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MANAGING RECLAMATION FACILITIES
ECOSYSTEM BENEFITS

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SUSTAINABLE USE OF THE WEST'S WATER

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I. Introduction

A. Summary

The Bureau of Reclamation constructed over 600 storage and diversion dams, more than 16,000 miles of canals and 37,000 miles of laterals, 280 miles of tunnels, and 52 hydroelectric power plants in the western states since 1902. The construction and operation of these facilities permanently transformed the rivers and streams on which they are located in the process of providing water for 30 million people and 48 billion kilowatt hours of electricity valued at $727 million in 1991. One of the challenges facing the Bureau today is to search for ways to restore and maintain an improved level of ecological functionality and integrity in these water systems.

This presentation summarizes findings from an examination of 15 Reclamation projects and six rivers or river segments with significant water-based ecological problems in which Reclamation project operations play an important role in river management. First the scope of the study is described. Then an overview of three of the studies areas is provided to introduce the nature of the issues. Next, five approaches are discussed through which changes in Reclamation projects could produce enhanced environmental benefits without necessarily diminishing traditional economic benefits: (1) structural changes in project facilities; (2) changes in project operations; (3) improvements in project efficiency; (4) changes in water storage and delivery arrangements; and (5) water marketing. The presentation returns to the three study areas to illustrate the use of these approaches. Finally a number of issues associated with designing and implementing such approaches are identified and discussed.

B. General References

Lawrence J. MacDonnell et al., Restoring the West's Rivers: Opportunities for the Bureau of Reclamation, Natural Resources Law Center Research Report, 1995.

MacDonnell and Teresa A. Rice, "Moving Agricultural Water to Cities: the Search for Smarter Approaches," 2 West-Northwest, pp. 27-54 (1994).

MacDonnell et al., Water Banks in the West, Natural Resources Law Center Research Report, 1994.

MacDonnell et al., Facilitating Voluntary Transfers of Bureau of Reclamation - Water, 2 volumes, Natural Resources Law Center Research Report, 1991.

II. Project Overview

A. The Study Areas

1. The 15 Reclamation Projects/Facilities

a. Rapid Valley Unit and Project, Rapid Creek, SD
b. Nelson Reservoir, Milk River Project, MT
c. Canyon Ferry Dam, Missouri River, MT
d. Hungry Horse Dam, S. Fork Flathead River, MT
e. Glendo Dam, N. Platte River, WY
f. Seminoe to Pathfinder Dam, N.Platte River, WY
g. Upper Arkansas, Fryingpan-Arkansas, CO
h. Dolores Project, Dolores River, CO
i. Rio Chama, Middle Rio Grande Project, NM
j. Fort Sumner to Brantley Dam, Pecos River NM
k. Meeks Cabin Reservoir, Blacks Fork River, Stateline Reservoir, East Fork - Smiths Fork River, Lyman Project, Wy-UT
l. Payette Division, Boise Project, ID
m. Yakima Project, Yakima River, WA
n. Newlands Project, Truckee and Carson Rivers, NV
o. Shasta Dam, Central Valley Project, Sacramento River, CA

2. The Six River Segments

a. The Yakima Basin, Washington
b. The Upper Snake River, Idaho
c. The Truckee and Carson Rivers, California and Nevada
d. The North Platte River, Wyoming and Nebraska
e. The Upper Colorado River, Colorado
f. The Middle Rio Grande, New Mexico

B. Why these projects/areas were selected

1. Projects

a. We contacted Reclamation personnel in all six regions, as well as EPA representatives, seeking recommendations of situations in which Reclamation facilities had changed operation in some manner because of environmental problems or concerns.

b. We took an initial list of 26 Reclamation projects that emerged from this process and narrowed it down to 15, based on preliminary research and telephone calls.

c. We focused on six questions: (1) what is the nature of the environmental problem(s) involved and the environmental benefit(s) sought? (2) what is the relationship between the Reclamation project and the environmental problem? (3) what changes were made or are proposed to be made? (4) what issues were raised by the changes? (5) how were these issues resolved (or are proposed to be resolved)? and (6) what is the present status of the case example?

2. Areas

a. The water resources in all six areas have been intensively developed and economic development in the areas is strongly tied to this development.

b. The Bureau of Reclamation played a central role in the water development and retains an important role in water management.

c. There are prominent water-based environmental problems in each area: the severe decline in salmon populations in the Yakima and the Snake; loss of the Lahontan cutthroat trout and threatened extinction of the cui-ui in the Truckee, of the whooping crane in the Platte, of the squawfish in the Colorado, and the silvery minnow in the Rio Grande.

d. Water development and use provide important economic benefits in all of the areas.

e. The manner of that development and use traditionally has reflected little or no concern with the in-place functions of water -- functions now understood to be valuable in their own right.

3. We did the study in two phases: first, the specific projects and then the area studies. The projects enabled us to focus on more site-specific issues while the case studies enabled us to look more broadly at environmental problems and the role of Reclamation.

III. <u>A Tale of Three Rivers</u>

A. The Truckee and Carson Rivers

1. Between 1903 and 1915 Reclamation constructed facilities in the Truckee and Carson River basins of California and Nevada to provide additional water for the irrigation of lands in the Great Basin of Nevada. Known as the Newlands Project, the original plan was to irrigate more than 200,000 acres of land. In fact, irrigated acreage within the project never exceeded much more than 65,000 acres and today is less than 60,000 acres.

2. The Truckee and Carson Rivers originate in the Sierra Nevadas of California and flow east where they terminate in the hydrolgically closed Great Basin of Nevada -- the Truckee in Pyramid Lake and the Carson in Carson Lake, Stillwater Marsh, and the Carson Sink.

3. Most of the irrigated lands in the Newlands Project are in the lower Carson River basin. Because the supply of water generally is greater in the Truckee River, Reclamation built Derby Dam to divert water out of the Truckee and into the 1,500 cfs capacity Truckee Canal which carries the water 32.5 miles to Lahontan Dam on the Carson River.

4. Efforts to change historical operations of the Newlands Project because of ecological concerns have been actively underway for more than 25 years. Large-scale, essentially unregulated diversions from the Truckee River for irrigation use resulted in an 80-foot decline in the surface level of Pyramid Lake. The Lahontan cutthroat trout went extinct in the 1940s and the cui-ui was placed on the endangered list in 1967.

5. More recently, the unique desert wetlands in the Lahontan Valley (Stillwater and other areas) have been substantially reduced in size because of reductions in imports of water into the Carson Basin, combined with periods of low flows due to drought. Moreover, the annual variation in wetland area has been extreme -- ranging, for example, from 46,000 acres in 1986 to only 20 acres in 1992.

B. The Yakima Basin, Washington

1. Approximately 465,000 acres of land are irrigated in the Yakima Basin. Much of this land, particularly in Yakima County, is high-value agriculture, producing apples and other fruit as well as hops and peppermint. Hay grows well in the agricultural lands of higher elevation Kittitas County. Corn for grain is an important crop in Benton County.

2. Direct flow irrigation from the Yakima River and its tributaries supported more than 100,000 farmed acres around the turn of the century. Most of the additional irrigation development was made possible because of water development by the Bureau of Reclamation.

3. In most years the Yakima Basin drainage produces a lot of water -- calculated by the Bureau of Reclamation to be an annual average of about 3.5 million acre feet. Storage facilities constructed by Reclamation in the basin have a total capacity of about one million acre feet. Each year, at the outset of the irrigation season, Reclamation calculates something called the Total Water Supply Available(TWSA) -- the amount of water available to meet diversion demands by water users with contracts from the Yakima Project. Between 1940 and 1980 the projected TWSA averaged 3,326,000 acre feet annually. In 1993 and 1994 the projected TWSA was about 2 million acre feet.

4. Reclamation holds contracts to supply about 1.7 million acre feet of water each year. Total diversions in the basin probably average well over 2 million acre feet annually.

5. Salmon populations in the Yakima River basin have declined precipitously in this century -- from an estimated 600,000 to 800,000 around the turn of the century to roughly 8,000 today. Water use in the Yakima is by no means the sole reason for the decline in returning salmon populations, but the Yakima contains some of the better salmon spawning habitat still remaining in the Columbia Basin. Thus there is considerable interest in protecting and improving this habitat.

C. The Upper Colorado River, Colorado

1. The Colorado River originates on the western side of the Rocky Mountains within the boundaries of Rocky Mountain National Park. The diversion and use of the water of this river occurred first on a large scale in the Grand Valley, a large, open, relatively flat expanse 30 miles long and roughly 12 miles wide adjacent to the river near the border with Utah. Local efforts had brought perhaps 20,000 acres in the Grand Valley into irrigation prior to Bureau of Reclamation involvement. Water provided through the federal Grand Valley project facilities now supplies about 38,000 acres while the private Grand Valley Irrigation Company supplies perhaps 30,000 acres in the valley.

2. The most significant upstream water development has occurred to enable the transport of the Colorado River water to uses on the Front Range of Colorado. The Denver Water Department diverts on average about 60,000 acre feet of water out of the basin while the City of Colorado Springs transports about 12,000 acre feet per year. The Bureau of Reclamation-constructed Colorado-Big Thompson project removes an annual average of 240,000 acre feet while Reclamation's Fryingpan-Arkansas project takes an average of about 53,500 acre feet each year.

3. Growth in the headwaters counties on Colorado's West Slope, primarily associated with recreation and tourist development, now is demanding a still relatively modest but increasing portion of the river's water.

4. A minnow now limited to portions of the Colorado River Basin above Lake Powell once grew up to six feet long, weighing 80 to 100 pounds. Named the Colorado squawfish, that minnow was listed as endangered in 1967. Together with three other endangered fish species -- the humpback chub, the bonytail chub, and the razorback sucker -- the squawfish is the subject of a concerted recovery program established in 1987. A major focus of the recovery program in Colorado is to improve flows of water through a segment of the river regarded as important habitat for the endangered fishes known as the 15-Mile Reach. Flows in this section of the Colorado River are heavily influenced by diversions for irrigation in the Grand Valley.

IV. Approaches for Increasing Environmental Benefits

Our examination of Reclamation projects suggested at least five general approaches involving Reclamation facilities that are being used to improve the ecological condition of rivers in the West: structural changes, operational changes, improvements in project efficiency, changes in water storage and delivery arrangements, and water marketing.

A. Structural Changes in Project Facilities

1. For the most part Reclamation facilities such as storage and diversion dams were designed and constructed with little or no consideration of their environmental consequences. Engineering decisions were based on maximizing economic benefits or meeting other non-environmental objectives.

2. Thus, for example, outlet works at Reclamation dams typically were designed for large volume releases suitable for meeting irrigation demands. Such works may be incapable of providing relatively low flow releases designed simply to maintain minimum streamflow conditions.

Examples: Reclamation has installed new outlet works at Deerfield Dam on Castle Creek in the Rapid Valley Project in South Dakota and at Glendo Dam on the North Platte River in Wyoming in recent years so that minimum flows can be maintained in the rivers below the dams during the non-irrigation season.

3. Outlet works also are designed to enable maximum possible drainage of the reservoir. Thus, they release water from the deepest possible storage level -- also the coldest water. While such cold water releases have produced excellent cold-water sport fisheries below many dams, cold water releases are sometime incompatible with native fisheries accustomed to warmer waters in the summer and fall.

Example: Significant adverse impacts on native fish below Hungry Horse Dam in Montana caused Reclamation to install outlet works capable of releasing water from higher storage elevations.

4. Alternatively, outlet works may exist to facilitate hydroelectric power production. The location of these outlet works may raise problems as well.

Example: at Shasta Dam on the Sacramento River in California, releases through the hydrolectric power turbines took water from higher storage elevations that was too warm for the needs of the salmon.

B. Changes in Project Operations

1. The traditional manner of Reclamation project operations, just as with project design, included little or no consideration of environmental factors. Understandably, operations focused on the best possible way to meet the needs of traditional users. In practice, the operation of water storage and delivery systems is flexible, within certain limits; modifications can, and are, being made that provide enhanced environmental benefits while still meeting traditional project needs.

2. Changing the manner in which water is released from Reclamation dams was perhaps the most widely encountered example. Releases historically have been designed around meeting the demands of project irrigators. The amount and timing of releases were designed to provide the maximum possible amount of water to irrigators for their use. Thus releases were demand driven, without regard for other downstream values.

Examples: Reclamation released water from Pactola Reservoir on Rapid Creek in South Dakota outside the irrigation season only if it was sure it would not impair its ability to fully meet the irrigation demand of users in the Rapid Valley Unit; no attention was given to effects on the downstream fishery. Now Reclamation is working to establish a dedicated pool of water in storage that is itself managed to meet the needs of the fishery. At McPhee Reservoir on the Dolores River in Colorado, built in the 1980s so that environmental reviews had resulted in a rigid, three-tiered minimum bypass flow requirement to protect the downstream fishery, Reclamation has shifted to a dedicated pool of storage water that can be managed flexibly to meet the needs of the fishery according to stream conditions.

3. Changes in historical hydroelectric power operations at Reclamation facilities also are occurring in response to environmental concerns. Perhaps the most

prominent example is Glen Canyon Dam. Lengthy studies of the effects of peaking power operations on the river environment in the Grand Canyon led to changes in the maximum rate of water releases for hydropower purposes and in the ramping rate of those releases. Similarly, the ramping rate at Hungry Horse Dam on the Flathead River in Montana has been moderated. At Kortes Dam on the North Platte River in Wyoming, Reclamation has moved from exclusive peaking power operations to the maintenance of a fixed annual release of 500 cfs in order to benefit the fishery in the "Miracle Mile." At Shasta Dam, as described above, Reclamation stopped utilization of its hydroelectric facilities because water releases through the turbines came from resevoir elevations containing water too warm for the needs of salmon.

4. In addition to changes in releases, changes in storage management can be significant. At Nelson Reservoir in Montana the nesting needs of the endangered piping plover caused a change in the timing with which the reservoir is filled. Traditionally the reservoir was filled in the spring runoff period, a period that coincides with the time the piping plovers build nests on the exposed, gravelly reservoir lakebed -- nests that would then be inundated. Instead the reservoir is filled prior to the nesting season in April and then maintained until completion of nesting in June.

5. Coordinating water management among two or more facilities may provide added flexibility. In the Upper Arkansas River of Colorado, for example, Reclamation utilized its ability to control the timing with which it shifted water from upstream to downstream storage in the Fryingpan-Arkansas Project in a manner that benefits recreational interests. The Fryingpan-Arkansas Project brings water from Colorado's western slope, stores it in reservoirs in the headwaters of the Arkansas and delivers it downstream to meet the needs of irrigators and cities on the eastern plains. Reclamation modified the timing of these downstream deliveries to be able to ensure the maintenance of at least a 700 cfs flow in the Upper Arkansas until August 15th of each year to support very active commercial whitewater rafting uses of this part of the river.

C. Improvements in Project Efficiency

1. The design and construction of Reclamation projects commonly represent a balance between utilization of the best engineering techniques available at the time, and the cost of building and operating the system. Particularly the early projects, designed solely to provide irrigation water, had to be simple and low cost. Storage projects, if they existed at all, were modest, and delivery systems typically were large earthen canals and ditches operating on a continuous flow basis with limited ability to manage or regulate the water once it had been diverted into the system. By today's standards these facilities are regarded as highly inefficient.

2. Efficiency is a tricky subject, however. One irrigator's waste (unused water) is another irrigator's water supply. Irrigators therefore are often quick to argue that, from a system standpoint, there is no inefficient use of water.

3. Another way to think about efficiency is from the standpoint of the stream. In this view, the most efficient system is one that most fully meets all water-based needs, both out-of-stream and instream. This view focuses on flows throughout the length of the stream, not just at return flow points below large irrigation systems. It emphasizes efficiency from the perspective of all valuable uses of water in a system, not just irrigation efficiency. It recognizes the externalities of water uses such as degraded return flows and the temperature changes in the water left instream as well as in the return flows.

4. Efficiency is not an end in itself. It does not create new water. Its importance from an environmental perspective is very site-specific. Water totally diverted out of a watershed is completely lost to that system; efficiency improvements making it possible to reduce such diversions are likely to have benefits for the native watershed. In addition, where large quantities of water are diverted from the river for distribution over a substantial land area, that portion of the river immediately below the diversion structure is likely to show the effects of the diversions. Reducing such diversions can benefit this section of stream.

5. More efficient water use can have adverse environmental consequences as well. For example, phreatophytes such as cottonwoods and willows have grown up along irrigation ditches and at the margins of irrigated fields because of the availability

of water. Wetlands have been created in some settings. Shallow groundwater aquifers are recharged in some locations by the generous use of irrigation water; discharge from these aquifers may maintain a year-round baseflow of water in adjoining streams or may emerge from springs that support unique habitat areas. Many people regard these as positive changes in the natural environment, but they would not exist without the artificial availability of water resulting from "inefficient" irrigation systems and practices.

D. Changes in Water Storage and Delivery Arrangements

1. Reclamation stores water in its impoundments under state-granted water rights. In most cases the water rights are held in the name of the U.S.; in some cases, the water districts hold legal title to the water rights.

2. Reclamation provides water from its facilities on the basis of contracts and other legal agreements with water users. The contracts specify the charges that are to be paid by the users over some term of years, usually 40 (generally intended to be the period in which the construction charges for the facilities are to be paid). In return, the contract specifies the project benefits to be enjoyed by the users -- typically the delivery of some amount of water during some specified period of time for described uses on lands within the project area. In many cases the legal agreement between the U.S. and the water users is not very clear about the quantity of water that is to be provided from the Reclamation project or about the timing with which the water is to be delivered.

3. What is the legally obligated quantity of water that Reclamation must provide from its facilities to water users? Or, viewed another way, what is the legally protected quantity of water that water users must receive? As with many matters of water law, this turns out to be a complex issue.

4. It is basic water law that a user does not hold an absolute right to some fixed quantity of water. Rather the extent of the right always is measured by beneficial use. Section 8 of the 1902 Reclamation Act states that "beneficial use shall be the basis, the measure, and the limit of the water right" that is to be obtained under state water law for Reclamation projects. Thus the first factor to be considered is historical beneficial use.

Beneficial use probably is to be determined on the basis of the law of the state in which the water right is established.

5. Irrigation water rights typically are measured on the basis of the land area that is irrigated and the water needs of the crops that are grown on those lands. Often this measure is described as the "duty" of water. There are two objective factors to be defined in this measure: the precise acreage being irrigated and the evapotranspiration requirements of the particular crops. Both of these factors can be identified with considerable precision.

6. In addition to these more objective factors there is a much less precise third factor: the additional quantity of water necessary to deliver crop irrigation water to the field headgate -- referred to here as "carriage" water. The amount of carriage water required varies primarily as a function of the water delivery system. The greater the amount of seepage, evaporation, evapotranspiration by phreatophytes, and spills necessary to get a unit of water to a headgate the larger will be the carriage water portion of the water delivery commitment.

7. The water user probably is not protected in any fixed amount of carriage water as a part of his water delivery commitment from a Reclamation project. Certainly the user is protected in the continuing availability of enough carriage water to deliver the necessary duty of water at the headgate. And, unless required as a matter of state law, the user is not obligated to make improvements in the delivery water system to reduce the amount of carriage water that is needed. Arguably, however, the U.S. is able to itself make such changes and then make other uses of the saved water.

8. In addition to these largely state law issues, users of Reclamation water are required to use water only on lands legally eligible to receive this water. Thus, Reclamation must have classified the lands as suitable for irrigation. The lands must be within the area to be served by the project. The use must be one authorized for the project. In short, the user must be in compliance with the terms of the contract. Investigations in recent years have revealed widespread "unauthorized" use of Reclamation water. Office of the Inspector General, U.S. Department of the Interior,

Irrigation of Ineligible Lands, Bureau of Reclamation, Report No. 94-I-930, July 1994.

9. Beyond these issues respecting the legal commitments for deliveries of water there are issues concerning the status of *portions* of water stored in Reclamation facilities. Generally water users do not control storage space in Reclamation facilities. Instead Reclamation controls this space, with the commitment to use that space first to provide the contracted-for water. In many cases it is the flexibility in the management of this space that enables Reclamation to make the operational changes described above without infringing on traditional water delivery commitments.

10. Clearly there is a direct correlation between the legally obligated quantities of water Reclamation must deliver and the manner in which it commits storage water to make these deliveries. Reduced carriage water requirements, for example, could make it possible to commit less storage space to delivery of irrigation water.

11. There may be room to revisit assumptions about the management of the flood control pool established in many Reclamation reservoirs. Management of flood control often is under the supervision of the Corps of Engineers. Nevertheless it may be worth reevaluating earlier decisions about the amount of reservoir storage space committed to flood control and the manner is which this space is managed.

12. The entire concept of horizontal pools of water as the means by which reservoirs are managed could be reconsidered. In a world of increasing relative water scarcity it may be time to begin thinking about more well defined allocations of storage space so that choices about water use are better defined. Water banking, discussed in the next section, can provide a mechanism by which this transition could occur.

13. Congress may also assert itself as it did with the Central Valley Project and legislatively allocate a portion of the water storage space to other users. The Central Valley Project Improvement Act dedicated about 800,000 acre feet of yield from that project to fish and wildlife uses, water theoretically not contracted for but in fact potentially providing valuable drought year benefits to existing users.

14. Congress might also choose to revisit the charges assessed on water users for water from Reclamation facilities. As mentioned, at present these charges are fixed by contract between the U.S. and the water districts. For §9(d) repayment contracts, the

charges are based on a calculated portion of the costs of constructing the facilities that is allocated to the water user to be paid (without interest) over a (usually) 40-year period. For §9(e) service contracts, the charges are for the operation and maintenance costs and for some portion of the construction costs to be determined by the Secretary of the Interior. The effect of this approach is that water is provided to users at far below the actual cost of making that water available. Richard Wahl, Markets for Federal Water (1989).

Increasing the cost of Reclamation-supplied water toward its full cost probably would affect water use more than any other single change described in this paper. Faced with this cost, users would be motivated to make the adjustments necessary to bring their use of water into line with the value it adds to their activity. Particularly in irrigation this added cost is likely to force changes in historical water uses.

It has been argued that the Secretary of the Interior does not have the legal authority to impose increased charges for water beyond those provided in existing contracts. Duane Mecham and Benjamin M. Simon, "Forging a New Federal Reclamation Water Pricing Policy: Legal and Policy Considerations," Ariz. State L. J. (forthcoming). At the end of the contract term, however, at least for water service contracts, there appears to be considerable secretarial discretion to establish new contract terms, including charges for water delivery. For repayment contracts, the Secretary's authority to impose charges on water users following completion of the initial payment obligation is less clear.

In any event Congress may itself choose to impose a "surcharge" on the delivery of water from Reclamation facilities to address the additional costs of operating these facilities. In fact such a surcharge initially appeared in the Administration's proposed budget in 1993 but was withdrawn.

E. Water Marketing

1. Voluntary changes of the use of water provided by Reclamation facilities provides still another possible mechanism for environmental enhancements.

2. Project water uses are defined generally in the project authorization and then spelled out more specifically in the contract with the water users. In addition, water uses are identified in the state water right(s).

3. Changing uses of project water has not been an easy matter, but the practice is becoming more common and many of the issues are getting worked out. Marketing of water from Reclamation facilities has been slowly gaining political and water user acceptance in recent years, but still raises major concerns on the part of many interests in the West.

4. The concept is simple: allow voluntary transactions between the holder of a water right and another wishing to make a different use of the right. The transaction can involve an outright sale of the water right, or it can be a lease of the right for another's use during some specified period of time.

5. Because water uses are interdependent, changes of uses are required to go through a review process to assure protection of other water rights and, potentially, other values as well. Changes of use are permitted only so long as they do not injure other water rights such as by diminishing the quantity of water historically available. Because of this requirement, the amount of water that can be changed in use commonly is limited to the quantity historically consumed in the original use.

6. Reclamation must also assure that its contract interests are protected. Thus, for example, it is concerned about assuring continued payment for the use of the water.

7. Water markets have tended to follow the model of permanent purchases of the water right and the change of use of the largest quantity of water legally possible under the water right. If the *original* use is irrigation then irrigated agriculture ceases on the land. In many cases the new use occurs at a different location as well as for a different purpose. In either case the land use changes as well as the water use.

8. Water banks may provide a mechanism by which a greater variety of water marketing arrangements can be facilitated. For example, it may be possible for a district to establish a water bank involving water available to it from Reclamation projects and sell that water under different arrangements to users within or outside the district without substantially reducing the amount of irrigated acreage within the district. See

MacDonnell et al, Water Banking in the West. For environmental uses of water there is the issue of who purchases the water.

V. A Return to the Study Areas

A. The Truckee-Carson

Defining the Delivery and Use Right

1. The first step (in 1967) was to place maximum limits on project diversions -- initially 406,000 acre feet for the roughly 65,000 acres.

2. The maximum diversion amount, especially from the Truckee River, has been in dispute continuously since that time. Litigation by the Pyramid Lake Paiute Tribe has tested: whether irrigated lands within the project area are "bench" or "bottom" (the first entitled to 4.5 acre-feet per acre at the headgate; the second 3.5 acre-feet per acre)(see, e.g. United States v. Alpine Land and Reservoir Co., 887 F.2d 207 (9th Cir. 1989); whether irrigated lands are specifically authorized to receive project water and, if not, whether the water right has been abandoned or may be changed to the existing place of use (see,e.g. United States v. Alpine Land and Reservoir Co., 878 F.2d 1217 (9th Cir. 1989) and 983 F.2d 1487 (9th Cir. 1992); and what specific acreage can be counted in determining the duty of water for delivery purposes (total farm acreage or only that specific acreage actually irrigated).

Structural Changes

3. In 1976, under the authority of the Washoe Project, Reclamation constructed Marble Bluff Dam on the Truckee River three miles above Pyramid Lake. The purpose of Marble Bluff Dam is to stabilize the downcutting of the river bed caused by the long-term decline in the surface elevation level of the lake. The soils in this area are highly erodible. As the lake level dropped, a delta with numerous small channels formed in the stream above the lake. These small channels tend to be shallow, impeding passage of fish out of the lake and up the river to spawn.

4. By controlling the rate at which water passes through this delta area, Marble Bluff has slowed the erosion of soils. The dam itself creates an absolute barrier

against fish migration. This problem is addressed through the contruction of an elevator system intended to lift migrating fish up over the dam. In addition, an old Corps of Engineers-constructed channel is utilized as a fish passageway directly from the lake to above the dam. Fish ladders have been constructed in the channel to enable the cui-ui to migrate up the channel.

Operational Changes

5. A unique opportunity existed in the Truckee Basin at the time the problems of the fish in Pyramid Lake started to receive focused attention. Stampede Reservoir, authorized by the Washoe project to provide supplemental irrigation water for projected use in the Truckee Meadows area around Reno, had been completed in 1970. No contracts had been written for the use of the 220,500 feet of usable storage water in the reservoir, primarily because irrigation demands in the Truckee Meadows were declining as the area urbanized. Under pressure from the Pyramid Lake Paiute Tribe the Secretary administratively decided to dedicate the use of this water to recovery of the cui-ui. The 9th Circuit upheld this action as warranted by the direction in the Endangered Species Act that he use all available authority to help in the recovery of endangered species. Carson-Truckee Water Conservancy District, 741 F.2d 257 (9th Cir. 1984).

5. An earlier operational change resulted from the 1967 decision to place limits on the amount of water that could be diverted from the Truckee River. The Truckee-Carson Irrigation District, operator of the Newlands Project, had diverted water from the Truckee during the winter to help run a hydroelectric power plant it operated at Lahontan Dam on the Carson River. Operation of the hydroelectric power facility was limited to the summer months when water was being released from Lahontan Dam for irrigation use.

Efficiency-Oriented Changes

6. In the 1988 Operating Criteria and Procedures (OCAP) Reclamation sought to tie the total quantity of diversions to the system delivery efficiency. Total annual diversions are calculated by multiplying the number of acres entitled to receive irrigation water times the headgate duty of water and then dividing that amount by the

system delivery efficiency "targets." The efficiencies were calculated based on engineering studies. They ratchetted up over a five-year period to about 68 percent, based on assumed gains from system improvements that TCID was to make. More efficient use of water than the target level would be rewarded with additional water; failure to meet the target would cause a reduction in total diversions the following year.

Experience to date with this approach has been difficult to evaluate because the available water supply has been below normal. At a minimum, however, it appears that at least some of the assumptions about efficiency gains that could be made were overly optimistic. The Bureau is spending a million dollars a year in monitoring costs.

Water Marketing

7. The Nature Conservancy and the U.S. Fish and Wildlife Service are purchasing water rights in the Newlands Project and transferring the consumptive use water to the wetlands. The Nature Conservancy and the Environmental Defense Fund instigated a program of purchasing water rights in irrigation use within the Newlands Project and transferring the use of the rights to the Lahontan wetlands in 1988. Now the U.S. Fish and Wildlife Service operates the program, under specific congressional authorization and with federal funding. By October 1993 over 12,000 acre feet of irrigation had been transferred for use in the wetlands.

8. The agricultural community in the Newlands project area is concerned about maintaining its viability in the face of reduced physical supply of water and the sale of water for transfer to other uses.

B. The Yakima

Structural Changes

1. To this point, most of the efforts to protect the salmon in the basin have focused on building fish ladders and other passageways around dams and installing screens across diversion structures. Fish ladders now exist at every diversion structure on the Yakima and its tributaries up to the point of the highest elevation storage structures.

These facilities are often quite elaborate. One estimate is that $70 million has been expended on such changes in recent years.

Operational changes

2. One significant operational change is the "flip-flop" which protects salmon spawning in the upper Yakima River. Operation of the Yakima Project in Washington was changed in 1981 to accommodate the spawning needs of the salmon in the upper Yakima River. In the fall of that year, prior to the usual sharp drop in upstream water releases from Cle Elum Dam to supply downstream irrigation demands, salmon redds were discovered in the bed of the river. A court order required continuation of the releases as necessary through the winter to flush and aerate the redds. The following year Reclamation instituted what is known as the "flip-flop", emphasizing releases of water from the upper Yakima storage earlier in the season and cutting back to release levels that can be maintained through the winter prior to spawning in late summer. Irrigation demands in this period are met as much as possible from storage on the Naches River arm of the system.

Defining Water Rights

3. A water rights adjudication process, now underway for more than 25 years, has essentially confirmed the status quo; the one important outcome of the adjudication is the recognition of a reserved water right in the Yakama Indian Nation to "the minimum instream flow necessary to maintain anadramous fish life in the river, according to annual prevailing conditions."

Efficiency

4. Improved water use efficiency is the major means proposed in the Yakima Basin to improve streamflows for the benefit of the salmon. In 1993 Congress authorized funds to encourage conservation improvements in the Yakima Project with the hope of reducing diversions and improving stream flows. Assuming this program moves forward, it will provide another opportunity to evaluate the efficacy of this approach.

Marketing

5. Very limited water marketing has occurred to date in the Yakima, primarily on an emergency basis to allow "proratible" users to obtain temporary supplies in a drought period. EDF has proposed a water leasing scheme for the basin that would substantially expand opportunities for water marketing.

C. The Upper Colorado

Structural Changes

1. Because of concerns about the amounts of salts returning to the Colorado River with drainage water and return flows from irrigation in the Grand Valley, Reclamation has lined portions of the Government Highline Canal in the Grand Valley Project. It has installed check structures to be better able to deliver water to new laterals that it converted from open ditches to pipes.

Operational Changes

2. For many years the Orchard Mesa Irrigation District utilized a "check" operation at its tailrace (discharge point) from pumps that lift water for irrigation 41 and 130 feet up onto the mesa for distribution through two canals. When in place, the check diverted the discharge of water through a channel 1,200 feet upstream, returning the water to the river above the diversion structure for the Grand Valley Irrigation Company. Use of the check enabled out-of-priority diversion and use of the water without injury to the senior GVIC water right.

Future operation of the check is a central issue in dealing with a large number of water concerns in the Upper Colorado River in Colorado.

3. In 1990, Reclamation began delivering water to the 15-Mile Reach from Ruedi Reservoir, a compensatory storage feature of the Fryingpan-Arkansas Project located on the Fryingpan River. The water comes from uncontracted storage capacity in the reservoir. To avoid the restriction of Colorado's instream flow law that only the state can hold an instream flow right, the water is delivered to the Roller Dam for use at the Grand Valley Power Plant for hydroelectric power generation before released into the Colorado River at the 15-Mile Reach.

Efficiency Changes

4. One of the most intriguing opportunities for achieving environmental benefits through improved project efficiency is at the Grand Valley Project. If reductions in diversions made at the Roller Dam could be kept instream through the so-called 15-Mile Reach, US Fish and Wildlife Service believes that important benefits would result for the endangered Colorado squawfish.

Physically it is possible to reduce diversions without necessarily reducing the quantity of water available at field headgates, but the structural changes in the water delivery facilities are expensive. Moreover, there are major legal issues creating uncertainty about whether reduced diversions could be kept in the river for the benefit of the fish.

VI. Selected Issues

A. Who Pays?

1. Retrofitting existing facilities can be very expensive. The work at Glendo cost $1.5 million. The release system at Shasta is expected to cost $50 million.

The question of who should pay these costs is a difficult one. On the one hand it could be argued that these facilities are not in fact complete until they are capable of being operated in an environmentally acceptable manner (at least from a legal perspective). These are real costs associated with the use of the facilities, and the users should recognize these "exernalities" and, by paying for them, reflect the cost in their use decisions.

On the other hand, the U.S. constructed these facilities to encourage users to make investments that would be facilitated by the availability of water. The facilities met legal requirements when they were built. The repayment contract represents the agreement between the U.S. and the users respecting the total construction costs for which the users were responsible.

Moreover, in addition to the dollar costs there are questions concerning the operational changes that result. For example, what water is being released to maintain minimum stream flows during the winter? Is it water that might otherwise have been available for delivery during the following irrigation season?

2. The most common example of clear economic losses associated with operational changes is the reduction in hydroelectric power generation. The ability to offset this lost benefit reflects in part the fungibility of electricity supply. It may also reflect the extra capacity that has been available in the grid during the 1980s in the West. Alternative supplies of electricity have been available, albeit at a higher cost than the hydropower it is replacing. Federally supplied electricity is becoming less of a bargain, causing its users to pay higher rates and subjecting its supply to potential competition from other sources.

B. Sharing the risks

1. Surprisingly few legal issues arose in the process of making these operational changes. In some cases the apparent reason for the acceptance of the changes was because they were accomplished without affecting traditional economic benefits derived from the project and without costs to the traditional users. For example, if water released during the winter for minimum flow maintenance from one dam could be captured at a downstream dam and then delivered to users located still further downstream, users were essentially unaffected. In such a case, it appears that two dams are better than one!

2. To a considerable degree the effect of operational changes on water users has not been to force them to reduce their traditional uses in normal years. Rather the effect is to cause water users to share more of the risk of droughts with environmental values. Reclamation facilities were intentionally designed to provide a high level of security of supply to water users. It appears that most of the operational changes to this point have been able to take advantage of the play that exists in the system. As this play is taken up, additional operational changes are likely to produce more legal challenges.

C. Getting the Signals Right

1. There is a schizophrenia among the western states concerning their approach to water use. On the one hand there is a long-standing legal requirement that

water rights must be used or they will be lost. Moreover, "waste" of water is roundly condemned. On the other hand, only a few states have given clear legal signals to water users that they will be rewarded if they make more efficient use of the water they divert. The law of most states, probably including Colorado, suggests that more efficient use of water simply benefits junior appropriators. Obviously there is not a lot of incentive to expend time and effort improving one's water use system if the benefits go to someone else. This is as true for the Bureau of Reclamation as for any individual irrigator.

2. Some legal issues still remain, potentially impeding the transfer of Reclamation project water to other uses. These impediments (such as whether the project is authorized for such uses, whether the new use must be within the project service area, whether the existing contract must be modified to allow the transfer, what payment obligations should attach to the new use, what third party mitigation requiremnts should be included, etc.) all have been successfully surmounted, however, when the various interests involved support the transfers.

D. Equity

1. Change of any kind raises issues of fairness. Who bears the burdens of change? Who receives the benefits? Traditional Reclamation project beneficiaries probably see little to be gained by changes that benefit the environment.

2. In fact, such changes should seek to produce such benefits wherever possible. For example, project changes may make water user systems more efficient, requiring less manual maintenance and upkeep, and providing more automated operations so less time and money is spent in water management. Revenues may be available by selling or leasing a portion of the historically used or carried over water supply.

3. Even voluntary water marketing, however, raises a number of issues. At its most basic the concern about water marketing boils down to control. The logic of a market is that decisions are based largely on price. Water in the West has never been allocated on that basis, and many people are uncomfortable with the idea. Irrigators fear that interests with money will be able to buy control of the streams, control that they have exercised for more than 100 years in many parts of the West. Of course,

markets also are voluntary -- no one has to sell water to which they have a legal right and no one has to buy water.

Transactions occur only if the participants find mutual advantage in moving forward. But there is no doubt that, generally speaking, irrigation use of water produces relatively low economic returns compared to household or commercial uses. If all available water supplies were somehow put up for bid every year in an auction, considerably more water would go to uses other than irrigation than is presently the case.

There is a critical need to find water marketing arrangements that go beyond the traditional permanent purchase of water rights that includes permanently removing land from irrigated agricultural use. See MacDonnell & Rice, "Moving Agricultural Water to Cities: the Search for Smarter Approaches," 2 West-Northwest pp.27-54 (1994).

V. Conclusion

Among the "new" responsibilities for the Bureau of Reclamation as it moves away from project construction and toward area management is one as steward for the rivers of the West in which it operates. While continuing to meet its traditional commitments, Reclamation now is broadening its view of its role and the interests that its project should seek to serve. Reclamation should set for itself a goal of restoring and maintaining the ecological integrity of the the western rivers that its facilities regulate. In some of these rivers, Reclamation so controls the river's flows that changes in Reclamation facilities alone can make signficant improvements. In most cases, however, there are many factors affecting the ecological viability of a river in addition to those more or less under Reclamation's control. Nevertheless, Reclamation should assume a position of leadership -- through partnership -- in taking steps necessary to assure the long-term sustainability of western waters. In those rivers with Reclamation projects, probably no one better understands how they operate. Armed with this unique knowledge, and sometimes with the direct ability to make necessary changes, Reclamation is well suited to play this role.