SALINITY CONTROL
ON BLM-ADMINISTERED PUBLIC LANDS
IN THE COLORADO RIVER BASIN

A REPORT TO CONGRESS
July 1987

U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
Washington, DC 20240

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report has been prepared in response to the 1984 amendment to the Colorado River Basin Salinity Control Act (PL 98-569). Section 203(b)(3) directed the Secretary:

> "to develop a comprehensive program for minimizing salt contributions to the Colorado River from lands administered by the Bureau of Land Management [BLM] and submit a report which describes the program and recommended implementation actions to the Congress and to the members of the advisory council established by section 204(a) of this title by July 1, 1987."

Water from the Colorado River supports the municipal and industrial needs of over 18 million people and irrigation for over 2.5 million acres of crop land both inside and outside the basin. Salinity—a measure of total dissolved solids including all inorganic material in solution, whether ionized or not—threatens all these uses. Salinity in the Colorado River ranges from 50 milligrams per liter (mg/l) at its headwaters to approximately 600 mg/l by the time it reaches Imperial Dam. The Bureau of Reclamation estimates that by the year 2010, salinity could reach 963 mg/l at Imperial Dam.

In 1972, the basin States established numeric criteria for salinity concentrations in the Colorado River. Approved as standards by the Environmental Protection Agency (EPA), they are 723 mg/l below Hoover Dam, 747 mg/1 below Parker Dam, and 879 mg/1 at Imperial Dam. The Bureau of Reclamation estimates current damages from salinity of more than $100 million each year to the lower basin States.

The BLM administers approximately 40 percent (48 million acres) of the lands in the Colorado River basin above Imperial Dam—approximately 7.2 million of these acres contain saline soils. It is impossible to determine exact amounts of salt contributed from BLM lands because ownership patterns are complex and saline ground water yields have not been quantified. Approximately 11,000 tons of salt added to the Colorado River from the upper basin accounts for 1 mg/l increase at Imperial Dam.

Salts enter the Colorado River system from both point and nonpoint sources, with nonpoint sources being the greatest contributor. Controlling salinity from nonpoint sources is closely related to controlling sediment yield. Vegetation cover is the most important management variable influencing runoff and sediment yield. Major point sources will be brought to the attention of the Bureau of Reclamation. Saline wells and springs will be controlled where appropriate.

BLM has developed a resource management planning process to make basic land-use decisions. Through this process, BLM identifies and evaluates salinity control activities. The effect of management actions on salt yields to the Colorado River will be determined by environmental analyses. Salinity control is accomplished through proper land use and in a way that enhances other resource values. The BLM's role in reducing salinity contributions from public lands is the implementation of land management practices. The BLM will control salinity on public lands through techniques that are cost-effective and provide multiple resource benefits, including salinity control.

INTRODUCTION

The 1984 amendment to the Colorado River Basin Salinity Control Act requires the Secretary of the Interior to submit the following report to Congress. Appendix C provides a detailed explanation of the requirement and legislative history. This report describes salinity problems and the BLM's role in controlling salinity. Under the Future Actions section, BLM recommends actions necessary to implement salinity control activities.

DESCRIPTION OF THE PROBLEM

Salinity is a major water quality issue in the Colorado River basin. Waters of the Colorado River support the municipal and industrial needs of over 18 million people and irrigate over 2.5 million acres of crops inside the basin and thousands of acres outside the basin through export.

Salinity—a measure of total dissolved solids including all inorganic material in solution, whether ionized or not—threatens all these uses. At its headwaters, salinity in the Colorado River has been measured at 50 mg/l of water. At Imperial Dam this amount has risen to over 800 mg/l in the past, and is currently about 600 mg/l—a result of several years of higher-than-normal runoff in the basin.

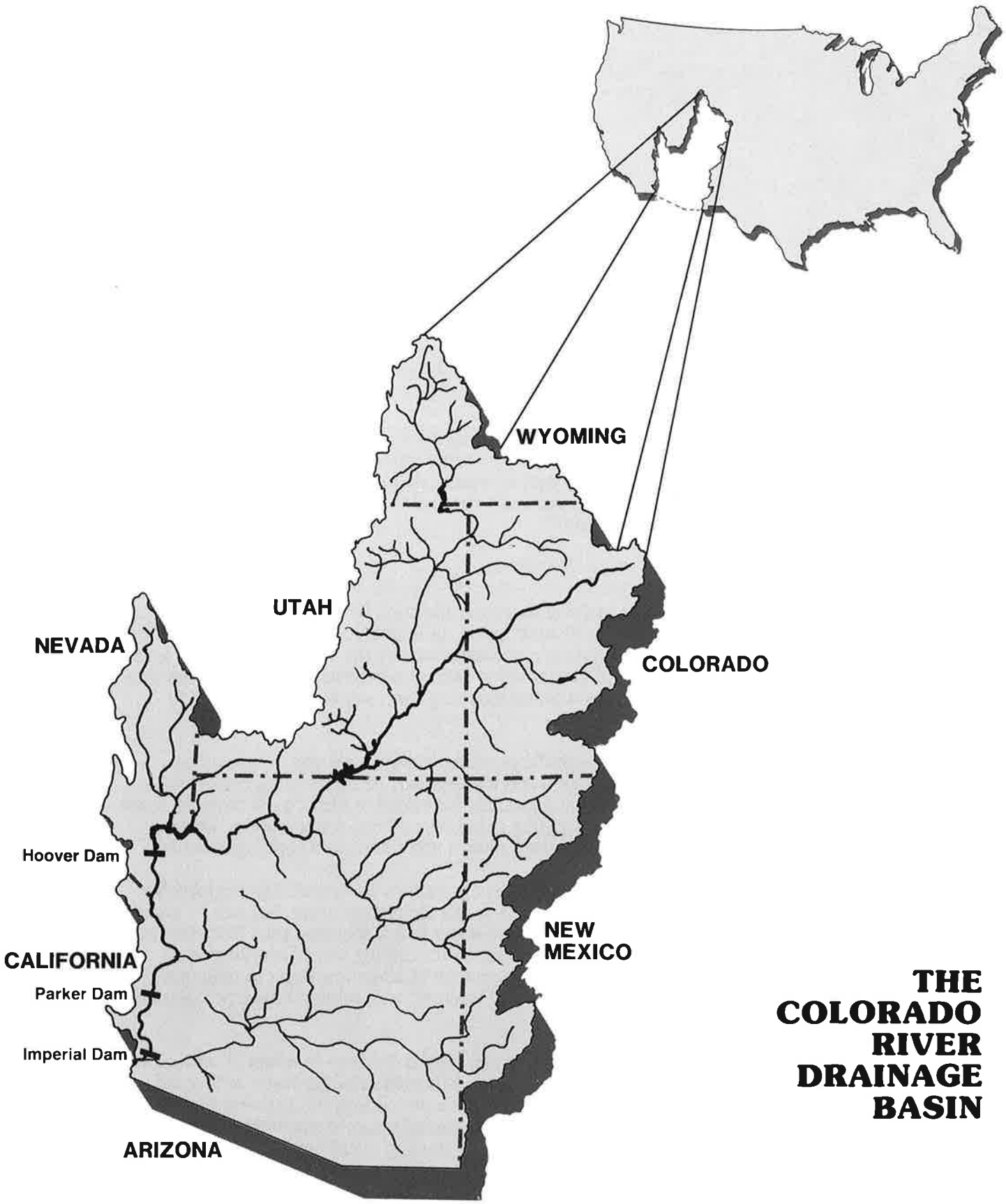
Basinwide Problems

As the upper basin States continue to develop waters allocated by the Colorado River Compact, and if river yield declines to historic levels, salinity levels are sure to rise in the Colorado River. The Bureau of Reclamation estimates that by the year 2010, salinity levels could reach 963 mg/l. The Bureau of Reclamation estimates current damages of more than $100 million annually to the lower basin States resulting from salinity in the Colorado River.

Municipal damages. Municipal damages from saline water are related to increasing capital costs and expenditures for operation and maintenance of water-using household equipment. Capital costs rise when salinity reduces the effective life of such items as water pipes, fixtures, and water-using appliances (e.g., clothes washers, water heaters, water softeners, steam irons, swimming pool heaters, pumps and filters, and cooking utensils).

Agricultural damages. Salinity affects irrigated agriculture by decreasing productivity and/or increasing production costs. Salinity also limits the type of crops that can be grown. Corrective measures depend on the availability of water to leach excess salts from the root zone of irrigated crops. Excess leaching saturates the underlying shales resulting in increased salinity to the river system. The management of irrigation water to maintain correct amounts of water for crop production and leaching with minimal deep percolation is critical.

Industrial damages. The mineral content of water affects industry in terms of corrosion and scale formation in boilers and cooling systems. Minerals in boiler water reduce the economic life of the boiler. Industrial water users have the options of obtaining higher quality water at an additional expense, acquiring additional water to maintain the production system, repairing or replacing affected equipment, or treating water before use.



THE COLORADO RIVER DRAINAGE BASIN

Contributions from BLM-Administered Lands

The Bureau of Land Management administers 53 million acres of public lands in the Colorado River basin above Yuma, Arizona, and 48 million acres above Imperial Dam, about 40 percent of the basin's total area. Approximately 8 million acres of BLM-administered lands in the basin contain saline soils. Of this total, BLM has identified roughly 180,000 acres of strongly saline soils, more than 1.5 million acres of moderately saline soils, and roughly 6.5 million acres with slightly saline soils. Refer to Appendix A for salinity maps and an explanation of salinity classes.

Salt enters tributaries of the Colorado River from nonpoint sources such as surface runoff, erosion, and ground water flows, and from point sources such as saline springs, spoil piles at mines, and oil and gas production sites.

Salt concentrations on BLM lands are highest in marine shale geologic settings where annual precipitation averages less than 12 inches. Most salt contributions from BLM lands to the Colorado River occur from nonpoint sources of salinity.

It is extremely difficult to determine exact amounts of salt contributed from BLM lands. Reasons for this difficulty are physical transport mechanisms associated with salt and sediment movement, saline ground water flow, and variability in land ownership.

The physical transport mechanisms include surface runoff and sedimentation. Salts in solution are readily transported by overland flow. Salts associated with sediments are transported by processes of erosion, sediment transport, and disposition. Sediment and salt yields refer to the amount of sediment and salt delivered from a watershed. Salinity

Strongly saline mancos shale rangeland in eastern Utah.

contributions from saline ground water inflows have not been quantified. Within one watershed, BLM lands are likely to be intermixed with private and other agency lands, further complicating determinations of salt sources.

In 1977, BLM attempted to estimate the sediment and salt yields from the upper basin States of Colorado, Utah, and Wyoming. This number was roughly 700,000 tons of salt annually. Over half of this yield is contributed from slightly saline soils. No attempt was made to estimate salinity contributions from ground water. Approximately 11,000 tons of salt added to the Colorado River in the upper basin account for 1 mg/l increase at Imperial Dam.

PLANNING PROCESS

BLM's planning process is the principal mechanism for making land-use decisions and the first step in implementing salinity control actions. BLM has developed a resource management planning process to make basic land-use decisions. Although all resource values and land uses on BLM-managed lands are included, the development of solutions to **specific planning issues** is emphasized in resource management planning.

BLM's planning process is used to develop resource management plans that examine management alternatives for all resources and land uses on BLM public lands. All resource management programs must utilize the planning system to identify management options. Thus, a comprehensive approach to salinity control on public lands must first be addressed resource area by resource area through the planning process. BLM invites land users and the public at large to identify specific issues and develop possible solutions.

BLM field offices have the primary responsibility to develop and implement resource management plans. Plans are prepared for individual resource areas. District or area managers initiate planning activities when significant resource issues or conflicts require resolution.

Information on salinity issues comes from several sources: the public and Federal, State, and local agencies. Once a planning issue is identified, BLM evaluates it for significance and treatability. When salinity is not an identified planning issue, it may be treated as a management concern or factor in the analysis of management alternatives. BLM invites public review and participation during all phases of the planning process.

BLM offices prepare Environmental Impact Statements (EISs) to meet requirements of the National Environmental Policy Act of 1969 and to aid decisionmakers in selecting a plan. The planning and EIS processes are fully integrated, and the results are often presented in one document.

BLM plans establish:

-areas for limited, restrictive, or exclusive use;
-allowable resource uses, including minimum or maximum levels of production or use to be maintained;
-resource condition goals and objectives;*
-general management practices necessary to achieve specific goals and objectives;*
-need for and areas to be covered by more detailed and specific acitivity plans;* and
-standards and intervals for monitoring or evaluating plans to determine their effectiveness or need for revisions.

* decisions most often used to resolve salinity issues.

Most BLM resource areas within the Colorado River basin have saline soils. In addition, saline springs and wells are common throughout the public lands in the basin. The severity and extent of the salinity issue vary widely, however, as do the planning status and potential for control in each area.

BLM offices have evaluated or will identify and evaluate salinity control activities in resource management plans, and several field offices are presently implementing salinity control activities. Appendix A identifies the status of the resource management planning process for areas with saline soils for each of the seven basin States. It also identifies classes of saline soils for each area and is accompanied by a map displaying the saline soils.

Upon completion of a resource management plan and the final EIS, and prior to project implementation, an **activity plan** may be prepared to guide more specific on-the-ground management actions or projects. An activity plan normally includes the purpose and objectives of the proposed action, problem identification, alternative solutions to the problem, cost analysis, planned actions, and monitoring requirements. Prior to implementation of any on-the-ground project identified through activity planning, a site-specific environmental analysis is prepared.

Activity plans are developed for many different disciplines and for many different purposes. As examples, allotment management plans are activity plans developed for implementing grazing management decisions, and habitat management plans are activity plans written to implement wildlife management decisions.

Opportunities for correcting salinity problems are included as management practices which are often incorporated into activity plans for other resource uses. For example, BLM may establish standards for forage use and vegetation maintenance in allotment management plans to achieve management objectives for runoff and surface erosion on saline rangeland.

If the salinity problem is highly significant and untreatable by incorporating these practices into activity plans for other resource uses, BLM prepares activity plans specific to watershed management. These plans identify significant watershed problems and their causes, quantify the extent and severity of the problems, formulate alternative projects to correct the problems, and schedule the implementation of selected projects.

Management practices, such as tillage and other surface manipulation, runoff retention and detention structures, and gully control structures, can be used to rehabilitate severely eroding landscapes and reduce sediment and salt yields.

A monitoring section will be included in each plan to verify salt-load estimates and track other objectives identified in the plan.

BLM coordinates its salinity control activities with State and Federal agencies, local officials, and public interest groups. BLM is a Federal advisor to the Colorado River Basin Salinity Control Forum Work Group, and attends all Work Group, Forum, and Advisory Council meetings. The Colorado River Basin Salinity Control Forum and Advisory Council are both composed of representatives of each of the seven basin States.

BLM is also a member of the Colorado River Salinity Control Interagency Committee, composed of the Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, USDA Soil Conservation Service, and U.S. Geological Survey.

CURRENT BLM ACTIONS TO MINIMIZE SALINITY

Controlling salinity in surface runoff from public lands is closely related to controlling surface runoff and sediment yield. Vegetation cover is usually the most important management variable influencing runoff and erosion rates on rangelands.

Therefore, vegetation management, either indirectly through the design and implementation of activity plans or directly through vegetation manipulation, is an important erosion and salinity control technique. However, on the most highly saline public lands, maximum potential cover is often too low to provide meaningful control of surface runoff and erosion. In these areas, stipulating surface occupancy is the best salinity control technique, and thus, maintains natural watershed processes.

Proper land use, with objectives for increasing ground cover, stabilizing stream banks, controlling accelerated gully erosion, and minimizing surface disturbing activities, is the BLM's preferred method of achieving salinity control. Rangeland management, energy and minerals management, and recreation management have the greatest potential for effective salinity control on public lands.

Salinity runoff monitoring project on mancos shale near Meeker, Colorado.

Rangeland Management

Vegetation, including canopy cover, ground cover, and litter, reduces upland soil loss by protecting soil from direct raindrop impact and by reducing surface runoff velocities. Increased sediment production from saline soils will cause increases in salinity contributions to the Colorado River. Vegetation also intercepts rainfall and enhances soil infiltration properties, thus reducing runoff volume and erosion on hillsides and in stream channels.

Riparian vegetation traps sediment from the uplands, reduces stream bank erosion, and provides stability for stream banks. Establishment of riparian vegetation in degraded areas reduces the need for continued structural control and lowers future maintenance costs.

Management of vegetation cover and resultant decreases in sediment yield are accomplished through grazing, land treatment, and structural techniques.

Grazing Techniques. Livestock grazing affects vegetation by influencing species composition, vigor, production, and cover densities. Proper livestock grazing techniques can increase ground cover in most areas. Quantitative relationships between livestock grazing systems and sediment production or salinity have not been fully researched and developed. Thus, it is difficult to accurately predict the effects of different livestock grazing plans on resulting runoff, erosion, and salinity. However, rangeland condition is carefully monitored to evaluate the extent to which management objectives are achieved.

Land Treatment Techniques. Land treatment techniques must be carefully tailored to the site, with topography and soil characteristics dictating treatment types and design. For example, some range sites such as large areas of pinyon-juniper or big sagebrush lack sufficient understory vegetation to provide appropriate ground cover. Livestock grazing has very little influence on these sites and, consequently, it is impossible to improve ground cover through grazing management. These sites may have high potential for increasing ground cover and reducing runoff with mechanical or prescribed burn treatments.

Mechanical land treatments involve soil tillage techniques such as contour furrowing, ripping, and pitting. Tillage is generally applied to increase infiltration volumes. This may be accomplished by increasing infiltration capacities or depression storage (the time available for infiltration) or both. When successful, runoff and erosion can be reduced.

Salinity benefits will be proportional to the amount of salt in the controlled runoff and sediment. If improved soil moisture regimes improve vegetation cover, benefits derived from land treatments may be sustained indefinitely, given compatible subsequent land-use management. If improved cover is not achieved or maintained, benefits from land treatments may be short-lived.

Structural Techniques. Common structural techniques used in managing runoff, sediment, and salt yields include rangeland dikes, retention plugs, retention and detention reservoirs, and gully plugs. Retention and detention structures trap runoff and sediment volumes in accordance with their design capacities. Generally, total runoff retention is required for a structure to effectively control salinity. Gully plugs usually have small retention capacities, but provide salt and sediment control by reducing erosion in active gully systems.

In addition to effectively controlling downstream impacts associated with runoff, erosion, and salinity processes, retention/detention structures may provide local benefits. Reservoirs provide water for livestock and wildlife. Even after filling with sediment, they may provide a riparian-like habitat. Gully plugs, when properly located, can cause

overincised channels to aggrade, and if conditions are adequate, result in the creation or restoration of streamside riparian zones.

Reservoirs are as efficient in controlling salinity as they are in trapping runoff and sediment and should be impermeable to avoid leaking salt through the subsurface. While a retention structure will cease to function for salinity control after it is filled with sediments in excess of its design capacity, a proper spillway will keep the structure from failing and becoming a future source of salt and sediment. Maintenance of retention structures—either by excavating stored sediments or by increasing structure height—will allow the structures to function beyond their original design life.

In strongly saline areas, retention structures may be the only practical management alternative. However, structure maintenance problems in saline sites are often severe. The feasibility of constructing these types of structures depends upon identifying secondary benefits such as flood control, water supply, and wildlife habitat. In less saline areas, onsite benefits to water supply, vegetation production, and riparian enhancement often will be greater than in highly saline areas, but mechanical treatments and vegetation management also may be more feasible treatment strategies, depending upon the management objectives.

Elephant Skin Wash salinity control verification project near Montrose, Colorado.

Energy and Minerals Management

The Bureau of Land Management administers the leasing of all Federally owned mineral resources. Coal, oil, gas, and oil shale development in the Colorado River basin can contribute salt to the Colorado River. Fossil fuel resources are located in marine-derived formations that are high in soluble salts. Salinity can be increased by the dissolution of minerals, or by consumption of good quality water during extraction of the resource. Any disturbance of saline formations will allow additional soluble minerals to enter the basin's water systems.

Salinity increases resulting from coal mining include:

-leaching of coal spoil materials,
-discharge of saline ground waters, and
-increased sediment yields resulting from surface-disturbing activities.

Spoil materials have higher permeabilities than similar undisturbed areas, allowing most of the precipitation falling onto spoils to infiltrate. The water percolates through the unconfined spoils encountering more mineral surfaces. The water moves vertically until it encounters undisturbed bedrock. The bedrock will be less permeable than the spoil material, creating a spoil pile aquifer. This increase in contact surfaces and residence time allows greater opportunity for dissolution of these soluble minerals. At some time in the future, the saturated spoils will begin discharging to the surface water systems.

Studies conducted on post-mining spoils in northwestern Colorado indicate that dissolved solids concentration of waters flowing from these spoils range from 3,000 to 3,900 mg/1. Salinity concentrations flowing from spoils vary depending on water residence time and the chemical and physical properties of the spoils.

Increased dissolved solids concentrations resulting from leaching of spoil materials can last for thousands of years. The time required to reduce the dissolved solid concentrations to pre-mining levels is dependent on spoil pile size, porosity of the spoils, and the annual precipitation of the area. The Bureau of Land Management along with the U.S. Geological Survey's (USGS) Water Resource Division, and Office of Surface Mining, are currently studying the rates of movement of recharge through coal spoils, increases in concentrations of dissolved constituents, regional ground water movement, and crop tolerance. This is the most current stage of the BLM's long-standing efforts with the USGS from 1975 to evaluate the problems related to coal drainage.

The dewatering of coal mines may increase salinity concentrations in the Colorado River. The disposal of the water is necessary if the volume exceeds the needs of the mine itself. The discharge of excess water to receiving waters requires a National Pollutant Discharge Elimination System (NPDES) Permit as required by the Clean Water Act.

Before a coal lease is issued, an environmental analysis is conducted to assess the impacts associated with the leasing action. Increased salt loading to the Colorado River is analyzed and mitigating measures recommended. When the lease is issued, the company completes a detailed mining plan. The Office of Surface Mining is required to complete another environmental analysis prior to issuance of the permit to mine. At the mine-permit analysis stage, specific salt-load analyses are conducted again with mitigation measures incorporated.

Saline waters are also a by-product of oil and gas production. It is not uncommon to produce much more saline waters than oil. The salinity of these production waters varies greatly from location to location and is dependent on the producing formation. Common disposal techniques include injection and disposal in lined and unlined pits.

The approval authority for produced water disposal varies from State to State, with the exception of underground injection which is administered by the State or EPA. The BLM's requirements for production water disposal methods are outlined in Notice to Lessees and Operators of Federal and Indian Oil and Gas Leases No. 2B (NTL-2B).

The disposal of production waters in lined pits relies on evaporation as a water disposal method. For this method, the operator must periodically dispose of precipitated solids and analyze water, type of liner, and leak detection system.

The disposal of production waters in unlined pits is only allowed if an applicant can show that the waters will not harm the environment. If production waters will eventually be discharged to surface streams, a NPDES Permit must be obtained.

Surface disturbance activities associated with drill-pad construction, roads, seismic trails, and pipelines also increase sediment and salt yields. Fragile soil and watershed areas are identified through BLM's planning process. These areas are usually located on steep terrain, sparsely vegetated, and highly erodible. BLM mitigates surface-disturbing activities within fragile soil and watershed areas to prevent accelerated erosion of saline soils.

The future development of oil shale in Colorado, Utah, and Wyoming has the greatest potential of all mining activities to increase the Colorado River's salt loads. These increases result from consumption of good-quality water, mine dewatering, and the leaching of both raw and spent shales.

Recreation Management

Many types of recreation uses such as camping, picnicking, hunting, fishing, river rafting, and off-road vehicle use occur on public lands. Some of these uses may increase salinity by decreasing ground cover and compacting soil, thus increasing sediment and runoff. Through BLM's planning process, sensitive soil areas are identified and conflicts between recreation uses are addressed. Mitigation measures and limitations on amount and location of recreation uses to meet salinity control objectives are developed.

Point-Source Salinity Control

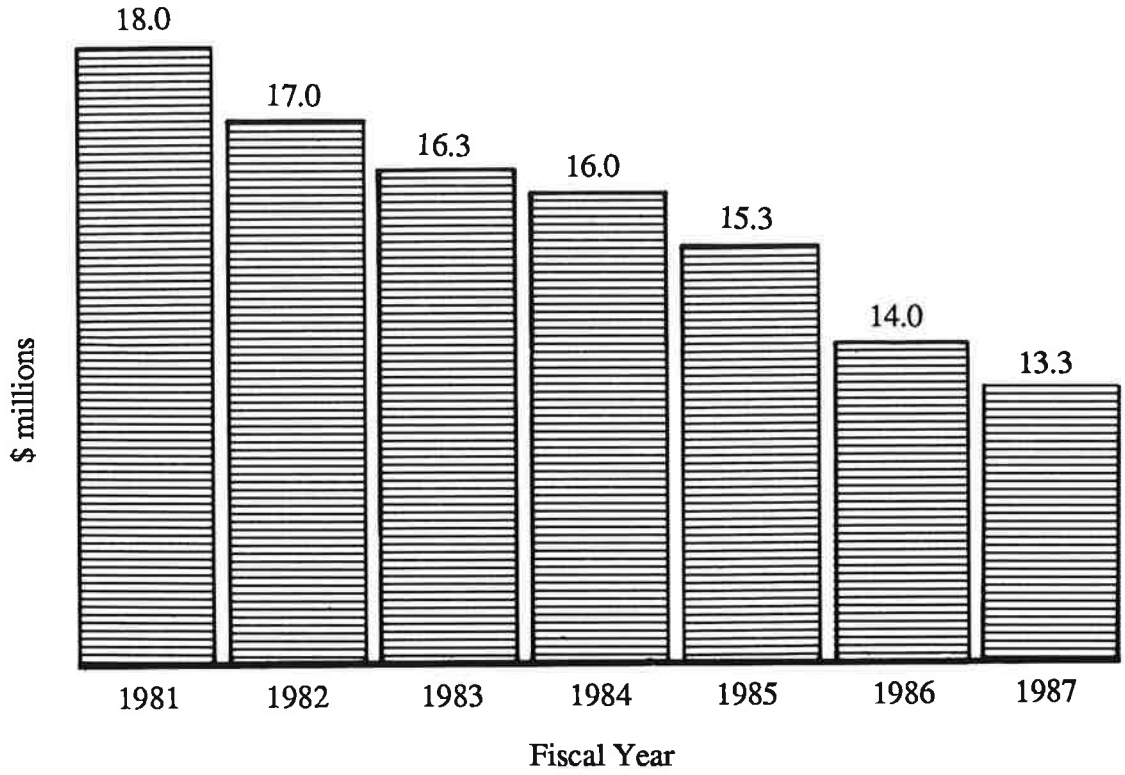
Many point sources exist on the public lands. Point sources can occur as either wells or springs. Several wells have been plugged (see section in Major Salinity Control Accomplishments) and future flowing wells will be plugged as the situation warrants. BLM has developed and currently maintains a water-use inventory to identify and characterize water uses and respective sources on the public lands. Saline springs will be identified through this inventory. Control of saline springs will be analyzed through BLM's planning process, with major sources (for example, Sinbad Valley) brought to the attention of the Bureau of Reclamation.

BLM Salinity Control Budget

The Bureau of Land Management's Colorado River salinity control activities are funded by the Soil, Water, and Air Management programs. Included in the costs of salinity control activities are inventory, planning, monitoring, improvement projects, project maintenance, and program development. As implementation of activities described in this report proceeds, a special effort will be made to identify salinity control funding needs through the normal budget process of requesting funds for soil, water, and air management activities.

Total annual appropriations to soil, water, and air resources programs, excluding the Hazardous Materials program, since Fiscal Year 1981 are shown below. Starting in Fiscal Year 1982, the BLM's general administration costs have been funded by Congress as a separate line item in the budget. 1981 amounts were adjusted by subtracting general administrative costs. Decreases in funding over the last 7 years are due to decreases in appropriations. Also, since 1984, the soil, water, and air resources programs have contributed funding to the BLM Hazardous Waste Management Program.

Soil, Water and Air Budget Authority



MAJOR SALINITY CONTROL ACCOMPLISHMENTS

Since 1975, BLM has invested substantially in the study and control of salinity from both diffuse (nonpoint) overland sources and point sources on BLM lands in the upper Colorado River basin. More than a dozen major studies were conducted from 1975 to 1982 to

-quantify salinity yields from public lands,
-identify salt transport mechanisms,
-describe the effects of livestock grazing on salinity processes, and
-describe the effects of coal mining on salinity processes.

BLM salinity status reports issued in 1978, 1980, and 1984 summarize the results of these studies and describe salinity control strategies on the public lands. Appendix B lists BLM salinity reports.

Additional studies are needed to

-quantify threshold conditions of marine shale stabilities to permit preventive conservation,

-determine effectiveness of various land conservation practices in controlling salt yields and provide a basis for an economic evaluation of erosion control techniques, and

-quantify salinity contribution from ground water flow.

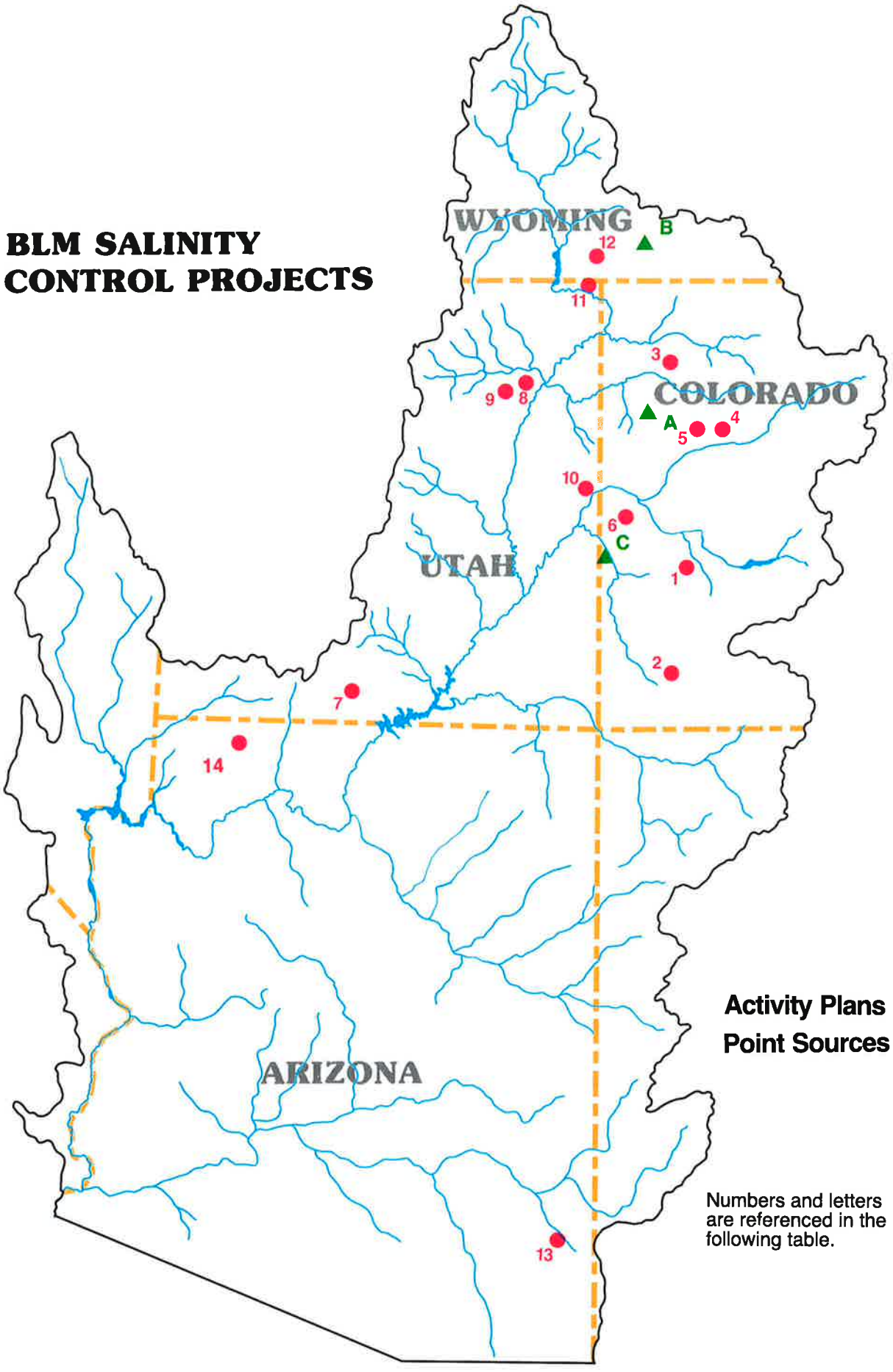
In 1983, BLM's emphasis shifted from studies to the identification and implementation of specific salinity control projects. BLM directed its offices in the upper basin States to identify issues and incorporate them in resource management and activity plans. Potential salinity control projects were identified for the Montrose, Grand Junction, Craig, and Moab Districts.

A total of 12 activity plans in three different States have been completed and partially implemented since 1983, with salinity control as an objective. Two earlier plans have been inplemented in Arizona. The following map identifies the locations of each plan, and the associated table lists objectives, status, and types of controls. The cost effectiveness for the 12 plans ranges from $35 to $60 per ton of salt removed. Total implementation costs of the individual plans may be misleading relative to salinity reduction. Since the plans generally provide multiple resource benefits, the total cost exceeds the cost associated with salinity reduction.

Most of the activity plans rely upon increased vegetation cover to reduce soil erosion and control salinity. Where annual precipitation is less than 12 inches per year, many years are required to verify cover objectives. Estimates of total completion and project verification times in years are included for each of the 12 activity plans.

Development and implementation of additional salinity activity plans is dependent on resource management planning schedules and available funding.

BLM SALINITY CONTROL PROJECTS



Bureau of Land Management Activity Plans			
Project	**Objectives***	**Status**	**Type of Control**
1 Elephant Skin Wash Verification Project Uncompahgre, CO	Reduce salt yields by 3,000 tons. Reduce sediment yields by 100,000 tons. Provide flood control. Increase wildlife habitat.	50% completed 1*C*	structural
2 Spring Creek Basin/ Disappointment Valley San Juan, CO	Reduce salt loads by 8,500 tons. Reduce sediment loads by 280,000 tons. Increase vegetation production. Provide seasonal water for wildlife, wild horses, livestock. Increase wildlife habitat.	Plan approved 10 *C* 20 *V*	vegetative, structural, point source
3 Lower Wolf Creek White River, CO	Reduce salt yields by 3,000 tons. Reduce sediment yields by 100,000 tons. Increase vegetation cover.	50% completed 5 *C* 20 *V*	vegetative, structural
4 Milk and Alkali Creeks Glenwood Springs, CO	Reduce salt yields by 500 tons. Reduce sediment yields by 51,000 tons. Create 1.8 acres of riparian habitat.	33% completed 3 *C*	structural
5 Poison Creek Glenwood Springs, CO	Reduce salt yields by 120 tons. Reduce sediment yields by 27,000 tons. Stabilize 1,300 feet of stream. Create 4.6 acres of riparian habitat. Create 1.9 acres of wetlands.	Plan approved 2 *C*	structural
6 Grand Valley Grand Junction, CO	Reduce salt yields by 5,000 tons annually. Reduce sediment yields by 250,000 tons annually. Increase vegetation cover by 20%.	10% completed 4 *C* 20 *V*	structural, vegetative
7 Round Valley Kanab, UT	Reduce salt yields by 350 tons. Reduce sediment yields by 113,000 tons. Increase vegetation cover.	Plan approved 5 *C* 20 *V*	structural, vegetative

*Salt and sediment reductions are estimates based upon project life unless specified otherwise.

C Years to complete.

V Years to verify objectives.

Bureau of Land Management Activity Plans			
Project	**Objectives***	**Status**	**Type of Control**
8 Pariette Draw Diamond Mountain, UT	Mitigate wildlife losses resulting from Uinta Basin Salinity Control Project.	Part 1 completed 5 *C*	structural
9 Castle Peak Diamond Mountain, UT	Reduce salt yields. Reduce sediment yields. Increase vegetation cover.	Plan approved 5 *C* 10 *V*	structural, vegetative
10 Sagers Wash Grand, UT	Reduce salt yields by 430 tons annually. Reduce sediment yields by 11,000 tons annually. Increase vegetation cover. Increase forage and wildlife habitat.	10% completed 20 *C* 20 *V*	structural, vegetative
11 Red Creek Diamond Mountain, UT	Reduce salt yields by 480 tons. Reduce sediment yields by 24,000 tons. Increase vegetation cover.	33% completed 5 *C* 20 *V*	structural, vegetative
12 Red Creek Salt Wells, WY	Reduce salt yields by 500 tons. Reduce sediment yields by 50,000 tons. Increase vegetation cover.	10% complete 5 *C* 20 *V*	vegetative, structural
13 San Simon San Simon, AZ	Control flooding. Reduce sediment. Reduce salinity. (Current plan does not quantify; it is being updated.)	Completed	structural
14 Fort Pierce Watershed Vermillion, AZ	Control flooding. Reduce sediment. Reduce salinity (Clayhole Basin). Improve watershed condition.	Completed	structural, land treatments
A Piceance Creek Well Rangely, CO	Reduce salt yields by 6,000 tons annually.	Completed	plug
B Bitter Creek Well Rock Springs, WY	Reduce salt yields by 1,000 tons annually.	Completed	plug
C Sinbad Grand Junction, CO	Reduce salt yields by 7,500 tons annually.	Under study	structural

*Salt and sediment reductions are estimates based upon project life unless specified otherwise.

C Years to complete.

V Years to verify objectives.

FUTURE ACTIONS

BLM Salinity Control Implementation Actions

Salinity control activities on public lands in the Colorado River basin are mandated by the Colorado River Basin Salinity Control Act of 1974, as amended (P.L. 98-569). The Bureau of Land Management recommends the following implementation actions be directed through its Soil, Water, and Air Management programs. The objective is to minimize salinity contributions to the Colorado River from public lands while recognizing multiple-use objectives and authorized uses. Proper land use is the BLM-preferred method of achieving salinity control while structural techniques for control will be limited. The planning process is the principal mechanism for the implementation of salinity control actions.

1. All BLM resource areas within the Colorado River basin that contain saline soils will identify and evaluate salinity control activities through the resource management planning process.

2. Plans will address salinity control objectives in a way that enhances and benefits other resource values, including soil stability, riparian resources, wildlife habitat, water quality and supply, and flood control in the management of saline soils.

3. BLM will incorporate salinity control objectives or mitigation into all activity plans involving saline soils. Environmental Assessments will analyze resource impacts to determine salinity increases or decreases resulting from proposed actions where saline soils are included.

4. The BLM's planning process will evaluate salinity control benefits, effectiveness, and costs associated with land management alternatives on all saline soils.

5. Where watershed conditions are unsatisfactory or severely degraded by past management actions and the areas have good recovery potential which cannot be efficiently achieved by modifying land uses that contribute to salt loading, BLM will consider other alternatives such as mechnical land treatments or minor structural methods to reduce salt loading. Whenever possible, these alternatives will be designed to achieve self-sustaining resource conditions requiring little or no future investment in mechanical treatments or structure maintenance.

6. Point-source salinity issues will be identified in the planning process and controlled or managed through resource improvement objectives or mitigative measures. Major sources requiring extensive engineering will be brought to the attention of the Bureau of Reclamation.

7. Continue to develop quantifiable values for sediment and salinity deliveries to the Colorado River from public lands.

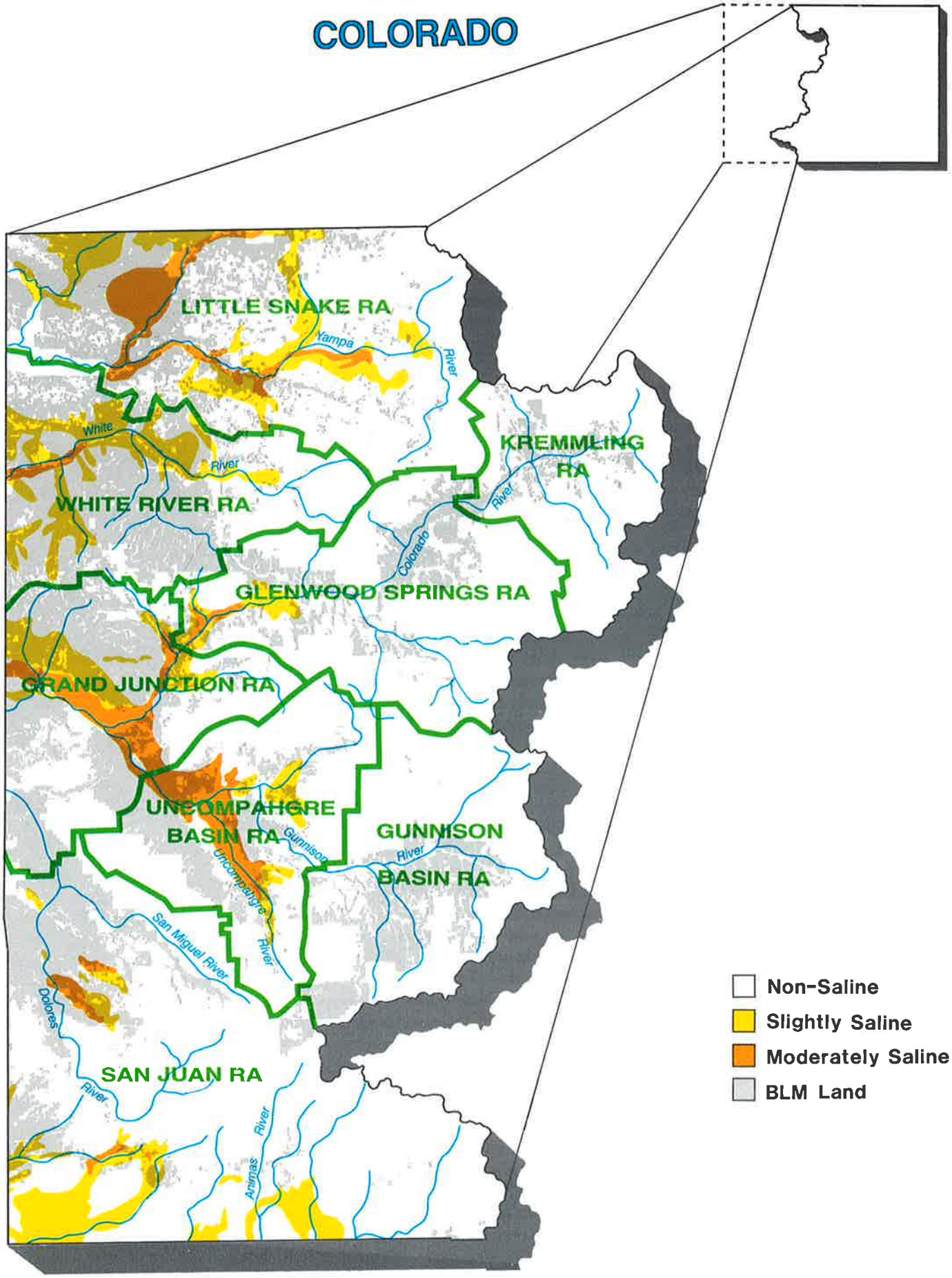
APPENDIX A

This Appendix includes resource management planning and salinity matrices for each of the seven basin States. Each matrix identifies existing plans by resource area, when the plans will be updated, the existence of saline soils by salinity class on public lands, other sources of salinity, whether or not salinity is currently identified and evaluated in the existing plan, and name of any completed activity plan that includes salinity control as an objective.

Soil salinity is indexed by electrical conductivity and the mapping units are defined as follows:

Soil Salinity Class	Electrical Conductivity (umhos/cm)[1]	
	Upper Soil Layer	Lower Soil Layer
Nonsaline	0-4,000	0-4,000
Slightly	4,000-8,000 above 8 in.	4,000 - 8,000 below 8 in.
Moderately	8,000 - 16,000 above 20 in.	>16,000 below 20 in.
Strongly	>16,000	>16,000

[1] Electrical conductivity is measured in micromhos per centimeter of saturation extract at 25°C.


COLORADO
LITTLE SNAKE RA
Yampa
River
White
River
WHITE RIVER RA
KREMMLING
RA
River
Colorado
GLENWOOD SPRINGS RA
GRAND JUNCTION RA
UNCOMPAHGRE
BASIN RA
Gunnison
Uncompahgre
River
GUNNISON
River
BASIN RA
San Miguel River
Dolores
River
SAN JUAN RA
River
Animas
River
Non-Saline
Slightly Saline
Moderately Saline
BLM Land

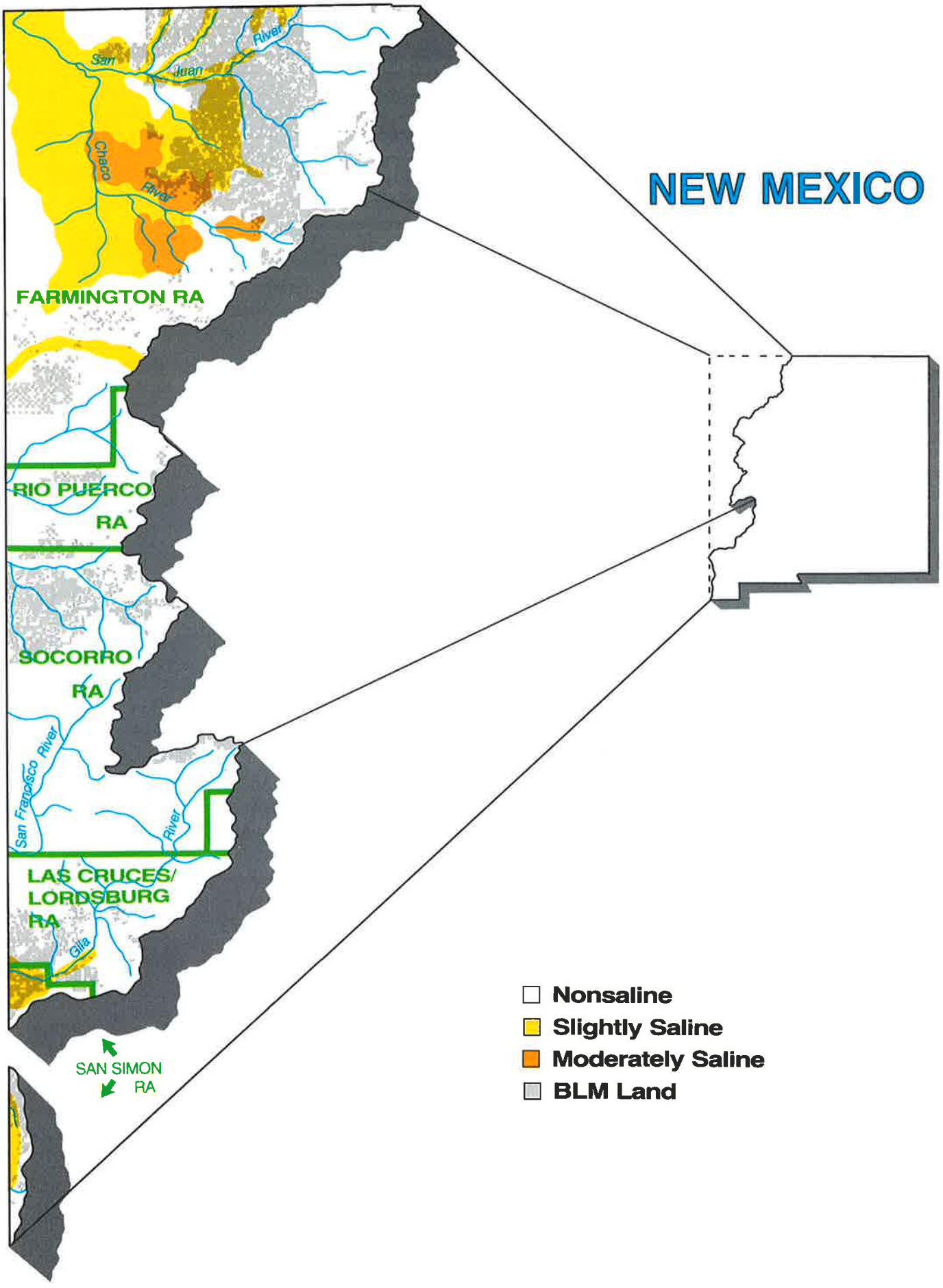
COLORADO
RESOURCE MANAGEMENT PLANNING AND SALINITY MATRIX

Resource Area	Existing Plan	Plan Update	Saline Soils	Other Salinity Sources	Salinity Identified and Evaluated	Activity Plans Completed
Uncompahgre	MFP 1974	RMP 1988	moderately slightly	Spr W		Elephant Skin Wash
San Juan	RMP 1985	RMP 1990*	moderately slightly	Spr W GW	X	Spring Creek Disappointment Valley
White River	MFP 1975	RMP 1991	moderately slightly	Spr C O&G	X	Lower Wolf Creek
Kremmling	RMP 1984	RMP 1989*		Spr C	X	
Little Snake	RMP 1987	RMP 1992*	moderately slightly	C O&G Spr	X	
Glenwood Springs	RMP 1984	RMP 1989*	slightly	Spr	X	Milk & Alkali Creek Poison Creek
Grand Junction	RMP 1987	RMP 1990*	slightly	Spr	X	Grand Valley

O&G Oil and Gas
C Coal
Spr Springs
W Wells
GW Groundwater

RMP Resource Management Plan
MFP Management Framework Plan

*Assumes a 5-year planning cycle.


NEW MEXICO
San Juan River
Chaco River
FARMINGTON RA
RIO PUERCO RA
SOCORRO RA
San Francisco River
Gila River
LAS CRUCES/ LORDSBURG RA
SAN SIMON RA
Nonsaline
Slightly Saline
Moderately Saline
BLM Land

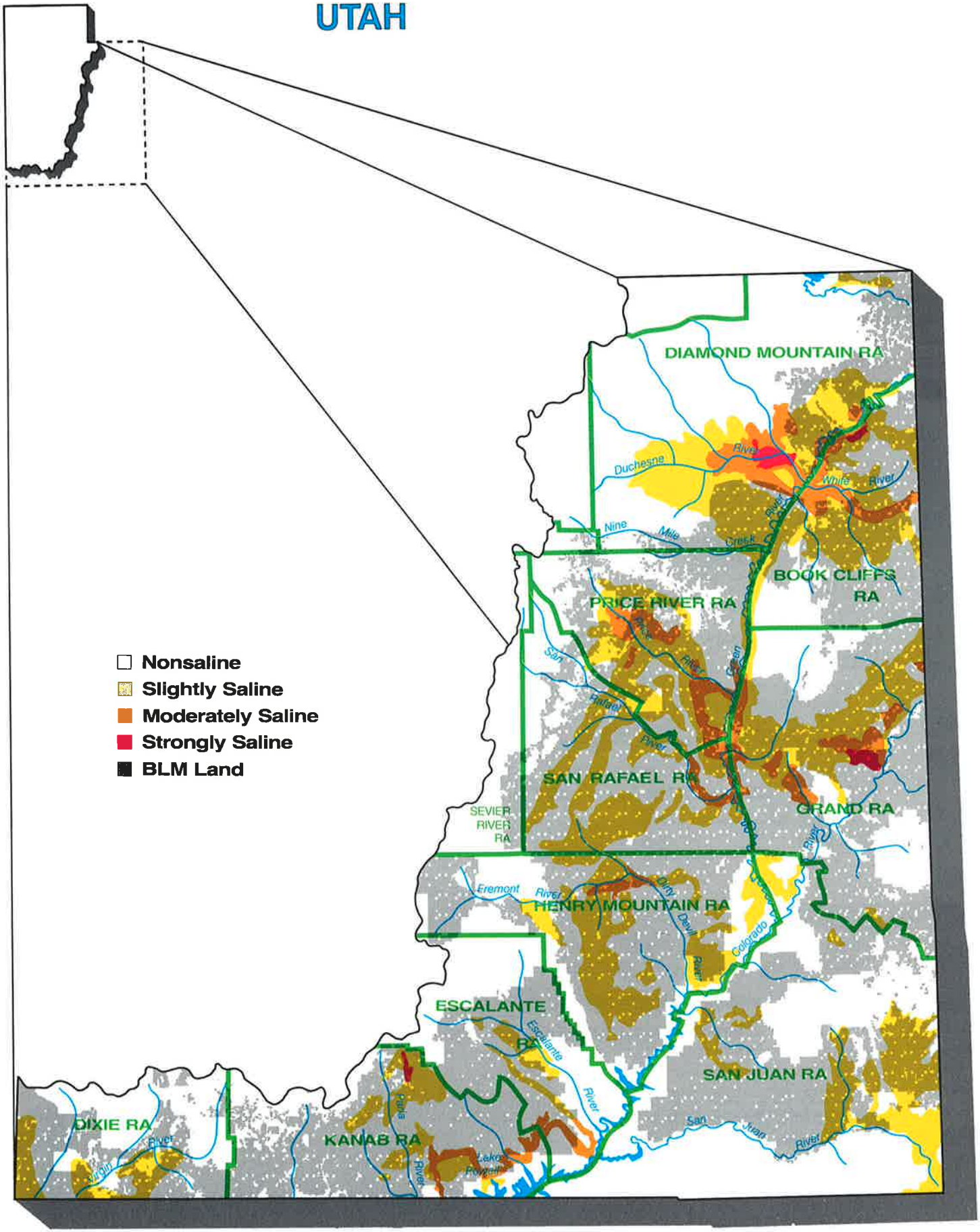
NEW MEXICO
RESOURCE MANAGEMENT PLANNING AND SALINITY MATRIX

Resource Area	Existing Plan	Plan Update	Saline Soils	Other Salinity Sources	Salinity Identified and Evaluated	Activity Plans Completed
Farmington	RMP 1987	RMP 1992*	moderately slightly	Spr O&G C	X	
Las Cruces/ Lordsburg**	MFP 1982	RMP 1988	slightly			
San Simon***	MFP 1973	RMP 1987	slightly		X	
Socorro	MFP 1983	RMP 1988	slightly	C		

O&G O&G
C Coal
Spr Springs

RMP Resource Management Plan
MFP Management Framework Plan

*Assumes a 5-year planning cycle.
**Drains to Gila and enters below Imperial.
***Administered by the State of Arizona.


UTAH
Nonsaline
Slightly Saline
Moderately Saline
Strongly Saline
BLM Land
DIAMOND MOUNTAIN RA
Duchesne
White River
Nine Mile Creek
BOOK CLIFFS RA
PRICE RIVER RA
Price River
San Rafael River
SAN RAFAEL RA
GRAND RA
SEVIER RIVER RA
Fremont River
HENRY MOUNTAIN RA
Dirty Devil River
Colorado River
ESCALANTE RA
Escalante River
SAN JUAN RA
San Juan River
DIXIE RA
Virgin River
KANAB RA
Paria River
Lake Powell

UTAH
RESOURCE MANAGEMENT PLANNING AND SALINITY MATRIX

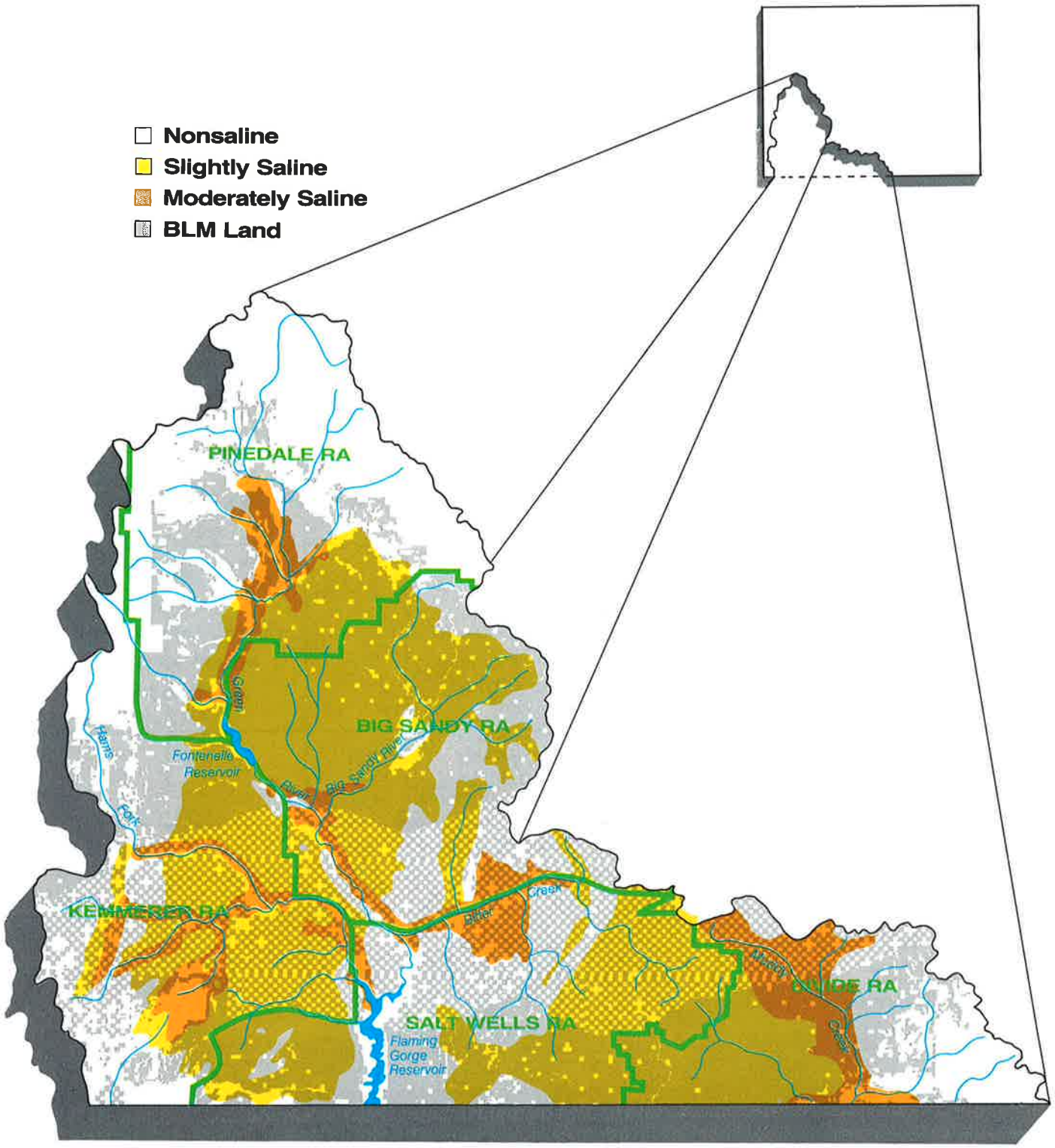
Resource Area	Existing Plan	Plan Update	Saline Soils	Other Salinity Sources	Salinity Identified and Evaluated	Activity Plans Completed
Grand	RMP 1985	RMP 1990*	strongly moderately slightly	**Spr W Str**	X	Sagers Wash
San Juan	RMP 1987	RMP 1992*	slightly	**Spr W**	X	
Price	MFP 1982	RMP 1990	strongly moderately slightly	**Spr W Str**	X	
San Rafael	MFP 1979	RMP 1988	strongly moderately slightly	**Spr W Str**	X	
Dixie	MFP 1977	RMP 1988	moderately slightly			
Kanab	MFP 1981	RMP 1989	strongly moderately slightly		X	Round Valley
Escalante	MFP 1981	RMP 1988	slightly		X	
Henry Mt.	MFP 1984	RMP 1989*	moderately slightly	**Str**		
Book Cliffs	RMP 1985	RMP 1990*	strongly moderately slightly	**Spr Str O&G**		
Diamond Mt.	MFP 1982	RMP 1988	strongly moderately slightly	**Spr Str O&G**	X	Pariette Draw Castle Peak Red Creek

O&G Oil and Gas
W Wells
Spr Springs
Str Streams

RMP Resource Management Plan
MFP Management Framework Plan

*Assumes a 5-year planning cycle.

WYOMING


Nonsaline
Slightly Saline
Moderately Saline
BLM Land
PINEDALE RA
BIG SANDY RA
Green
Fontenelle Reservoir
Big Sandy River
Hams Fork
KEMMERER RA
Creek
SALT WELLS RA
Flaming Gorge Reservoir
Creek

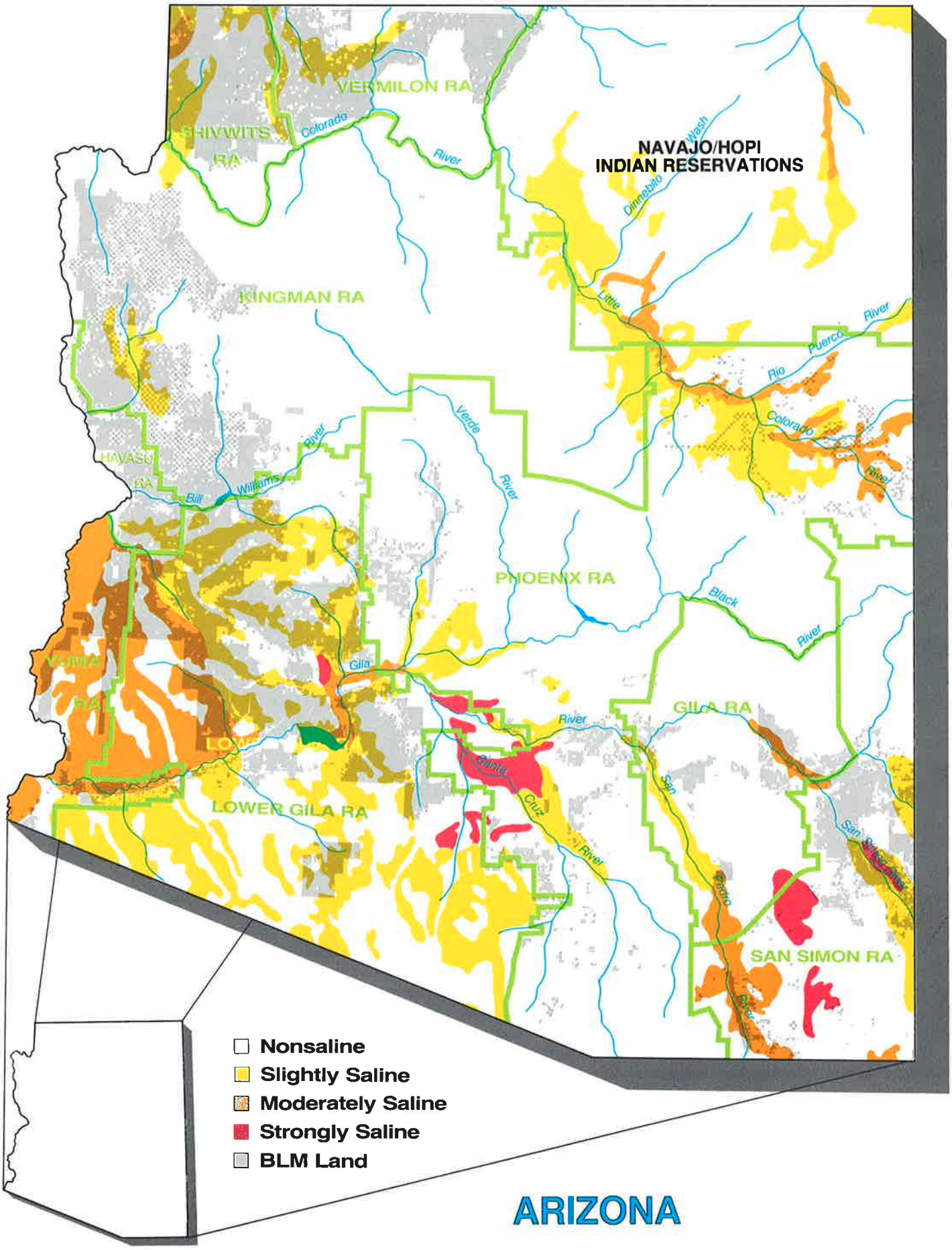
WYOMING
RESOURCE MANAGEMENT PLANNING AND SALINITY MATRIX

Resource Area	Existing Plan	Plan Update	Saline Soils	Other Salinity Sources	Salinity Identified and Evaluated	Activity Plans Completed
Big Sandy	MFP 1982	RMP 1987	moderately slightly	S O&G IRF	X	
Salt Wells	MFP 1982	RMP 1989	moderately slightly	O&G C Spr		Red Creek
Divide	MFP 1983	RMP 1987	moderately slightly	O&G Spr IRF C		
Kemmerer	RMP 1986	RMP 1990*	moderately slightly	C O&G Spr	X	
Pinedale	RMP 1987	RMP 1992*	moderately slightly	S	X	

S	Seeps
O&G	Oil and Gas
IRF	Irrigation Return Flow
C	Coal
Spr	Springs

RMP	Resource Management Plan
MFP	Management Framework Plan

*Assumes a 5-year planning cycle.


VERMILON RA
SHIVWITS RA
Colorado River
NAVAJO/HOPI
INDIAN RESERVATIONS
Dinnebito Wash
KINGMAN RA
Little Puerco River
Rio Puerco
Colorado River
Verde River
HAVASU RA
Bill Williams River
PHOENIX RA
Black River
YUMA RA
Gila River
GILA RA
LOWER GILA RA
Santa Cruz River
San Pedro River
SAN SIMON RA
Nonsaline
Slightly Saline
Moderately Saline
Strongly Saline
BLM Land
ARIZONA

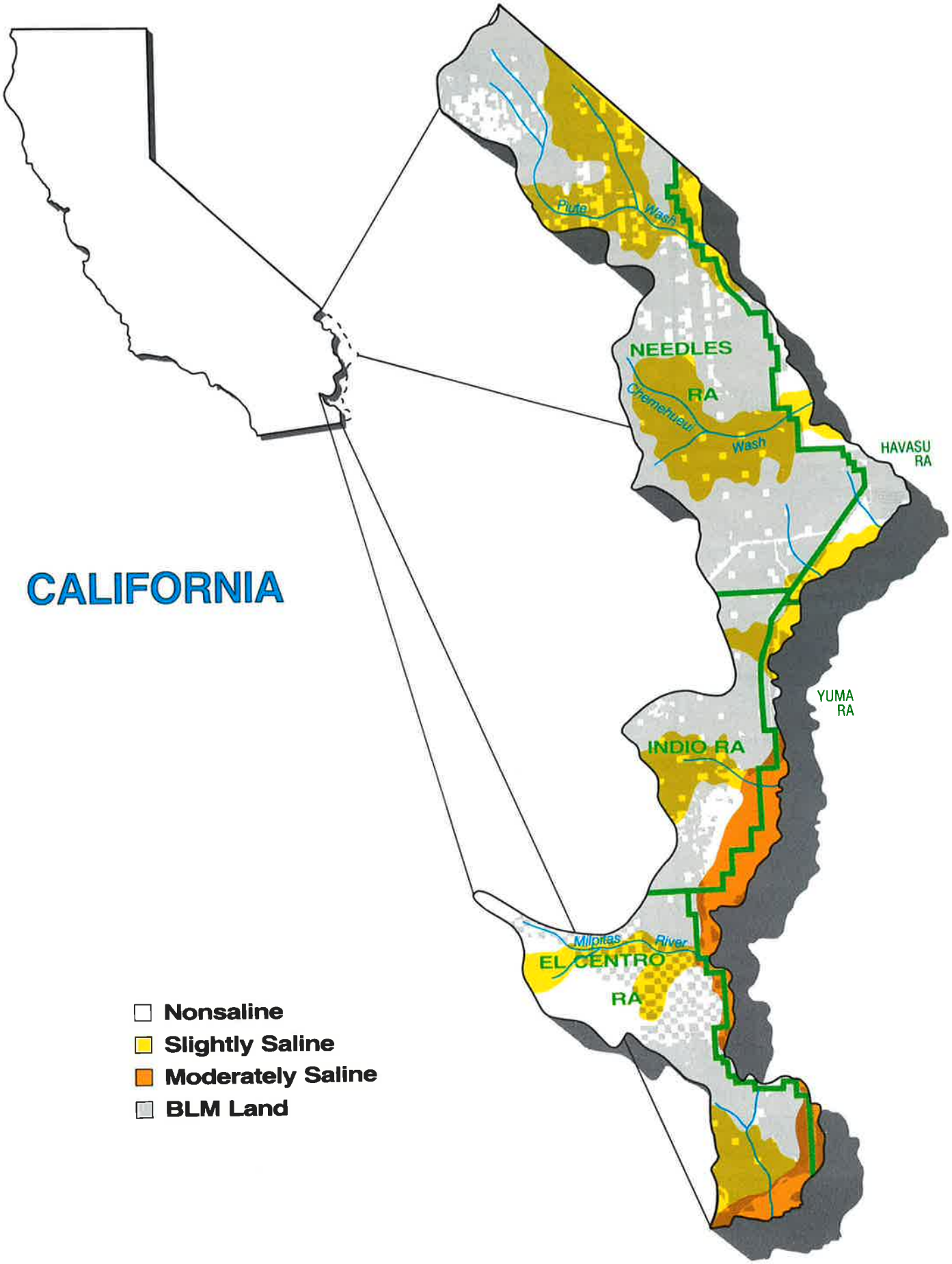
ARIZONA

RESOURCE MANAGEMENT PLANNING AND SALINITY MATRIX

Resource Area	Existing Plan **	Plan Update	Saline Soils	Other Salinity Sources	Salinity Identified and Evaluated	Activity Plans Completed
Shivwits***	MFP 1981	RMP 1989*	moderately slightly			
Vermillion***	MFP 1979	RMP 1989*	slightly		X	Fort Pierce
Lower Gila	RMP 1987	RMP 1992*	strongly moderately slightly			
	MFP 1983	RMP 1990*	moderately slightly			
Phoenix	RMP 1988	RMP 1993*	strongly moderately slightly		X	
Kingman	MFP 1980	RMP 1991*	slightly		X	
San Simon***	MFP 1973	RMP 1990*	moderately slightly		X	San Simon
	MFP 1974	RMP 1990*	slightly			
Gila***	MFP 1985	RMP 1990*	strongly moderately slightly		X	
	MFP 1981	RMP 1990*	moderately slightly			
	MFP 1973	RMP 1990*	strongly moderately slightly			
Yuma***	RMP 1986	RMP 1991*	moderately slightly			
Havasu***	RMP 1986	RMP 1991*	moderately slightly			

RMP Resource Management Plan MFP Management Framework Plan

*Assumes a 5-year formal monitoring review.
**Subparts of resource areas used for planning under the MFP system.
***Districtwide RMP.

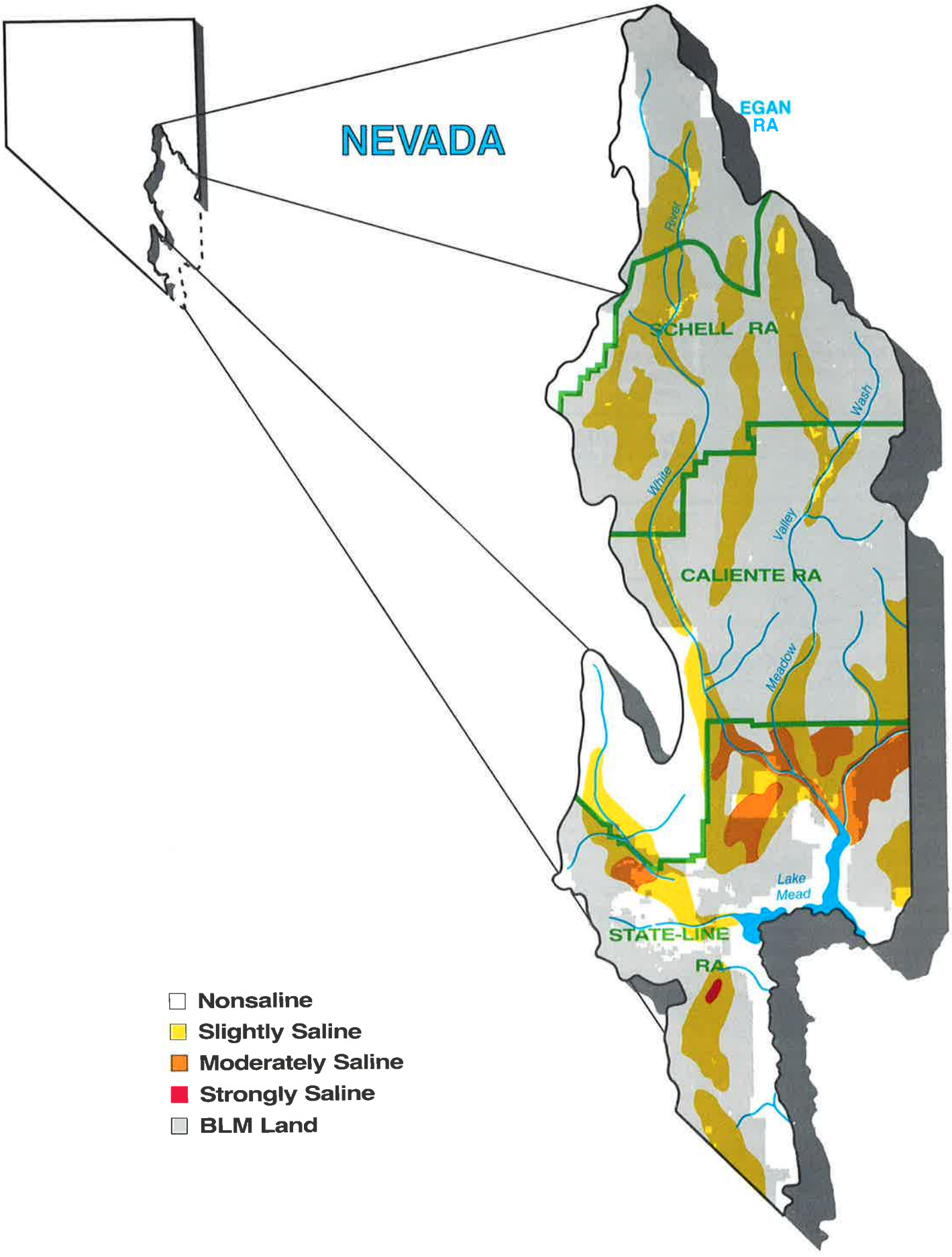

CALIFORNIA
Piute
Wash
NEEDLES
RA
Chemehuevi
Wash
HAVASU
RA
YUMA
RA
INDIO RA
Milpitas
River
EL CENTRO
RA
Nonsaline
Slightly Saline
Moderately Saline
BLM Land

CALIFORNIA
RESOURCE MANAGEMENT PLANNING AND SALINITY MATRIX

Resource Area	Existing Plan	Plan Update	Saline Soils	Other Salinity Sources	Salinity Identified and Evaluated	Activity Plans Completed
El Centro	Desert Plan 1980**	Yearly ***	moderately slightly			
Indio	Desert Plan 1980**	Yearly ***	slightly			
Needles	Desert Plan 1980**	Yearly ***	slightly			
Yuma****	RMP 1985	RMP 1990*	moderately slightly			
Havasu	RMP 1985	RMP 1990*	slightly			

RMP Resource Management Plan

*Assumes 5-year planning cycle.
**Covers several resource areas; specific to California.
***Amended to specific items already addressed in the document.
****Administered by the State of Arizona.


NEVADA
EGAN RA
SCHELL RA
CALIENTE RA
STATE-LINE RA
Lake Mead
Meadow
Valley
Wash
White
River
Nonsaline
Slightly Saline
Moderately Saline
Strongly Saline
BLM Land

NEVADA
RESOURCE MANAGEMENT PLANNING AND SALINITY MATRIX

Resource Area	Existing Plan	Plan Update	Saline Soils	Other Salinity Sources	Salinity Identified and Evaluated	Activity Plans Completed
Caliente	MFP 1982	RMP 1987*	slightly			
Stateline	MFP 1982	RMP 1988*	strongly moderately slightly	**Spr**	X	
Egan	RMP 1987	RMP 1992*	slightly			
Schell	MFP 1983	RMP 1988*	slightly	**Spr**		

Spr Springs

RMP Resource Management Plan
MFP Management Framework Plan

*Assumes a 5-year planning cycle.

APPENDIX B

Bureau of Land Management Salinity Reports.		
Date	**Title/Reference**	**Contents**
1975	Salinity and sediment study: upper Colorado River basin. U.S. Department of the Interior (**USDI**), Bureau of Reclamation, Salt Lake City, Utah. Contract No. 52500-CT5-1022. BLM Service Center. Denver, CO. 80 pp.	Evaluates salinity classes of upper Colorado River basin soils: Wyoming, Colorado, Utah.
1977	Effects of land processes on the salinity of the upper Colorado River basin. Contract No. 52500-CT5-16, Utah State Univ., Logan, Utah. USDI, BLM Service Center. Denver, CO. 196 pp.	Reviews interactions between sediment and salt transport mechanisms.
1978	The effects of surface disturbance of the salinity of public lands in the upper Colorado River basin. 1977 Status Report. USDI, BLM Service Center. Denver, CO. 180 pp.	Thorough review of the salinity issue on public lands, including management strategies.
1979	Potential of interflow as a salt transport mechanism, upper Colorado River basin. Colorado State University. Contract YA-512-CT6-245. USDI, BLM Service Center. Denver, CO. 52 pp.	Analysis of interflow mechanisms on salt yields.
1980	Control of salinity from point sources yielding ground water discharge and from diffuse surface runoff in the upper Colorado River basin. 1978-79 Status Report. USDI, BLM Service Center. Denver, CO. 37 pp.	Analysis of point-source salinity issues on public lands.
1982	QWSALT: A FORTRAN program for the analysis of point source discharges for salinity control. USDI, BLM Service Center. Denver, CO. unpubl. report 12 pp.	Analyzes daily streamflow and dissolved solids data and sizes evaporation ponds for salinity control.

Bureau of Land Management Salinity Reports (continued).		
Date	**Title/Reference**	**Contents**
1982	Runoff and water quality from three soil landform units on Mancos shale. Water Resources Bulletin, 18(6) pp. 995-1001.	Results of rainfall simulator studies on saline soils near Woodside, Utah.
1982	Potential of water and salt yields from surface runoff on public lands in the Price River Basin. UWFL/P-82/01, Utah State Univ., Logan, Utah. 94 pp.	Assessment of salinity-producing mechanisms in surface runoff.
1982	A study of runoff and water quality associated with the wildlands of Price River Basin, Utah. Uintex Corporation, Salt Lake City. Contract No. YA553-CT1-1064. USDI, BLM Service Center. Denver, CO.	Review of 11 site-specific salinity studies in Eastern Utah and Western Colorado.
1982	Development of small-plot rainfall simulation devices to study effects of livestock grazing on infiltration rates, runoff, sediment yields, and salinity of surface runoff from Mancos shale-derived soil. Simons and Li Associates, Ft. Collins, CO. Contract No. YA553-CTO-1069. USDI, BLM Service Center. Denver, CO.	Controlled study of the effects of livestock grazing on salinity runoff.
1982	Salinity control projects: eastern Utah. USDI, BLM Service Center. Denver, CO. unpubl. report. 12 pp.	Review of potential salinity control projects.
1982	Salinity control projects: Grand Junction District. USDI, BLM Service Center. Denver, CO. unpubl. report. 18 pp.	Review of potential salinity control projects.
1982	Sinbad Valley salinity report. USDI, BLM Colorado State Office and Grand Junction District Office. unpubl. report. 16 pp.	Review of alternatives for controlling salinity from a saline spring.
1983	Book Cliffs, Utah soil survey. USDI, BLM Service Center. Denver, CO. 61 pp.	Study of soil-landform-salinity associations on Mancos shale.
1983	Analysis of salt yields associated with the construction and operation of Pariette Draw Wildlife Area, Utah. **In:** Proc. Int. Symp. on State of the Art Salinity Control. July 13-15, 1983. Ann Arbor Press.	Reviews the effects of construction and operation of a riparian-type wildlife management area on salt yields in Pariette Draw.
1983	Salinity control projects: Montrose District. USDI, BLM Service Center. Denver, CO. unpubl. report. 18 pp.	Review of potential salinity control projects.

Bureau of Land Management Salinity Reports (continued).		
Date	**Title/Reference**	**Contents**
1983	Salinity control projects: Craig District. USDI, BLM Service Center. Denver, CO. unpubl. report. 9 pp.	Review of potential salinity control projects.
1984	Storm runoff and water quality on three ephemeral washes: Price River Basin, Utah. Journal of Soil and Water Conservation, 39(3):211-214.	Results of water quality sampling studies on three ephemeral washes in the Price River Basin, Utah.
1984	Elephant Skin Wash salinity control project. USDI, BLM Montrose District, CO. 27 pp.	Plan for Elephant Skin Wash salinity control project.
1984	Analysis of salinity trends in the Colorado River at Imperial Dam with implications for salinity control planning. USDI, BLM Service Center. Denver, CO. unpubl. report. 12 pp.	Review of salinity trends in the Colorado River at Imperial Dam.
1984	Results of Bureau of Land Management Studies on Public Lands in the Upper Colorado River 1980-82 Status Report USDI BLM Service Center, Denver, CO. Technical Note YA-PT-84-008-4340.	Review of Salinity Studies conducted by BLM from 1980-82.
1986	Diffuse-source salinity: Mancos shale terrain. Water engineering and technology. Contract No. CO-910-PH5-591. USDI, BLM Colorado State Office, Denver. 169 pp.	Review of salinity-land form associations on Mancos Shale and rangelands, with management considerations.

APPENDIX C

LEGISLATIVE HISTORY

Three Acts require the Department of the Interior to develop and implement a salinity control program in the Colorado River basin:

Federal Water Pollution Control Act Amendment of 1972	[P.L. 92-500]
Colorado River Basin Salinity Control Act of 1974	[P.L. 93-320]
Colorado River Basin Salinity Control Act Amendment of 1984	[P.L. 98-569]

The Colorado River Basin Salinity Control Forum was established in 1972 as a result of P.L. 92-500. The Forum, representing the seven basin States, has since developed numeric criteria for salinity concentrations in the Colorado River (723 mg/l below Hoover Dam, 747 mg/l below Parker Dam, and 879 mg/l at Imperial Dam).

The Bureau of Land Management intensified its salinity control activities in 1973 when the Assistant Secretary of the Interior for Land and Water Resources directed the BLM and the Bureau of Reclamation to establish a working relationship that integrates reclamation and public land programs to reduce salinity in the Colorado River basin.

Title II of P.L. 93-320 authorized construction of four salinity control units in the basin and required planning reports be completed on 12 other units. The Act required Interior to undertake research on additional methods for salinity control, utilizing the capabilities and resources of other Federal departments and agencies, interstate institutions, States, and private organizations. Title I of P.L. 93-320 authorized the construction, operation, and maintenance of a desalting complex to allow the United States to meet its water quality obligations to Mexico. These obligations are to deliver water with an average annual salinity of no more than 115 parts/million ± 30 parts/million greater than the water arriving at Imperial Dam.

Increased demands for water use, partially resulting from potential energy development, created new water quality pressures on the Colorado River. Because P.L. 93-320 only authorized construction of four salinity control units, salinity management efforts at the time were considered insufficient to control projected salt yields.

In 1982, the seven basin States became concerned that the salinity control standards established by the Forum could be exceeded. As a result, the States (via the Forum) supported the 1984 amendment to the Act. This report has been prepared in direct response to Section 203(b) of the 1984 amendment to the Colorado River Basin Salinity Control Act.

Section 203(b)(3) directed the Secretary of the Interior:

> "to develop a comprehensive program for minimizing salt contributions to the Colorado River from lands administered by the Bureau of Land Management and submit a report which describes the program and recommended implementation actions to the Congress and to the members of the advisory council established by Section 204(a) of this title by July 1, 1987."

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. BLM/YA/PT-87/019+7000	2.	3. Recipient's Accession No.

4. Title and Subtitle
Salinity Control on BLM-Administered Public Lands in the Colorado River Basin

5. Report Date
July 1987

6.

7. Author(s)
Bureau of Land Management

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
U.S. Department of the Interior
Bureau of Land Management
P.O. Box 25047
Denver, CO 80225-0047

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address
U.S. Department of the Interior
BLM, Branch of Soil, Water & Air
Washington, DC 20240

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

This report has been prepared in response to the 1984 amendment to the Colorado River Basin Salinity Control Act (P.L. 98-569). Section 203(b)(3) directed the Secretary of the Interior to "develop a comprehensive program for minimizing salt contributions to the Colorado River from lands administered by the Bureau of Land Management (BLM) and submit a report which describes the program and recommended implementation actions to the Congress and to the members of the advisory council established by section 204(a) of this title by July 1, 1987."

This report describes salinity problems in the Colorado River basin and the BLM's role in controlling salinity. Under the Future Actions section, BLM recommends actions necessary to implement salinity control activities.

17. Document Analysis a. Descriptors

0704 Salinity
0504 Public land
1302 Water quality
0808 0810 Salt water

b. Identifiers/Open-Ended Terms

Colorado River Basin; Salinity control; sediment yield

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release Unlimited	Unclassified	48
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse*

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce