WATER CONSERVATION IN THE WIND/BIG HORN BASIN

Technical Memorandum
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Overview

Water conservation is the intelligent use, or wise management of water. Water is a finite resource, essential economically, ecologically, and sociologically. Good management considers all these aspects of water use. This memorandum discusses water conservation from a multiple-use perspective.

The Wind/Big Horn Basin (WBHB) is an arid region, with most moisture coming from winter snowfall in the mountains that rim the basin. Even ground water depends on snowfall for recharged aquifers. Most lower elevations in the WBHB receive only six to eight inches of precipitation per year, and since the short summers tend to be quite warm evaporation rates are high. Because of the seasonal nature of runoff, sparse precipitation and warmer temperatures at lower elevations, storage and distribution capacity is key to water management.

Wyoming's Water Law, administered by the State Engineer's Office, has been widely influential in the west. It is based on the principle of "first in time, first in right." Originally, water rights were attached to property, making water a private property right. The goal was to foster agricultural development and other recognized "beneficial uses." The definition of beneficial uses has been broadened, until today "Water rights can be issued to anyone who plans to make beneficial use of the water. Recognized beneficial uses include: irrigation, municipal, industrial, power generation, recreational, stock, domestic, pollution control, instream flows, and miscellaneous. Water right holders are limited to withdrawals necessary for the purpose. For example, irrigators are allowed to divert up to 1 cfs (cubic foot per second) for each 70 acres under irrigation."[1]

With the extension of the definition of beneficial use, and given the variety in land ownership in the state, numerous governmental and quasi-governmental agencies concerned with water management exist at State, Local, and Federal levels.

The State Engineer's Office, Department of Agriculture, Game and Fish Department, Department of Environmental Quality, State Forestry, State Parks, and Water Development Commission play important roles in water management at the state level.

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[1]Wyoming State Engineer's Office.

At the local level, conservation districts, water districts, municipalities, and irrigation organizations are important players. Conservation Districts in the WBHB are headquartered in Cody, Dubois, Thermopolis, Riverton, Meeteetse, Lander, Lovell, Greybull, and Worland. The Wind River Indian Reservation manages water systems on the Reservation.

Given that 70 percent of the WBHB is public land, and that 61 percent of the Basin is federally owned, the Bureau of Land Management, Bureau of Reclamation, Fish and Wildlife Service, Park Service, and Department of Agriculture agencies such as the Forest Service and Natural Resource Conservation Service manage resources or are programmatically active in virtually all areas of the Basin.

These agencies make assistance, technical and/or financial, available to landowners or associations wishing to develop, improve the use of, or conserve water. This plethora of official and quasi-official agencies, combined with numerous private or public groups representing tourism, agriculture, hunting and fishing, municipalities, industrial, and business, ensures a broad representation of interests in the development of water management policies and decisions.

Water Supply

Three major river systems, the Wind/Bighorn, Shoshone, and Clarks Fork supply water to the Basin. The waters of the Wind/Bighorn/Shoshone are apportioned between Wyoming and Montana by the Yellowstone Compact, as is the flow of the Clarks Fork. Table 1 displays the apportionment, average annual flows and Wyoming's share for each system.

Table 1.

River System	Compact Apportionment	Avg. Annual Flow (Acre-feet)	Wyoming's Apportionment (Acre-feet)	Montana's Apportionment (Acre-feet)
Wind/Big Horn	80% WY, 20% MT	1.6 million	1.28 million	.32 million
Shoshone	80% WY, 20% MT	1 million	.8 million	.2 million
Clarks Fork	40% WY, 60% MT	.7 million	.28 million	.42 million
TOTALS		3.3 million	2.36 million	0.94 million

The annual flow of the Wind/Bighorn River is measured above its confluence with the Shoshone above (south of) Big Horn Lake. The Shoshone River furnishes water for most of Park County and much of northwestern Big Horn County, but because Bighorn Lake straddles the Wyoming-Montana border, much of the Shoshone's water is not accessible to most of the Basin.

The Clarks Fork, Wyoming's only federally designated "wild and scenic" river, produces about 690,000 acre-feet annually. Heading in Montana near the Wyoming state line, it flows south into Wyoming through a portion of the Shoshone National Forest, emerging

from the Forest to turn back toward the north and Montana. In Wyoming it provides irrigation water for part of Park County.

The total water available to Wyoming from these three river systems, then, is around 2.4 million acre-feet per year.

Reservoir storage capacity in the Basin's major impoundments, including Yellowtail Reservoir, has been estimated at 3,025,300 acre-feet.[2] Waters from Bighorn Lake, or Yellowtail Reservoir, however, are not available for irrigation in Wyoming, and the reservoir is not included in Table 2, which summarizes the capacity of those reservoirs which do provide irrigation water in Wyoming.

Table 2.

River System	Reservoir	Storage Capacity (acre feet)
Wind/Big Horn	Bull Lake	153,000
Wind/Big Horn	Boysen	802,000
Shoshone	Buffalo Bill	695,300
WBHB		1,650,300

Water Demand

About 54,000 people live in Fremont, Hot Springs, Washakie, and those portions of Big Horn and Park counties primarily dependent on Wind/Big Horn water, while the population of the portions of Park and Big Horn counties in the Shoshone and Clarks Fork drainages is around 31,000. Thus, leaving groundwater aside for the moment (most public water systems in the Basin rely on groundwater rather than surface water), about 64% of WBHB people are within the Wind/Big Horn drainage, and 36% in the Shoshone or Clarks Fork drainages.[3]

Population growth in the region in general has been slight over the past two decades. The Basin's population in 2000, according the U.S. Census, was lower than it was in 1980, though about 5,600 higher than in 1990. Agricultural use remains the major factor in water consumption in the Basin, but significant expansion of agriculture seem unlikely. Industrial growth has been slight, and few Basin industries are large consumers of water. Perhaps non-consumptive water uses, such as recreational and environmental uses, are the most likely uses for which potential exists for significant demand increases.

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[2]"Wyoming's Water Resources," August, 2000, J. Jacobs and D. Brosz, University of Wyoming College of Agriculture, Cooperative Extension Service.

[3]The waters of the Clarks Fork, which heads in Montana, are allocated 60% to Montana and 40% to Wyoming.

Agriculture

In terms of consumptive use, agricultural irrigation using surface water is by far the largest water use in the WBHB (as in Wyoming and the West as a whole). Much of the water used for irrigation returns to the water table and to streams eventually, of course, but irrigation withdrawals remain a far larger consumer of water than municipal, domestic or industrial uses. Major crops include alfalfa, grass hay, sugar beets, beans, corn, malt barley and spring grains.

In the WBHB, it has been estimated that there are about 381 miles of major irrigation district canals and ditches using water from Bureau of Reclamation reservoirs. These are dirt conveyances, and it is likely that water losses are as high as 40%.[4] Although it has been estimated that up to 75% of irrigation water may return to the system through overland and underground flow, return flows vary according to weather, terrain and soil conditions.[5]

Most of the Basin's agricultural water comes from the Wind/Big Horn drainage, but the Shoshone and Clarks Fork watersheds are also important. Park County leads the WBHB in the value of agricultural sales, and the larger part of that value is produced in the Shoshone drainage. The Greybull/Wood River drainage around Meeteetse, the upper reaches of which are also in Park County, is part of the Big Horn drainage.

Irrigation is essential for most crop production in the Basin. Major crops are alfalfa, small grains, and sugar beets. Alfalfa production dominates in terms of acreage and value, and also requires the most water. Sugar beets are important in some areas, and also demand considerable water. Spring grains (oats, barley) require less water.[6]

Irrigation methods vary in efficiency, with sprinkler irrigation generally considered most efficient, followed by gated pipe and lined ditches. Automated diversion and sprinkling can be helpful in maximizing the efficiency and effectiveness of water application. Center pivot systems cost around $75k for a quarter mile system. Pivot systems 9-12 feet high are good for such crops as corn, and can achieve 80-85% efficiency. Micro pivots (about 6' high – too low for corn) cost around $40,000 to $50,000. Gated pipe is the next most efficient system, while flood irrigation runs 40-60% efficiency. While not many such systems are in use in the WBHB, micro-irrigation, drip systems with pressure-flow regulation, are promising in some situations.

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[4]Ron Vore, Water Conservationist, Basin Advisory Group Presentation, Worland, Wyoming, August 13, 2002.

[5]Wyoming State Engineer's Office, "Water Conservation, Green River Basin Plan," Ron Vore and Sue Lowry, December, 2000.

[6]Wyoming Water Resources Center, "Consumptive Use and Consumptive Irrigation Requirements: Wyoming," 1992.

Another management option is the burial of gypsum blocks in fields. Gypsum blocks absorb and release water. Measurement of the water in the blocks indicates the amount of moisture in the soil, helping the farmer determine when it is necessary to irrigate. The use of gypsum blocks may save, on average, about one irrigation per season. Cost sharing programs for conservation purposes are available from several governmental agencies.[7]

Many farmers and ranchers actively seek to diversify income sources, deriving income for the same ground from multiple uses. Some raise corn and after cropping rent the fields for livestock feeding on stalks. After cropping, some plant radishes or turnips to kill nematodes and provide winter graze. A key tactic is re-irrigation after cropping, which encourages late growth for forage. Diversification opportunities include seed production, setting up small feedlots, providing space for commercial beehives, offering space for recreation activities, and, in some areas, selling bentonite.

Other conservation methods include contouring fields to improve water distribution and good maintenance of headgates and ditches. Canals and ditches may need to be lined, since many of the soil types found in the Basin do not seal well. On rangeland, maintaining, enhancing or creating riparian areas is beneficial ecologically and practically. Intermittent streams, as well as perennial ones, can be improved in terms of both quality and quantity of water, browse, wildlife habitat, and erosion control.

Public Water Systems

Public water systems (PWS) are charged with supplying the populace with safe and adequate supplies of potable water. There are currently 58 active municipal and non-municipal community public water systems in the WBHB. Thirty-six of these are serviced by ground water. These systems serve, collectively, about 59,000 people. Total daily water usage by these systems is about 10.6 million gallons per day, or about 180 gallons per day per person. The source of about 69% of the water used in these systems is surface water.[8]

The Environmental Protection Agency lists 174 permitted water systems within the WBHB, serving everything from rest stops and campgrounds to larger municipalities. A community water system, by EPA definition, is "any water system that serves 15 connections or 25 people per day for a minimum of 60 days per year."[9]

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[7]Laura Galloway, USDA Natural Resource Conservation Service irrigation specialist, Worland NRCS office, personal communication, 2001.

[8]Lidstone and Associates, Technical Memorandum, "Wind/ Bighorn Basin Plan, Municipal Basin Water Use Profile, May, 2002.

[9]Wyoming Department of Environmental Quality, Water Quality Division,

Water conservation measures are scarce in Wyoming: of the 188 systems listed in the Wyoming Water Development Commission's 2002 report on public water systems, only 29 report having tiered rates as a water conservation measure, 24 have ordinances prohibiting the wasting of water and two report providing subsidies for efficiency. There are 25 entities that have some other form of water conservation measures in place. The average reported percentage of water loss due to leakage is 8.5%.[10]

In the WBHB, according to the 2002 report of the Wyoming Water Development Commission (WWDC), thirteen water systems have some form of conservation measure. Wasting ordinances are the most common measure (although used in a minority of systems), while tiered rates are used in three systems. Greybull and Lander report a ten percent reduction of water usage due to conservation measures, while Byron reports a 25% reduction. Other systems did not report any reductions.

The primary factor discouraging overuse of water is probably cost to the user. As long as water is accurately metered and appropriately billed, it will generally be used in a reasonably conservative manner. The same logic applies to commercial and industrial water users, especially those which rely on public water systems.

In Wyoming the average cost of treated water is about $1.90 per thousand gallons. One WBHB industry was using over 66,419 gallons per day (gpd) for cooling compressors. The company discovered it could operate on 23,081 gpd by installing a recirculating cooling system. This provided an annual savings of 11 million gallons per year of treated water, lowering water costs as well as the bill for wastewater, which is based on the amount of metered water used.[11]

Environmental and Recreational Considerations

Non-consumptive uses of water have become increasingly important, for a variety of reasons. Growing societal sensitivity about ecological considerations is an important factor. Additionally, the economic value of recreational opportunities and facilities is well known – tourism is a fundamental component of Wyoming's economy. It can be enhanced by the development of more and higher-quality water-related recreational opportunities. Such opportunities include the desire of people to enjoy clean, relatively pristine water. Consideration of the ideational and recreational value of water is now a fundamental element in water planning and conservation.

"Wyoming's Source Water Assessment and Protection Program," October 2000, pg. 26.

[10]http://wwdc.state.wy.us/watsys/2002/watsys.html

[11]Donnell & Allred, Inc., August 2002.

Many visitors to the Basin come to experience relatively unspoiled natural vistas and high-quality outdoor recreational opportunities. Most of these opportunities, such as fishing, pleasure boating (including white-water rafting and kayaking), swimming, photography, nature viewing, hunting, backpacking and skiing are fundamentally non-consumptive in terms of water usage. Providing infrastructure for these kinds of amenities makes the Basin a more attractive place to live, and thus may aid economic development efforts.

A list of suggestions for recreational facilities to be considered in water development includes whitewater recreation parks, fishing access at all state highway stream crossings, identification signage at all stream and canal highway and road crossings, handicapped access to fishing and hunting at existing and future impoundments and lakes, canoe and rafting access and portages at existing and future low-head dams, divisions, etc., and development and promotion of eco-tourism components at water projects.[12]

That agricultural uses also have recreational, environmental and ecological effects must not be overlooked, although some may seem more ecologically benign than others. In regard to waste water, for instance, the Greater Yellowstone Organization notes that:

> Even though it is a major concern, water "waste" is an imprecise term. Comparing the ecosystem consequences of water delivery systems is more complex than adding and subtracting volumes of water. For example, while pipelines and sprinkler systems may be more efficient in transporting water and delivering it precisely, they are less effective than flood irrigation systems for recharging groundwater and enhancing private land for wildlife. Overgrown, unlined irrigation ditches provide habitat and movement corridors, and flooded fields offer nesting habitat to species such as sandhill cranes.[13]

This statement hints at the complexity of water management in the WBHB, begging the question of what water conservation really is. Water "loss" is a "natural" occurrence, but human actions, such as constructing dams and irrigation systems, add to "natural" evaporation from lakes, ponds, streams and wetlands.

Riparian areas produce forage and habitat for both domestic livestock and wildlife, and are ecologically important in many other ways, including erosion control. Reservoirs maintain conservation pools, generate power, control flooding, ensure stream flows, enable solids to settle out, improving downstream water quality, and provide recreational

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[12]Sterling Hansen, WBHB Advisory Group, personal communication, August, 2001.

[13]Greater Yellowstone Coalition, http://www.greateryellowstone.org/water_allocation.html, 2002.

opportunities. Waterfowl and upland game bird hunting, as well as the well-being of wildlife of all sorts, are helped by good water conservation.

All these considerations are important elements in the Basin's economy, its quality of life, and in water management regimes that may be developed.

Conclusion

In the Wind/Big Horn Basin, as in Wyoming as a whole, focal points for water managers are many. Irrigation, livestock water, industrial, municipal, recreational, ecological and fish and wildlife uses must all be considered. Whether labeled water conservation, wise use, or multiple use, what is required is careful definition, consideration and balancing of all beneficial uses.