the Interior Department has stuck to its decision and may extend it to tens of thousands of additional acres. California farmers may be forced to stop growing \$500 million worth of vegetables, grain, and cotton on a Rhode Island-sized stretch of salt- and mineral-laden cropland requiring drainage. "Never in my wildest dreams did I ever imagine that one day we would be considering taking half a million acres of some of the richest land on earth out of production," said Congressman Tony Coelho.

Moreover, taxpayers may be asked to foot the

has ricocheted between Sacramento and Washington. The Interior Department has pledged \$43 million for studies proposing solutions. The California Legislature is considering a bill that would provide up to \$17 million for state studies. Most observers expect farmers whose land drains into Kesterson to seek an extension on the Interior Department's July 1986 deadline. Few believe an extension will not be granted.

Still, all the hand-wringing does nothing to reduce the threat to wildlife, public health, or California farmers. The truth is that a sizeable portion of California's farmland is loaded with dangerous salts and minerals. Kesterson is simply the first dramatic indication of an envi-

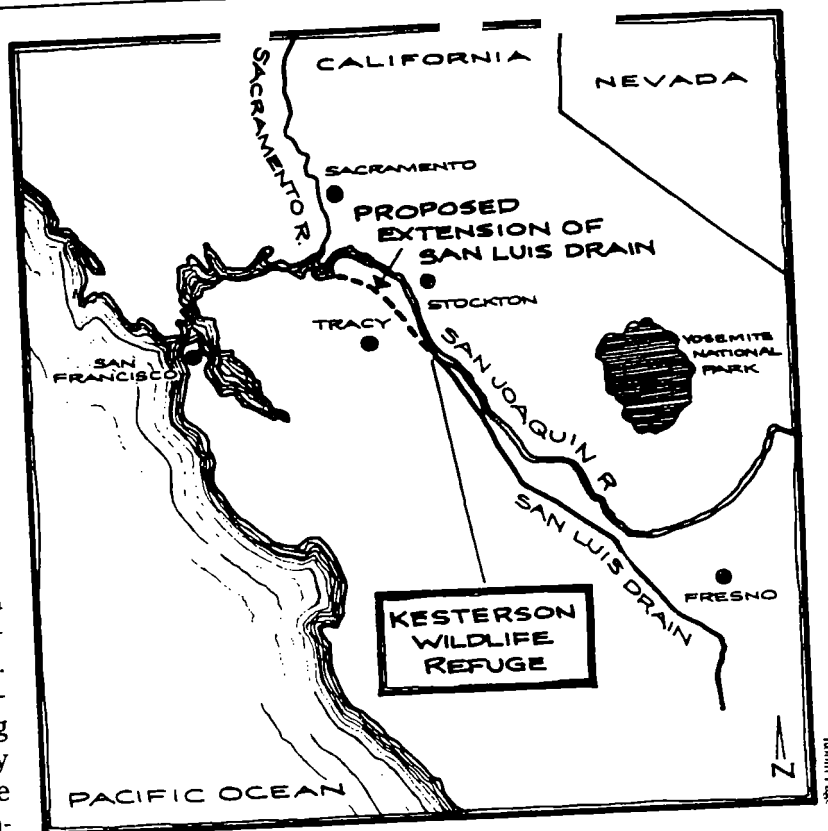
ronmental emergency that threatens to become much worse.

The Kesterson crisis has its roots in geologic time. When the High Sierra and Coast Ranges formed some 60 million years ago, the Pacific Ocean evaporated, and the San Joaquin Valley basin slowly dried. East of the San Joaquin River, erosion from the Sierras brought clean soil. East side farmers had little trouble earning a living as they diverted Sierra streams and produced record harvests on some of the planet's most fertile soil.

But on the west side of the valley, the Coast Range emerged from the sea floor leaving huge deposits of salts and minerals in the soil. Nature further hindered development of the west side by placing a thick, impermeable layer of clay beneath the surface. Much of the region receives less than ten inches of rain each year, not nearly enough to flush away toxic elements, or to cause the clay barrier to begin trapping water. From the beginnings of this century, hardy farm families have eeked livings from the parched soil by raising cattle and growing crops that required little water. Some drilled wells, but by the early 1930s the underground aquifers yielded only brackish water unfit for irrigation.

If farmers were to continue farming the west side, they would need help. Fifty years ago, during the height of the New Deal construction boom, the Bureau of Reclamation authorized the start of one of the most ambitious engineering projects in history—California's Central Valley Project. More than \$2.5 billion later, the project's sixteen dams, eight major canals, two tunnels, and six generating stations trap water that first fell as snow in northern California's High Sierra and transport it hundreds of miles south where it is sprayed across the fields by huge wheeled sprinklers.

Though the project brought wealth, it also created hydrologic headaches. First, the irrigation water dissolved salts and minerals. Secondly, the clay barrier acted like the bottom of an immense tub, trapping billions of gallons applied to the surface. In many areas, it would be only a matter of years before the water would rise to the



root zones and drown crops. What was needed was a primary drainage system.

In the mid-sixties, Interior officials proposed building a 207-mile-long canal to carry waste water from the San Joaquin Valley north to the Sacramento River Delta where it would eventually empty into San Francisco Bay. Federal scientists argued that sea water would render the waste water harmless.

In 1970 construction began on the master San Luis Drain, which would sweep away subsurface drainage water from nearly one million acres. But by 1975, with only 82 miles of the project completed, the money ran out. The canal now would drain directly into the Kesterson Refuge, where engineers had designed a dozen 100-acre evaporation ponds to regulate the flow.

For six years there were no problems at Kesterson. The refuge was fed small amounts of drain water diluted by larger doses of fresh surface water. In 1981, however, the fresh water supply was turned off as farmers required larger quantities, and the refuge's sole source of water came from subsurface runoff from 8,000 acres just south of Los Banos. It was not long before strange biological events began to occur.

Since 1919 federal scientists have been aware

that farming the west side of the San Joaquin Valley would result in toxic contamination. Yet the issue received scant bureaucratic attention until the spring of 1983 when biologists with the U. S. Fish and Wildlife Service checked 350 nests of coots, grebes, and other ducks at Kesterson and discovered the refuge had become an avian death trap. Says Harry Ohlendorf, a federal biologist who led the nesting survey, "We were looking into eggs and seeing things we'd never seen before."

Scientists found hatchlings and embryos without eyes, feet, or wings. Many were missing all or parts of their beaks. In some chicks, brains had pushed through the skulls. In birds the natural deformity rate is 1 percent. In Kesterson, the deformity rate in some species was 42 percent. The breeding failures were without precedent in the nation's 90-million-acre refuge system.

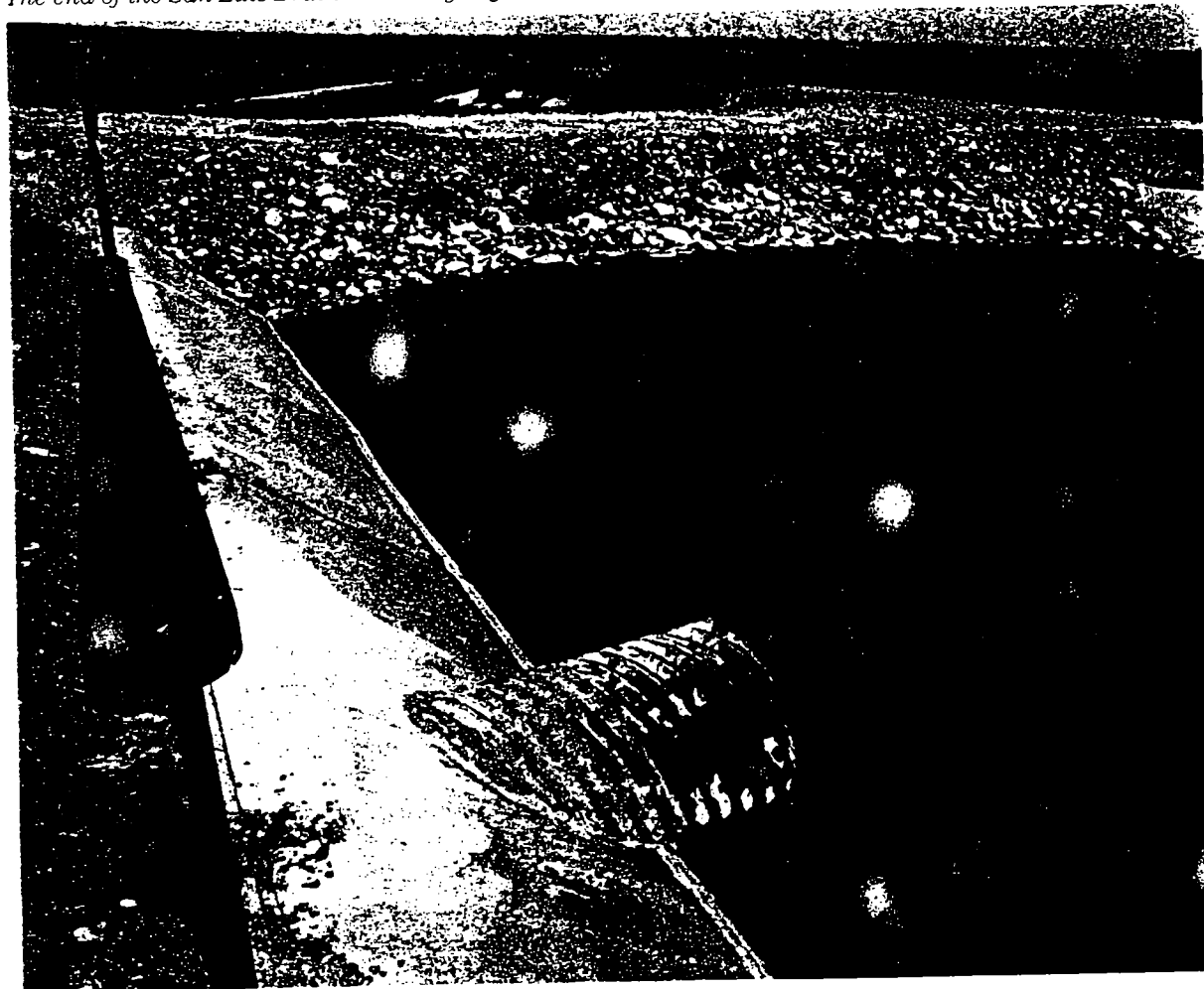
Adult birds suffered as well. Each day dozens of bloated carcasses were found floating in the

refuge's tea-colored waters. And crayfish, snakes, muskrats, and raccoons that once flourished here had vanished. In short, the Kesterson Refuge had become a place that killed the animals it was supposed to protect.

Further research identified the principal culprit. It was the element selenium, a salt that had leached from the fields and drained into Kesterson. A necessary dietary constituent at levels in the parts-per-billion range, selenium becomes a murderous toxic contaminant at higher levels. (Breast tissues from adult coots tested at Kesterson contained selenium levels between 3 and 9.5 parts per million.) Scientists believe selenium causes deformities and death by interfering with the ability to synthesize oxygen. In developing chicks, selenium poisoning causes the growth systems to shut down, while in adult birds, the primary symptom is muscle cell deterioration.

Faced with a degree of widespread contamination not seen since the DDT emergencies of

The end of the San Luis Drain that brings agricultural water to Kesterson.

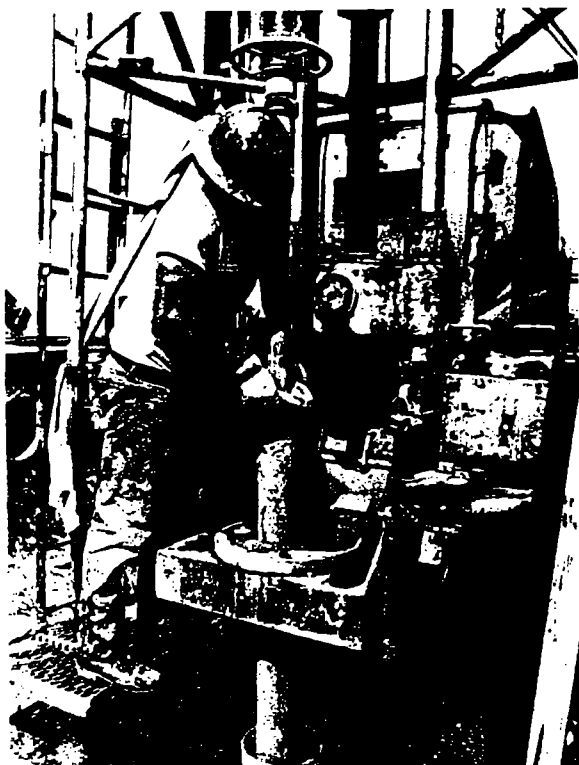


resistant crops that can be grown with minimal moisture. But plant geneticists and biologists say this work is still years away from field testing.

In effect, no feasible solution has yet appeared, except for taking cropland out of production. This approach has incensed farm interests, one of California's most powerful political lobbies. As a result, state and federal agencies are adopting a wait-and-see attitude. They are waiting for new studies. And they are seeing if the contamination will spread beyond Kesterson. There are strong indications, however, that the poison has moved into other areas. Near Kesterson, in an even larger refuge known as the Grasslands, scientists have identified worrisome levels of selenium and heavy metals in water draining into the area. Similar examples of birth deformities and adult waterfowl deaths have recently begun to occur.

Should the Interior Department abide by its deadline for halting the flow of irrigation water and plugging the drains leading to Kesterson, farmers say they would continue to work the land until they were forced to abandon it. This pattern may be repeated across the San Joaquin Valley as heavily irrigated land causes more salts and metals to leach away, forcing the govern-

The Interior Department has begun drilling wells around the refuge to monitor for leakage from drainage ponds.



Keith Schneider



Keith Schneider

Ranger examining dead coot.

ment to shut off the water supply. An Interior Department study published last year says that between 500,000 and 900,000 acres of west side farmland will need drainage, most of it within the next two decades. If the government turns its irrigation channels into empty ditches, almost \$2 billion worth of acreage would be rendered worthless for farming, between \$500 million and \$1 billion in annual farm income would vanish, and 20,000 workers would be out of jobs. The massive economic dislocation would swamp banks that have billions of dollars in outstanding farm loans, and strike with equal devastation everything from grocery stores to seed merchants to farm machinery outlets.

That prospect has alarmed many San Joaquin Valley residents. But it may be the only way to halt the spread of even more dangerous toxic contamination. The Kesterson crisis represents the first time the government has decided to reduce the irrigated land base, perhaps ultimately by hundreds of thousands of acres. Agricultural decline, not growth, is going to become a much more familiar process in California and throughout the West. It is going to take some time before state lawmakers get used to this new reality. And it may take years before they can come up with sensible plans to lessen the dramatic economic dislocations that will occur. □