Technical Memorandum 5.2

Table of Contents

List of Tables

List of Appendices

Platte River Basin Water Plan

Technical Memorandum 5.2

SUBJECT**:** Platte River Basin Water Plan
Section 5.2 – Future Water Use Opportunities

PREPARED BY: Trihydro Corporation

DATE**:** August 1, 2005

PURPOSE: The Platte River Basin Plan is a planning tool developed for the Wyoming Water Development Office. It presents estimated current and estimated future uses of water in Wyoming's Platte River Basin. The Plan is not used to determine compliance with or administration of state law, federal law, court decrees, interstate compacts, or interstate agreements.

5.2 FUTURE WATER USE OPPORTUNITIES

5.2.1 Introduction

The purpose of this technical memorandum is to identify and describe future water use opportunities that may be implemented to satisfy present and future water demand in Wyoming's Platte River Basin. The list of opportunities that is discussed in this technical memorandum is intended to be used by individuals and organizations as a basis for consideration of potential new or expanded Basin water supplies. Differing positions have been taken by individuals and organizations regarding some of the Platte River Basin future water use opportunities that are discussed in this technical memorandum. It is the purpose of this memorandum to present those positions but not to assess the value or validity of those positions.

5.2.1.1 Structural and Non-structural Future Water Use Opportunities

The future water use opportunities that are considered in this technical memorandum are categorized as being either structural or non-structural. Structural future water use opportunities are those that include, but are not limited to, new storage reservoirs, conveyance system upgrades, water distribution enhancements, groundwater development, aquifer storage and recovery projects, in-basin water transfer components, and transbasin diversions. Non-structural future water use opportunities are those that include, but are not limited to, local and basin-wide conservation and management, modified reservoir operations, municipal water conservation, improved agricultural efficiencies, water right transfers and exchanges, water banking, and conjunctive use options.

5.2.1.2 Future Water Use Opportunity Assessment Framework

This technical memorandum assesses potential future Platte River Basin water use opportunities on the basis of the following nine considerations:

Pertinent Water Use Sectors

Platte River Basin water use sectors that are identified and considered in this and other Platte River Basin Plan technical memoranda include agriculture, municipal/domestic, industrial, recreational, and environmental sectors. Each future water use opportunity may benefit some Basin water use sectors more than others.

Water Availability

Water availability relates to the viability of the proposed future water use opportunity in terms of the physical availability of water to support the opportunity in question. In the case of groundwater, it relates to the ability of an aquifer to yield anticipated demand.

Technical Factors

Technical factors relate to the physical aspects of implementing a water use opportunity. Bringing some opportunities to fruition, particularly structural opportunities, will require engineering design, construction, and maintenance; while others may be implemented by means of a governmental or institutional process.

Economic Factors

Economic factors include planning and construction costs required for and economic returns derived from possible future water use opportunities as well as the ability to afford implementing a future water use opportunity or to meet funding source requirements.

Environmental Factors

Environmental factors include the potential impacts a proposed future water use opportunity may have on the environment and the potential impacts that regulatory permitting may have on implementation of a future water use opportunity.

Legal and Institutional Factors

Legal and institutional factors pertain to the relationship among public policies, private positions, potential litigation, and future water use opportunities. These factors also relate to the perceived ease or difficulty with which a future water use project could be authorized and permitted under existing state and federal laws and regulations. Some future water use opportunities may have significant legal or institutional implications.

Public Acceptance

Public acceptance relates to the nature and extent of public support for or opposition to a future water use opportunity.

Water Quality

Water quality relates to the potential for a future water use opportunity to impact water quality or to encounter water quality issues during or after implementation.

Ability to Satisfy Multiple Demands

Ability to satisfy multiple demands relates to the potential a future water use opportunity has for providing beneficial use to more than one water demand sector, such as both the municipal and industrial water use sectors.

5.2.1.3 Basin Advisory Group (BAG) Comments

BAG members were given the opportunity to comment on and expand the initial draft list of Platte River Basin future water use opportunities that was presented during the February 8, 2005 BAG meeting in Casper. Summaries of BAG comments are presented for each future water use opportunity that is discussed in this technical memorandum.

5.2.2 Development of a List of Future Platte River Basin Water Use Opportunities

The first draft long list of future Platte River Basin water use opportunities was developed by:

- reviewing Platte River Basin Water Plan technical memoranda and noting potential future Basin water use opportunities that were identified in the memoranda;
- reviewing previous Basin Plan lists of future water use opportunities to determine which opportunities that had been identified for other basins may be applicable to the Platte River Basin;
- obtaining input regarding potential long list items from the Wyoming Water Development Commission (WWDC);
- a literature review; and
- reviewing, following the recommendation of a Basin Plan BAG member, the *Integrated Regional Water Management Grant Program Guidelines* that were published by the State of California in November 2004. (State of California, 2004)

The first draft long list of potential future Platte River Basin water use opportunities was prepared and submitted to the Wyoming Water Development Commission (WWDC) for review and comment. Following receipt of WWDC comments, a draft short list of future Platte River Basin water use opportunities was then prepared. The short list was presented to the Platte River Basin Advisory Group (BAG) during the regular February 8, 2005 BAG meeting. The short list, which was not ordered on the basis of priorities or relative importance, that was presented to the BAG included:

1. Drought response planning;
2. Weather modification – cloud seeding;
3. Transbasin diversions;
4. Groundwater augmentation – non-hydrologically connected to North Platte River surface water;
5. Water conservation;
6. Water right transfers;
7. Upper Laramie River storage opportunities literature review;
8. Snow fences;
9. Stormwater capture, storage, treatment, and management;
10. Irrigation with treated municipal wastewater or grey water;

11. Municipal irrigation using untreated water;
12. Enhancement of recreational use of water resources;
13. Modification of Pathfinder Dam and Reservoir;
14. Improvement of agricultural irrigation systems and control efficiencies;
15. Coal bed natural gas (methane);
16. Increasing runoff from national forests based on modified U.S. Forest Service policies and practices;
17. Water exchange/banking; and
18. Multipurpose flood control programs.

During and after the February 8, 2005 BAG meeting, attendees suggested adding the following items to the list of future Platte River Basin water use opportunities:

19. Regionalization of public water supply systems;
20. Utilization of the WWDC's small water project program; and
21. Co-production of electricity and hydrogen at Basin hydropower generating facilities.

On February 16, 2005, the WWDC transmitted a letter to BAG members that included the revised draft list of future water use opportunities shown above and requested BAG input regarding revision or expansion of the proposed list. This letter was transmitted to all Platte River Basin Water Plan BAG members who had attended and registered their attendance at any previous Platte River Basin Plan BAG meeting. A copy of that letter, which requested BAG input regarding future Basin water use opportunities no later than March 4, 2005, is included in Appendix 5.2.A of this technical memorandum. Responses to the February 16 WWDC transmittal were received from the Wyoming Farm Bureau Federation and from one Albany County rancher. A suggested additional future water use opportunity was subsequently received from another BAG member. BAG comments are noted in the discussion of Platte River Basin future water use opportunities that comprises the remainder of this technical memorandum. It is important to note that the order in which future Basin water use opportunities are discussed in this technical memorandum is random and is not based on any prioritization.

Following receipt of WWDC and BAG comments regarding the list of future Platte River Basin water use opportunities, the list was reorganized and is provided below organized on the basis of structural and non-structural water use opportunities. The reorganized list follows:

Structural future water use opportunities include:

1. Transbasin diversions;
2. Groundwater augmentation – non-hydrologically connected to North Platte River surface water;
3. Upper Laramie River storage opportunities;
4. Snow fence;

5. Stormwater capture, storage, treatment, and management; irrigation with treated municipal wastewater; grey water irrigation; and municipal irrigation using untreated water;
6. Modification of Pathfinder Dam and Reservoir;
7. Coal bed natural gas (methane);
8. Regionalization of public water supply systems;
9. Co-production of electricity and hydrogen from existing hydropower facilities; and
10. Improving agricultural irrigation system efficiencies.

Non-structural future water use opportunities include:

1. Drought response planning;
2. Weather modification;
3. Water conservation;
4. Water right transfers;
5. Enhancing recreational use of water resources;
6. Increasing runoff from national forests based on modified U.S. Forest Service policies and practices;
7. Water exchange/banking;
8. Multi-purpose flood control programs; and
9. Utilization of WWDC's small water project program.

5.2.3 Structural Future Water Use Opportunities

5.2.3.1 Transbasin Diversions

Transbasin diversions may be defined as structures or systems that divert previously unappropriated water from one river drainage basin to and for appropriation and use in another river drainage basin. The diversion of water from the Little Snake River drainage into the Platte River Basin at Hog Park Reservoir to replace Douglas Creek water that is used as part of the City of Cheyenne public water supply system is a well-known example of an existing Wyoming transbasin diversion.

Pertinent Water Use Sectors

All Basin water use sectors may benefit from future transbasin diversions. Allocation of transbasin diversion benefits would probably be based to some extent on the source(s) of funding for the transbasin diversion project. Given the anticipated complexity and cost of potential transbasin diversion projects, the Basin water use sectors that would most likely participate in funding and completing a transbasin diversion project are the agricultural, industrial, and municipal water use sectors.

Water Availability

The Green, Powder/Tongue, Wind/Bighorn, and Northeast Wyoming river basins are adjacent to the Platte River Basin in Wyoming. Basin plans for the adjoining basins have been completed and are available at the Wyoming Water Development Commission Internet site at

http://waterplan.state.wy.us. Information regarding available surface and groundwater resources in the adjoining basins is provided in the basin plans for these basins and is summarized below.

Wyoming's Green River Basin is located immediately west of the Platte River Basin. Major subbasins within the Green River Basin include the Little Snake River, Henrys Fork, Blacks Fork, and Green River subbasins. Data in Table III-2 (page III-10) of the Green River Basin Plan Final Report indicate that, based on basin plan river modeling, surface water is available in varying amounts from all four of the Green River Basin subbasins during dry, normal, and wet year conditions. The final report of the Green River Basin Plan also estimates availability of between 50,000 acre-feet and 100,000 acre-feet per year of groundwater in the Green River Basin and states that no evidence exists to indicate current over-development of major basin aquifer systems (p. III-28). More detailed information regarding surface and groundwater availability in the Green River Basin is available in basin plan technical memoranda. (States West Water Resources Corporation, 2001)

The Wind/Bighorn Basin is located immediately north of the Sweetwater River drainage in the Above Pathfinder subbasin of the Platte River Basin. Section 3.3.4, Available Flow (Chapter 3, p. 27), in the Wind/Bighorn Basin Plan Final Report includes text and tables that show estimated available flows in major rivers in the Wind River and Bighorn River basins during dry, normal, and wet year conditions based on output from a basin river flow spreadsheet model. Table 3.3-7 (Chapter 3, p. 32) summarizes the estimated Wyoming portion of unallocated flows in the Clarks Fork and Bighorn Rivers. Chapter 3 of the Wind/Bighorn Basin Plan Final Report also assesses future development potential for major basin aquifers, including the Quaternary Aquifer, the Wind River Aquifer, the Madison Aquifer, and the Flathead Sandstone (Chapter 3, pp. 45 and 46). More detailed information regarding surface and groundwater availability in the Wind/Bighorn Basin is available in basin plan technical memoranda. (BRS, Inc., et al., 2003)

The Powder/Tongue River Basin is located immediately north of the western portion of the Pathfinder to Guernsey subbasin of the Platte River Basin. The Final Report of the Powder/Tongue River Basin Plan also contains information regarding estimated surface and groundwater availability. Of the four major subbasins within the Powder/Tongue River Basin, including the Little Bighorn, the Little Powder, the Powder, and the Tongue River subbasins, the upper Powder River subbasin is adjacent to the north side of the Platte River Basin while the other three Powder/Tongue subbasins are located in northern Wyoming a significant distance away from the Platte River Basin. Chapter III of the Final Report of the Powder/Tongue River Basin Plan discusses basin surface and groundwater availability, including description of the basin river flow spreadsheet model that was developed as part of the basin plan. Table III-15 on page III-36 of the final report summarizes estimated available surface water in each major subbasin of the Powder/Tongue River Basin based on output from the basin plan river flow model. Table III-34 on page III-76 of the final basin plan report contains an assessment of basin groundwater supplies, including descriptions of aquifers, groundwater quality, and groundwater availability and development potential. Detailed information regarding surface and groundwater availability in the Powder/Tongue River Basin Plan is available in basin plan technical memoranda. (HKM Engineering, Inc., et al., 2002b)

The Northeast Wyoming Basin is located immediately north of the eastern portion of the Pathfinder to Guernsey subbasin and the Guernsey to State Line subbasin of the Platte River Basin. The Final Report of the Northeast Wyoming Basin Plan contains surface and groundwater availability information that is similar in nature to that provided in other river basin plans. Like the three river basin plans described above, a river flow spreadsheet model was prepared for streams in the Northeast Wyoming Basin, and output from that model provided the basis for estimation of available basin surface water. Summaries of estimated available basin surface water are contained in Tables III-10 through III-21 on pages III-31 through III-42 of the basin plan Final Report. Table III-24, beginning on page III-62, contains a summary assessment of basin groundwater supplies similar to that contained in Table III-34 of the Powder/Tongue River Basin Plan final report. As with the other basin plans discussed above, detailed surface and groundwater availability information is available in basin plan technical memoranda. (HKM Engineering, Inc., et al., 2002a)

Technical Factors

The complexity of designing and constructing a transbasin diversion may be greater than that associated with any of the other structural future water use opportunities that are discussed in this Basin Plan. This complexity results in required expenditure of large quantities of both time and money in order to complete a transbasin diversion that will convey a significant quantity of water from one river basin to another river basin. By definition, diverting water from one basin to another basin requires conveying water either uphill out of the basin of origin or from the basin of origin to the basin of use via an underground conveyance. Either process or any combination of these processes is technically complex.

Economic Factors

Economic considerations pertinent to transbasin diversions may be as complex and significant as technical factors. The technical complexity of transbasin diversions carries a high cost for designing and constructing this type of system. Conveying significant quantities of water uphill, out of the source basin, is expensive.

Environmental Factors

Planned construction of a transbasin diversion of significant conveyance capacity would presumably result in detailed analyses of environmental impacts, both in the basin of origin and in the basin of use. The available water supply in the basin of origin would decrease, and the available water supply in the basin of use would increase. As a result, environmental impacts resulting from diversion construction could be significant in either or both basins in question.

Completion of the Stage II City of Cheyenne water project resulted in creation of year-round releases of water into the South Fork of Middle Crow Creek, a previously ephemeral stream located west of Cheyenne in the Laramie Range. The year-round releases into the South Fork of Middle Crow creek were the result of transbasin diversion. *Assessment of a Flow Enhancement Project as a Riparian and Fishery Habitat Mitigation Effort* (Wolff et al., 1986) assessed environmental impacts of this

basin system modification. This article may be indicative of the type of environmental studies that would result from or be required as a result of future transbasin diversions.

Legal and Institutional Factors

In Wyoming, water must be available both physically and legally in order to be allocated for a beneficial use. Therefore, assessment of a proposed transbasin diversion would include determination that unappropriated water is available in one basin for diversion to another basin and that acquisition of a water right for beneficial use of the unappropriated water in the receiving basin would be feasible.

One justification for transbasin diversions has been use of such diversions as rescue operations to provide water to users in a basin who lose access to adequate water either as a result of a declining water table or water rights adjudication. In a 1990 report, D.S. Brookshire and others speculated that the need for this type of rescue operation in Wyoming was "hard to imagine" but that "extreme developments regarding the North Platte might well lead to the long term need for a 'rescue operation.'" (Brookshire et al., 1990, Appendix D)

The Operating Criteria of the Wyoming Water Development Program requires that, when evaluating and administering water development proposals, the Wyoming Water Development Commission (WWDC) will address the financial impacts of proposed transbasin diversions and will "recommend measures to mitigate any adverse impact identified in the basin of origin." (WWDC, 2005)

One interpretation of the 2001 Modified North Platte Decree and the Cooperative Agreement holds that water that is provided via transbasin diversions would not be regulated by either the 2001 Modified Decree or the Cooperative Agreement. (Holliday, 2005)

Public Acceptance

The nature and extent of public support for or opposition to a future water use opportunity is an important consideration during the evaluation of water development proposals.

Water Quality

Since the most likely sponsors and beneficiaries of Wyoming transbasin diversions would be municipalities, industries, or the agricultural sector, water quality requirements may vary somewhat but would presumably be relatively stringent. It is unlikely that the significant costs and time involved in designing, permitting, and constructing a transbasin diversion would be invested for diverting water of less than potable quality.

Ability to Satisfy Multiple Demands

As noted above, the complexity of and costs associated with transbasin diversions are such that likely Wyoming sponsors and beneficiaries would be municipalities, industries, or the agricultural sector. It is feasible that a single transbasin diversion project could benefit more than one municipality or could benefit more than one of the municipal, industrial, and agricultural water use sectors. The relatively high economic value of water to municipalities and industries compared to the presumably lower

economic value of water to the agricultural sector may complicate planning and constructing a transbasin diversion to serve municipal, industrial, and agricultural interests.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation believes that transbasin diversions should be considered only after "what the Platte River Basin can do for itself" is known. (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher stated his firm belief that Wyoming should use "all of Wyoming's water that we can by any means . . ." before bordering states use Wyoming water. (Engen, 2005)

5.2.3.2 Groundwater Augmentation – Non-hydrologically Connected to North Platte River Surface Water

Groundwater augmentation refers to potential development of Platte River Basin groundwater resources to augment available Platte River Basin surface water resources. Water development in Wyoming is dependent upon both the physical availability of water and the developer's ability to obtain a legal right to beneficially use the water. It is generally assumed that surface water in Wyoming's Platte River Basin has been fully appropriated and that future acquisition of water rights for development of significant quantities of Basin surface water would be difficult or impossible. As a result, augmentation of Basin surface water resources with Basin groundwater, which has not been fully appropriated, may be a potential source of Basin water development. An important consideration regarding future development of Platte River Basin groundwater is the issue of identifying groundwater that is "hydrologically connected" to the North Platte River or its tributaries. This issue is discussed below under "Legal and Institutional Factors."

Pertinent Water Use Sectors

Future Basin groundwater development may be feasible by and for the benefit of all Basin water use sectors. Development of groundwater in significant quantities to appreciably augment Basin surface water supplies would presumably require development of large quantities of groundwater. As a result, future groundwater development to augment Basin surface water supplies would require government involvement, and use of this water would involve major Basin municipal, agricultural, and/or industrial water users.

Water Availability

Platte River Basin Water Plan Technical Memorandum 3.3, Available Groundwater Determination, discusses Platte River Basin groundwater availability in detail. This memorandum concludes that the Platte River Basin is one of the "most complicated groundwater regions" in the state of Wyoming and that "future development opportunities exist for high capacity (groundwater) supplies throughout the area. . . ."

Technical Factors

Two primary technical factors will impact development of groundwater to augment Basin surface water supplies, including:

- the technical feasibility of constructing wells and designing well pumping systems that will provide access to high-yield aquifers, and
- the technical feasibility of transporting groundwater, after it has been brought to the surface, to the location or locations where it will be beneficially used.

Economic Factors

Development and transport of significant quantities of groundwater to augment Basin surface water supplies will be expensive. The Wyoming Water Development Commission (WWDC) initiated the North Platte River Groundwater Assessment Study in August 2002. The purpose of this study is to identify the feasibility of developing "new groundwater supply sources that may be used to provide replacement water to offset depletions stipulated in the (2001) Modified North Platte Decree." (Trihydro Corporation and Lidstone & Associates, 2005) The goal of the study is to identify groundwater sources that could provide between 5,500 acre-feet (about 1.8 billion gallons) of groundwater and 10,000 acre-feet (about 3.3 billion gallons) of groundwater per year. The draft final report for this study includes descriptions of 10 potential well construction sites where large quantities of groundwater are thought to be available for use in augmenting Basin surface water supplies. Reconnaissance-level cost estimates for designing and constructing wells, pumping systems, and conveyance pipelines for these sites range from about $3.4 million to about $7.4 million. The estimated present worth value of 35 years of well and pipeline operation and maintenance ranges from about $3.4 million to about $12 million. (Trihydro Corporation and Lidstone & Associates, 2005)

Environmental Factors

Well and conveyance pipeline construction typically disturbs the natural environment to a lesser extent than does dam or transbasin diversion construction. This assessment is particularly true when considering the long-term environmental impacts of well and pipeline construction, since the disturbance footprint of an in-place wellhead structure is minimal and the visibility and impact on the surrounding environment of an in-place pipeline footprint are typically minimal. Environmental factors that could impact future large-scale Basin groundwater development may include:

- well siting and drilling to minimize impacts on wildlife such as sage grouse and raptors, and
- pipeline crossings of streams, rivers, and wetlands.

Legal and Institutional Factors

Major groundwater development in the Platte River Basin will require consideration of several legal and institutional factors. As with any water development in Wyoming, future groundwater development may occur only in conjunction with acquisition of a legal appropriation for beneficial use of the groundwater. In addition, the *Final Settlement Stipulation* of the 2001 Modified North Platte Decree regulates development for irrigation use of groundwater upstream of Guernsey Reservoir from wells that are hydrologically connected to surface water of the North Platte River or its tributaries. The *Final Settlement Stipulation* defines "hydrologically connected groundwater well" as:

> . . . one that is located and constructed that if water were intentionally withdrawn by the well continuously for 40 years, the cumulative stream depletion would be greater than or equal to 28% of the total groundwater withdrawn by that well. (Supreme Court, 2001, Exhibit 4, Appendix G)

At the time of this writing, the Groundwater Subcommittee of the North Platte Decree Committee is in the process of preparing maps that the Committee is calling Green Area Maps. These maps show delineated areas within the Platte River Basin that are not, based on application of a standardized calculation method, assumed by the North Platte Decree Committee to be hydrologically connected to North Platte River system surface water. The maps will be used for administering provisions of the 2001 Modified North Platte Decree.

Another potential legal factor pertains to land access or acquisition, both for well sites and for conveyance pipelines from well sites to points at which the groundwater will be used. Obtaining access to private land may be difficult, and obtaining access to and use of public land requires participation in a permitting process that may not be either simple or brief in duration. For example, acquisition of a U.S. Department of the Interior, Bureau of Land Management (BLM), Right-of-Way Grant/Temporary Use Permit(s) (Form 2800-14, August, 1985) may be required prior to working on lands administered by the BLM.

Exhibit 11, Procedure for Whalen Diversion Dam to the State Line Reach Administration of Surface Water Rights from Tributaries and Drains, in Appendix G of the *Final Settlement Stipulation* includes water replacement requirements that provide the basis for ongoing Wyoming efforts to develop new groundwater sources to augment North Platte River surface water. (Supreme Court, 2001)

Public Acceptance

Public acceptance of groundwater development to augment Platte River Basin surface water supplies is unknown at the time this document was prepared. Estimated depths of surface water augmentation wells in the draft project report for the WWDC North Platte River Groundwater Assessment range from 500 feet to 2,700 feet, and most are 1,000 feet or more. These wells target aquifers that are significantly deeper than those that are usually tapped for rural domestic or livestock watering use. In addition, most Basin municipalities are located close to the North Platte River or one of its major tributaries. Ongoing map delineation by the North Platte Decree Committee of Green Areas within which future surface water augmentation wells could be permitted may exclude areas near many basin municipalities from consideration as sites for surface water augmentation wells. These factors decrease the likelihood that a future surface water augmentation well will interfere with or impact existing water wells and, as a result, arouse public objections to construction of surface water augmentation wells. Public resistance to conveyance pipeline installation may occur. Such resistance may be limited to those individuals across whose private property pipeline construction is planned or those who have a particularly strong interest in a segment of public land across which a pipeline may be placed.

Water Quality

The draft WWDC North Platte River Groundwater Assessment report includes assessment of probable water quality at each of the proposed alternative surface water augmentation well sites. The indicator water quality parameter used in this assessment is known or estimated total dissolved solids (TDS) concentrations in groundwater from wells at the various potential Basin drilling sites. TDS indicate the concentrations of dissolved inorganic salt minerals in water or the salinity of the water. Groundwater having a TDS concentration exceeding 1,000 parts per million (ppm, equals milligrams per liter, mg/L) is considered corrosive to metal well components (Driscoll, 1986). U.S. Environmental Protection Agency (USEPA) secondary (taste, odor, or color related; not health-related; not enforceable) drinking water standards include a secondary maximum contaminant level (MCL) of 500 ppm (mg/L) for TDS. Known or estimated TDS concentrations at potential surface water augmentation well sites that are assessed in the draft WWDC North Platte River Groundwater Assessment report range from 250 ppm to 500 ppm, with most in the range of 300 ppm. (Trihydro Corporation and Lidstone & Associates, 2005)

Ability to Satisfy Multiple Demands

As with transbasin diversions and other large-scale potential future Basin water development plans, the high cost of developing groundwater to augment surface water to an appreciable degree in the Platte River Basin would most likely require both governmental financial involvement in planning and construction and beneficial use by larger water-use entities such as municipalities, major industrial facilities, or agricultural irrigation districts.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation stated that groundwater augmentation of Basin surface water must occur in conjunction with management of "surface resources to recharge groundwater supplies. The land must be used to store water." (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher stated his conviction that Basin groundwater is "largely exchange water" from irrigation and that irrigation conservation measures should be thoroughly studied in terms of their potential impacts on groundwater recharge. (Engen, 2005)

5.2.3.3 Upper Laramie River Storage Opportunities

Surface water from the Upper Laramie River subbasin of Wyoming's Platte River Basin supplies a portion of City of Laramie drinking water and two major Basin irrigation districts, the Pioneer Canal-Lake Hattie Irrigation District and the Wheatland Irrigation District. Several studies regarding upper Laramie River storage were completed between 1991 and 1993 under sponsorship of the Wyoming Water Development Commission (WWDC), and the City of Laramie completed a water rights study in 2004 that includes information regarding upper Laramie River storage opportunities.

Pertinent Water Use Sectors

The most likely beneficiaries of increased upper Laramie River storage would be the City of Laramie, the Pioneer Canal-Lake Hattie Irrigation District, and/or the Wheatland Irrigation District. The City of Laramie Internet site notes that the Laramie River is the City's largest single source of water and that the "Monolith Ranch (which the City purchased about 20 years ago) is where Laramie's future

water is located." (City of Laramie, 2005) Monolith Ranch surface water rights are for agricultural irrigation and are available via the Dowlin irrigation ditch. Future use of this water by the City does not imply or necessarily require construction of additional water storage capacity.

Water Availability

Laramie River surface water is currently fully appropriated. Water availability for additional upper Laramie River storage would therefore be available only through transfer of existing water rights, transbasin diversion, or non-hydrologically connected groundwater development. An inadequate water supply is identified in the 1991 planning study of the upper Laramie River basin as the "major problem" in the basin insofar as future water development is concerned. (States West Water Resources Corporation, 1991)

Technical Factors

A major technical factor pertaining to future upper Laramie River storage opportunities is the shortage of high-quality dam and reservoir sites. A potential reservoir site that was assessed in a 1993 upper Laramie River basin storage report was Dodge Reservoir, which would be located on the Laramie River about 40 miles north of the city of Laramie (Western Water Consultants, 1993a). This reservoir, which has been considered several times by both state and federal agencies, would provide storage for the Wheatland Irrigation District but, because of its relatively downstream location in the Upper Laramie River subbasin, would probably not provide storage for the City of Laramie or for the Pioneer Canal-Lake Hattie Irrigation District.

Economic Factors

The 1991 upper Laramie River planning study states that upper Laramie River irrigators have considered diverting water from Douglas Creek, located in the Medicine Bow Mountains, into the upper Laramie River basin for irrigation purposes. Estimated costs for this plan have been determined to be "too high," and the existing City of Cheyenne diversion of Douglas Creek water, which "the State of Wyoming heavily subsidizes," further reduces the economic viability of this irrigation diversion option (States West Water Resources Corporation, 1991).

Several past studies have assessed replacing existing Wheatland Irrigation District reservoirs with a single reservoir having less surface area and lower evaporation rates. The 1991 upper Laramie River basin plan report states that the economic feasibility of this project, discussed above and called the Dodge Reservoir project, would be "borderline." (States West Water Resources Corporation, 1991)

Financing options for future construction of Dodge Reservoir, discussed above and in the 1991 and 1993 studies of upper Laramie River basin storage options, would be limited by the fact that the beneficial use of water stored in the reservoir would be to provide irrigation water to the Wheatland Irrigation District. The 1993 study concludes that "there appear to be few prospects for successfully financing Dodge Reservoir through the WWDC. . . ." (Western Water Consultants, Inc., 1993a). In conclusion, the 1993 study states that the "cost of construction of a dam at the Dodge site is more than the benefits would justify." (Western Water Consultants, Inc., 1993a)

A 1993 study pertaining specifically to assessment of potential new upper Laramie River storage identifies four potential "storage options," only one of which, enlarging Sodergreen Reservoir, actually involves creating additional basin water storage. The report states that a Sodergreen Reservoir enlargement project would be an "expensive option." (Western Water Consultants, Inc., 1993b)

The Robertson-McConnell Reservoir has been proposed at various times for construction on the Laramie River a short distance north of the Wyoming-Colorado state line. The Laramie Rivers Company surveyed the proposed reservoir site in 1909, and water right permit 2051R was obtained for this reservoir but has since expired and been cancelled. The proposed reservoir, with a capacity of 100,000 acre-feet, was "extensively studied" in 1949, at which time realignments of "some existing storage facilities and water rights in the Laramie River Basin were proposed" which would arouse "many political, legal, and environmental concerns. To create a reservoir of this size, water would have to be imported into the Laramie River basin." A 2004 study stated that "such water supply planning is well beyond the forecasted needs and financial means of the City (of Laramie) and should not be considered further by the City." (Fassett Consulting, LLC, 2004)

The 2004 study that discussed the Robertson-McConnell Reservoir also summarized information regarding potential use of Lake Hattie; the proposed 6,000 acre-foot Fox Creek Reservoir at the mouth of Squaw Creek; the proposed 6,000 acre-foot Boswell Creek Reservoir; two proposed 6,000 acre-foot Laramie River reservoirs; and the proposed 2,700 acre-foot Monolith Ranch Reservoir. All of these potential upper Laramie River storage options were considered not viable and/or too expensive. (Fassett Consulting, LLC, 2004)

In 1981 and, later, in about 1990, retired University of Wyoming engineering faculty member John Hill, PE and LS, and rancher Frank Bosler prepared a proposal and brochure promoting reconsideration of construction of the Robertson-McConnell Reservoir. The 1990 brochure, entitled *The Robertson-McConnell Reservoir - More Water for Southeast Wyoming*, stated that evaporation from the proposed Robertson-McConnell Reservoir would be less than that from Lake Hattie, Wheatland No. 2 Reservoir, and Wheatland No. 3 Reservoir and that Robertson-McConnell Reservoir would store "imported Colorado River water from the west (Little Snake River Basin)." These proposals also included other points supporting construction of this reservoir, including electrical power generation, maintenance of instream flow, and recreational benefits. This brochure noted that, under the 1909 Wyoming State Engineer's permit for the Robertson-McConnell Reservoir, maximum reservoir capacity would be 320,000 acre-feet. (Hill and Bosler, 1990)

Environmental Factors

Planning and construction of a storage reservoir having enough capacity to be of significant beneficial use to the City of Laramie or nearby irrigation districts carry inherent environmental concerns and issues. Planning and construction of a large storage reservoir in the upper Laramie River subbasin may, as do most current dam permitting and design, require significant effort in addressing regulatory and environmental issues.

Legal and Institutional Factors

As noted regarding other potential structural future water use opportunities, a primary legal consideration for increasing upper Laramie River basin storage is the acquisition of water rights in a basin where existing surface water resources are fully appropriated. In addition, many upper Laramie River basin water rights have very early (senior) priority dates. In 1981, the City of Laramie purchased the Monolith Ranch and associated agricultural water rights. This purchase "was an excellent long-term investment in establishing a reliable municipal water supply." (Fassett Consulting, LLC, 2004) The Dowlin Ditch surface water right for Monolith Ranch irrigation is "the most senior priority surface water right in the entire Laramie River basin" for irrigation purposes. (Fassett Consulting, LLC, 2004) The City of Laramie strategy regarding potential future municipal use of existing Monolith Ranch irrigation water rights "has always been targeted towards water rights protection and completing the steps necessary for a future transfer or change of use for municipal purposes." (Fassett Consulting, LLC, 2004) This process has not been completed at the time of this writing. The Laramie River Decree may impact design and operation of a new storage reservoir(s) on the upper Laramie River.

Public Acceptance

Public acceptance of future upper Laramie River basin storage could involve conflicting points of view from citizens of the city of Laramie, members and supporters of the Pioneer Canal-Lake Hattie Irrigation District, and members and supporters of the Wheatland Irrigation District. In addition, since the Dodge Reservoir construction option would result in elimination of Wheatland Reservoirs No. 2 and No. 3, sportsmen and the Wyoming Game and Fish Department may voice opposition to the elimination of the popular Wheatland Reservoir No. 3 fishing site. In 1993, the Wyoming Game and Fish Department estimated that Wheatland Reservoir No. 3 experienced about 34,000 fisherman days annually (Western Water Consultants, Inc., 1993a).

Water Quality

Surface water quality would probably not be an issue insofar as potential additional upper Laramie River basin storage is concerned. Laramie River water quality is generally good, and the river serves as the major source of drinking water supply for the City of Laramie. Technical Memorandum 5.3, Water Quality Issues, of this Basin Plan includes discussion of an ongoing Laramie Rivers Conservation District water quality sampling and testing program for surface waters of the Laramie River and the Little Laramie River. This program is aimed at better understanding non-point source pollution of the rivers and reducing the impacts of this pollution.

Ability to Satisfy Multiple Demands

As noted above, three upper Laramie River basin storage options have been identified and assessed in the recent past. The first option, enlarging Sodergreen Lake, could benefit the City of Laramie as well as both the Pioneer Canal-Lake Hattie Irrigation District and the Wheatland Irrigation District. The economic feasibility of this project, however, is considered marginal at best. The second option, constructing Dodge Reservoir about 40 miles north of Laramie, would, because of its location downstream of the Pioneer Canal-Lake Hattie Irrigation District and the city of Laramie, benefit only the Wheatland Irrigation District and is also considered to be of marginal economic benefit. The third

option, constructing Robertson-McConnell Reservoir on the upper Laramie River in Wyoming and near the Wyoming-Colorado border, was studied "extensively" in 1949. Construction of this reservoir as proposed and studied would result in the arousal "many political, legal, and environmental concerns." (Fassett Consulting, LLC, 2004)

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation believes that upper Laramie River storage should be considered on the basis of a clear understanding of existing storage and potential future opportunities. (Wyoming Farm Bureau Federation, 2005) An Albany County rancher responded that upper Laramie River storage opportunities are not likely based on the fact that Laramie River surface water has been fully appropriated. (Engen, 2005)

5.2.3.4 Snow Fence

Snow fence is a common part of Wyoming highway infrastructure. Significant quantities of well-compacted snow often accumulate on the leeward sides of these structures. The Rocky Mountain Research Station, Laramie Forest Sciences Laboratory, has collected and summarized on the Internet extensive information pertaining to more than 30 years of research regarding snow fences and use of snow fences as a water resource management tool. The Research Station includes shelterbelts and vegetation management in its consideration of snow fences, and its Internet site contains a lengthy bibliography regarding use of wind-blown snow as a water resource. (Rocky Mountain Research Station, 2005)

Pertinent Water Use Sectors

Given the rural locations of most Wyoming snow fences, both existing and potential, the most likely beneficiary of snow fence design and placement as a water resource development tool would be the agricultural sector and, to a presumably lesser extent, the recreational and environmental water use sectors. Research pertaining to building pit reservoirs that will trap snow drifts to provide early-season water for stock and wildlife has been ongoing.

Water Availability

Water availability from snow fences depends on the amount of snow that falls and is accumulated by a snow fence. During recent years, snowfall amounts in Wyoming have generally been lower than historical averages. However, since consideration of snow fence as a water resource tool is a relatively recent activity, the extent of potential augmentation of Platte River Basin water resources by means of snow fence construction is impossible to predict.

Technical Factors

Technical factors regarding use of snow fence as a water resource management tool should not be significant. Snow fence design is an ongoing process, undertaken by the Wyoming Department of Transportation (WYDOT) and other state transportation agencies based on the desire to utilize and improve snow fence to increase highway safety. Construction of snow fence based on current and anticipated snow fence designs should not incorporate major technical challenges.

Of considerably more importance as a technical consideration is the apparent loss of water through sublimation (transformation of ice to water vapor without passing through the liquid state) as snow blows toward a snow fence. Approximately 80 percent of snow is assumed to sublimate when wind-blown over a five-mile distance along which no snow fence or other obstacles exist. Research indicates that as much as 4 million acre-feet of water are lost each year in Wyoming by sublimation of blowing snow during blizzards. Four million acre-feet of water equal about 25 percent of average total Wyoming annual runoff. Determination of how some portion of this lost water could be recovered may constitute a significant technical factor in the use of snow fences to manage water resources. Ongoing use of small-scale (1:30) snow fence model studies may simplify and reduce the cost of research to capture this lost water resource. (Rocky Mountain Research Station, 2005)

Economic Factors

The Wyoming Department of Transportation (WYDOT) and other state agencies have, in association with various researchers, developed standard snow fence designs ranging from 6 feet to 14 feet high. These designs are intended to be built quickly, adaptable to rolling terrain, and durable. Given the existence of these state-financed standard snow fence designs, economic expenditure required to design and build snow fence for the purpose of water resource management should be relatively low. Ongoing research focusing on snow fence as a water resources management tool is aimed at improving snow fence efficiency – capturing more snow at less cost.

Environmental Factors

Significant environmental factors that may negatively impact use of snow fences as a water resource management tool are difficult to imagine. Some objection may be raised based on the contention that installation of snow fence creates visual pollution.

Legal and Institutional Factors

Legal and institutional factors should have relatively little impact on consideration of snow fences as a means of increasing the quantity of Basin water resources.

Public Acceptance

Given the significant role snow fences play in increasing the safety of winter travel in Wyoming, it is reasonable to assume that public acceptance of snow fences in Wyoming is and will remain generally positive.

Water Quality

The quality of water from natural precipitation, including snowfall, is very high.

Ability to Satisfy Multiple Demands

As noted above, predominant use of snow fence as a water resource management tool in rural areas is most likely to provide water for the agricultural, the environmental, and the recreational sectors.

Comments from the Basin Advisory Group (BAG)

Regarding derivation of usable water from snow accumulations created by snow fences, the Wyoming Farm Bureau Federation stated that "anything that catches and spreads water is desirable." (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher believes that use of snow fences to enhance Basin water resources is a "good idea" if snow fence is "placed in the right places to help increase" stream flow. He further states his belief that snow accumulations resulting from placement of snow fences on flat ground "seem to help the water table a little." (Engen, 2005)

5.2.3.5 Urban Stormwater Capture, Storage, Treatment, Management, and Reuse; Irrigation with Treated Municipal Wastewater; Grey Water Irrigation; and Municipal Irrigation Using Untreated Water

Since these four future water use opportunities are similar, they are considered together in this technical memorandum. All four items involve the use or reuse of water that in the past was considered unusable to provide irrigation water. In most instances, this irrigation water would be used for turf irrigation in or near municipal areas. Reused treated wastewater or stormwater could also be used for some industrial applications. Grey wastewater – which is domestic wastewater from showers, washing machines, and sinks, as opposed to black wastewater from toilets – could be used by industry or for irrigation.

Pertinent Water Use Sectors

Municipalities and industries will be the most likely beneficiaries of these future water use opportunities.

Water Availability

Stormwater; reused, treated municipal wastewater; and grey water are existing water sources, not new water sources. These future water use opportunities entail reusing water for beneficial purposes that have not been common in the past. Use of untreated water (water that has not been treated to meet U.S. Environmental Protection Agency standards for drinking water) for irrigation may be the result of bypassing a portion of a city's water supply around the water treatment system to reduce treatment costs for providing municipal irrigation water.

Technical Factors

Technical factors that are pertinent to these future water use opportunities include:

- treating and reusing municipal wastewater for irrigation such that a health hazard is not created;
- separating grey wastewater from black wastewater in order to land-apply the grey water without creating a health hazard;
- providing an efficient, cost-effective system to collect, treat, convey, and reuse municipal stormwater; and
- providing separate municipal water distribution systems for untreated water that is intended only for use as irrigation water.

Economic Factors

The economic feasibility of municipal reuse of treated wastewater is evident in an ongoing City of Cheyenne Board of Public Utilities (BOPU) project that involves upgrading the Crow Creek Wastewater Treatment Plant. This upgrade includes a treated wastewater filtration and distribution system that will permit the City to reuse, in the near term, up to 4 million gallons per day (mgd) of treated wastewater to irrigate city parks, athletic fields, and green areas. The City plans to increase the use of reused treated wastewater for turf irrigation to 10 mgd in the future. (Bassett, 2005 and City of Cheyenne Board of Public Utilities, 2005) An untreated water turf irrigation system using City-owned irrigation water from the Monolith Ranch has also been proposed to the City of Laramie as a means of reducing summer treated water demand. (Fassett Consulting, LLC, 2004) Industrial use of treated wastewater or stormwater may be economically feasible and of significant benefit to the industrial user. While not located within Wyoming's Platte River Basin, the three Wyodak coal-fired electrical power generation plants located near Gillette, Wyoming, fill most of their water demand through the use of treated Gillette municipal wastewater. The power generating plants provide additional treatment for this water before using it for plant process water. (HKM Engineering, Inc., et al., 2002b)

Environmental Factors

The Wyoming Department of Environmental Quality has developed and enforces regulations regarding reuse of treated wastewater. In addition, the U.S. Environmental Protection Agency (USEPA) has prepared a number of publicly available guidelines and recommended practices regarding the safe reuse of treated wastewater. Pertinent USEPA documents are available at http://search.epa.gov/s97is.vts.

Legal and Institutional Factors

Chapter 21, Standards for Reuse of Treated Wastewater, of Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) rules and regulations contains detailed regulations regarding reuse of treated wastewater, typically for irrigation. Reuse of treated wastewater in Wyoming must conform to the regulations and policies included in Chapter 21. This and other WDEQ/WQD rules and regulations are available at http://deq.state.wy.us/wqd/WQDRules/index.asp.

Public Acceptance

Reuse of treated municipal wastewater or grey water for turf irrigation may not be acceptable to some members of the public, particularly those who live near lands that are irrigated with reused treated wastewater and who may be concerned about the effects of this practice on their health. The City of Cheyenne Board of Public Utilities is, at the time of this writing, planning a public information campaign to describe the reused treated wastewater turf irrigation system that is expected to become operable in 2007 in Cheyenne. (Bassett, 2005)

Water Quality

Water quality, particularly real or imagined health threats posed by reuse of treated wastewater or grey water, may be a significant issue impacting utilization of these future water use opportunities for turf irrigation in populated areas. Water quality may also be an issue with industrial use of one or

more of these water sources, as noted above in the reference to supplemental in-plant treatment of treated municipal wastewater at the Wyodak power plants near Gillette. City of Cheyenne Board of Public Utilities information notes that treated wastewater is "better suited" for irrigation than is potable water since "production of reuse water does not remove all of the nutrients that plants need, thereby decreasing fertilizer requirements." (City of Cheyenne Board of Public Utilities, 2005)

Ability to Satisfy Multiple Demands

These four future water use opportunities would most likely satisfy demand for municipal turf irrigation water and industrial water demand, where high-quality water is not required or where treated wastewater or reused water may be subjected to additional treatment before application.

Comments from the Basin Advisory Group (BAG)

Regarding these future water use opportunities, the Wyoming Farm Bureau Federation stated that "anything that recycles, catches, and spreads water is desirable." (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher generally supported these future water use opportunities but expressed concern regarding reduction of municipal treated wastewater discharges to the North Platte River and its tributaries as a result of reuse of treated wastewater. (Engen, 2005)

5.2.3.6 Modification of Pathfinder Dam and Reservoir

Construction of Pathfinder Dam on the upper North Platte River occurred between 1905 and 1909. Detailed information regarding Pathfinder Dam is available in Platte River Basin Plan Technical Memorandum 2.6, Water Use from Storage. Proposed modification of Pathfinder Dam and Reservoir would increase reservoir capacity by 54,000 acre-feet to recapture storage space lost to sediment accumulation. The proposed increase in reservoir storage capacity would be accomplished by raising the existing spillway flow line elevation by about 2.39 feet.

Pertinent Water Use Sectors

Attachment 5, Section 4, "Wyoming's Pathfinder Modification Project," in the Draft Platte River Recovery Implementation Program (U.S. Department of the Interior, Bureau of Reclamation and U.S. Fish and Wildlife Service, 2003) states that the proposed additional 54,000 acre-feet of Pathfinder Reservoir storage capacity will, when available, be allocated as follows:

- 34,000 acre-feet in an environmental account, operated for the benefit of endangered species in Nebraska, and
- 20,000 acre-feet in a Wyoming account to be held by the U.S. Bureau of Reclamation (USBR) to provide water for Wyoming municipalities during periods of river water regulation, to provide replacement water to satisfy Wyoming obligations under the 2001 Modified North Platte Decree, or to be leased by Wyoming to the Platte River Recovery Implementation Program (PRRIP).

Water Availability

The purpose of the proposed Pathfinder Dam Modification project is to replace 54,000 acre-feet of previous but lost storage on the North Platte River in Wyoming. This quantity of water was presumably available early in the life of Pathfinder Dam and Reservoir. Upon completion of the

proposed project, additional stored water will be allocated for beneficial use under the existing 1904 reservoir storage water right with the exception that the recaptured storage space cannot place regulatory calls on the existing water rights located upstream of Pathfinder Reservoir other than the water rights pertaining to Seminoe Reservoir.

Technical Factors

Current documents, including Appendix F of the 2001 *Final Settlement Stipulation* in Nebraska v. Wyoming, No. 108 Orig., 534 U.S. 40 (2001), state that the Pathfinder Dam spillway flow line elevation will be raised by means of an "inflatable dam or some other means." (Supreme Court, 2001) At this time, more detailed engineering assessment of the means of raising the Pathfinder Dam spillway flow line to replace lost reservoir storage capacity is not known to have been completed.

Economic Factors

The Pathfinder Modification Project would occur in conjunction with abandonment by Wyoming of a U.S. Army Corps of Engineers (USCOE) permit and related plans to construct Deer Creek Reservoir, a proposed 66,000 acre-foot reservoir on Deer Creek, a tributary of the North Platte River in Wyoming. This abandonment is required by Appendix F of the 2001 *Final Settlement Stipulation* in Nebraska v. Wyoming, No. 108 Orig., 534 U.S. 40. (Supreme Court, 2001)

Environmental Factors

Given the mandated use of the majority of new water to be provided by the Pathfinder Modification Project, it is reasonable to assume that normal environmental assessments and permitting will be required for the modification project but that environmental roadblocks to the project may not be significant. As currently described, the proposed Pathfinder Modification Project may be viewed as a positive action insofar as environmental issues are concerned.

The proposed Pathfinder Dam and Reservoir Modification Project is addressed in the Summary of the Draft Environmental Impact Statement (DEIS) – Platte River Recovery Implementation Program (PRRIP). This DEIS, in conformance with standard DEIS and EIS organization, considers and compares a number of alternative courses of action, including a "no action" alternative. The Platte River DEIS considers five action alternatives, including two variations of the Governance Committee Alternative, the Water Leasing Alternative, the Wet Meadow Alternative, and the Water Emphasis Alternative. As shown on Table E-1 of the DEIS summary, the Pathfinder Modification Project is a component of all five of the DEIS alternative actions. The DEIS Summary of Impacts of Each Alternative Compared to the Present Condition indicates that the proposed Pathfinder Modification Project could "impact the dam's historic character." The DEIS assessment of "Common Elements of Action Alternatives" includes the proposed Pathfinder Modification Project as one of three "initial" state water sources projects that are included under all alternative actions. In Table E-7, under the DEIS "Governance Committee Alternative," the combined three state water sources projects, including the proposed Pathfinder Modification Project, are projected to improve annual North Platte River flows by 80,000 acre-feet. Table E-12 provides the same projection under the "Water Leasing Alternative," and Table E-16 repeats this projection under the "Water Emphasis Alternative." The DEIS summary of "Affected Environment and Environmental Consequences" notes that the

Pathfinder Modification Project component of the alternatives under consideration in the DEIS would:

- increase the frequency and magnitude of irrigation shortages as a result of "allocating some of the storage in the Pathfinder Reservoir recovered through the Pathfinder Modification Project to environmental purposes"; and
- affect water users above Pathfinder Reservoir only "during times of increased water right administration for Pathfinder's 1904 right."

The draft DEIS notes that, under all of the action alternatives, "moderate adverse impacts to the lake fisheries" are projected for Pathfinder Reservoir. Table E-21 of the DEIS summary shows an estimated $2,243,000 cost for the Pathfinder Modification Project under all action alternatives. (U.S. Department of the Interior, Bureau of Reclamation and U.S. Fish and Wildlife Service, 2003)

Legal and Institutional Factors

As noted above, Appendix F of the 2001 *Final Settlement Stipulation* states that the 54,000 acre-feet of Pathfinder Reservoir storage that would be restored as a result of the Pathfinder Modification Project would be administered under the existing 1904 Pathfinder Reservoir storage water right, with the exception that the recaptured storage space cannot place regulatory calls on the existing water rights upstream of Pathfinder Reservoir other than the water rights pertaining to Seminoe Reservoir. Opposition to the Pathfinder Modification Project, primarily from individuals who live upstream of Pathfinder Dam, resulted in the filing of a petition with the Wyoming State Board of Control by the Town of Saratoga that seeks abandonment of Pathfinder Reservoir storage rights that correlate to the proposed 54,000 acre-feet of restored Pathfinder Reservoir storage. Subsequently, the petition was withdrawn. In addition, prior to implementation of the Pathfinder Modification Project, both the Governor and Legislature of Wyoming must approve the proposed Pathfinder Modification Project and the Platte River Recovery Implementation Program (PRRIP), of which the Pathfinder Modification Project is one component, during the 2006 legislative session.

The *Draft Platte River Recovery Implementation Program* (2003) states that the following must occur "in order for the (Pathfinder Modification) project to be implemented:"

- amendment of the federal authorization of Pathfinder Reservoir "if necessary to include municipal and environmental purposes;"
- completion of a partial change of use of the Pathfinder Reservoir water right to "allow the uses of the Wyoming and environmental accounts contemplated by this Stipulation;"
- approval by the Wyoming Legislature of the "export of water for downstream environmental purposes;" and
- decision by the U.S. Bureau of Reclamation to proceed with the Pathfinder Modification Project "after completion of any appropriate analysis under NEPA (National Environmental Policy Act) or consultation with the ESA (Endangered Species Act)." (U.S. Department of the Interior, Bureau of Reclamation and U.S. Fish and Wildlife Service, 2003)

Public Acceptance

As noted above, some Wyoming water users have opposed both the PRRIP and the Pathfinder Modification Project, and the Town of Saratoga sought to block the Pathfinder Modification Project by means of a petition to the Wyoming State Board of Control. Like other components of the pending PRRIP, execution of the Pathfinder Modification Project will occur in an environment of active public involvement.

Water Quality

Addressing water quality issues is not a goal of the proposed Pathfinder Modification Project.

Ability to Satisfy Multiple Demands

The *Draft Platte River Recovery Implementation Program* (2003) states that the proposed Pathfinder Modification Project will "increase the capacity of the existing Pathfinder Reservoir by approximately 54,000 acre-feet." This document also states that:

- "approximately 34,000 acre-feet of the proposed 54,000 acre-foot modification would be accounted for in an environmental account and operated for the benefit of endangered species and their habitat in Central Nebraska;" and
- The State of Wyoming "would have the exclusive right to contract with the Bureau of Reclamation for use of the remaining 20,000 acre feet of the modification capacity in a 'Wyoming account' to provide municipal water to North Platte communities in Wyoming, replacement water to satisfy any obligations under the modified North Platte Decree or any stipulation in this case, or water for endangered species." (U.S. Department of the Interior, Bureau of Reclamation and U.S. Fish and Wildlife Service, 2003)

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation response to this future water use opportunity indicated the desire of this organization for continuing discussion and the conviction of the organization that "there will be lessons to be learned" from consideration of this project. (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher was unaware of this proposed project. (Engen, 2005)

5.2.3.7 Coal Bed Natural Gas (Methane)

Coal bed natural gas (methane) development has been growing in Wyoming during the past decade. Methane gas is found in coal seams and is often confined in those seams by groundwater pressure. Methane production occurs when groundwater is pumped from a coal seam, thereby relieving the pressure that holds the methane in the coal seam. Methane readily separates from surrounding groundwater as the groundwater is pumped out of the coal seam, allowing the methane to be piped to the ground surface for use (Keith et al., 2003). Most coal bed natural gas development in Wyoming is in the Powder and Tongue River Basins in northeastern Wyoming.

The number of existing coal bed natural gas wells in the Platte River Basin is small compared to the number of Powder River Basin coal bed natural gas wells. Most Platte River Basin coal bed natural gas wells are located in Carbon County in areas east and west of Seminoe Reservoir, and a few wells are located in Converse County, just inside the northern Platte River Basin boundary.

Pertinent Water Use Sectors

Current coal bed natural gas development in the Platte River Basin is limited and located in relatively remote areas. The most likely water use sectors to benefit from water that is produced by this development are the agricultural sector and the environmental sector.

Water Availability

Coal bed natural gas development produces groundwater as a by-product of the natural gas extraction process. Since reduction of water pressure by means of groundwater pumping is required to obtain coal bed natural gas at the ground surface, groundwater availability is always increased to some extent as a result of coal bed methane development.

Two environmental assessments (EAs) have been prepared for coal bed natural gas projects in Wyoming's Platte River Basin. The Seminoe Road coal bed natural gas development EA estimated long-term well water discharge from each of the 18 proposed coal bed natural gas wells to be 0.058 cubic feet per second (cfs, equal to about 26 gallons per minute). (U.S. Department of the Interior, Bureau of Land Management, 2001b) The Hanna Draw coal bed natural gas development EA estimated long-term well water discharge from each of 16 wells to be 0.023 cubic feet per second (cfs, equal to about 10 gallons per minute). (U.S. Department of the Interior, Bureau of Land Management, 2002)

Technical Factors

Technical factors regarding water development due to coal bed natural gas development pertain primarily to providing the means for discharging, storing, conveying, and/or eliminating pumped groundwater. Discharge may be to an embankment impoundment or an incised impoundment, to an existing natural flow channel, or back into the ground via an injection well and pumping system. Implementation of specific coal bed natural gas water discharge alternatives is typically based on the quality of the water that is discharged from coal bed natural gas wells, the quality of local surface and groundwater, the characteristics of local soils, local land use, and regulatory permitting requirements.

Economic Factors

Groundwater produced during coal bed natural gas extraction is a normal and continuous by-product of this development. The goals of coal bed natural gas developers are typically to discharge this water in a manner that can be permitted by various state agencies at as low a cost as possible. When coal bed natural gas water can be put to beneficial use by someone other than the developer, the cost of the water to the user may be minimal or nonexistent given the natural gas developer's goal of removing the water from his development site as inexpensively as possible. Alternatively, required treatment before discharge of coal bed natural gas water by the developer could impact the economic viability of a coal bed natural gas development project.

Environmental Factors

Environmental permitting for coal bed natural gas development in Wyoming has evolved during recent years concurrently with development of the coal bed natural gas industry. Extensive environmental permitting from federal and state agencies is required prior to initiation of coal bed natural gas development. Post-development environmental issues that have arisen, particularly in Wyoming's Powder River Basin, included impacts on local plants, soil, and water of saline groundwater that has been generated and discharged to the ground surface during coal bed natural gas development. Potential Platte River Basin environmental impacts of coal bed natural gas development, as summarized in the Seminoe Road project EA, include declining water quality, downgrading of local WDEQ/WQD surface water classifications as a result of coal bed natural gas discharge water inflow, and failure to meet Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) National Pollutant Discharge Elimination System (NPDES) discharge water quality requirements. (U.S. Department of the Interior, Bureau of Land Management, 2001b)

Legal and Institutional Factors

Legal and institutional factors pertaining to coal bed natural gas development include extensive permitting that is required prior to project development. Federal environmental assessments (EAs) were required by the U.S. Bureau of Land Management (BLM) for each of the two significant coal bed natural gas development projects that are located in the Platte River Basin, the Seminoe Road project and the Hanna Draw project. Potential legal impacts of coal bed natural gas development, as summarized in the Seminoe Road project EA, include adversely affecting permitted beneficial use of water in the vicinity of the development and depleting local water supplies to the extent that the terms of existing (senior) water rights would be violated. (U.S. Department of the Interior, Bureau of Land Management, 2001b)

Public Acceptance

Public involvement in Platte River Basin coal bed natural gas development has been limited, probably due the limited extent of coal bed natural gas development in the Basin. To date, no known significant public opposition has been voiced regarding proposed and ongoing coal bed natural gas development in the Platte River Basin. Appendix B, Summary of EA Comments and BLM Responses, of the Seminoe Road Development U.S. Bureau of Land Management (BLM) Decision Record contains comments and BLM responses to comments regarding the proposed coal bed natural gas development. These comments were received from the Wyoming Department of Environmental Quality (WDEQ), the Wyoming Department of Transportation (WYDOT), the U.S. Geological Survey (USGS), the U.S. Bureau of Reclamation (USBR), the U.S. Environmental Protection Agency (USEPA), and numerous other agencies, companies, and individuals. (U.S. Department of the Interior, Bureau of Land Management, 2001a)

Water Quality

The Seminoe Road coal bed natural gas project is located within Pool Table Draw, Ayers Draw, and Dirtyman Draw ephemeral drainages, all of which discharge into Seminoe Reservoir. All of these

drainages have been classified by the Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) as Class 4 waters of the state (aquatic life uses are not attainable), and Seminoe Reservoir is classified as Class 2 waters of the state (supports fish and usable as drinking water). Water produced by the Hanna Draw project is discharged into a 500 acre-foot capacity reservoir that was constructed specifically to receive coal bed natural gas water. The Hanna Draw project EA states that surface water quality in the vicinity of the development is "fair." The EAs and EA Appendix B for the Seminoe Road and Hanna Draw coal bed natural gas projects contain detailed information regarding surface and groundwater quality at the two proposed development sites. (U.S. Department of the Interior, Bureau of Land Management, 2001b and 2002)

Ability to Satisfy Multiple Demands

Depending on the quantity and quality of groundwater produced during coal bed natural gas development and the location of the development, this water could satisfy a variety of types of water demand. Given the remote locations of ongoing Platte River Basin coal bed natural gas development and the relatively low assumed discharge rates from existing Basin coal bed natural gas wells, it is likely that the agricultural, environmental, and recreational water use sectors are the water users that will receive limited benefits from groundwater discharge resulting from Platte River Basin coal bed natural gas development.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation noted that coal bed natural gas water quality is "very site specific," as are soil characteristics with which discharged coal bed natural gas water will interact. The Federation believes that "many approaches have worked with CBM (coal bed methane) production water" and that management of coal bed natural gas water is "dependent upon the characteristics of the surface land resource where it is produced." (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher believes that coal bed methane "is a topic that needs a lot of study" and that opinions regarding the benefits of coal bed methane water vary. (Engen, 2005)

5.2.3.8 Regionalization of Public Water Supply Systems

Regionalized public water supply systems are typically systems having a single source of supply and a single treatment system to serve several municipalities, residential developments, or local rural areas. Regionalized public water supply systems are not uncommon in Wyoming. The *State of Wyoming 2004 Water System Survey Report* (Wyoming Water Development Commission, 2004a) provides information regarding Wyoming public water supply systems. Review of this report indicates that a number of Wyoming public water systems either receive water from other public water supply systems or provide water to other public water supply distribution systems. Table 5.2.1 presents a summary of regional Wyoming public water supply systems based on reported systems that provide water to other systems or entities. Table 5.2.2 presents a summary of regional Wyoming public water supply systems based on reported systems that receive water from other systems or entities.As shown on these tables, a significant portion of regionalized Wyoming public water supply systems is located within the Platte River Basin. The largest regional Platte River Basin public water supply system is the Central Wyoming Regional Water System (CWRWS) in the Pathfinder to

Guernsey subbasin. This system includes the City of Casper, four Natrona County improvement districts, the Pioneer Water and Sewer District, the Salt Creek Joint Powers Board, and the Wardwell Water and Sewer District.

Pertinent Water Use Sectors

Of the water use sectors considered in this Basin Plan, the municipal/domestic water use sector would be most heavily impacted by regionalization of public water supply systems.

Water Availability

Water availability, both in terms of quantities of water available and quality of water available, is always an issue for public water supply system operators, both within and beyond Wyoming's borders. While a public water supply system may have access to an adequate local quantity of water, the quality of available water may not be suitable for public use, or treatment required to make the water potable may be very costly. Alternatively, a municipality may not have access to an adequate local quantity of water. Water availability issues presumably played major roles during establishing of existing Wyoming regionalized public water supply systems and during consideration of other potential Wyoming regionalized public water supply systems.

Technical Factors

Regionalization of public water supply systems in Wyoming implies construction of pipelines, storage tanks, and pumping systems as well as developing water sources that are adequate to supply more customers living within the boundaries of larger regionalized systems. Regionalized water supply systems could consist of several surface or groundwater sources that discharge into a single regionalized distribution network. Surface water sources of supply would require treatment (filtration) and disinfection before use, and groundwater would presumably require disinfection given the need to provide a safe drinking water supply over a relatively large regionalized distribution network.

Economic Factors

Economic factors are significant relative to regionalization of public water supply systems. Regionalization may be economically feasible based on the potential reduction of costs associated with water treatment, operating staff, and other factors. Regionalization may not be economically feasible if regionalized system pipelines and related infrastructure provide water to too few people to

Table 5.2.1 Summary - Wyoming public water supply systems that provide water to other entities

Source: State of Wyoming 2004 Water System Survey Report (WWDC)

Providing public water supply system name	Status	Public Water Supply ID#	City	County	Receiving public water supply systems
Afton	municipality	5600002C	Afton	Lincoln	North Afton
Bridger Valley Joint Powers Board	jt powers bd	5600757C	Mt View	Uinta	Lyman, Mountain View
Cheyenne	municipality	5600011C	Cheyenne	Laramie	South Cheyenne Water and Sewer District, FE Warren Air Force Base
Cowley	municipality	5600206C	Cowley	Big Horn	South End Water
Douglas	municipality	5600137C	Douglas	Converse	Ridgewater District
Edgerton	municipality	5600017C	Edgerton	Natrona	Midwest Joint Powers Board
Evansville	municipality	5600018C	Evansville	Natrona	Brookhurst Subdivision
Force Road Joint Powers Board	jt powers bd	5600148C	Gillette	Campbell	Rocky Point, Sundog Estates
Green River	municipality	5601181C	Green River	Sweetwater	JPWB, Rock Springs, Green River
Kemmerer-Diamondville Joint Powers Board	jt powers bd	5600028C	Kemmerer	Lincoln	Oakley, SD; P&M Coal Mine; PacifiCorp
Laramie	municipality	5600029C	Laramie	Albany	South Laramie, Nine Mile Water District
Lusk	municipality	5600032C	Lusk	Niobrara	Niobrara Park
Mills	municipality	5600036C	Mills	Natrona	North MountainView Improvement District
New Castle	municipality	5600256C	Newcastle	Weston	Cambria & Salt Creek Water Districts
North Uinta I&S	district	5601019C	Evanston	Uinta	Deer Mountain
Rawlins	municipality	5600045C	Rawlins	Carbon	Sinclair
Rock Springs	municipality	5601182C	Rock Springs	Sweetwater	Mobile homeparks
Sheridan	municipality	5600052C	Sheridan	Sheridan	Sheridan Area Water System/Joint Powers Board, Downer Neighborhood Service District, VA hospital
Sinclair	municipality	5600054C	Sinclair	Carbon	Refinery, CIG, I-80 travel plaza, Overland Cattle
Sundance	municipality	5600055C	Sundance	Crook	Green Mountain Water District
Teton Village Water and Sewer District	district	5600218C	Teton Village	Teton	Ski Corps, Granite Ridge
Torrington	municipality	5600164C	Torrington	Goshen	South and North Torrington
Wardwell Water and Sewer District	district	5600067C	Mills	Natrona	Town of Bar Nunn
West End Water	district	5601032C	Newcastle	Weston	Oil Creek
Wheatland	municipality	5600187C	Wheatland	Platte	Rick Tracks
Worland	municipality	5600197C	Worland	Washakie	South Worland, Washakie Rural, Hillcrest, and more

Note:
indicates public water supply systems within Wyoming's Platte River Basin

Table 5.2.2 Summary - Wyoming public water supply systems that receive water from other entities

Source: State of Wyoming 2004 Water System Survey Report (WWDC)

Receiving public water supply system name	Status	Public Water Supply ID#	City	County	Source of water supply
Byron	municipality	5600008C	Byron	Big Horn	Shoshone Municipal Pipeline
Cambria I&S	district	5601028C	Newcastle	Weston	City of Newcastle
Casper	municipality	5601415C	Casper	Natrona	Central Wyoming Regional Water System
Cody	municipality	5600207C	Cody	Park	Shoshone Municipal Pipeline
East Thermopolis	municipality	5600226C	Thermopolis	Hot Springs	Town of Thermopolis
Edgerton	municipality	5600017C	Edgerton	Natrona	Salt Creek Joint Powers Board
Frannie	municipality	5600210C	Frannie	Big Horn/Park	Shoshone Municipal Pipeline
Grand View Water Company	company	--	Cody	Park	Shoshone Municipal Pipeline
Kirby	municipality	5600236C	Kirby	Hot Springs	Town of Thermopolis
Lovell	municipality	5600031C	Lovell	Big Horn	Shoshone Municipal Pipeline
Lower Bench Water and Sewer District	district	5601031C	Lyman	Uinta	Joint Powers Board
Lucerne	district	5600935C	Thermopolis	Hot Springs	Town of Thermopolis
Lyman	municipality	5600033C	Lyman	Uinta	Joint Powers Board
Midwest	municipality	5600201C	Midwest	Natrona	Salt Creek Joint Powers Board
Moorcroft	municipality	5600037C	Moorcroft	Crook	Madision Pipeline
Mountain View	municipality	5600847C	Mt View	Uinta	Bridger Valley Joint Powers Board
North Afton Water & Sewer	district	5600155C	Afton	Lincoln	Afton Utility
North Platte Water and Sewer District	district	5600081C	Casper	Natrona	City of Casper
Pioneer Water and Sewer District	district	5600828C	Mills	Natrona	Central Wyoming Regional Water System
Red Lane Domestic Water Inc.	company	5600232C	Thermopolis	Hot Springs	Town of Thermopolis
Ridgewater I&S	district	5600285C	Douglas	Converse	City of Douglas
Shell Water Users	company	5600205C	Shell	Big Horn	Town of Greybull
South Thermopolis	district	5601083C	Thermopolis	Hot Springs	Town of Thermopolis
South Torrington Water & Sewer	district	5600168C	Torrington	Goshen	Town of Torrington
South Worland	company	--	Worland	Washakie	City of Worland
Southeast W&S	district	--	Sheridan	Sheridan	Sheridan Area Water Supply
Wardwell Water and Sewer District	district	5600067C	Mills	Natrona	Central Wyoming Regional Water Systems

Note:
indicates public water supply systems within Wyoming's Platte River Basin

financially support construction or operation of the regionalized system. The economic feasibility of expanding and operating regionalized water distribution, storage, and pumping systems is related to:

- the number of people who would benefit from and could financially support a regionalized system, and
- the areal extent of the regionalized system.

The National Drinking Water Advisory Council (NDWAC) was chartered under the 1974 federal Safe Drinking Water Act (SDWA); is administered by the U.S. Environmental Protection Agency (USEPA); and consists of representatives from the USEPA , the general public, state and local governmental agencies, and private groups. The 2003 *National Small Systems Affordability Criteria Work Group: Recommendations to the National Drinking Water Advisory Council* includes the statement that "probably the most effective long-term (regulatory) compliance option for small (water supply) systems is a cooperative approach. This approach is being increasingly implemented to achieve cost reduction and greater water management expertise." The Work Group report notes that, while governmental support for public water system consolidation has increased during recent years, "significant political, geographical, and business barriers have prevented widespread consolidation." The report includes suggested actions to overcome these barriers. (U.S. Environmental Protection Agency, 2003)

In *Consolidation Potential for Small Water Systems – Differences Between Urban and Rural Systems,* the National Rural Water Association (NRWA) assesses consolidation of small rural water supply systems. The authors of this document note the increased financial, technical, and managerial burdens that have been placed on small public water supply systems by federal water quality regulations. They further note that "consolidation (sometimes referred to as regionalization or cooperation) is advocated in some circles as a widely applicable solution to many of these small system problems." A basis for this NRWA document is the contention that "while the concept (of water system consolidation) has been widely advocated, there has been little empirical investigation on whether consolidation – whether by physical interconnection or a shared management strategy – is an economically viable and feasible solution to the affordability issues faced by many small (water supply) systems." (Ottem et al., 2003)

Environmental Factors

Environmental factors should not be a major consideration relative to regionalized public water supply systems. Disturbances to the environment, including stream crossings, resulting from pipeline, storage tank, and pumping station construction are typically relatively minor and often temporary. A majority of this type of infrastructure is often constructed within existing highway rights-of-way or on other publicly owned land.

Legal and Institutional Factors

Legal and institutional factors that could impact regionalization of public water supplies may include:

- the need to obtain formal agreement between municipalities and individuals to participate in the regionalized public water supply system, and
- operation of and regulatory accountability for a regionalized public water supply system.

Examples of Wyoming interest in regionalized public water supply systems are included in the 2005 Wyoming Water Development Commission (WWDC) water development project list. This list includes:

- The Alpine Master Plan Update Level II Feasibility Study
  Part of the scope of work for this pending project is assessment of regionalization of the Town of Alpine public water supply system with North Alpine developed areas.
- The Burlington Regional Master Plan
  This project will focus on the feasibility of providing the Town of Burlington and surrounding areas, including the community of Otto, with a regional water supply system.
- The Level I Reconnaissance Study of the Hoback Junction Water Supply
  This project will assess the potential for constructing a rural domestic water supply system for Hoback Junction and adjacent areas.
- The Big Horn Regional Groundwater Level II Feasibility Study
  This study will assess the feasibility of a regional groundwater supply, distribution pipeline, and water storage system in the Buffalo Creek area of the Big Horn Basin.
- The Sheridan/Veterans Center Level II Feasibility Study
  This study will assess the feasibility of connecting the Sheridan Veteran's Administration Hospital water supply system with the City of Sheridan municipal water supply system.

(Wyoming Water Development Commission, 2005c)

The Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) does not have a formal policy regarding regionalization of public water supply systems in Wyoming. When this issue arises, WDEQ/WQD considers it on a case-by-case basis. (Robinson, 2004) Chapter 23, Minimum Standards for Subdivision Applications, of WDEQ/WQD Rules and Regulations requires submittal to WDEQ/WQD of preconstruction information from both the subdivision developer and the owner of an existing public water supply system regarding proposed connection of a new subdivision public water supply system to an existing public water supply system. (Wyoming Department of Environmental Quality, Water Quality Division, 2002)

The U.S. Environmental Protection Agency (USEPA) year 2000 *Report of the National Drinking Water Advisory Council Small Systems Implementation Working Group* considers options that the USEPA and individual states "should consider to assist small (public water supply) systems in meeting the public health protection objectives of the Safe Drinking Water Act (SDWA)." In assessing the challenges and opportunities facing small public water supply systems, the report identifies regionalization as a positive opportunity for small systems to improve their organizational structures. The report recommends that:

- USEPA should continue to "provide information and policy research related to changing market conditions affecting the water industry and organizational alternatives for water systems," including regionalization;

- states should "facilitate and encourage partnerships among water systems and remove barriers to strategic regionalization and consolidation;" and
- states should "provide incentives for strategic regionalization and consolidation (of public water supply systems) that improves capacity and lowers costs." (U.S. Environmental Protection Agency, 2000)

The American Water Works Association (AWWA) is a large and well-known "international non-profit scientific and educational society dedicated to the improvement of drinking water quality and supply." Among its many activities, the AWWA has issued policy statements regarding a variety of drinking water issues, including the regionalization of water utilities. The AWWA policy regarding regionalization states:

> The American Water Works Association (AWWA) encourages water utilities to identify local and regional solutions to resource management and water supply service needs. If a regional program is necessary or desirable, water utilities should work with the appropriate levels of government to develop the program and promote the use of good utility management principles. State, provincial, territorial, and federal agencies are encouraged to support local government efforts to develop a regional program and ensure equitable benefits to all water utilities.

The AWWA statement continues by noting, as have the National Rural Water Association (NWRA) and others, that the economic effects of regulatory reform as it pertains to drinking water have placed significant financial burdens on many public water supply systems and that "regionalization of water supply sources, either through physical connections or management structures, may provide economies of scale and reduce the costs of water services." AWWA also contends that regionalization may also "increase water use efficiency, promote water conservation, minimize capital investment, and enhance source protection." AWWA notes that "no single approach or mandate" should be universally applied to all water system regionalization plans. (American Water Works Association, 2004)

In a recent editorial in the *Rural Water Magazine* that is published by the National Rural Water Association (NRWA), Mr. Rob Johnson, CEO of the NRWA, noted that:

- a decade ago, water system consolidation was "advocated as a solution to the drinking water compliance problems of small (water supply) systems;"
- water system consolidation is a "complex, expensive and emotional process" for small water supply systems;
- data show that water supply systems serving between 101 and 50,000 users have "significantly lower (customer billing) rates . . . . while maintaining the same level of profitability" as do water supply systems serving more than 50,000 users;
- EPA compliance data show that regulatory compliance problems for small systems are proportionately about the same as for large systems; and

- at “minimum costs of $50,000 a mile for (water pipeline) interconnections,” the consolidation “solution” is usually worse than the problems faced by many small rural water supply systems. (Johnson, 2004)

Public Acceptance

Public acceptance of regionalized water supply systems may vary. Those whose current water supply systems, whether private or public, provide substandard water quality, quantity, or pressure may strongly favor regionalization if the end result is supply of higher-quality water, a more reliable water supply, and/or improved water pressure at an acceptable cost. The not uncommon disconnect between the public’s desire for high-quality water in adequate quantities and at satisfactory pressure and the public’s ability or willingness to bear the costs of obtaining high-quality water may impact consideration of regionalized public water supply systems in Wyoming, particularly given the small and scattered population of the state.

Water Quality

Providing drinking water of higher quality to more people may be a significant factor supporting regionalization of public water supplies. While existing, smaller public water supply systems may meet U.S. Environmental Protection Agency (USEPA) enforceable primary health-based water quality requirements, water from these systems may not always meet USEPA non-enforceable secondary aesthetic water quality recommendations. Such water may be legally potable, but unsatisfactory because of odor, taste, or color. A regionalized water supply system may provide water that meets both USEPA primary and secondary water quality requirements and recommendations and is therefore both safe and satisfactory.

Ability to Satisfy Multiple Demands

Regionalized public water supply systems have the capability of providing safe, potable water to an expanded number of people but would presumably not significantly impact water use sectors other than the municipal/domestic sector.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation believes that this topic should be discussed further based on the unknown factors associated with the concept. The Federation believes that this future water use opportunity “could be a disaster waiting to happen; or the best idea anyone ever had.” Two issues relative to this concept that the Federation believes require further consideration are the safety of larger, expanded water supply systems insofar as disinfection and public health are concerned and the cost-effectiveness of constructing and operating regionalized public water supply systems. (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher noted that public water supply systems could be an important issue for consideration. (Engen, 2005)

5.2.3.9 Co-production of Electricity and Hydrogen from Hydropower Facilities

Pertinent Water Use Sectors

Unlike other future water use opportunities that are discussed in this memorandum, co-production of electricity and hydrogen at hydropower facilities is a potential non-consumptive future use of Platte River Basin water resources to generate hydrogen to serve as a replacement for hydrocarbon fuels.

Water Availability

The existing system of U.S. Bureau of Reclamation (USBR) dams and hydroelectric power generating plants on the North Platte River in Wyoming's Platte River Basin are described in Platte River Basin Water Plan Technical Memorandum 2.6. Hydroelectric power generation is a significant ongoing non-consumptive use of Platte River Basin water resources.

Technical Factors

Hydrogen is the simplest, most abundant element in the universe, but hydrogen is not found as a pure element in nature. Pure hydrogen must be generated via the application of another source of energy to natural substances that contain hydrogen such as water, hydrocarbon liquids, or gases. Once available, hydrogen may be used as the energy source for fuel cells, which, similarly to batteries, generate electrical power for vehicles and other uses without relying on combustion or causing pollution.

One of several techniques for generating hydrogen is through the use of electrical energy. This technique is referred to as electrolysis. At this time, wind power and hydropower are considered potential renewable energy sources for the production of both electricity and hydrogen via electrolysis.

On February 16, 2003, an article entitled "Columbia's Power: The river contains the secret to drive a national energy revolution" appeared in the Eugene, Oregon, *Register-Guard*. The major ideas in this article may be as applicable to Wyoming's North Platte River as to the Columbia River and include:

- the assertion that nighttime (off-peak) hydroelectric power generation at existing Columbia River hydroelectric plants holds a "remarkable secret" that can "put the Northwest at center of a global energy revolution;"
- the referenced global energy revolution consists of the production of hydrogen at existing Columbia River hydroelectric power plants "faster, cleaner, and cheaper" than hydrogen could be produced "anywhere in the world;" and
- hydrogen produced at night at these hydroelectric plants "can revolutionize energy consumption in the 21st century. The end of the age of oil can begin here." (Robertson, 2003)

Economic Factors

Uncertainties currently exist regarding the "technical and economic feasibility of . . . production of hydrogen from . . . hydropower," including:

- the ability to produce electricity at a low enough cost to allow economically feasible co-production of hydrogen;
- the need to lower the capital costs and increase the operating efficiency of electrolysis equipment;
- the need for optimal hydropower/hydrogen generating system designs;
- the need to resolve "power system integration issues;" and
- the current lack of hydrogen storage and transmission facilities. (U.S. Department of Energy, 2003)

Generation of hydrogen via electrolysis using hydroelectric power may, as suggested by the BAG member who requested consideration of this potential future water use opportunity, be most feasible during daily "off-peak" power generating hours. According to the U.S. Department of Energy, peak and off-peak electrical power prices can vary by a factor of three or four. (U.S. Department of Energy - Energy Efficiency and Renewable Energy, 2004)

Environmental Factors

As noted above, large hydroelectric generating facilities currently exist in Wyoming's Platte River Basin. Use of hydrogen as a fuel produces no combustion or pollution.

Legal and Institutional Factors

At this time, assessments of legal and institutional factors relative to future hydrogen generation at Wyoming Platte River Basin hydroelectric power plants are not known to be available. Current information regarding this potential future Platte River Basin water use opportunity is either general in nature or pertains to other regions of the United States.

Public Acceptance

Public reaction to hydroelectric generation of hydrogen in Wyoming is difficult to assess at this time. It is possible that construction and use of hydrogen storage and transmission infrastructure may draw more public response than would hydrogen generation at existing hydroelectric power plants.

Water Quality

Water quality is not a pertinent issue relative to hydroelectric generation of hydrogen.

Ability to Satisfy Multiple Demands

Hydroelectric generation of hydrogen does not relate to satisfaction of water demand.

Comments from the Basin Advisory Group (BAG)

This potential future Platte River Basin water use opportunity was suggested for consideration by a BAG member after the February 2005 Platte River Basin BAG meeting. As a result, consideration of this potential future water use opportunity was unknown to those whose comments are included in this discussion of these opportunities.

5.2.3.10 Improving Agricultural Irrigation System and Control Efficiencies

Recent and ongoing modifications to Wyoming irrigation systems have been intended to improve system efficiency and to address other issues, such as water quality. Technical Memorandum 5.3, Water Quality Issues, discusses recent and ongoing efforts by the Casper-Alcova Irrigation District to address selenium-based water quality issues. These efforts have included implementation of a number of technical measures to increase irrigation efficiency that are described in this section. The Goshen Irrigation District (GID) has installed motorized, remote-controlled gates and other remote telemetry to increase the efficiency of the district irrigation system. These improvements are discussed in greater detail below. In 1997, the Wyoming Legislature appropriated $100,000 to construct improvements to the Hill Irrigation District canal system. (Lidstone & Anderson, Inc., 1997) A group of individuals and organizations recently secured a $250,000 Wyoming Water Development Commission (WWDC) grant to improve the Gunbarrel Lateral Irrigation Ditch system, including installing large-diameter PVC pipelines to save water and improve system efficiency. (Wyoming Association of Conservation Districts, 2005)

A number of WWDC studies and projects have been focused on assessing and improving irrigation system efficiency in Wyoming's Platte River Basin. A representative list of such studies includes:

- Priority Improvements of the LaPrele Irrigation Project: Estimates of Increased Returns to Irrigators. J.J. Jacobs, University of Wyoming. 1983.
- Horse Creek Reservoir, Level II Study, Executive Summary. HDR Infrastructure, Inc. 1986.
- Ferris Irrigation District Canal Improvements Project, Level II Feasibility Report. Kennedy Engineering. 1990.
- Gunbarrel Lateral Ditch Studies Final Report, Rehabilitation Plan – Preferred Alternative B on Gunbarrel Ditch Water Delivery System. Kennedy Engineering. 1995.
- Hill Irrigation District Improvements Level II Project. Lidstone & Anderson, Inc. 1997.
- Horse Creek Conservation District Improvements Project, Level II. PMPC and Lidstone & Anderson, Inc. 1998.
- Executive Summary for Casper Alcova Irrigation District Rehabilitation Needs Analysis. Anderson Consulting Engineers. 2003.
- Final Report for Casper Alcova Irrigation District Rehabilitation Needs Analysis Phase II. Anderson Consulting Engineers. 2003.

Pertinent Water Use Sectors

The agricultural water use sector would be the primary sector that would be affected by increases in irrigation system efficiency in that this sector may bear much of the cost for these improvements and would have to modify agricultural practices on the basis of modified irrigation systems. The agricultural water use sector may benefit from increased irrigation efficiency if that increased efficiency results in higher crop yields. Assuming that irrigation practices affect wetland creation, aquifer recharge, and consistent stream flows, all Basin water use sectors could be affected by changes in irrigation efficiency.

Water Availability

Increasing water availability by reducing current utilization of water resources is the primary goal of increasing irrigation system and operation efficiency. However, the "idea that more water will be available for other uses if irrigators become more efficient in their use of irrigation waters is false thinking. Most generally, more water becomes available only when irrigators change to crops that consume less water. Many downstream irrigators depend upon so called 'inefficient' irrigation upstream" by utilizing return flows from upstream irrigation operations. (Brosz, 2005).

Technical Factors

Increasing the efficiency of agricultural irrigation may be based on a number of technical factors, including:

- lining irrigation canals to reduce seepage losses;
- replacing irrigation storage reservoirs having large surface areas with reservoirs having smaller surface areas in order to reduce evaporation losses;
- designing and installing remote automated irrigation system flow monitoring and control systems to increase operating efficiencies;
- replacing flood irrigation systems with sprinkler irrigation systems or drip/micro irrigation systems;
- installing irrigation water transmission pipelines to replace open-channel canals and laterals;
- installing gated (perforated) irrigation gravity discharge pipe;
- installing surge irrigation systems; and
- installing soil moisture detection instruments.

Modification of headgates, check structures, and wasteways is the "most effective way to minimize waste" in an irrigation canal. These modifications may include replacing check structures with adjustable motorized gates that are monitored and operated remotely. (Cassidy, 2000) Wyoming's Goshen Irrigation District (GID) automated four of its "most important" wasteways in 1995 and 1996 by installing remote-controlled motorized gates. GID has also installed remote telemetry equipment to read and transmit canal flow depths to GID's control facility in Torrington. (Cassidy, 2000)

The Wyoming Association of Conservation Districts (WACD) provides information, pamphlets and brochures, and seminars regarding various items and practices that may be used to increase irrigation efficiency. Publications available through the WACD include an "Irrigator's Pocket Guide;" information regarding use of gypsum blocks as an "economical and accurate management tool for irrigation systems;" information regarding use of surge valves to save "water, time, labor, and money while reducing runoff;" and information regarding polyacrylamide (PAM) polymer to eliminate erosion and sediment loss during irrigation. WACD also hosts irrigation water management seminars and retains irrigation specialists to assist with development of irrigation water management programs. (WACD, 2005)

A less concrete technical consideration pertaining to irrigation efficiency is the irrigator's knowledge of local soils and the crops under cultivation. Different soils have different capacities to hold water

and different infiltration rates. Different crops have different rooting depths and patterns. Different amounts of water should be applied during germination and maturation of different crops. These factors relate to determination of the timing and quantity of irrigation. Timing and quantity of irrigation water application relate to the efficiency with which irrigation water is utilized. (Brosz, 2005)

Rain Bird Corporation, a leading U.S. manufacturer of sprinkler irrigation equipment, has published a booklet entitled *The Intelligent Use of Water*. Rain Bird states that the goal of the booklet, which is intended for use by agricultural customers, "is about using water efficiently – in the most precise and even manner possible, minimizing waste." In this booklet, Rain Bird Corporation notes and describes the following key methods of "intelligently using (irrigation) water":

- use the right amount of water at the right time;
- automate the irrigation system to improve profits and save water;
- apply (treated wastewater) effluent wisely to save water and avoid groundwater pollution; and
- take advantage of The Irrigation Association's Certification Program. (Rain Bird Corporation, 2005)

The Irrigation Association is an international organization started in 1949 with the stated goal of "water conservation through efficient irrigation." The Association website states that:

- nearly 80 percent of annual water use in the United States is for agricultural purposes;
- nearly all types of modern irrigation have become more efficient;
- increases in irrigation system efficiencies have given farmers the opportunity to "increase the effective use of water from less than 50% to more than 90%;"
- more efficient use of irrigation water supports more effective use of fertilizers and agricultural chemicals;
- irrigated acres account for 15% of U.S. farmland but produce 38% of farm revenue;
- irrigation ensures higher, more predictable crop yields;
- growers of irrigated acreage can increase production without increasing acreage; and
- irrigated fields are more productive (than non-irrigated fields).

The Irrigation Association also states that technology is the key to improved irrigation efficiency. (Irrigation Association, 2005c)

The U.S. Bureau of Reclamation (USBR) has developed and supports continuing development of "remote data collection sites linked through efficient telemetry networks" to provide "real-time" irrigation system operational information and support more efficient management of water resources. USBR efforts in this regard, which are located primarily in the Pacific Northwest at this time, have been supported by development of the United States geostationary satellite system (GPS or global positioning system). USBR also contends that agricultural weather monitoring system data "coupled with other remotely sensed data" are improving the efficiency with which agricultural irrigation water is used. (Moore et al., 1991)

Economic Factors

Increasing irrigation efficiency may rely on a variety of costly and increasingly sophisticated technical factors. Economic costs of increasing irrigation efficiency will likely be an important determinant of the extent to which Basin irrigation system efficiency will be improved.

The Irrigation Association recommends the following governmental and institutional economic actions to support increased irrigation efficiency:

- creating conversion incentives for farmers to embrace modern irrigation technologies;
- establishing tax credits for investment in irrigation systems;
- offering low-interest loans to encourage purchase and installation of more efficient irrigation technology;
- adjusting the price of water to more closely reflect its market value;
- removing obstacles to utilize recycled water (treated wastewater) for irrigation;
- assuring farmers who invest in efficient irrigation technologies that they will have the water they need to operate their upgraded irrigation systems; and
- educating farmers regarding the economic advantages of environmentally sound irrigation practices. (Irrigation Association, 2005b)

Environmental Factors

Increasing irrigation system efficiency, including increasing reliance on center-pivot sprinkler irrigation systems, may result in one or more of several environmental impacts. These potential environmental impacts include loss of wetlands, more intermittent stream flows, and declining local water tables. The Irrigation Association, which states that it is dedicated to promoting "water and soil conservation through proper water management," contends that properly managed irrigation technology both "helps protect the environment and improves water quality by using a lower level of resources," and states that efficient irrigation protects the environment by:

- reducing non-point source water pollution by reducing chemical-laden runoff;
- keeping groundwater clean by reducing percolation of irrigation chemicals into groundwater;
- allowing more precise application of nutrients to cultivated plants;
- preventing topsoil erosion;
- protecting the soil and water from destructive salt buildup; and
- permitting land application of animal waste by providing for filtration of animal wastes as it percolates through the soil. (Irrigation Association, 2005b*)*
-

The responding Albany County rancher and BAG member whose position regarding increased irrigation efficiency is summarized below believes that improved irrigation efficiency could "improve the use of water" but that benefits of (flood) irrigation such as return flows, groundwater recharge, and wetlands creation should be studied and evaluated during consideration of improving irrigation system efficiency. (Engen, 2005) These issues addressed by the Albany County rancher are environmental issues. Dr. Don Brosz, retired University of Wyoming Extension Irrigation Engineer, provided views similar to those of the Albany County rancher. Dr. Brosz noted that, about 20 years ago, 6,000 acres of irrigated land in the Afton, Wyoming, area, in Wyoming's Snake/Salt River

Basin, were converted from flood irrigation to sprinkler irrigation. This conversion included replacing earthen canals and lateral ditches with underground pipelines. Since this conversion, spring flooding of the Salt River has occurred regularly, and late fall and winter Salt River flows have "been reduced substantially." Dr. Brosz concluded that the replaced earthen canals and ditches and surface irrigation methods had "served as a storage area of the stream runoff and those waters returned to the Salt River later in the year as late fall and winter flows." (Brosz, 2005)

Legal and Institutional Factors

A Wyoming Association of Conservation District (WACD) position regarding increasing irrigation efficiency as a means of reducing water consumption may be inferred from WACD endorsement of the 1998 Water Policy statement of the Wyoming Water Coalition (WWC). The WWC statement represents the positions of a number of Wyoming agricultural organizations, conservation districts, the Wyoming Department of Agriculture, and several individuals. The pertinent WWC position statement follows:

> Under present law, the incentive to implement practices which conserve water is overshadowed by the concern that saved water is no longer considered part of the appropriator's entitlement. As water rights in Wyoming are property rights, it must be recognized that water conserved by the beneficial efforts of an appropriator is still part of his appropriation, and he has a right to expect consideration for that saved water that otherwise accrues only to the benefit of others on his stream. (Wyoming Association of Conservation Districts, 2005)

The Northern Plains Agricultural Research Laboratory (NPARL), which is operated by the U.S. Department of Agriculture, is located in Sidney, Montana, and is one of more than 120 federal Agricultural Research Service (ARS) facilities in the United States. While NPARL efforts appear to focus on the Montana-Dakota agriculture, NPARL research may be applicable to Wyoming agriculture. The stated NPARL mission is to "develop ecologically based strategies, technologies, and products for the sustainable management of crops and rangeland, and natural resource systems." The goal of NPARL research regarding irrigation is to "develop scientifically based ways to more efficiently use agricultural water in response to water quality issues, endangered species, increased competition for water resources and the need to increase water conservation. . . ." One of three major current NPARL research topics is "development of sustainable irrigated and dryland agricultural production systems." (U.S. Department of Agriculture, 2005) Two ongoing five-year NPARL research efforts pertain to irrigation, including:

- Irrigation Methods, Technology and Management for Increased Water Use Efficiency, Project Number 6209-13000-010-00 (http://www.ars.usda.gov/research/projects/projects.htm?ACCN_NO=405267), and
- Irrigation Systems and Precision Management Strategies to Conserve Water and Protect Water Quality, Project Number 5402-13220-002-00 (http://www.ars.usda.gov/research/projects/projects.htm?accn-no=405357)

A key goal of the first of these two studies is to "develop and evaluate drip and sprinkler irrigation control systems to minimize application losses and enhance water use efficiency while reducing management effort by using remote sensed data." An objective of the second study is to "develop management tools that enable producers to readily implement precision agricultural techniques for spatial and temporal application of water, nutrients, and pesticides."

Public Acceptance

The largest user of Platte River Basin water is the agricultural sector, but the majority of Platte River Basin population is urban. The majority of the Basin population may therefore support increased agricultural irrigation efficiency.

Water Quality

As noted in sections above, irrigation practices and irrigation efficiency are related to both surface and groundwater quality.

Ability to Satisfy Multiple Demands

Increasing irrigation efficiency could reduce the quantity of water required for irrigation of existing irrigated lands within the Platte River Basin, thereby potentially allowing irrigation of additional lands, beneficial use of conserved water for other purposes, and/or increased crop yields.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation contends that improving agricultural irrigation system and control efficiencies requires an understanding of the "trade-offs." The Federation contends that irrigation can create wetlands, provide more consistent stream flows via return irrigation flows, and recharge local aquifers. (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher provided a position that is similar to that of the Wyoming Farm Bureau Federation. He stated that improved irrigation efficiency could "improve the use of water" but that benefits of flood irrigation such as return flows, groundwater recharge, and wetlands creation should be studied and evaluated during consideration of improving irrigation system efficiency. (Engen, 2005) Dr. Don Brosz, University of Wyoming Extension Irrigation Engineer (retired), contends that increasing irrigation water application efficiency is "serious business" and that each Wyoming river basin needs to "approach increasing irrigation water application efficiency with an understanding of what impacts will result on all water users and interests" in each basin. Additional comments regarding irrigation efficiency that were provided by Dr. Brosz are incorporated into the text above. (Brosz, 2005)

5.2.4 Non-structural Future Water Use Opportunities

5.2.4.1 Drought Response Planning

The purpose of this section is to discuss drought response planning. The Wyoming drought that is ongoing at the time of this writing has evolved over a number of years, is continuously changing, and will, at some point in the future, pass. This section, in addressing drought response planning, is intended to focus on drought response planning as a tool that may be useful in addressing future Wyoming droughts.

The results of long-term studies have indicated that "severe, long-duration (> 10 year) droughts are a common feature of Wyoming's climate." These studies have also shown that, while the Wyoming droughts of the 1930s and 1950s were "extreme events in terms of their social and economic impacts," Wyoming's climate system is "capable of producing longer and stronger droughts." (Case and Bersie, 2005)

Pertinent Water Use Sectors

Drought impacts all water use sectors, and drought response planning may benefit all Basin water use sectors. Prior to the drought that is ongoing at the time of this writing, Wyoming experienced a major drought between 1952 and 1956. The impacts between 1999 and 2003 of the current drought on Wyoming's agricultural sector were greater than the impacts of the 1952-1956 drought, and the 1999-2003 drought "can be shown to be the drought of historic record." (Case and Bersie, 2005)

Water Availability

Drought response planning or drought preparedness would presumably focus on developing approaches to mitigating the impacts of drought on Basin water users. Water availability relates to drought response planning in that the lack of water and associated impacts are the results of drought and the primary justification for undertaking drought response planning.

Technical Factors

Drought is a "normal part of life in Wyoming. This knowledge should . . . affect how we plan for Wyoming's economic and agricultural development." The inevitability of drought in Wyoming should be incorporated into "our management of natural resources and include severe, sustained droughts in our plans for timber production, wildland, prescribed fires, non-native plant invasions, and water resources." (Case and Bersie, 2005) Drought is considered to be the "most complex of all natural hazards," and drought "affects more people than any other (natural) hazard." The three "critical components" of a drought preparedness plan, include:

- preparing a comprehensive early warning system,
- developing risk and impact assessment procedures, and
- developing mitigation and response strategies.

These components of drought preparedness may be considered technical factors pertaining to drought response planning. (National Drought Mitigation Center, 2003a) Drought response planning may

also include providing some physical means of attempting to respond to the drought, such as weather modification or enhanced flow monitoring.

The current *Wyoming Drought Plan*, revised January 2003, contains a response plan. This plan was revised on the basis of information and similar plans from other states and agencies. The role of drought assessment and response as defined in the *Wyoming Drought Plan* is "to be proactive and to assist existing state, federal and local agencies to carry out their designated missions for assisting drought affected customer groups." (Micheli and Ostermann, 2003)

Drought response planning may be undertaken by individual farmers and ranchers as well as by governmental agencies. Planning by individuals may "focus on things that the manager can do to reduce risk (uncertain consequences) associated with climatic variability." (Thurow and Taylor, 1999)

Economic Factors

The Wyoming Water Association (WWA) prints the statement "Water is Wyoming's Gold!" on the header of WWA newsletters. During droughts, the WWA statement may be an understatement. Droughts may be very costly. Analysis has shown that drought can be as expensive as floods and hurricanes. Annual costs resulting from drought in the United States are estimated to be between $6 billion and $8 billion. A goal of drought response planning should be to "relieve the most suffering at the least expense." (National Drought Mitigation Center, 2003b)

Cost has historically been a major impediment to drought planning, since significant drought planning costs are difficult to compare to unknown future costs resulting from drought. (National Drought Mitigation Center, 2003b) This point of view is supported in the following statement:

> One reason that policy-makers and landowners persist in treating drought as a quirk of nature is that if they accept the challenge of planning for drought, then they implicitly accept the responsibilities associated with the development and implementation of proactive responses to drought. These are difficult responsibilities to bear because the costs of planning for drought are fixed and occur now while the costs of degradation from drought are uncertain and occur later. (Thurow and Taylor, 1999)

Environmental Factors

The environmental impacts of drought may include water quality degradation resulting from low or terminated stream flows, loss of wetlands and resultant decreasing groundwater recharge, and loss of vegetation leading to subsequent erosion. The Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) has not assessed or studied impacts of the current Wyoming drought on water quality in the state. (Wagner, 2005)

Drought response planning may also affect to the long-term environmental impacts of drought. One article has noted that, because the onset of drought may not be recognized until some time after it has occurred, livestock "stocking rates" on rangeland may not be adjusted in response to drought until

vegetation has already been reduced by the drought, thereby "increasing the potential for accelerated erosion following the drought." The drought and range management-induced erosion may result in long-term "reduction in soil depth, a decline in soil structure and a decrease in infiltration rate and water storage capacity." Soil degradation may cause plant stress, "effectively increasing the perceived frequency and consequences of drought." The authors conclude that "management and policy tools must improve the integration of economic and ecological aspects of drought-induced de-stocking decisions, especially by incorporating the long-term irreversible costs of erosion." (Thurow and Taylor, 1999)

Legal and Institutional Factors

The "severe drought of 2000. . . prompted Governor Geringer to form a drought task force and one of the charges of that task force was to develop a drought response plan." (Micheli and Ostermann, 2003). The *Wyoming Drought Plan* includes:

- definitions of "drought;"
- a discussion regarding drought vulnerability;
- a description of the structure and function of drought planning in Wyoming;
- a description of sources of information used for drought monitoring; and
- various supporting attachments.

In Wyoming, the Wyoming Drought Task Force administers the implementation of drought-related activities in the state. Task force co-chairs are the Director of the Wyoming Department of Agriculture and the State Forester. The task force meets at least twice a year regardless of drought conditions and meets as often as deemed necessary during drought years (Micheli and Ostermann, 2003).

Development and implementation of drought response planning by existing institutions rather than by newly created institutions are considered to increase the effectiveness of the planning (National Drought Mitigation Center, 2003b). The Irrigation Association shares the position that the best way to cope with drought is to be proactive – "to have every citizen take steps to get the most out of the water he or she uses." (Irrigation Association, 2005a)

Drought planning may include both responding to ongoing droughts and developing responses to future droughts. The Wyoming Department of Agriculture (WYDA), in "Process by which a disaster is declared," notes that, unlike many natural disasters, drought and its impacts may not be recognized until some time after the onset of drought. The end of a drought may not be recognized for some time after the end of drought conditions. Like other natural disasters, severe drought may lead to a disaster declaration in one or more counties. The U.S. Department of Agriculture (USDA) administers four types of disaster declaration, including:

- Presidential major disaster declaration;
- USDA Secretarial disaster designation;
- Farm Service Agency (FSA) Administrator's Physical Loss Notification; and
- Quarantine designation. (WYDA, 2005)

The Secretarial disaster designation is "the most widely used" of the four categories listed above. The process whereby this type of disaster is declared is the most complicated of the four processes by which disaster may be declared. The WYDA summarizes the process by which a Secretarial disaster designation may be declared, noting that "a minimum 30-percent loss of at least one crop" in the county under consideration must have occurred in order for this type of disaster declaration to occur. The WYDA also describes low-interest loans that are available in a county that has been declared a disaster area. (WYDA, 2005)

As part of its role as the primary source of funding for Wyoming water development projects, the Wyoming Water Development Commission (WWDC) supports a variety of projects that are focused on conserving water. A number of recent and ongoing conservation projects, including irrigation system improvements, municipal water supply improvements, municipal water supply regionalization, weather modification, and others, are discussed in other sections of this technical memorandum. By conserving Wyoming's water resources, these projects serve as an important component of long-term drought response planning and implementation.

The Wyoming Office of Homeland Security has proposed the following drought mitigation projects:

- groundwater development;
- study regarding productive use of coal bed natural gas (methane)-produced water;
- GIS training for local Wyoming officials with "emphasis on hazards recognition and analysis for application to mitigation planning;"
- public education regarding drought-related issues;
- continuing collaboration with Wyoming Counties to identify cost-effective and feasible drought mitigation projects; and
- maintaining and expanding "hazards databases" that were generated as part of the Wyoming State Mitigation Plan. (Case and Bersie, 2005)

Information regarding drought conditions in Wyoming is available from the following agencies:

- University of Wyoming Cooperative Extension Service – www.uwyo.edu/ces/drought/drought_main.html;
- Natural Resources Conservation Service (NRCS) Drought Information Center – www.wy.nrcs.usda.gov/technical/wydrought/drought.html;
- Wyoming Water Resources Data System (WRDS) Drought Monitor – www.wrds.uwyo.edu/wrds/wsc/dtf/drought.html;
- Wyoming Department of Agriculture Drought Information – www.wyagric.state.wy.us/relatedinfo/droughtmain.htm; and
- U.S. Geological Survey (USGS) Wyoming Drought Watch – www.wy.water.usgs.gov/projects/drought.

Public Acceptance

Public acceptance of the costs of drought response planning may be difficult to obtain during periods of adequate water supplies. Public acceptance of drought response planning after the onset of a major drought is less difficult to obtain, despite the fact that drought planning and response that occur during a drought crisis may be more costly than drought planning that occurs during periods of adequate water supplies. Mr. Don Britton, Manager, Wheatland Irrigation District, stated that he "wasn't exactly ready for this drought but I plan to have the district ready for the next one." (Britton, 2004)

Water Quality

At the time this document was written, the Wyoming Department of Environmental Quality, Water Quality Division (WQEQ/WQD) had not studied or assessed impacts of the ongoing drought on water quality in Wyoming. (Wagner, 2005) A general assessment of the impact of drought on water quality in Wyoming indicates that water quality may decrease during drought because of higher salinity concentrations and that the increased risk of fire during drought may result in air quality degradation and soil erosion. (Case and Bersie, 2005) References to water quality within the context of drought or drought response planning were not noted in most of the documents that were reviewed during preparation of this section.

Ability to Satisfy Multiple Demands

The current *Wyoming Drought Plan* addresses drought as it impacts Wyoming agriculture, municipal drinking water systems, wildlife, and tourism. Drought response planning, undertaken by governmental agencies, is applicable and useful to all water use sectors.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation considered drought response planning to be the "over arching goal of resource management in the basin" and suggested that the terms "drought mitigation" or "drought preparedness" may be more appropriate than drought response planning. (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher noted that the end to the current drought is not in sight and that "being prepared" and applying proper water management are important considerations regarding drought response planning in Wyoming's Platte River Basin. (Engen, 2005)

5.2.4.2 Weather Modification

Pertinent Water Use Sectors

As a means of increasing available water for the state of Wyoming through increased precipitation, weather modification is pertinent to all water use sectors in the state and in the Platte River Basin.

Water Availability

Weather modification programs are typically initiated based on the desire to obtain more usable water by increasing precipitation, particularly snowfall. Implementation of weather modification programs

therefore implies the need to increase insufficient water availability. Weather modification programs could result in a 10 percent to 20 percent increase in snowpack. (Weather Modification, Inc., 2005)

Technical Factors

Technical factors pertaining to weather modification are numerous and complex. Weather modification is commonly referred to as cloud seeding, and may include rain enhancement, snowpack augmentation, hail damage mitigation, and fog dissipation (Weather Modification, Inc., 2005) Cloud seeding may be accomplished using ground-based or airborne systems.

A printed summary describing University of Wyoming Department of Atmospheric Sciences weather modification research is not available. The Department has not conducted weather modification research since the 1980s, when it completed a U.S. Bureau of Reclamation (USBR)-funded weather modification study in California. Department weather modification research in Wyoming predated the USBR project in California. (Rodi, 2005)

Economic Factors

American companies have provided weather modification services for about the past 50 years. A five-year weather modification pilot project administered by the Wyoming Water Development Commission (WWDC) is expected to cost $1.765 million dollars per year for the five-year program duration. Conservative estimates of projected benefits from the program range from $4.3 million to $8.3 million per season depending on the unit value of water. These estimated economic benefits do not include benefits that may result from "increased hydroelectric power generation, improved recreation and fisheries, slowing the melting of glaciers, improved water quality and conditions for certain endangered species, or by meeting downstream water requirements." (Weather Modification, Inc., 2005)

The cost of cloud seeding varies significantly depending on a variety of factors, including the specific cloud seeding chemicals that are used, the frequency of seedable conditions, the size of the seeded area, and the duration of the seeding project. (North American Weather Consultants, 2005) The Wyoming Water Development Commission (WWDC), which has successfully proposed state funding of weather modification projects in Wyoming, has contended that the costs of weather modification programs compare favorably with the costs of structural water resource management programs, such as dams and transbasin diversions, that are intended to increase the availability of water for beneficial use. (Wyoming State Engineer's Office, 2004, and Galbreath, J., personal meeting notes, 2004)

Environmental Factors

A silver-iodide-based agent is frequently used to "treat" clouds, and this agent is the intended cloud seeding material for the pending WWDC five-year pilot weather modification program in Wyoming. Studies have indicated that the "extremely low silver concentrations" in seeded precipitation pose "no danger to human health." The results of one study demonstrated that silver concentrations in water produced by cloud seeding efforts contained silver concentrations about 1,000 times below U.S. Environmental Protection Agency standards for public drinking water supplies. Studies have also

indicated that cloud seeding operations do not significantly decrease precipitation in downwind areas. (Weather Modification, Inc., 2005)

Legal and Institutional Factors

The Wyoming Water Development Commission (WWDC) has proposed assessment and use of weather modification to increase Wyoming's water supply. The Wyoming Legislature has supported the WWDC's proposals by appropriating funds for a Level II weather modification feasibility study, which has been completed, and a pending five-year weather modification pilot program for the Wind River and Medicine Bow/Sierra Madre Ranges. The Medicine Bow and much of the Sierra Madre Ranges are within Wyoming's Platte River Basin. The WWDC is also currently administering a weather modification study for the Salt and Wyoming Ranges.

Organizations that provide information regarding weather modification include:

- Weather Modification Association,
- American Meteorological Society,
- World Meteorological Organization, and
- American Society of Civil Engineers.

Public Acceptance

Public reaction to the 2004 Level II Wyoming Weather Modification Study has been somewhat mixed, but the WWDC reported during a recent Water Forum that the Wyoming Stock Growers Association, the Wyoming Wool Growers Association, and numerous conservation districts support moving forward with state-sponsored and funded weather modification projects. (Wyoming State Engineer's Office, 2004)

One concern that has been raised by the public regards the potential for cloud seeding at a given location to decrease downwind precipitation. As noted above, studies have indicated that cloud seeding operations do not significantly decrease precipitation in downwind areas. (Weather Modification, Inc. 2005)

Water Quality

The quality of water from direct precipitation is very high.

Ability to Satisfy Multiple Demands

With the goal of increasing winter precipitation and snowpack in Wyoming, weather modification may increase water availability for water use sectors in the Platte River Basin. Current weather modification programs are focused on the Wind River Mountains, upwind of the Sweetwater Basin, and the Medicine Bow/Sierra Madre Mountains, which are located within or upwind of the Platte River Basin.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation noted that provisions for weather modification were included in the 2005 Wyoming Omnibus Water Bill. (Wyoming Farm Bureau Federation, 2005) The

responding Albany County rancher also noted that the University of Wyoming and the 2005 Wyoming Omnibus Water Bill will be addressing this issue and expressed concerns regarding the unpredictability of weather modification efforts. (Engen, 2005)

5.2.4.3 Water Conservation

Water conservation relates to all future water use opportunities in Wyoming's Platte River Basin. Water conservation has been referred to as "effective water use" consisting of any beneficial reduction in water losses, waste, or use. "Demand management" is another term associated with effective water use and, hence, water conservation (Shields, 2004). Five years into a drought cycle at the time of this writing, water conservation is an issue of great importance to water users in Wyoming's Platte River Basin and to the entire state. As a result, consideration in this technical memorandum of water conservation is more extensive than is consideration of some other Platte River Basin future water use opportunities. Activities of Platte River Basin conservation districts pertaining to water conservation are discussed in Technical Memorandum 5.3 of the Platte River Basin Plan.

The Wyoming Water Association (WWA) is a private, voluntary, state-wide organization of individuals who are interested in Wyoming water issues. WWA was founded in 1933, and the organization's objective is promoting "the development, conservation, and utilization of the water resources of Wyoming for the benefit of Wyoming people." (WWA, 2005) The topic of the 2004 WWA educational seminar and annual meeting in Casper was "Water Conservation: Challenges and Opportunities." Much of the information contained in this section was taken from presentations that were made during the 2004 WWA educational seminar and annual meeting.

Pertinent Water Use Sectors

Conservation is a future water use opportunity that can be practiced by and can benefit all Basin water use sectors.

Water Availability

Water conservation and water availability are closely related concepts. As noted by Wyoming State Engineer Pat Tyrrell during the October 2004 Wyoming Water Association annual meeting, one may seek a specific definition of water conservation. Is water conservation:

- diverting less water by utilizing more irrigation center pivots or lining irrigation canals;
- consuming less water by putting bricks in toilet tanks or cultivating different crops;
- storing more water in reservoirs or in shallow groundwater; or
- reducing water user conflicts in times of shortage?

In addition, water conservation has different meaning at different times of the year and to different water users. Given Wyoming's climate and topography, storage of spring runoff "must" be included in consideration of water conservation for any water use sector (Tyrrell, 2004).

Agricultural consumption is the major water use sector in Wyoming's Platte River Basin. The Irrigation Association, an international organization that was started in 1949 and states that it is

dedicated to "promoting water and soil conservation through proper water management," takes the following positions regarding long-range water conservation planning:

- measure all water use;
- price water so as to recognize its finite nature, provide financial incentives to users who conserve water, and provide financial penalties to users who waste water;
- hold all water users responsible for protecting the quality of the water that they use;
- create financial systems to reward users of efficient irrigation systems;
- create national education programs regarding the "absolute necessity of supporting regulatory policies which reward conservation and efficient water use;"
- support water reclamation and reuse initiatives, particularly for irrigation, but also for municipal, industrial, and other water use sectors;
- increase support for developing new water sources, including new conveyance and storage systems and incorporating into development plans appropriate environmental concerns;
- maintain water conservation planning as an ongoing program; and
- promote policies which allow for the lease, sale, or transfer of "established water rights" and/or the lease, sale, and transfer of water without jeopardizing established water rights, whenever possible. (Irrigation Association, 2005d)

As discussed in greater detail below, the U.S. Forest Service (USFS) has considered the role which that agency may play in alleviating water shortages during the ongoing drought. In a 2002 letter from William P. Levere, Director, USFS Bio-Physical Resources, to Forest Supervisors in the Rocky Mountain West, Mr. Levere stated that, "although outside the scope of direct Forest Service authority, ... in the arid west the most effective and reliable way to increase water availability is through conservation measures." (Levere, 2002)

Technical Factors

The Wyoming Water Development Commission (WWDC) currently provides financial support for irrigation and municipal water conservation projects, including:

- lining irrigation canals;
- replacing open ditches with piped laterals;
- constructing re-regulation storage reservoirs;
- collaborating with the federal Natural Resources Conservation Service (NRCS) during implementation of various on-farm irrigation system improvements;
- constructing new water storage facilities; and
- providing raw water irrigation transmission systems for municipalities.

In the future, WWDC support for agricultural and municipal water conservation projects may expand to include:

- computerized irrigation delivery scheduling studies;
- drought studies;
- weather modification projects;

- local use of snow fence and groundwater resources to supplement existing irrigation water supplies;
- municipal water reuse systems;
- promotion of groundwater development for municipal use; and
- development of conjunctive management principles (principles pertaining to concurrent use of surface and groundwater by municipalities) (Besson, 2004a).

The Wheatland Irrigation District is a major Platte River Basin irrigation district. Measures that have been employed by the Wheatland Irrigation Districts to conserve water have included:

- planned system start-up at the beginning of the irrigation season;
- careful monitoring of individual allotments;
- careful system operation during short-term flooding;
- canal maintenance to minimize canal losses;
- canal check operation improvements;
- efficient placement of headgates;
- use of re-regulation ponds; and
- close, ongoing communication with Wyoming State Engineer's Office (SEO) Hydrographer-Commissioners regarding water availability and water storage (Britton, 2004).

The City of Casper is a major municipality in Wyoming's Platte River Basin. In Casper, a variety of measures have been implemented to reduce municipal water demand, including:

- using non-potable water for turf irrigation;
- implementing computerized control systems for city park irrigation;
- planting low water demand vegetation on municipal property;
- reducing water line leaks and breaks; and
- improving the extent and accuracy water metering.

The City of Casper has not found irrigation of some city soccer fields using treated municipal wastewater to be cost-effective. (Hill, 2004)

The capital of Wyoming, Cheyenne, is located in the southeast quadrant of Wyoming's Platte River Basin. The City of Cheyenne has also instituted water conservation measures during the current drought, including:

- employing a consultant with water conservation expertise;
- implementing long- and short-term structural and non-structural water supply system improvements;
- adopting short-term water use restrictions, particularly for turf irrigation; and
- establishing for use when required five levels of conservation regulation (Wilson, 2004).

Economic Factors

The goal of obtaining the fullest achievable beneficial use of water is based on two major considerations: making the resource widely available and maximizing the economic benefit of the

resource to society (MacDonnell, 2004). Strategies for encouraging water conservation may be largely economic, including:

- providing financial incentives for conservation;
- subsidizing installation of more efficient water delivery and use systems; and
- using pricing to reflect the "full cost of water." (MacDonnell, 2004)

Basin municipalities have utilized economics to reduce water consumption. Mr. David Hill, Public Utilities Manager for the City of Casper, stated that the quantity of municipal water usage is "dependent upon water rates." (Hill, 2004)

Environmental Factors

Water has value both as an economic and as an environmental resource. Protecting fisheries and aquatic life is a primary motivation for water conservation (MacDonnell, 2004). The relationship between water quality and water conservation is discussed below.

Legal and Institutional Factors

The Wyoming Water Development Commission (WWDC), the Wyoming State Engineer's Office (SEO), and the U.S. Bureau of Reclamation (USBR) initiated a Wyoming state water conservation program in 1998. In March 2005, the WWDC released the third edition of the *Water Management and Conservation Assistance Program Directory.* The purpose of this directory is to "provide information about water related programs available in Wyoming." The director provides information regarding water conservation-related programs and assistance that are available to Wyoming water users from a variety of federal agencies, state agencies, and private organizations. The Internet address of this document is available in the References section of this technical memorandum. (WWDC, 2005b)

The doctrine of prior appropriation, which serves as the basis of Wyoming water law, distributes water on a "first come, first served" basis. This doctrine allows only specified beneficial uses of water and allows permitted water users to utilize water free of charge according to their permits and priorities. (National Drought Mitigation Center, 2003c). Another viewpoint is based on the ideas that it is the water user's duty to beneficially and reasonably use water, to refrain from wasting water, and to accept loss of the right to future use of water that has not been used in the past. "Beneficial use" relates to the nature of water use; "reasonable use" relates to the impact of water use on others. (MacDonnell, 2004)

Mr. Pat Tyrrell, Wyoming State Engineer, believes that "the future of water conservation in Wyoming" depends upon:

- a common understanding of the definition of water conservation;
- development of a consensus regarding additional governmental involvement in water management or increased voluntary cooperation among water users to conserve water;
- an understanding that, if governmental and voluntary conservation measures fail, more forced conservation will occur in the future; and

- willingness on the part of water users who differ in their views of water conservation to accept the premise that compromise is necessary. (Tyrrell, 2004)

The U.S. Bureau of Reclamation (USBR), which is the "nation's largest wholesale water supplier," believes that "improving water management and water conservation must become the status quo." (Limbaugh, 2004) In June 2003, Gale Norton, U.S. Secretary of the Interior, initiated a program entitled "Water 2025 – Preventing Crisis and Conflict in the West" (also known as "Water 2025"). This program is based upon five "realities," including:

- explosive population growth in the arid West;
- existing water supplies in some areas of the West that are or will be inadequate to meet demand;
- the premise that water shortages can cause "bitter conflicts;"
- an existing western water infrastructure which is old and obsolete; and
- the premise that crisis management is not effective in dealing with water conflicts (Limbaugh, 2004).

Tools considered most effective in preventing crisis and conflict regarding water in the West include:

- conservation and efficiency;
- collaboration among water users;
- using technology to reduce water treatment costs; and
- improving interagency cooperation.

One of the fiscal year 2004 components of the Water 2025 program is a challenge grant to the Casper-Alcova Irrigation District, which is located in Wyoming's Platte River Basin, for an irrigation canal lining/water management project. (Limbaugh, 2004)

The USBR also administers the Water Conservation Field Services Program (WCFSP), which is an "incentive-based program of technical and financial assistance" that emphasizes:

- water management planning through partnerships with various agencies including the Natural Resources Conservation Service (NRCS) and the Wyoming Water Development Commission (WWDC);
- conservation education, often through the public schools;
- demonstrations of water conservation measures, including drip irrigation, xeriscaping, surge valves, elbow meters, and surface and groundwater models; and
- implementation of water conservation measures, including installation of water accounting software, automated canal gates, and a variety of other irrigation structures. (Lawson, 2004)

Platte River Basin irrigation districts in Wyoming that have received assistance through WCFSP include the Casper-Alcova Irrigation District, the Goshen Irrigation District, the Hill Irrigation District, the Lingle Water Users, and the Pathfinder Irrigation District.

Public Acceptance

Water conservation "encourages a collective view of water: how do we share a stream or an aquifer among all of its users in a way that meets needs and produces desired benefits?" (MacDonnell, 2004)

Public reaction to recent City of Cheyenne water conservation measures has included:

- statements that the City should have implemented conservation measures earlier;
- belief that the City over-waters parks and cemeteries; and
- confusion regarding City water conservation regulations. (Wilson, 2004)

Public satisfaction with the Cheyenne municipal water and sewer systems has exceeded 70 percent since year 2000, and Cheyenne residents believe that water and sewer issues are among the most important issues facing the City. The Cheyenne Board of Public Utilities (BOPU) contends that municipal water customers want:

- simple, understandable information regarding the public water supply system;
- maintenance of water supply system property;
- participation in the process of determining water use policies;
- equitable treatment of all water users;
- education regarding water conservation; and
- exploration of new water resource options. (Wilson, 2004).

Water Quality

Water quality may be closely associated with water conservation in that the act of protecting or improving the quality of a body of water or an aquifer may conserve that water for a beneficial use that is dependent upon water quality. Conversely, water quality degradation may result in elimination of available water from one or more beneficial uses that are dependent on water quality. Water quality degradation would therefore be contrary to the goal of conserving water.

Chapter 1, Wyoming Surface Water Quality Standards, of Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) *Rules and Regulations* defines different surface water uses, defines surface water classes on the basis of water quality, relates classes of surface water uses, and summarizes enforcement standards for surface water quality. Maintenance of surface water quality is tied closely to water use; maintenance of water quality is therefore critical to conservation of water for a variety of beneficial uses. For example, Class 2 surface water, Fisheries and Drinking Water, are waters "known to support fish or drinking water supplies or where those uses are attainable." (WDEQ/WQD, 2001) If Class 2 surface water quality is degraded to an adequate extent, that water would presumably be reclassified and not usable to support public drinking water supplies. Chapter 8, "Quality Standards for Wyoming Groundwaters," of WDEQ/WQD *Rules and Regulations* defines different classifications of Wyoming groundwater based on uses to which the water may be applied. For example, Class I Groundwater of the State is "suitable for domestic use." (WDEQ/WQD, 2005). As with surface water, WDEQ/WQD relates groundwater quality to potential beneficial uses of that water.

The Wyoming Water Development Commission (WWDC) *Water Management and Conservation Assistance Program* Directory provides information about Wyoming water-related programs. (Wyoming Water Development Commission, 2005b) Information regarding a number of organizations and agencies that are described in this WWDC document indicate a relationship between water quality and water conservation. Some of the organizations and programs that are described in this directory are described below. The membership of the Wyoming Association of Rural Water Systems (WARWS) consists of small rural water and wastewater systems. WARWS administers a Groundwater/Wellhead Protection (GW/WHP) program intended to assist small water system operators protect groundwater supplies from contamination, thereby conserving those supplies for use as drinking water. Wyoming Department of Agriculture programs also focus on water quality by addressing wellhead protection, pesticide container disposal, confined livestock feeding, rangeland best management practices, and other measures. As noted above, the Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) focuses on maintenance of water quality, remediation of impaired water quality, and conservation of water for beneficial use. The Wyoming Department of Environmental Quality, Watershed Management Section, manages programs intended to "protect and restore the quality of Wyoming's surface water resources to assure they support their designated uses." The U.S. Bureau of Land Management (BLM) is involved in watershed and water quality improvement projects in cooperation with the State of Wyoming, Wyoming conservation districts, ranchers, and conservation groups. The Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture provides a variety of water-related services. The Farm Service Agency of the U.S. Department of Agriculture administers the Conservation Reserve Program (CRP) in part to enhance water quality.

Ability to Satisfy Multiple Demands

Water shortages impact all water use sectors. Water conservation is applicable to and may be expected from all water use sectors.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation stated that listing water conservation as a distinct future water use opportunity is redundant – that "this entire effort" is about water conservation, and that conservation is "won through management." (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher stated his belief that water conservation is a good idea for the agricultural, municipal, and recreational water use sectors. He further stated that "new ideas and management must be considered." (Engen, 2005)

5.2.4.4 Water Right Transfers

Pertinent Water Use Sectors

Platte River Basin water use sectors most likely to be affected by water right transfers are the agricultural sector, the industrial sector, the municipal sector, and the recreational sector. Past and potential Basin water right transfers have typically transferred agricultural water to municipalities, industrial facilities, or recreational entities. The "largest (water right) transfer" in Wyoming history was from agricultural use to PacifiCorp, an industrial water user. (Holliday, 2005) A summary of

historical water right transfers in the Above Pathfinder and Pathfinder to Guernsey subbasins of the Platte River Basin is shown in Table 7 on page 228 of the *Final Settlement Stipulation* of the 2001 Modified Platte River Decree. (Supreme Court, 2001)

Water Availability

Surface water in Wyoming's Platte River Basin has been fully appropriated under Wyoming water law. Lack of available surface water is therefore a significant motivation for considering water right transfers. An entity desiring to obtain surface water for a new or expanded beneficial use may be required to purchase land with accompanying water rights or water rights without accompanying land in order to obtain the desired surface water. If the intended beneficial use of the purchased surface water rights is different than the permitted beneficial use for those rights, the buyer must follow a specified legal process that has been established by the State Board of Control of the Wyoming State Engineer's Office to change the beneficial use of the water rights in question.

Technical Factors

Water right transfers are primarily legal and political issues and, to a lesser extent, technical issues. Obtaining the legal right to change a permitted water use in Wyoming is probably more complicated than the engineering and construction required to utilize water for a different purpose after the right to do so has been granted by the State of Wyoming.

Economic Factors

Water right transfers may be viewed by some water users as the most economical way to obtain additional water supplies for a specified beneficial use. Given current full appropriation of Platte River Basin surface water rights, municipalities may view acquisition of agricultural land and accompanying surface water rights as an economical approach to increasing available municipal water supplies.

Economic factors affect the decisions of the State Board of Control of the Wyoming State Engineer's Office regarding Board responses to petitions for changes in beneficial use of water. The Wyoming State Board of Control may deny a petition to change the beneficial use of a water right if the transfer would cause an "unacceptable economic loss to the community." (W.S. 41-3-104(a)(i)) Economic factors are therefore central components to consideration of water right transfers as a future water use opportunity in Wyoming's Platte River Basin.

Environmental Factors

Environmental factors may play a significant role in water right transfers if the intent of the transfer is to supplement instream flows or support other environmentally focused processes or activities.

Legal and Institutional Factors

Procedures for change in use or place of use of a Wyoming water right are addressed in Wyoming Statute (W.S.) 41-3-104. This statute:

- describes the required petitioning process that must be followed to change the use or place of use of a water right, and

- requires that the "proper district court" will resolve all compensation disputes that arise from the filing of a petition for change in use or change in place of use of a water right.

The process for changing the permitted beneficial use of appropriated water is described in Chapter V, Petition Information, Section 15, Change of Use, in Part IV, Regulations and Instructions – State Board of Control, of the Wyoming State Engineer's Office (SEO) *Regulations and Instructions* (adopted 2004). Some key provisions in Section 15 pertaining to preparing and submitting a petition to the State Board of Control for a change in permitted beneficial water use include:

- Heading – showing "sufficient description and identification" of the water right appropriation for which a change of use is being requested;
- Opening statement – identifying the petitioner, providing his or her address, and providing a general introduction to the petition;
- Body
    - proving that the lands from which an existing appropriation is to be detached for the purpose of using the appropriated water for a different beneficial use is owned by the person who is requesting the change of water use, or providing consent from the owner of the lands from which the existing appropriation is to be detached;
    - describing the water right and lands under consideration;
    - describing in detail the desired change in beneficial use, demonstrating historical and current beneficial use of the water right appropriation under consideration, describing related changes in point of diversion and/or means of conveyance that may be required by the requested change of use;
    - documenting consents from other appropriators who use the same structures, such as irrigation headgates, as that used by the appropriation for which a change of use is requested;
    - identifying intervening headgates between the original point of diversion and the proposed new point of diversion and providing consents from the appropriators who use those headgates;
    - providing a study that compares the proposed and historical uses and seasons of use of the water right under consideration;
    - stating whether any other appropriator from the same source of supply will be injured;
    - providing a map meeting State Board of Control requirements; and
    - providing the required fee.

Other State Board of Control change of use petition requirements include showing that the appropriation under consideration is an "actual appropriation of water that is being applied to beneficial use on specific lands." Board regulations note that the Board will "look with disfavor on petitions for change of use for which recent historic use cannot be documented." (Wyoming State Engineer's Office, 2004)

An example of a recent major change in use from agricultural to industrial use was the 1992 transfer of Cannon Land and Livestock agricultural irrigation water to PacifiCorp Electric Operations for

industrial use at the Dave Johnston Power Plant. (A detailed summary of PacifiCorp water rights associated with operation of the Dave Johnston Power Plant is included in Appendix 2.3.B.5 of Platte River Basin Plan Technical Memorandum 2.3, Water Use for Industrial Purposes.) The Cannon-PacifiCorp change in beneficial use may be indicative of similar future changes in beneficial use of Wyoming water. Both a State Board of Control Order Record describing the change of use and change in point of diversion for the Cannon Land and Livestock water and a Wyoming State Engineer's Office (SEO) Amended Exchange Petition for Diversion of the Natural Flow of the North Platte River were executed on November 27, 1992. The State Board of Control Order Record describes a change in use from agricultural irrigation to industrial use of 3,037 acre-feet of water per year (about 100 million gallons per year) and change in the point of diversion for this water from the Douglas Canal to the Wyoming Steam Electric Generating Intake at the Dave Johnston Power Plant. Both of these points of diversion are located along the North Platte River in Wyoming. The agricultural water rights that were changed included all or parts of three Mortons Incorporated appropriations, each having a July 1904 priority date. The State Board of Control Order Record also specifies that the water may be diverted for industrial purposes during the period May 1 through September 30 each year as had been the case when the water was used for agricultural irrigation purposes. The SEO Amended Exchange describes approved changes in North Platte River direct flow water accounting procedures for Pathfinder and Glendo Reservoirs to allow use of previous Cannon agricultural irrigation water at the Dave Johnston Power Plant during the entire year rather than only during the May 1 through September 30 irrigation season. (Wyoming State Board of Control, 1992 and Wyoming State Engineer's Office, 1992)

The U.S. Bureau of Reclamation (USBR) believes that "there are formidable legal and institutional barriers to transfer of water in the West, particularly if there is a change in water use." While transfers of irrigation water within individual irrigation projects are "done routinely," water transfers outside irrigation district boundaries are "more complicated because Federal project authorization and western water laws have generally restricted changes in location or change in nature of use of the water." (Moore et al., 1991)

Public Acceptance

Water rights transfer is a potentially contentious issue. However, purchase by the City of Laramie of the Monolith Ranch and purchase by the City of Cheyenne of the Belvoir Ranch, both motivated by the desire to acquire ranch irrigation water rights for future change to municipal use, have not been particularly contentious. Future water use transfers involving transbasin diversion within Wyoming or use of water from Wyoming in other states are more likely to arouse significant public opposition in Wyoming.

Water Quality

Improving water quality may provide motivation for a proposed water right transfer. Beyond that consideration, water quality is probably not a central component of water right transfers.

Ability to Satisfy Multiple Demands

A water rights transfer could satisfy water demand by any water use sector. In Wyoming, most existing or proposed water right transfers relate to changing beneficial use from agricultural use, the major water use sector in Wyoming, to some other use or uses that could benefit any of the other water use sectors. Water rights transfers in Wyoming are controlled by Wyoming law.

Comments from the Basin Advisory Group (BAG)

Wyoming Farm Bureau Federation policy opposes the expansion of temporary uses and transfers of water. (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher stated his belief that current water law governing water right transfers should not be changed and that currently available temporary water use "will have an effect on downstream users." (Engen, 2005)

5.2.4.5 Enhancing Recreational Use of Water Resources

Pertinent Water Use Sectors

This section pertains directly to the recreational water use sector. However, enhancing recreational use of Basin water resources has the potential to affect the agricultural and municipal sectors as well. Recreational activities involving out-of-state people result in an infusion of out-of-state money into municipal economies, and the growth of farm and ranch recreational facilities as described below is an ongoing phenomenon in Wyoming and the Platte River Basin.

Water Availability

Recreational use of water resources is dependent upon water availability. Inadequate stream flows or reservoir storage volumes resulting from inadequate precipitation, particularly snowfall, reduce recreational use of those water bodies during the short term and may negatively impact fisheries, thereby reducing recreational use of water bodies over the longer term. Inadequate snowpack may also inhibit or preclude skiing and snowmobiling, both of which are major water-based Wyoming recreational activities.

Technical Factors

Technical factors that may impact recreational use of Platte River Basin water resources include reservoir operations and instream flow management. These programs provide, or in the absence of available water supplies may not provide, adequate water to support water-based recreational activities in the Basin.

Economic Factors

Recreational use of Platte River Basin water resources comprises a significant component of Basin tourism and thereby supports the Basin economy. This support entails not only the tourism industry, but also the agricultural sector as farm and ranch recreational programs appear to be a growing phenomenon in this area. Recreational use of farms and ranches is typically intended by farm and ranch owners to provide a supplemental source of income rather than to replace the basic farm or ranch income derived through agriculture. (Powell and Rottman, 1991) State licenses for recreational ranch bed and breakfast operations were first available in 1986. In 1989, about 4,900 primarily out-

of-state guests stayed at licensed Wyoming farm and ranch recreation facilities, generating about $2,000,000 for the Wyoming economy. In addition to economic benefits, "an intangible benefit to the state is the goodwill generated by Wyoming ranch families in the minds of urban and out-of-state voters who will influence the destiny of Wyoming agriculture, water rights, environmental aesthetics, and the many other benefits we now enjoy." (Powell and Rottman, 1991) The University of Wyoming Cooperative Extension Service has assisted in establishing the Wyoming Homestay and Outdoors Adventure (WHOA) organization. This organization has supported educational efforts directed at Wyoming ranchers and farmers who are considering incorporating recreational opportunities into their operations and has helped farmers and ranchers operate as "partners in a new industry." (Powell and Rottman, 1991)

Environmental Factors

A major reason that is advanced for the increase in Wyoming recreational opportunities on privately owned farms and ranches is the increased crowding on Wyoming public lands. (Daniels et al., 2001) Farm and ranch recreation in Wyoming is considered "adventure travel, ecotourism, heritage or cultural travel." (Daniels et al., 2001) In addition, the growth during the past 20 years or so of snowmobiling as a major recreational activity has extended use of Wyoming and Platte River Basin water-based recreation from the summer months to include most months of the year. For some Wyoming resort operators, winter snow-based activities have surpassed summer water-based activities as sources of income. Significantly increased use of the Medicine Bow Mountains in Wyoming's Platte River Basin by both in-state and out-of-state snowmobilers during the past 20 years has been apparent.

Recreational use of Platte River Basin water resources is connected to environmental conservation of those water resources. The Nature Conservancy manages the North Platte River Program, the goal of which is to maintain the North Platte River landscape and associated riparian areas. Noting in regard to Wyoming's upper North Platte River that a "free-flowing river system is unique in the West," the Nature Conservancy states that a significant portion of the biotic diversity of the West is "strongly tied to water." (Nature Conservancy, 2004) It is reasonable to state that the Platte River Basin's biotic diversity is a primary reason for its use for water-based recreational purposes.

Legal and Institutional Factors

Public use of public lands is usually on a non-fee basis, though use of certain public areas and facilities requires payment of a nominal fee. In 1986, the State of Wyoming began a licensing program for recreational activities on privately owned farms and ranches. Another pertinent legal factor regarding recreational use of Platte River Basin water is the Wyoming law which stipulates that, while the water in a river such as the North Platte is publicly owned, the land under the water and along the banks of the river may be privately owned. As a result, conflicts have arisen between those floating the North Platte River and landowners. In an attempt to reduce these conflicts, the Wyoming Game and Fish Department has posted signs along the North Platte River indicating whether specific river reaches are flowing through public land, private land, or private land for which a fishing easement exists.

Recreational fishing is a major water-dependent recreational activity in the Platte River Basin. A legal issue pertaining to recreational fishing is the existence of a Wyoming instream flow statute and the controversy that has accompanied passage and implementation of that statute. Instream flow is discussed in Platte River Basin Plan Technical Memorandum 2.4, Recreational Water Use.

The Wyoming Game and Fish Department (WGF) administers and enforces Wyoming regulations regarding recreational fishing. The WGF considers instream flow to be "an integral part of essentially all fishery management programs." The WGF has requested filing of instream flow permit applications on "many of the state's most important streams so residents and visitors alike can continue to enjoy these spectacular resources for generations to come." (Annear and Dey, 2001 and WGF, 2005) The WGF Internet site provides access to documents that discuss instream flows, the controversies surrounding this concept, and the WGF positions regarding these issues.

While the WGF and recreational users of Wyoming and Platte River Basin streams may endorse instream flow legislation and regulations, instream flow is not a universally supported activity by members of other Basin water use sectors. Nineteen instream flow legislative measures were defeated in the Wyoming Legislature during the 12 years prior to passage in 1986 of the current Wyoming instream flow law. "Traditional water users" had strongly opposed a law that would "protect water in stream channels for fisheries." (WGF, 2005) The Wyoming Association of Conservation Districts (WACD) states in the Water Resources section of its on-line *2005 WACD Policy Book* that the organization supports the "current in-stream flow statute" and opposes "any legislation to broaden the current in-stream flow statute." (WACD, 2005)

Public Acceptance

Recreational use of water resources is typically a non-consumptive use of the resource. It is likely that the Wyoming public generally views the influx of out-of-state money resulting from recreational activities favorably. Potential infringement on private property rights by recreationists may result in limited public opposition, but the large expanses of public land and the increasing farm and ranch-based recreation industry in Wyoming should mitigate these concerns to an extent. As noted above, the instream flow issue is a matter of both institutional and public concern in Wyoming.

Water Quality

Surface water quality in Wyoming is generally high, particularly in relation to surface water quality in downstream and more highly developed states. It is reasonable to assume that out-of-state people come to Wyoming to enjoy water-based activities in large part because of the relatively high quality of Wyoming water, the sport fisheries that Wyoming water sustains, and the clean environment that Wyoming water supports.

Ability to Satisfy Multiple Demands

Enhancing future recreational use of Platte River Basin water resources benefits several water use sectors in that:

- recreational activities generally do not consume water;
- various water use sectors benefit economically from water-based recreation;

- water-based recreation brings out-of-state money into Wyoming's economy; and
- water-based and other types of recreation may provide significant supplemental income and positive publicity to the Basin agricultural sector.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation requested a definition of "recreational uses" and supported the consideration of "trade-offs" associated with recreational water use. The Federation stated that "mitigation of the undesirable effects of desirable actions must be part of every project." (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher noted that increased recreational use of Basin water resources is possible "if instream flows from storage" are available. He further noted that low stream flows can only be increased by releasing water from storage. (Engen, 2005)

5.2.4.6 Increasing Runoff from National Forests Based on Modified U.S. Forest Service Policies and Practices

Pertinent Water Use Sectors

Beneficial uses for which significantly increased runoff from the Platte River Basin's national forests could be appropriated are numerous. Any of the water use sectors that have been discussed in this Basin Plan – including agricultural, municipal/domestic, industrial, recreational, and environmental – could utilize additional water resources provided by significantly increased forest runoff.

Water Availability

Like many of the other future water use opportunities that are discussed in this technical memorandum, increasing the amount of water that is available for beneficial use would be the primary goal of implementing policies intended to increase runoff from Platte River Basin national forests. U.S. Forest Service (USFS) research has demonstrated that "trees have a direct influence over water yield. . ." and that "a thick stand of mature timber combines a high transpiration rate with a higher interception (of snow and other precipitation) loss and results in the lowest water yield of any forest cover." (Wagner, 1998)

Technical Factors

The U.S. Forest Service (USFS) states that, generally, forest harvest increases water yield and afforestation (forest regrowth) decreases water yield. (Schmidt, 1999) The USFS has studied impacts of clear-cutting and thinning in forests comprised of different types of trees, including Ponderosa pine, mixed conifer, chaparral, pinyon-juniper, sagebrush, alpine zone, and eastern hardwoods. To date, "runoff augmentation" studies have taken place in very small drainage basins covering less than one square mile. The USFS believes that extrapolating the results of studies in very small watersheds to larger basins is "problematic" and that increases in runoff resulting from forest management practices "are not within our ability to detect in basins of 10 mi^2 and larger." (Schmidt, 1999) The USFS also notes that increased runoff resulting from forest management increases at a relatively consistent rate during both drought years and flood years. Fixed capacities and operations of existing reservoirs may result in passing additional forest runoff via emergency spillways rather than storing

the additional runoff for later beneficial use during years of plentiful water. (Schmidt, 1999) The USFS further contends that, "when routed downstream to major points of potential use," increased runoff from forests "constitutes such a small portion of the total stream flow that it cannot even be measured." (Maxwell, 1997)

USFS research has shown that, in order to achieve "measurable on-site water yield increases in any size of watershed, a large percentage (25% or more) of the basal area of the watershed would have to be removed at one time. Generally, it is undesirable and often infeasible to make this significant of a change on larger landscapes due to physical, biological, legal, and practical constraints." In addition, the increase in runoff would be temporary because of subsequent forest regrowth. (Cables, 2002)

A Colorado water official who viewed this issue from a different perspective noted that past USFS research at the Fraser Experimental Forest in Colorado showed that "carefully designed timber harvesting can increase water yield up to 40% above that of an unmanaged old-growth forest, without increasing the risk of damaging floods, degrading water quality, or causing environmental damage." This individual contended that the USFS has not implemented watershed practices that were developed at the Fraser Experimental Forest on a large scale and noted that national forest "timber harvest has been less than the rate of growth since the national forests were established." (Wagner, 1998)

Economic Factors

The sources that were reviewed during preparation of this report contain very little specific information regarding the economic factors associated with increasing water yield from national forests. One author stated that past projects aimed at increasing water yield from national forests failed, in part, because of questions regarding the differences of opinion between the parties who paid for the programs and the parties who received the benefits from the programs. (Ziemer, 1986)

Environmental Factors

The U.S. Forest Service (USFS) believes that forest "treatments focused on water yield often result in compromising other resource values." USFS forest runoff augmentation studies to date have not incorporated "environmental and other considerations." (Schmidt, 1999) The USFS lists the following potential consequences of forest management practices aimed at increasing forest water yield:

- activation of landslides;
- slight increases in stream channel erosion;
- erosion and sedimentation associated with road construction and other disturbances associated with vegetation management; and
- potential reduced timber growth resulting from an emphasis on water yield. (Schmidt, 1999)

Legal and Institutional Factors

U.S. Forest Service (USFS) personnel note that, in the Organic Administration Act of 1897, which created the first national forests, the stated purposes of national forests were to "provide for favorable

conditions of flow and a continuous supply of timber. . . .” and that the USFS has a “long history of managing for ‘favorable flow conditions’.” The Multiple-Use Sustained-Yield Act of 1960 supplemented but did not replace the Organic Administration Act of 1897 and its required management of national forests for “favorable conditions of flow” and a “continuous supply of timber.” (Wagner, 1998) USFS forest management policies may be based to some extent on the results of extensive western logging in the late 1800s. This unrestricted logging resulted in earlier annual runoff and decreased late summer runoff that deprived farmers and ranchers of late season irrigation water. “People of the day were worried that continued over harvest of timber in the western mountains would ruin ranching and farming, as well as deplete timber supply.” (Levere, 2002)

A lawsuit was filed in the 1990s by the Coalition for Sustainable Resources, a group headquartered in Colorado’s North Park (the upper North Platte River Basin) against the Medicine Bow – Routt National Forests in Wyoming and Colorado. This lawsuit was based on the belief by irrigators that “they should not be required to reduce their diversions as required by the U.S. Fish and Wildlife Service until the Forest Service maximizes its efforts to produce increased water yields.” (Schmidt, 1999)

In the 2001 Utah State Water Plan, the State of Utah expresses its concern “about the ability of these (U.S. Forest Service- and U.S. Bureau of Land Management-administered) lands to yield a high quality, non-declining supply of water” for a variety of beneficial uses. The Utah State Water Plan notes that successful federal fire suppression efforts during most of the past century have resulted in a “buildup of standing vegetation. . .” which may be “reducing overland flow of runoff. This vegetation buildup may also lead to increasing losses to evapotranspiration, which will ultimately reduce water yields from historic levels . . .” and which increase the risk of “catastrophic fire,” the results of which can include heavily sediment-laden flash floods. The Utah State Water Plan concludes that “Federal agencies should practice responsible watershed management that will help ensure a continued high quality, nondeclining supply of water to meet the state’s increasing needs.” (Utah Department of Natural Resources, Division of Water Resources, 2001)

Public Acceptance

Based on U.S. Forest Service (USFS) estimates of the significant extent of vegetation that must be removed to significantly increase watershed runoff and the expanded forest road networks that would be required to accomplish significant vegetation removal, public acceptance of USFS activities of this type may be questionable. When the issue of forest management to provide additional runoff became a subject of public debate in the 1980s in Colorado, Denver newspapers “published articles suggesting Colorado’s forests might be clearcut to satisfy California’s thirst.” (Wagner, 1998) Use of national forests for recreational purposes may also affect public sentiment regarding implementation of forest management practices aimed at increasing water yield.

Water Quality

The U.S. Forest Service notes that runoff water quality resulting from runoff enhancement programs may decrease as a result of road construction and other land disturbances that are required to remove vegetation for the purpose of enhancing runoff. (Schmidt, 1999)

Ability to Satisfy Multiple Demands

In Wyoming's Platte River Basin, which contains a significant area of national forest, it is reasonable to assume that, if feasible, a successful, long-term program to increase runoff from Basin national forests could benefit all water use sectors.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation believes that "this strategy will result in the largest increase of water supplies" and that "it is also the most controversial" future water use opportunity. The Federation believes that education must play a major role in management of the Platte River Basin and that "a large population in this country . . . has been misled regarding the benefits of active management of our natural resources." (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher noted successful studies of the use of strips of uncut forest as large snow fences on national forest land in the Hayden, Colorado, area. The rancher stated his belief that "other plans and management could be applied." (Engen, 2005)

5.2.4.7 Water Exchange and Water Banking

As defined by Lawrence J. MacDowell, who was quoted in *Analysis of Water Banks in the Western States* (Clifford and others, 2004):

> Water banking in its most generalized sense is an institutionalized process specifically designed to facilitate transfer of developed water to new uses. Broadly speaking, a water bank is an intermediary. Like a broker, it seeks to bring together buyers and sellers. Unlike a broker, however, it is an institutionalized process with known procedures and with some kind of public sanction for its activities.

Pertinent Water Use Sectors

Typical water buyers in western states include municipalities, industry, energy, real estate developers, agriculture, and conservation groups. Typical water sellers are agriculture and decommissioned industrial facilities and mines. (Stelting, 2004)

Water Availability

The stated purpose of water banks in states where water banks exist is to facilitate the sale and purchase of water resources, thereby potentially making water available to users who need more water.

Technical Factors

In western states where water banks exist, water bank operation and the degree of water bank involvement in water sales, pricing, and price controls vary between the states. Individual state water banks may:

- serve as a broker, connecting or soliciting water buyers and sellers to create sales;
- serve as a clearinghouse repository for bid and offer information;
- serve as a market-maker attempting to ensure equality in the number of water sellers and buyers;
- determine which water rights may be banked;
- establish the quantity of bankable water;
- determine who can purchase or rent water from the water bank;
- set contract terms and/or prices for water sales; and/or
- facilitate regulatory requirements that are associated with water banking. (Clifford and others, 2004)

Economic Factors

Water banking is by definition an economics-based future water use opportunity in that institutionalized water banking is based on the economic value of water resources to the various users of the water and the financially based marketing of water resources.

Environmental Factors

Wyoming and Utah, among the western states, are "lagging behind" in the area of environmental water markets. (Stelting, 2004) Wyoming's 1986 instream flow legislation allows change in water right beneficial use, with the target beneficial use being an instream flow. The target instream flow is typically intended to support the environmental and recreational water use sectors by enhancing fisheries and wildlife habitat. Environmental water markets, typically based on recognition of instream flow water rights, have evolved as a result of regulatory activities and litigation as well as non-regulatory activities.

Legal and Institutional Factors

"Wyoming has the least active water market of all prior-appropriation states." A water bank does not exist in Wyoming, and "no evidence suggests that the State has contemplated developing one." (Clifford and others, 2004) Montana and Utah also do not have water banks.

In the 1950s, the State of Wyoming enacted legislation allowing irrigators to "temporarily transfer water to an 'industrial' or 'other uses' for a period of up to two years." The primary purpose of this law was to provide water for highway and railroad construction. (Clifford and others, 2004) The 1986 Wyoming instream flow law allows private water right holders to "change the use of an existing water right to instream flow. However, the original water right holder must give up ownership of that right to the state . . . ." (Clifford and others, 2004)

The State of Idaho Water Resources Board administers an established water supply bank program. Beginning in the 1930s, eastern Idaho water users operated a water rental pool for the purpose of

allowing water users who had surplus water to make that water available to water users who needed additional water. In 1979, the Idaho Legislature enacted legislation that formalized 1976 recommendations for the "creation of a water supply bank for the purpose of acquiring water rights or water entitlements from willing sellers for reallocation by sale or lease to other new or existing uses." (Idaho Water Resource Board, 2005) The first Idaho water bank was established in 1979 for Water District 1, which includes the Snake River drainage in Idaho upstream of the Milner Diversion Dam near Twin Falls. Like Wyoming's North Platte River Basin, the Snake River drainage in Idaho Water District 1 contains a number of U.S. Bureau of Reclamation dams, reservoirs, and powerplants. Since 1979, additional water banks have been established in Idaho's Boise River Drainage, Payette River Basin, and Lemhi River Basin. (Idaho Water Resource Board, 2005)

The Idaho Water Resource Board, which was established in 1965 and which has responsibilities similar to those of the Wyoming Water Development Commission, administers Idaho's Water Supply Bank. The purposes of the bank are to "encourage the highest beneficial use of water; provide a source of adequate water supplies to benefit new and supplemental water uses; and to provide a source of funding for improving water user facilities and efficiencies." (Idaho Water Resources Board, 2005) The Idaho Water Supply Bank is a water exchange market that is intended to assist with the marketing of both natural flow water, including groundwater, and water that is stored in Idaho reservoirs. (Idaho Water Resources Board, 2005) During a given year, water users who have rights to more water than they anticipate needing may put the excess water, whether natural flow or stored water, in the Bank. The water can then be sold or leased to those in need of water. "This Water Bank approach helps put the maximum amount of water to beneficial use." (Idaho Water Resources Board, 2005) The Idaho Water Resource Board "directly controls the sale or rental of water covered under natural flow water rights." Rental pool committees set prices for stored water, and the Board approves these prices. (Idaho Water Resources Board, 2005) Idaho Water District 1 Rental Pool Procedures were published in 2004. Idaho Administrative Rule 37.02.03 – Water Supply Bank Rules contains Idaho water supply bank rules and procedures.

Public Acceptance

Water banking has been used in the western United States for some time, and this practice is currently "emerging as an important management tool to meet growing and changing water demands throughout the United States." The general popularity of water banks is increasing, and water banks have "been either proposed or in operation in almost every western state." (Clifford and others, 2004)

Water Quality

While water quality may be a factor in the utilization of water banking, quantity, not quality, of water is typically the focus of water banking.

Ability to Satisfy Multiple Demands

As noted above under "Pertinent Water Use Sectors," water banking may be used to satisfy the water demand of any water use sector.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation stated that water exchange and water banking are issues that require more discussion but that these ideas are "probably not entirely bad." The Federation believes that these practices are best suited to times when water is plentiful and that they are "luxuries, not necessities." The Federation also stated that groundwater should be incorporated into any discussion regarding water exchange or water banking. (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher stated his belief that water exchange and water banking are "probably not a bad idea" and also stated that groundwater must be considered relative to these issues. (Engen, 2005)

5.2.4.8 Multipurpose Flood Control Programs

For the purposes of this report, discussion of multipurpose flood control programs is restricted to programs pertaining to construction of relatively small, locally controlled structures. This discussion does not include consideration of the large federal North Platte dams which serve multiple purposes, including irrigation water storage, electrical power generation, recreation, and flood control.

Pertinent Water Use Sectors

Multipurpose flood control programs by definition serve more than one purpose. As a result, such programs have the potential to provide future water use opportunities to more than one water use sector. For example, a flood control program may be intended both to protect man-made structures from flood damage and to provide additional storage for irrigation water. Reservoirs not only provide flood control, but are also sources of water for livestock watering, irrigation water storage, wildlife habitat, and recreation.

Water Availability

A major goal of multipurpose flood control programs is typically to control flooding by constructing relatively small dams in order to make water available to users in quantities and at times the users need the water.

Technical Factors

An animated drawing of a small earthen multipurpose flood control dam that was found at two separate Internet sites depicts and describes the same design and operation of a small multipurpose dam. (Community Internet Cooperative, Inc., 2005 and South Dakotans for Natural Flood Control, 2005) The dam outlet works design, reserved reservoir flood capacity, and operation based on draining the reservoir each fall to provide storage capacity for runoff during the following spring are unique to this type of structure. A more detailed description of these multipurpose dam design criteria follows under the Legal and Institutional Factors heading.

Economic Factors

While general observations regarding the economic costs of floods and potential economic savings resulting from flood control are presumably valid, specific economic information regarding multipurpose flood control structures was not located during this study.

Environmental Factors

Multipurpose flood control structures are intended for other uses in addition to flood control. Environmental issues such as wetland and wildlife habitat creation could be among the purposes filled by one of these structures. Since the multipurpose earth dams considered in this study are typically small, the extent of environmental regulatory permitting for these structures should be less than that required for larger dams.

Legal and Institutional Factors

Multipurpose flood control programs may be part of watershed management projects. After construction of 11 watershed projects in the United States based on the provisions of Federal Public Law 78-534, Congress passed the Federal Public Law 83-566, the Watershed Protection and Flood Protection Act of 1954, to expand management projects to other "approved watersheds." (Oklahoma Conservation Commission, 2005)

The Deerwood Soil and Water Management Association (DSWMA), located in Manitoba, Canada, is a group of 150 local landowners which focuses on agriculture and on soil and water conservation. The DSWMA Internet site includes basic design information for different types of water resources structures, including an animated design for small earthen multipurpose dams. These dams are intended to hold water for "various seasonal, domestic, and irrigation uses" and are designed to control spring and summer flood water and to store water for summer use. These structures are drained in the fall of each year "to prepare for full flood control potential in the spring." The dams are designed with manually controlled outlet structures and without uncontrolled emergency spillways so that they can be operated for multipurpose use. (DSWMA, 2005)

Information regarding multipurpose flood control programs in Wyoming is very limited. The U.S. Natural Resource Conservation Service (NRCS, formerly the Soil Conservation Service, SCS) provides technical and financial assistance for watershed planning in Wyoming, including construction of small multipurpose reservoirs. NRCS financially supported construction of about eight dams in Wyoming between 1962 and 1985. No NRCS dam projects in Wyoming are known to be ongoing at the time of this study. Current Wyoming Water Development Commission (WWDC) operating criteria for both the WWDC New Development and the Rehabilitation Programs designate multipurpose projects as having the highest priority insofar as WWDC support is concerned. WWDC operating criteria define multipurpose projects as "projects which serve two or more of the following functions: agricultural, municipal, industrial, rural domestic, recreation, environmental, flood control, erosion control, and hydropower." (WWDC, 2005a)

According to the National Watershed Coalition, more than 20,000 federally supported watershed management projects in the United States include more than 11,000 flood control dams that "provide reduction in flooding; erosion control; water quality protection and improvement; recreation; groundwater recharge; municipal and rural water supplies; and wildlife habitat." (National Watershed Coalition, 2002) Multipurpose flood control programs exist in other states where larger populations, more extensive development, and different precipitation patterns require a higher level of flood

protection than does much of Wyoming. Some of these state programs, which could serve as sources of information for future implementation of a comparable Wyoming program, are described below.

The State of Kansas administers a Multipurpose Small Lakes Program under which a planned flood control structure may "become a multi-purpose structure by adding water supply storage and/or recreation. A planned water supply structure may become a multipurpose structure by adding flood control or recreation." Objectives of the Kansas Multipurpose Small Lakes Program include:

- to provide flood protection;
- to provide dependable water supplies "in close proximity to communities that need water;"
- to provide a gradual process for water supply development whereby development matches demand; and
- to provide water storage projects that can be maintained locally. (Kansas Water Office, 2001)

The Lower North Platte Natural Resources District in Nebraska is involved in several watershed improvement projects. These projects are multipurpose in that they are intended to provide environmental restoration, flood control, and recreational benefits.

South Dakotans for Natural Flood Control state that their mission, based on the assumption that "flood control is necessary because of human encroachment of delicate natural floodplains," is to encourage "cooperation in attaining joint organizational efforts to provide environmentally friendly flood control solutions with minimal agricultural and social impact." (South Dakotans for Natural Flood Control, 2005) The Internet site that is maintained by this organization contains a somewhat different version of the same animated multipurpose flood control dam design that is located on the Deerwood Soil and Water Management Association Internet site that is described above.

Public Acceptance

Flood control is typically not a matter of major public concern in Wyoming. Small multipurpose flood control dams as described herein are often components of watershed management plans that are administered by the National Resources Conservation Service (NRCS) and/or local conservation districts. Conservation district activities are typically received in a positive manner by the Wyoming public.

Water Quality

Multipurpose flood control dams and reservoirs may provide as one of their functions the detention of stormwater runoff and resultant settling of sediment from that runoff. As a result, these structures may positively impact water quality in the drainages in which they are constructed.

Ability to Satisfy Multiple Demands

Based on the multiple purposes that may be served by multipurpose flood control dams, these structures could presumably satisfy the needs of multiple water demand sectors.

Comments from the Basin Advisory Group (BAG)

The Wyoming Farm Bureau Federation stated that this topic requires discussion and speculated that it may be most pertinent to Wyoming municipalities rather than rural areas since, in rural areas, floods are "usually over quickly and generally viewed favorably." (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher stated that this topic "no doubt needs to be studied." (Engen, 2005)

5.2.4.9 Utilization of the Wyoming Water Development Commission (WWDC) Small Water Project Program

Discussion regarding the WWDC Small Water Project Program (SWPP) in this report will not be based on the topics used during discussion of other future water use opportunities because of the brevity of this summary. Information and application forms associated with the WWDC SWPP are available from the WWDC or from the WWDC internet site at http://wwdc.state.wy.us/smallwaterproj/smallwaterproj.html.

The WWDC SWPP is intended to be compatible with and to complement the regular WWDC water resources support program as well as comparable programs that are administered by other local, state, and federal agencies. The WWDC defines small water projects as:

- projects that provide multiple benefits and have total estimated costs of not more than $100,000, and
- projects for which the maximum WWDC contribution is 50 percent of all project costs or $25,000, whichever is less.

Various water projects are eligible for WWDC SWPP funding, including stock pond, well, and pipeline projects that serve both wildlife and livestock, and irrigation conveyance projects that provide documented public benefits as described in a watershed plan. The WWDC gives priority to projects which "provide benefit for wildlife, livestock, the environment and the recreational community that are supported by state and federal natural resource management agencies and related scientific/technical agencies." (WWDC, 2004b)

The WWDC seeks, through the SWPP, to work closely with other land management agencies to support partnering of agencies "for the benefit of the people of Wyoming." WWDC SWPP documentation describes eligible applicants for this funding, including conservation districts, irrigation districts, and municipalities. This documentation also provides application forms and describes the application evaluation process.

The Wyoming Farm Bureau Federation strongly supported use of the WWDC SWPP to address future water demand issues in the Platte River Basin. (Wyoming Farm Bureau Federation, 2005) The responding Albany County rancher stated his opinion that the WWDC has "done a good job and should continue." (Engen, 2005)

5.2.5 References

American Water Works Association. 2004. *Statements of Policy on Public Water Supply Matters*. "Regionalization of Water Utilities." www.awwa.org/About/OandC/officialdocs/AWWASTAT.cfm

Annear, T.S., and Dey, P.D. 2001. *Fish Division Administrative Report.* Wyoming Game and Fish Department.

Bassett, C. 2005. Water Conservation Manager, City of Cheyenne Board of Public Utilities. Telephone interview on July 5, 2005.

Besson, L.M., Director, Wyoming Water Development Office. 2004a. *Conservation & the Water Development Program.* In *Proceedings of the Wyoming Water Association 2004 Annual Educational Seminar and Meeting.* October 27-29, 2004, Casper, WY.

Besson, L.M. 2004b. *Deer Creek Dam and Reservoir*. Memorandum to Nicole Novotny, Legislative Service Office

Britton, D., Manager, Wheatland Irrigation District. 2004. *How a Little Can Be Stretched a Long Way*. In *Proceedings of the Wyoming Water Association 2004 Annual Educational Seminar and Meeting.* October 27-29, 2004, Casper, WY.

Brookshire, D.S., Cummings, R.G., and Watts, G.L. 1990. *An Analysis of Contemporary and Historical Economics Associated with Water Development Projects in Wyoming*. Wyoming Water Research Center, University of Wyoming.

Brosz, Don. 2005. E-mail transmittal. May 20, 2005.

BRS, Inc., MHW, Lidstone and Associates, Trihydro Corporation, Donnell and Allred, Inc., and Water Rights Services LLC. 2003. *Wind/Bighorn River Basin Plan.* Wyoming Water Development Commission.

Cables, R.D., Regional Forester. 2002. *Water Yield Enhancement.* Memorandum. U.S. Department of Agriculture, Forest Service, Rocky Mountain Region.

Case, J.C., and Bersie, P.B. 2005. *Wyoming Multi-Hazard Mitigation Plan.* Wyoming Office of Homeland Security.

Cassidy, J.J. 2000. *Canal Operations: Interstate, Ft. Laramie, Mitchell-Gering, and Tri-State Canals*. Wyoming State Attorney General.

City of Cheyenne Board of Public Utilities. 2005. *Reuse*. http://www.cheyennebopu.org/reuse.htm.

City of Laramie. 2005. http://cityoflaramie.org/cityservices/waterutilities/water/index.html.

Clifford, P., and others. 2004. *Analysis of Water Banks in the Western States.* Washington Department of Ecology and WestWater Research.

Community Internet Cooperative Incorporated. 2005. *Multi-Purpose Dams*. http://www.cici.mb.ca/deerwood/dams04.html.

Daniels, B., Powell, J., and Rottman, S. 2001. *Is a Farm/Ranch Recreation Business for You?* Cooperative Extension Service, University of Wyoming.

Deerwood Soil and Water Management Association. 2005. *Multi-Purpose Dams*. www.cici.mb.ca/deerwood/dams04.html

Driscoll, F.G. 1986. *Groundwater and Wells.* Johnson Filtration Systems, Inc. Page 187.

Engen, Gil. 2005. Hand-delivered list of comments regarding draft Platte River Basin Plan future water use opportunities.

Fassett Consulting, LLC. 2004. *Final Report – Management Plan for Water Rights on Monolith Ranch, Volume I of II.* City of Laramie.

Hill, D.W., Public Utilities Manager, City of Casper. 2004. *Efforts to Address Water Demand.* In *Proceedings of the Wyoming Water Association 2004 Annual Educational Seminar and Meeting.* October 27-29, 2004, Casper, WY.

Hill, J., and Bosler, F. 1990 (approximately). *The Robertson-McConnell Reservoir – More Water for Southeast Wyoming*. Unpublished.

HKM Engineering, Inc., Lord Consulting, and Watts and Associates. 2002a. *Northeast Wyoming River Basins Plan.* Wyoming Water Development Commission.

HKM Engineering, Inc., Lord Consulting, and Watts and Associates. 2002b. *Powder/Tongue River Basin Plan*. Wyoming Water Development Commission.

Holliday, Brad. 2005. Comments of the Medicine Bow Conservation District and the Converse County Conservation District on the Platte River Basin Plan Final Report.

Idaho Water Resource Board. 2005. *The Idaho Water Resource Board*. "History and Responsibilities;" "Idaho Water Supply Bank;" "History of the Water Supply Bank". State of Idaho. http://www.idwr.idaho.gov/waterboard.

Irrigation Association, The. 2005a. *Drought: A Handbook for Prevention and Action.* http://www.irrigation.org.

Irrigation Association, The. 2005b. *More Food with Less Water*. http://www.irrigation.org.

Irrigation Association, The. 2005c. *Watch Every Drop*. http://www.irrigation.org.

Irrigation Association, The. 2005d. *About the IA*. http://www.irrigation.org.

Jacobs, J.J., and Brosz, D.J. 1993. *Wyoming's Water Resources.* Cooperative Extension Service, University of Wyoming.

Johnson, R. 2004. "From the CEO". *2004 Rural Water Magazine – 3rd Quarter.* National Rural Water Association. http://www.nrwa.org/prMag3.htm.

Kansas Water Office. 2001. *Multipurpose Small Lakes Program.* Fact Sheet No. 9.

Keith, K., Bauder, J., and Wheaton, J. 2003. *Frequently Asked Questions – Coal Bed Methane (CBM)*. Montana State University Department of Land Resources and Environmental Sciences. http://waterquality.montana.edu/docs/methane/cbmfaq.shtml.

Lawson, J.H., Area Manager, Wyoming Area Office, U.S. Bureau of Reclamation. 2004. *Reclamation Water Conservation Assistance*. In *Proceedings of the Wyoming Water Association 2004 Annual Educational Seminar and Meeting*. October 27-29, Casper, WY.

Levere, W.P. 2002. *Drought Conditions and Conservation Measures*. U.S. Department of Agriculture, U.S. Forest Service. March 14, 2002.

Lidstone & Anderson, Inc. 1997. *Hill Irrigation District Improvements – Level II Project*. Wyoming Water Development Commission.

Limbaugh, M., Deputy Commissioner, U.S. Bureau of Reclamation. 2004. *Western Water Management: Meeting the Challenges of the 21st Century*. In *Proceedings of the Wyoming Water Association 2004 Annual Educational Seminar and Meeting*. October 27-29, Casper, WY.

MacDonnell, L. 2004. *The Role of Conservation in Western Water*. In *Proceedings of the Wyoming Water Association 2004 Annual Educational Seminar and Meeting*. October 27-29, Casper, WY.

Maxwell, J. 1997. *Water Yield Enhancement Strategy for the Rocky Mountain Region*. U.S. Forest Service.

Micheli, R., and Ostermann, T. 2003. *Wyoming Drought Plan.* State of Wyoming, Department of Agriculture and State Forester. Pages 7, 19.

Moore, L., Phillips, C, and Powers, A. 1991. *Technical and Institutional Innovations Changing Water Resources Management and Allocation in the Western United States.* In *Proceedings of the International Seminar on Efficient Water Use.* October 21, 1991, Mexico City, Mexico. www.unesco.org.uy/phi/libros/efficient_water/wmoore.html.

National Drought Mitigation Center. 2003a. *Mitigating Drought*. University of Nebraska – Lincoln. http://www.drought.unl.edu/mitigate/status/htm.

National Drought Mitigation Center. 2003b. *Planning for Drought – Why Plan for Drought?* University of Nebraska – Lincoln. http://www.drought.unl.edu/plan/whyplan.htm.

National Drought Mitigation Center. 2003c. *Planning for Drought – Managing Water: Policies and Problems*. University of Nebraska – Lincoln. http://www.drought.unl/edu/plan/managewater.htm.

National Watershed Coalition. 2002. *A Guide to the Watershed Protection and Flood Protection Program*. http://www.watershedcoalition.org/water.html.

Nature Conservancy. 2004. North Platte River Program. http://nature.org.

North American Weather Consultants, Inc. 2005. http://www.nawcinc.com/wmfaq.html.

Oklahoma Conservation Commission. 2005. *Small Watershed Upstream Flood Control Programs*. www.okcc.state.ok.us/CP/CP_FC_home.htm

Ottem, T., Jones, R., and Raucher, R. 2003. *Consolidation Potential for Small Water Systems – Differences Between Urban and Rural Systems.* National Rural Water Association.

Powell, J., and Rottman, S.J. 1991. *Rural Development Strategies for Farm and Ranch Recreation*. Cooperative Extension Service, University of Wyoming.

Rain Bird Corporation. 2005. *The Intelligent Use of Water*. http://www.rainbird.com/iouw/tips/tips_ag.htm

Robertson, J. 2003. "Columbia's Power: The river contains the secret to drive a national energy revolution." *Eugene, Oregon Register-Guard.* February 16, 2003.

Robinson, L. 2004. Personal telephone communication. April 4, 2004.

Rocky Mountain Research Station – Laramie Forest Sciences Laboratory. 2005. *Wind-blown Snow as a Water Resource*. www.wrds.uwyo.edu/wrds/rmfres.

Rodi, Alfred. 2005. Chairman, Department of Atmospheric Sciences, University of Wyoming. Telephone interview. June 2, 2005.

Schmidt, L. 1999. *National Forest Water Yield Augmentation – Limited Opportunities Due to Operational Realities*. U.S. Forest Service.

Shields, John. 2004. *Water Conservation: Challenges and Opportunities*. Wyoming Water Flow. Wyoming Water Association. August 2004. Page 2.

South Dakotans for Natural Flood Control. 2005. http://www.floodcontrol.us/default.asp.

State of California. 2004. *Integrated Regional Water Management Grant Program Guidelines*. Department of Water Resources and State Water Resources Control Board. http://www.swrcb.ca.gov/funding/irwmgp/index.html.

States West Water Resources Corporation. 1991. *Upper Laramie River Basin Planning Study*. Wyoming Water Development Commission.

States West Water Resources Corporation. 2001. *Green River Basin Water Plan*. Wyoming Water Development Commission. Page 48.

Stelting, N. 2004. *An Overview of Water Markets in the West*. WestWater Research.

Supreme Court of the United States. 2001. *Final Settlement Stipulation in State of Nebraska v. State of Wyoming*. No. 108.

Thurow, T.S., and Taylor, C.A. 1999. *Viewpoint – The Role of Drought in Range Management*. Society of Range Management. Journal of Range Management, September, 1999.

Trihydro Corporation and Lidstone & Associates. 2005. *Project Report: North Platte River – Groundwater Assessment Study – Southeast Wyoming (Draft for Review)*. Wyoming Water Development Commission.

Tyrrell, P., Wyoming State Engineer. 2004. *Water Conservation and Wyoming Law: What Are Our Current Constraints?* In *Proceedings of the Wyoming Water Association 2004 Annual Educational Seminar and Meeting*. October 27-29, 2004, Casper, WY.

Urbigkit, Cat. 2003. "Governor opposes transbasin diversion". *Sublette Examiner*. June 26, 2003.

U.S. Department of Agriculture. 2005. *Northern Plains Agricultural Research Lab*. http://www.sidney.ars.usda.gov

U.S. Department of Agriculture, Forest Service. 2002. *Water Yield Enhancement*. Memorandum to Forest Supervisors and Regional office Staff Directors. July 12, 2002.

U.S. Department of Energy. 2003. *Workshop on Electrolysis Production of Hydrogen from Wind and Hydropower*. September 9-10, 2003, Washington, D.C.

U.S. Department of Energy - Energy Efficiency and Renewable Energy. 2004. *Hydropower Systems Integration and Technology Acceptance.* Wind and Hydropower Technologies Program Internet site. www.eere.energy.gov/windandhydro/hydro_sys_integ_tech.html.

U.S. Department of the Interior, Bureau of Land Management. 2001a. *Decision Record and Finding of No Significant Impact – Seminoe Road Coalbed Methane Pilot Project, Carbon County, Wyoming*.

U.S. Department of the Interior, Bureau of Land Management. 2001b. *Environmental Assessment for the Seminoe Road Coalbed Methane Pilot Project, Carbon County, Wyoming*.

U.S. Department of the Interior, Bureau of Land Management. 2002. *Environmental Assessment for the Hanna Draw Coalbed Methane Exploration Project, Carbon County, Wyoming*.

U.S. Department of the Interior, Bureau of Reclamation, and U.S. Fish and Wildlife Service. 2003. *Summary of the Draft Environmental Impact Statement and Draft Environmental Impact Statement - Platte River Recovery Implementation Program.*

U.S. Environmental Protection Agency. 2000. *Report of the National Drinking Water Advisory Council Small Systems Implementation Working Group*.

U.S. Environmental Protection Agency. 2003. *National Small Systems Affordability Criteria Work Group: Recommendations to the National Drinking Water Advisory Council*.

Utah Department of Natural Resources, Division of Water Resources. 2001. *Utah's Water Resources – Planning for the Future*.

Wagner, E. 1998. "National Forest Watershed Issues". *Colorado Stream Lines*. Quarterly Newsletter of the Division of Water Resources, State of Colorado, Vol. XII, No. 2. www.water.state.co.us/pubs/streamlines/archive/national.htm.

Wagner, John. 2005. Administrator, Wyoming Department of Environmental Quality, Water Quality Division. Telephone interview. June 13, 2005.

Weather Modification, Inc. 2005. *Wyoming Level II Weather Modification Feasibility Study*. Executive Summary and full report. Wyoming Water Development Commission.

Western Water Consultants, Inc. 1993a. *Report on Upper Laramie River Storage Projects – Level II. Volume II. Dodge Dam and Reservoir*. Wyoming Water Development Commission.

Western Water Consultants, Inc. 1993b. *Final Report on Upper Laramie River Storage Projects – Level II. Volume III. City of Laramie Storage*. Wyoming Water Development Commission.

Wilson, T., Cheyenne Board of Public Utilities. 2004. *Water Management Plan – Board of Public Utilities – City of Cheyenne, Wyoming.* In *Proceedings of the Wyoming Water Association 2004 Annual Educational Seminar and* Meeting. October 27-29, 2004, Casper, Wyoming.

Wolff, S.W., Wesche, T.A., and Hubert, W.A.. 1986. *Assessment of a Flow Enhancement Project as a Riparian and Fish Habitat Mitigation Effort*. In *Proceedings of the Twenty-First Annual Meeting of the Colorado-Wyoming Chapter of the American Fisheries Society*. March, 1986, Fort Collins, Colorado.

Wyoming Association of Conservation Districts. 2005. http://www.conservewy.com/wacd

Wyoming Department of Agriculture. 2005. *Drought – Process by Which a Disaster is Declared*. http://wyagric.state.wy.us/relatedinfo/droughtmain.htm.

Wyoming Department of Environmental Quality, Water Quality Division. 2001. *Rules and Regulations: Wyoming Surface Water Quality Standards. Chapter 1*.

Wyoming Department of Environmental Quality, Water Quality Division. 2002. *Rules and Regulations: Minimum Standards for Subdivision Applications. Chapter 23*.

Wyoming Department of Environmental Quality, Water Quality Division. 2005. *Rules and Regulations: Quality Standards for Wyoming Groundwaters. Chapter 8*.

Wyoming Farm Bureau Federation. 2005. Letter regarding Platte River Future Water Use Opportunities.

Wyoming Game and Fish Department. 2005. http://gf.state.wy.us.

Wyoming State Board of Control. 1992. *Order Record No. 40*. Page 393. Docket Number I-92-1-6.

Wyoming State Engineer's Office. 1992. *Order Granting an Exchange for Direct Flow Water for Direct Flow Water*. S.E. Docket No. 92-10-1.

Wyoming State Engineer's Office. 2004. *Wyoming State Water Forum Meeting Minutes, December 7, 2004*. http://seo.state.wy.us.

Wyoming State Engineer's Office. 1974 and 2004. *Regulations and Instruction.s*

Wyoming Water Association. 2005. www.wyomingwater.org

Wyoming Water Development Commission. 2004a. *State of Wyoming 2004 Water System Survey Report*.

Wyoming Water Development Commission. 2004b. *Small Water Project Program*. http://wwdc.state.wy.us/smallwaterproj/smallwaterproj.html.

Wyoming Water Development Commission. 2005a. *Operating Criteria of the Wyoming Water Development Program – Purpose*. http://wwdc.state.wy.us/opcrit/purpose.html.

Wyoming Water Development Commission. 2005b. *Water Management & Conservation Assistance Program Directory*. Third edition. http://wwdc.state.wy.us/wconsprog/WtrMgntConsDirectory.html.

Wyoming Water Development Commission. 2005c. *2005 Legislative Report – Wyoming Water Development Program*.

Ziemer, R.R. 1986. *Water Yields from Forests: An Agnostic View*. California Watershed Management Conference. November 18-20, 1986, West Sacramento, California.

Appendix 5.2.A

Letter Requesting BAG Input
Regarding Future Basin Water Use Opportunities

Final draft letter
Submitted to WWDC
For transmittal to bag members

February 16, 2005

Dear Platte River Basin BAG member:

One component of the work description for the Platte River Basin Plan requires Trihydro to "compile a list of potential structural and non-structural opportunities to meet current and projected water demands" in Wyoming's Platte River Basin. "Structural opportunities" might include reservoirs, trans-basin transfers, conveyance system upgrades, water distribution system enhancements, and other related items. "Non-structural opportunities" might include water conservation, modified reservoir operations, water right transfers, water banking, improved farm efficiencies, and other related items.

At the February 8, 2005 BAG meeting in Casper, Trihydro presented a draft list of "future water use opportunities" to the BAG and requested BAG input regarding items to be added to or removed from the list as well as suggested modifications to the list. Following receipt of BAG comments regarding this list, Trihydro will assess each of the items in a basin plan technical memorandum and in the final basin plan report.

In order to give every BAG member the opportunity to see and provide comments regarding the draft list of future Platte River Basin water use opportunities, we are hereby providing that list to you for your review and comment. Please review the list, then provide your comments to me regarding additional items or modification of existing items by e-mail, telephone, FAX, or regular mail. I look forward to hearing from you.

<u>Current draft list of future water use opportunities, Platte River Basin, including February 8 suggestions from BAG members:</u>

1. Drought response planning
2. Weather modification – "cloud seeding"
3. Trans-basin diversion(s)
4. Groundwater augmentation of surface water resources using groundwater that is non-hydraulically connected to North Platte River surface water
5. Water conservation
6. Water right transfers, both temporary and permanent, from agricultural to municipal use, agricultural to agricultural use, or agricultural to environmental use
7. Upper Laramie River storage
8. Snow fences

9. Urban stormwater capture, storage, treatment, management, and re-use
10. Irrigation with treated municipal wastewater
11. Grey-water irrigation
12. Municipal irrigation using untreated water
13. Enhancing recreational use of water sources
14. Modification of Pathfinder Dam and Reservoir
15. Improve agricultural irrigation structure and control efficiencies
16. Coalbed methane
17. Increase runoff from national forests based on modified USFS policies and practices
18. Water exchange/water banking, with focus on key areas such as the "triangle"
19. Multi-purpose flood control programs
20. Regionalization of public water supply systems
21. Utilization of WWDC's small water project program

If you have any questions or would like additional information regarding this list of potential Platte River Basin water use opportunities, please do not hesitate to contact me.

Please provide your input to me regarding this list no later than March 4, 2005.

Thanks very much for your assistance.

Sincerely,
Trihydro Corporation

John Galbreath, PE
Trihydro Corporation
1252 Commerce Drive
Laramie, WY 82070
Telephone: 307-745-7474
FAX: 307-745-7729
e-mail: jgalbreath@trihydro.com