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Distribution of Contaminants and Nutrients in Sediments of the Salton Sea

Principal Investigators:

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Summary:

This study proposes to collect SURFICIAL BOTTOM sediments along several transects in the Salton Sea. All sediments will be analyzed to determine the concentrations of selenium, organic carbon, nitrogen and phosphorus. Particle size and gross macroinvertebrate composition will also be determined. A subset of the samples will be analyzed for the Environmental Protection Agency's (EPA) priority pollutants, organochlorine pesticides (i.e., DDT's), and inorganic elements.

Objective:

The objective of this study is to determine the distribution of contaminants and nutrients in sediments of the Salton Sea . This information is needed to evaluate the potential bioavailability of contaminants to fish and wildlife resources in the Salton Sea's current configuration, but will also be needed to assess the effects of potential remediation alternatives on future contaminant distribution and bioavailability. Determining the distribution of nutrients within the sediments is a key component of describing the nutrient cycling in the Salton Sea. Sediments can function as a source as well as a sink for nutrients. If future management of the Salton Sea' eutrophication process is required to improve the overall health of the system, an understanding of this cycling process involving the sediments will be required.

Narrative:

Background

Agricultural practices in the Imperial Valley concentrate selenium and other contaminants of ecological concern in irrigation drainwater which discharges via surface drains and the New and Alamo Rivers to the Salton Sea. Previous investigations for the Department of Interior's National Irrigation Water Quality Program (NIWQP) have shown that selenium accumulates in the fine-grained sediments of the Salton Sea (Setmire and others, 1993). A bottom sediment sample collected in 1996 near the center of the Salton Sea had a selenium concentration of 9.3 mg/kg (parts per million)--about 30 times greater that the selenium concentration in soils and in bottom material from surface drains and rivers in the Imperial Valley (Setmire and Schroeder, 1998). The sample also had a high organic content and was enriched in molybdenum, uranium, and calcium. Bottom sediment samples collected for the NIWQP in 1994 (Setmire, in press) from about 20 surface drains in the Imperial Valley indicated a positive correlation between selenium concentration and percent material finer that 0.062mm (clay plus silt content). This fine material is readily transported to the Salton Sea where it results in slight enrichment of the selenium in sediments accumulating in the Sea. However, bottom material in the Salton Sea also is composed of detrital matter from the decomposition of dead organisms which are highly enriched in selenium

that is bioaccumulated and biomagnified through the food chain of the Sea. The net result of the deposition and redistribution of fine sediment and detritus is likely to produce areas in the Salton Sea having high concentrations of selenium, and perhaps other contaminants. Both the distribution and bioavailability of these contaminants in the bottom sediment are unknown. Certain management alternatives being considered to lower the salinity and stabilize water level of the Salton Sea could redistribute the most-highly contaminated sediments, thought to now reside in deeper parts of the Sea, to areas of increased biological availability thereby posing an increased selenium hazard.

Study Design

Currently, the National Irrigation Water Quality Program (NIWQP) has funded the Salton Sea core team to collect and analyze a limited number of surficial bottom sediment samples (11) at several discrete locations around the Salton Sea. This includes the center of each basin and the Whitewater, New and Alamo River deltas. This proposal, in response to the reconnaissance request for proposals (RFP), recommends that the NIWQP sampling be expanded to provide information on selenium concentrations in bottom sediments throughout the entire Salton Sea. Samples will be collected along a series of transects: 1) from the center of the south basin to the New River; 2) from the center of the south basin to the Alamo River; 3) from the center of the north basin to the Whitewater River; 4) between the centers of the north and south basins; 5) laterally to the west and east shores at the center of the north basin; and 6) laterally to the west and east shores at the center of the south basin. Individual sites will be located on the bathymetric map from the survey by Ferrari and Weghorst (1995). The latitude and longitude for each site will be determined. Core samples will be analyzed for a variety of constituents. All samples will be analyzed to determine concentrations of selenium, organic carbon, nitrogen and phosphorus, along with particle size, and gross macroinvertebrate composition. A subset of these samples will be analyzed for EPA's priority pollutants, organochlorine pesticides, and inorganic elements.

Methods

Bottom sediment will be collected from a boat using an Ekman dredge. The material for analysis will be taken from the top few centimeters of the dredge sample. Although some wash-off of the sediment surface typically occurs with this type of sampling, previous experience (corroborated by the presence of cesium-137 in the 1996 sample from the Sea) has indicated that recent sediment is obtained by the procedure. The sediments collected will be thoroughly mixed before the separate samples are taken for individual analyses.

Sediment samples will also be collected by means of an Ekman dredge and sieved for invertebrates. Representative samples of the invertebrates collected will be preserved in ethanol for identification to the lowest taxonomic level possible. If adequate material is available, samples will be collected for optional chemical analysis (see attached additional study).

Water-column profiles of dissolved oxygen concentration, temperature, pH, and specific

conductance and Secchi disc readings will be made at each collection site. Readings will be taken at a minimum of every 5 feet with additional readings taken as the conditions warrant. Water depth will be recorded and location will be obtained using GPS technology. All data collected will reference this location information.

Reporting

Site locations will be plotted on a map generated from the 1995 bathymetric data collected by the U.S. Bureau of Reclamation. Selenium and nutrient concentrations in the bottom sediments will be plotted on the map and included in spreadsheet format. Data for all other constituents will be included in a spreadsheet format. The depth profiles will be presented both graphically and in spreadsheet format. A short report detailing the collection and analysis of the results will be prepared.

Quality Assurance (QA)

A quality assurance project plan (QAPP) will be developed for the bottom sediment sampling program. This will include protocols for all steps of the sampling process including sampling equipment cleaning between sites to minimize the potential for any cross-contamination between sample sites. All samples collected for chemical analysis will be placed in chemically-clean jars of the appropriate type for the analysis to be conducted. Samples will be analyzed at the USGS National Water-Quality Laboratory in Arvada, Colorado, using standard protocols. The USGS laboratory has an extensive internal quality assurance program and also participates in national "round-robin" programs. The quality control (QC) samples will be in the form of splits from the original dredge material. These split samples are processed using the same procedures as the original samples. The number of QC samples was determined by multiplying the total number of samples by 20 percent. The Hydrolab used to obtain profile data will be calibrated daily with appropriate standards and internal references. The GPS unit used will be calibrated daily at a location with known coordinates.

Milestones and Products:

The NIWQP Core Team can mobilize for sample collection within 30 days of the contract being awarded for this work. The sampling is anticipated to take 12 work days to complete and can be completed within 60 days of the contract being awarded.

The sample analysis will take approximately 90 days to complete. Sample data will be available in spreadsheet format within 30 days of receiving the data from the analytical laboratory. An additional 20 days will be required to complete report writing including coordination between authors and internal review. All work on this contract will be complete within 8 months of the contract being awarded.

Staffing:

The NIWQP core team will be completing the work described in the proposal and is composed of Jim Setmire a USGS hydrologist on detail to the U.S. Bureau of Reclamation (USBR), Roy Schroeder a USGS research hydrologist, and Carol Roberts a U.S. Fish and Wildlife Service (USFWS) environmental contaminant specialist. See attached biographies.

Staff time (in days):

Core Team member	QAPP preparation	Sample collection	Preparation and clean-up	Invertebrate analysis	Data analysis and report writing
Jim Setmire	5	12	5		10
Roy Schroeder	5	12	5		10
Carol Roberts	5	12		15	10

Experience:

Please see the attached biographies for a list of completed publications/reports.

Facilities:

The Core Team currently has all major equipment required for field sampling in this project including: Ekman dredge, Hydrolab, a GPS unit. A boat for sampling is available from the U.S. Fish and Wildlife Service's Salton Sea National Wildlife Refuge on a subcontract basis for the duration of the study. The Core Team members have access to appropriately equipped vehicles for towing the boat and trailer in their agencies' vehicle fleets. Adequate sample storage facilities are available at either the USGS San Diego Office or the Carlsbad Fish and Wildlife Office. Sample shipment will occur within 7 days of the completion of sample collection.

Samples will be analyzed at the USGS National Water-Quality Laboratory in Arvada, Colorado, using standard protocols. This facility is currently equipped to complete all sediment analyses proposed for this study and are adequately staffed to meet the time frame described above.

Budget:

1) Personnel (costs include salary, benefits and overheads. Please note that each agency has its own overhead costs resulting in differences in daily costs between team members.)

Jim Setmire, USBR	32 days X $600/day	= $ 19,200
Roy Schroeder, USGS	32 days X $900/day	= $ 28,800
Carol Roberts, USFWS	42 days X $800/day	= $ 33,600
	Total Personnel Costs	$ 81,600

2) Chemical analysis costs

Samples included	8 complete with priority pollutants at $6,000	=$48,000
	2 QA/QC samples - split samples at $6,000	*=$12,000*
	47 of the base set of constituents at $700	=$32,900
	10 QA/QC samples - split samples at $700	*=$ 7,000*
	Total analytical costs	$ 99,900

3) Travel (including overhead)

Travel for field work: 3 people for 15 days at $160/day = $7,200

4) Equipment (includes fuel costs)

Boat use:	12 days of field sampling at $ 150/day	= $1,800
Vehicle use:	12 days of field sampling at $ 75/day = $ 900	
	3 travel days at $75/day	= $ 225
	Total equipment costs	$2,925

5) Supplies

Chemically-clean jars for sample storage	= $ 720
Macroinvertebrate handling supplies	= $ 100
Total supply costs	$ 820

Total Proposal Budget **$192,445**

References

Ferrari, R.L., Weghorst, Paul, 1995, Salton Sea 1995 Hydrographic GPS Survey: U.S. Bureau of Reclamation Technical Service Center, Denver, Colorado, 17p.

Setmire, J.G., 1998 (in press), Selenium in water, sediment, and transplanted *Corbicula* in irrigation drainage and wildlife use of drains in the Imperial Valley, California, 1994-1995. U.S. Bureau of Reclamation Publication.

Setmire, J.G. and Schroeder, R.A., 1998. Selenium and Salinity Concerns in the Salton Sea Area of California. In W.T. Frankenberger, Jr. and R.A. Engberg (eds), *Environmental Chemistry of Selenium*, pp. 205-221, New York, Marcel Dekker, Inc.

Setmire, J.G., Schroeder, R.A., Densmore, J.N., Goodbred, S.L., Audet, D.J., and Radke, W.R., 1993, Detailed study of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea area, California, 1988 to 1989. U.S. Geological Survey Water Resources Investigations Report No. 93-4014, 102 p.

Possible Additional Study

Biota

Macroinvertebrate samples will be collected as part of the bottom sediment sampling. Analysis of a composite sample of these macroinvertebrates will be made for selenium and organochlorine pesticide residues. Samples for analysis will focus on shallow habitats used by water birds such as eared grebes, ruddy ducks, black-necked stilts, American avocets, dowitchers and by fish such as tilapia.

Costs

Laboratory analyses of 14 samples X $500/sample	=$ 7,000
Laboratory analyses for QA samples = 3 samples X $500/samples	=$ 1,500
Sample preparation and shipping: 1 person X 2 days	=$ 1,600
Reporting: 1 person X 3 days	=$ 2,400
Supplies: jars for samples	=$ 120
Total costs	**=$12,620**

Total costs of combined study **$205,065**

Staff biographies for Salton Sea bottom sediment study:

James G. Setmire - Hydrologist with the U.S. Geological Survey (USGS), currently on detail to the U.S. Bureau of Reclamation (USBR)(28 years experience). BS in biology and chemistry from University of Southern California. Served as the project leader for the multi-agency National Irrigation Water Quality Program's (NIWQP) Salton Sea reconnaissance investigation and the detailed study of irrigation drainage in the Salton Sea area. Former chief of the National Water Quality Assessment (NAWQA) program's Western Lake Michigan Drainages Study Unit located in Middleton, Wisconsin. Currently project chief for the Imperial Valley drainwater reclamation and reuse study, a cooperative venture between the USBR and the Imperial Irrigation District investigating selenium removal and drainwater reuse. Also member of the NIWQP Salton Sea Core Team currently maintaining an active involvement in Salton Sea area activities. Other duties include federal co-chair of the California/Baja California Region Natural Resources Workgroup for the Border XXI program.

Selected Reports:

Michel, R.L., Schroeder, R.A., Setmire, J.G., and Hall, S.S., 1988, Soluble salts and tritium concentrations in irrigation drainwaters from the Imperial Valley, California: Eos, Transactions of the American Geophysical Union, Abstracts, v. 69, no. 44, p. 1181.

Schroeder, R.A., Setmire, J.G., and Densmore, J.N., 1989, Controls on drainwater composition in the Imperial Valley, California, in Pederson, G.L., and Smith, M.M., compilers, U.S. Geological Survey Second National Symposium on Water Quality: Abstracts of the Technical Sessions, Orlando, Florida, November 12-17, 1989: U.S. Geological Survey Open-File Report 89-409, p. 85.

Schroeder, R.A., Setmire, J.G., and Densmore, J.N., 1991, Use of stable isotopes, tritium, soluble salts, and redox-sensitive elements to distinguish ground water from irrigation water in the Salton Sea basin, in Ritter, W.F., ed., Irrigation and drainage: American Society of Civil Engineers, National Irrigation and Drainage Division Conference, Honolulu, Hawaii, July 22-26, Proceedings, p. 524-530.

Schroeder, R.A., Setmire, J.G., and Wolfe, J.C., 1988, Trace elements and pesticides in Salton Sea area, California: American Society of Civil Engineers, National Irrigation and Drainage Division Conference on Planning Now for Irrigation and Drainage, Lincoln, Nebraska, July 18-21, Proceedings, p. 700-707.

Setmire, J.G., 1979, Water-quality conditions in the New River, Imperial County, California: U.S. Geological Survey Resources Investigations Report 79-86, 63 p.

Setmire, J.G., 1984, Water-quality appraisal, Mammoth Creek and Hot Creek, Mono County, California: U.S. Geological Survey Water-Resources Investigations Report 84-4060, 50 p.

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Setmire, J.G., and Bradford, W.L., 1980, Quality of urban runoff, Tecolote Creek drainage area, San Diego County, California: U.S. Geological Survey Water-Resources Investigations Report 80-70, 33 p. (PB-811594511)

Setmire, J.G., Schroeder, R.A., Densmore, J.N., Goodbred, S.L., Audet, D.J., and Radke, W.R., 1993, Detailed study of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea area, California, 1988-90: U.S. Geological Survey Water-Resources investigations Report 93-4014, 102 p.

Setmire, J.G., Wolfe, J.C., and Stroud, R.K., 1989, Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea area, California, 1986-87: U.S. Geological Survey Water-Resources Investigations Report 89-4102, 68 p.

Roy A. Schroeder - Hydrologist with the USGS since 1978, in the San Diego Office since 1985. B.S. in chemistry from Bethel College (North Newton, KS), M.S. in chemistry from University of California (Berkeley), and Ph.D. (1974) in oceanography from University of California (San Diego). Faculty positions in the Department of Geology & Geophysics at Yale University (1974-76) and the University of Utah (1976-78). Currently project chief for a study of water-quality (organic chemical, nitrogen, and microbial) changes associated with recharge and potable reuse of treated municipal wastewater in Los Angeles County. Project chief for a study of irrigation drainage in the Tulare Lake Basin (1986-88) and a binational study of chemical contaminants in the New and Lower Colorado Rivers (1995-96). Involved in studies in the Salton Sea Basin since 1988.

PUBLISHED MANUSCRIPTS ON STUDIES IN THE SALTON SEA BASIN

Setmire, J.G., and Schroeder, R.A., 1998, Selenium and salinity concerns in the Salton Sea area of California, *in* Frankenberger, W.T., Jr, and Engberg, R.A., ed., Environmental Chemistry of Selenium: Marcel Dekkar, Inc., Chapter 12, p. 205-221.

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Carol A. Roberts - Supervisory Resource Contaminant Specialist, U. S. Fish and Wildlife Service

B.S. - 1984 - Biological Sciences, University of Cincinnati

M.S. - 1987 - Biological Sciences, University of California, Irvine

Professional Experience:

Ms. Roberts began her current position with the Fish and Wildlife Service in 1992. As a part of her duties, she has conducted reviews of environmental clean-up projects at several military facilities in Southern California. She is the Carlsbad Fish and Wildlife Office's point of contact on contaminants issues involved with dredging projects, including evaluation of potential impacts to fish and wildlife resources under different disposal scenarios. Ms. Roberts has also been involved with consultations with the California Department of Agriculture and Bureau of Land Management regarding the potential for wildlife impacts in large scale pest control programs in Southern California. She developed, conducted and has completed the report on a study on the potential for contaminant impacts to the Yuma clapper rail in the Salton Sea area. She is currently the primary contact for the Carlsbad Fish and Wildlife Office on contaminant issues at the Salton Sea, including providing technical support to the Science Subcommittee and the New River Task Force. She is also the Service's representative to the San Diego Bay Interagency Water Quality Panel.

Selected reports:

Roberts, C.A. 1996. Trace Element and Organochlorine Contamination in Prey and Habitat of the Yuma Clapper Rail in the Imperial Valley, California. A report to the Division of Environmental Contaminants, U.S. Fish and Wildlife Service, Portland Oregon. 20 pp.

Roberts, C.A. 1996. Selenium Contamination in *Corbicula* Transplanted into Agricultural Drains in the Imperial Valley, California. A report submitted to the National Irrigation Water Quality Program for inclusion in Setmire, J.G., 1998 (in press), cited above.

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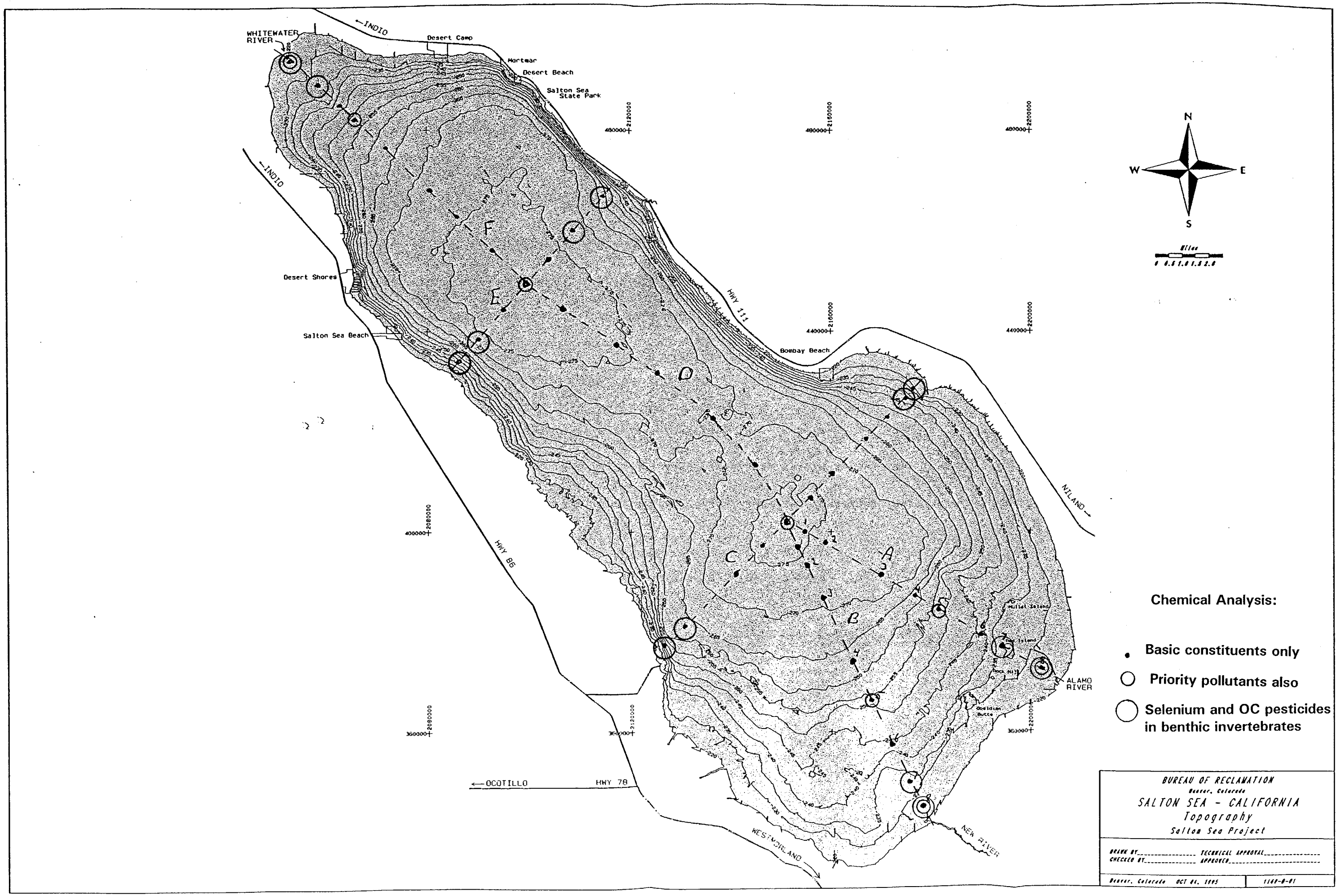
WHITEWATER RIVER
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Desert Camp
Mortmar
Desert Beach
Salton Sea State Park
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Desert Shores
Salton Sea Beach
HWY 111
Bombay Beach
NILAND→
HWY 86
←OCOTILLO
HWY 78
WESTMORLAND
NEW RIVER
ALAMO RIVER
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Chemical Analysis:
Basic constituents only
Priority pollutants also
Selenium and OC pesticides in benthic invertebrates
BUREAU OF RECLAMATION
Denver, Colorado
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Topography
Salton Sea Project
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