Technical and Physical Feasibility Fact Sheet

Alternative 45: Reservoir Management

Acknowledgements: This fact sheet was written by Robert Leutheuser of Leutheuser Consulting as part of the "Evaluation of Alternative Actions for Technical, Physical, Hydrological, Environmental, Economic, Social, Cultural, and Legal Feasibility and Water Quality Issues and Legal Overview" contracted to Daniel B. Stephens & Associates, Inc. The format and organization of the fact sheet and the definition of the alternative were developed by the Water Assembly.

1. Definition of Alternative

A-45: Reduce open water evaporation in storage reservoirs by retaining water at higher elevations or latitudes, or by reducing surface areas.

45A—Move stored water to reservoirs at higher elevations / more northern latitudes:

i. Move water to an *existing storage space*
ii. Move water to *currently unauthorized storage space in an existing reservoir*
iii. Move water to a *new reservoir*

45B—Reduce reservoir surface area for a given volume of water by dredging

45C—Apply surfactant to Elephant Butte Reservoir water surface to reduce evaporation

2. Summary of Alternative Analysis

2.1 Alternative 45A: Move Stored Water to Higher/More Northern Reservoirs

The principal of reducing reservoir losses to evaporation by storing water at higher elevations and/or more northern latitudes is sound. In addition to the locations having lower average annual temperatures, the topography of the landscapes in which the reservoirs are or would be located *generally* tend to provide for a higher volume-to-surface area ratio, which would also contribute to reductions in evaporation per unit of water stored.

2.2 Alternative 45B: Reduce Reservoir Surface/Volume Ratio by Dredging

It is economically infeasible to use dredging as a reservoir management tool to reduce evaporative losses on the large reservoirs that effect middle Rio Grande water management. However, where sediment deposition negatively interferes with a reservoir's mainstem delivery of water due to the formation of deltas, such as at the upper end of Elephant Butte Reservoir, dredging is a viable alternative to improve the efficiency of water delivery to the reservoir

2.3 Alternative 45C: Apply Surfactant to Elephant Butte to Reduce Evaporation

Surfactants that would be effective in reducing evaporative losses from large reservoirs are still in the research stage. It is unknown whether or not such a product will ever be developed. However, because of the potential water savings benefits and potential cost effectiveness, research should be continued in this area. Funding is a limitation, so the supporting public should, in coordination with universities and other research organizations such as Sandia National Laboratories, petition legislators for federal and stated efforts by increasing funding for continued research in this area.

Details and further discussion of these alternatives are provided in Exhibit 45A.

3. Alternative Evaluation

3.1 Technical Feasibility

Enabling New Technologies and Status

45A (Move water). None required.

45B (Dredge). Available technology is not a limiting factor. Equipment is constantly being modernized for widespread dredging applications for river and harbor maintenance, offshore drilling, construction, etc. Conventional equipment such as draglines and amphibious excavators are still used, as well as hydraulic pumps, robotic dredges, and bucket dredges. "Silt curtain" technology has also been developed to contain silts mobilized during dredging operations.

45C (Apply surfactant). A chemical film that creates a molecular monolayer when applied to a water surface to reduce evaporative losses has been developed for small impoundments. In an experimental setting, this commercial product has reduced evaporation on a 7.5-acre pond by 25 to 40 percent. No product is currently available that would be effective on a large reservoir. Sandia National Laboratories has conducted laboratory experiments on two surfactant formulae with encouraging results.

Infrastructure Development Requirements

45A.i (Move to existing storage space). None.

45.A.ii (Move to currently unauthorized storage space in existing reservoirs). Relocation of reservoir-associated facilities; possible relocation of road and private residences.

45.A.iii (Move to new reservoirs). Construction of new dam, reservoir, and appurtenant structures.

45B (Dredge). Any large-scale dredging operation would require the construction of large staging areas for heavy equipment storage, maintenance and repair, fueling, and mobilization, as well as for contractor offices. Fuel storage and dispensing facilities would also be required, as would power lines to service the entire area.

45C (Apply surfactant). None.

Total Time to Implement

45A.i (Move to existing storage space). Total time could be five years to several decades. Institutional critical pathway for Abiquiu Reservoir includes Rio Grande Compact and State of New Mexico storage permits. Same considerations for Cochiti Lake, but add federal legislation and government-to-government negotiations with Cochiti. Pueblo

45A.ii (Move to currently unauthorized storage space in existing reservoirs). Could take ten years to several decades. Same considerations as above, plus need for federal legislation for Abiquiu Reservoir and obtaining flood easements.

45A.iii (Move to new reservoirs). This alternative could take many decades, unless it comes under the auspices of the Homeland Security program.

45B (Dredge). Using 20 cubic-yard-capacity trucks, it would take about 45 years to haul 50,000 acre-feet (ac-ft) of material, running 10 trucks/hour, 24 hours/day, 365 days/year.

45C (Apply surfactant). It is not possible to predict whether or not a surfactant that would be effective on large reservoirs can be developed, much less how long it would take to develop such a product.

3.2 Physical and Hydrological Impacts

Effect on Water Demand

None.

Effect on Water Supply

Increased water supply.

Water Saved/Lost

45A.i (Move to existing storage space). Ranges from a low of about 3,000 ac-ft/yr (moving 50,000 ac-ft to El Vado Reservoir from a more-full Elephant Butte), to a high of 6,200 ac-ft/yr (moving 100,000 ac-ft to Abiquiu Reservoir from a less-full Elephant Butte).

45A.ii (Move to currently unauthorized storage space in existing reservoirs). Ranges from a low of 750 ac-ft/yr (adding 50,000 ac-ft to Cochiti Lake from a more-full Elephant Butte), to a high of 7,300 ac-ft/yr (moving 100,000 ac-ft to Abiquiu Reservoir from a less-full Elephant Butte).

45A.iii (Move to new reservoirs). Moving 100,000 ac-ft to the not-yet-built Wagon Wheel Gap Reservoir could save 11,700 ac-ft/yr.

45B (Dredge). Dredging of 50,000 ac-ft of material from a 150,000 ac-ft Abiquiu Reservoir pool would result in an average annual savings of 1,600 ac-ft of evaporative losses. Dredging 50,000 ac-ft from a 50,000 ac-ft Cochiti Lake pool, thereby doubling the capacity but maintaining the same water surface area, would result in an average annual savings of 4,500 ac-ft.

45C (Apply surfactant). If such a product could be developed, and assuming a reduction in evaporation from Elephant Butte Reservoir of 50 percent (range from 25 to 70 percent), there could be an average annual savings of about 63,500 ac-ft from a 1-million ac-ft Elephant Butte pool.

Impacts on Water Quality

45A.i (Move to existing storage space). None.

45A.ii (Move to currently unauthorized storage space in existing reservoirs). None.

45A.iii (Move to new reservoirs). Reduction of water temperatures below new reservoir. For Wagon Wheel Gap Reservoir, there are no significant impacts on sediments below reservoir because of the paucity of sediment in the system above the proposed location.

45B (Dredge). If dredging occurred "in the wet," there would be an increase of sediments in the reservoir and downstream riverine environment.

45C (Apply surfactant). The commercial product on the market is a food-grade chemical (fatty alcohol) that has received the designation of an "Environmentally Sound Technology" from the United Nations International Environmental Technology Center. Sandia National Laboratories experiments showed no decrease in dissolved oxygen during treatments, and fish in the experimental tanks showed no apparent ill effects.

Watershed / Geologic Impacts

45A (Move). None.

45B (Dredge). The deposition of massive quantities of dredged materials (about 80 million cubic yards) could cause increased sediment inflow from the watershed unless extensive land *surface remediation was undertaken.*

45C (Apply surfactant). None.

3.2.1 Environmental Impacts

45A.i (Move to existing storage space). Alteration of hydrographs between Elephant Butte and "move-to" reservoir. Effects on riverine and riparian communities and on associated endangered species could range from detrimental to beneficial. Impacts on reservoir communities could also be beneficial to detrimental. In total, nature and magnitude of environmental impacts would be largely influenced by the quantities of “moved” storage and the subsequent water management decisions.

45A.ii (Move to currently unauthorized storage space in existing reservoirs). Same as “existing storage space” with additional impacts on the “move-to” reservoir. Lands near Cochiti Lake and Abiquiu Reservoir that have never been inundated or have been subject to inundation only by shorter duration flood storage events, would be subjected to prolonged inundation. There would be a loss of terrestrial ecosystems during inundation, and a permanent change in these ecosystems during periods of lower water levels. The reservoirs’ aquatic ecosystems would be enlarged and would benefit. Elephant Butte would generally have less water, and the impacts on the more perennially exposed delta area could be beneficial with active management.

45A.iii (Move to new reservoirs). Same as “existing storage space” plus complete direct alteration of the reservoir site and long-term secondary impacts to the area due to anticipated population influx. Downstream riverine and riparian environments would be altered in response to changes in the hydrographs.

45B (Dredge). The most enduring environmental impacts would be associated with the spoil site permanently altering the landscape. Because of the volume of material to be moved, the construction activities, in and of themselves, would be significant. If sediments were mobilized and transported into the downstream riverine environment, the impacts to the aquatic ecosystem would be devastating.

45C (Apply surfactant). To date, no adverse environmental impacts have been identified.

Implications to Endangered Species

Depending on decisions regarding how saved water is managed, impacts to endangered species in the riverine and riparian ecosystems (Rio Grande silvery minnow and Southwestern willow flycatcher) could either be beneficial to detrimental.

3.3 Financial Feasibility

3.3.1 Initial Cost to Implement

45A.i (Move to existing storage space). If terms of current temporary storage agreements for El Vado Reservoir were obtained for the City of Albuquerque's space in Abiquiu Reservoir, implementation would cost about $130/ac-ft of water saved per year. For the 18,000 ac-ft of storage space managed by the U.S. Army Corps of Engineers (USACE), it would cost about $5 per ac-ft per year (ac-ft/yr) for the 1,000 ac-ft of water saved annually through reduced evaporation.

45A.ii (Move to currently unauthorized storage space in existing reservoirs). Based on a 1987 USACE report, the average annual cost of adding storage space to Abiquiu Reservoir was about $30 to $35 per acre foot of stored water (adjusted to 2002 dollars for inflation only). This would result in a cost of about $440 per ac-ft of water saved per year. These estimates could be quite low, as the costs for obtaining easements have certainly increased much more than the rate of inflation.

45A.iii (Move to new reservoirs). Using the Bureau of Reclamation construction cost indices to convert cost estimates from original planning documents, a 500,000 ac-ft Wagon Wheel Gap Dam and Reservoir would cost about $150 million, and the 5,500 ac-ft Indian Camp Dam and Reservoir would cost about $35 million. (These estimates are likely quite low as current dam safety and environmental mitigation standards are much more stringent than in the past.)

45B (Dredge). Using very conservative estimates, the initial cost to dredge 50,000 ac-ft from a reservoir would be about $375 million. Depending on the reservoir, the cost would be between about $85,000 and $235,000 per ac-ft of water saved annually, based on evaporative savings.

45C (Apply surfactant). The costs to develop a surfactant that would be effective on large reservoirs are unknown. Continued research and development will be required. However, extrapolating data from the preliminary results at Sandia National Laboratories, it would cost about $30 per ac-ft of water saved (product only; does not include application costs). For the commercial product, the cost is about $250 per ac-ft of water saved.

3.3.2 Potential Funding Source

45A.i (Move to existing storage space). Local or state-level funding would be possible.

45A.ii (Move to currently unauthorized storage space in existing reservoirs). Federal funding would be required, with some percentage of non-federal cost-sharing from project beneficiaries. Repayment for the federal portion would be negotiated under federal guidelines.

45A.iii (Move to new reservoirs). Federal funding would be required, with some percentage of non-federal cost-sharing from project beneficiaries. Repayment for the federal portion would be negotiated.

45B (Dredge). None.

45C (Apply surfactant). The most promising and logical avenue for continued research and development is for Sandia National Laboratories to form a partnership with the private sector, or to obtain grants from other public agencies.

3.3.3 Ongoing Cost for Operation and Maintenance

45A.i (Move to existing storage space). The terms of the agreements with the owners of the storage spaces would include O&M expenses.

45A.ii (Move to currently unauthorized storage space in existing reservoirs). The USACE charges San Juan-Chama contractors who store water in Abiquiu Reservoir's "discretionary pool" $0.30 per ac-ft to cover operation and maintenance costs.

45A.iii (Move to new reservoirs). Annual O&M costs for a dam and reservoir such as El Vado, can amount to $100,000 without any extraordinary maintenance or replacement activities.

45B (Dredge). To maintain the dredged spaces would cost about $7.5 million per year.

45C (Apply surfactant). Because of biodegradation, surfactants need to be frequently applied to water surfaces. The commercial product requires reapplication every 2 to 2½ days. A year-round application of this product to a 1-million ac-ft Elephant Butte pool would require about 700 tons of product. Extrapolating experimental data from India (see Exhibit 45A), the annual cost of product and application by boat would be about $6.5 million dollars, or about $100 per ac-ft/yr.

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