TECHNICAL MEMORANDUM

SUBJECT: **Snake/Salt River Basin Plan**
Water Conservation

PREPARED BY: Sunrise Engineering, Inc.

DATE: November 5, 2002

Introduction:

Water conservation in the Snake/Salt River basin involves all uses including agriculture, municipalities, industry, recreational, and environmental concerns. In the past, water conservation efforts were mainly focused on improving efficiency of agricultural water use. As communities within this basin have changed, there is a growing interest in flat water activities and stream flow related recreation. There continue to be opportunities for water conservation within the Snake/Salt River basin and there are various incentive based, voluntary programs that promote water conservation. Following is an examination of water conservation activities and opportunities in the Snake/Salt River basin.

Agricultural Water Conservation:

Since the time of the first settlers in the basin, crops have been irrigated in order to increase yields. According to the technical memorandum entitled “Snake/Salt River Basin Plan, Basin Water Use Profile – Agriculture”, the oldest water right in the basin is a territorial right filed on Spring Creek, a tributary of Crow Creek, in 1885. Flood irrigation utilizing canals and ditches was the standard method of distributing irrigation water until the late 1960’s and early 1970’s. At that time, many areas of the Salt River basin converted from flood irrigation methods to pressure irrigation using sprinklers. This provided a much more efficient way of supplying water to the growing plants, and greatly reduced the quantity of water lost during conveyance as well as seepage losses from over-application of water. As the efficiency of water distribution increased, the reduced flows in late summer could be applied to a larger area, thus increasing yields. However, the reduction in conveyance and seepage losses also resulted in less water to recharge the groundwater system, and return flows in the fall and winter were reduced. Another result was that spring runoff that had been previously diverted and flooded in the fields was now allowed to stay in the stream, which resulted in higher peak flows during runoff.

The topic of change in agricultural production due to the conversion to sprinkler irrigation has been discussed with local producers. According to one producer in the Salt River basin, when utilizing flood irrigation he would produce approximately one ton of alfalfa per acre per year, and 34 bushels of barley per acre per year. Rarely did they have enough hay growth for a second crop. After the installation of sprinkler irrigation, yields increased to over 4 tons of alfalfa per acre per year, and 95 bushels of barley per acre per year. While previously the farm could support about 25 dairy cows and was short of hay on some years, they now have adequate feed for 50 cows utilizing the same farm ground. The improvement caused by sprinkler irrigation is seen in more than just crop yields. It was estimated that 10% of the farm ground was used for ditches and laterals, where now most of this ground is now used for growing crops due to the elimination of ditches within the field as well as the installation of buried pipe. Also, harvesting has become much more efficient without having to cut around the various distribution laterals and ditches in a field.

A Case Study of Irrigation Water Application in the Salt River Basin:

The following information on the Salt River basin case study was taken from the technical memorandum entitled "Green River Basin Plan, Water Conservation", prepared by States West Water Resources, 2000. Additional references can be found in that document.

The Salt River basin drains approximately 829 square miles, with approximately 60,000 acres (94 mi^2) of irrigated land. During 1971-1974, approximately one-half of the irrigated acres in the valley were converted to sprinkler irrigation. A study presented in July 1985 discussed the hydrologic impacts seen downstream of the project.

An evaluation of gauging station flow data was performed for the Salt River and Greys River, both for the "pre-sprinkler" period and the "post-sprinkler" period. The Greys River basin is adjacent to and northeast of the Salt River basin. It is approximately half the size of the Salt River basin, and contains very few irrigated acres. However, the climate and run-off characteristics are comparable. The Greys River data were used to help determine if any changes in river flow were due to changes in climate (i.e. a "wetter" or "dryer" period). The "pre-sprinkler" period is defined as October 1953 to April 1971, and the "post-sprinkler" period is defined as May 1971 to September 1982.

A comparison of the flows in the Salt River after completion of the project showed significantly higher monthly flow volumes during spring and early summer, slightly higher flows in late summer and fall, and slightly lower flows in winter.

An evaluation of the flows in the Salt River versus the flows in the Greys River was then performed. The analysis concluded that, as the total annual flow volume in the Greys River increased, the increase in flow in the Salt River was greater after the conversion to sprinklers than before. This suggests that more run-off (and therefore river flow) exists after the project, even when factoring in climate changes.

A study of annual flood peaks was also performed. The 50-year recurrence flood flow for the pre-sprinkler period was calculated from Log Pearson III distribution curves. An inspection of the flow data after sprinkler conversion revealed that this 50-year flood flow was exceeded in seven of the 12 years. The probability of that happening without outside influence was found to be approximately one in 225. When comparing floods of varying recurrence intervals, it was found that the peak flows were greater in the post-sprinkler period than pre-sprinkler for all recurrence intervals greater than 4 years.

An investigation to determine if other factors, such as climate or development, influenced the changes in river flows was completed. This study determined that there were no other significant changes in hydrologic conditions over the 1953 to 1982 period of analysis.

Municipal and Industrial Water Conservation:

Water conservation measures have been implemented by some of the municipalities in the basin, however it has not been a major focus. The largest town in the basin, Jackson, has implemented metering as have many other public water systems. However, many public systems do not meter their water use and have no incentive to conserve water. The expense of installing meters can be seen as prohibitive, and is unpopular politically. Also, some systems encourage water use during the winter months to prevent frozen pipes. Some systems are requiring meters on new hookups, and look to phasing in metering to the existing population.

During the last two summers, drought conditions have prompted some communities, such as Afton, to implement voluntary and mandatory water restrictions. Generally, these restrictions have consisted of elimination of outside lawn watering during daytime hours with exceptions for automatic sprinkler systems. In Afton, this was done to reduce daytime demand to better match the output from the Periodic Spring.

Industrial water conservation has not been significant, as water use for industrial purposes has been fairly low. However, one example of conservation is the Northern Foods soy processing plant in Afton. Cooling towers have been installed at the plant to facilitate the reuse of water for cooling at the plant instead of requiring a constant supply of fresh water for cooling purposes. This was done in response to problems at the Town's wastewater lagoons due to possible overloading, not specifically for conservation purposes.

Recreational and Environmental Water Conservation:

Various wetland and riparian enhancement projects have been conducted throughout the basin over the years. While these projects do not necessarily conserve water, they do conserve or enhance habitat for fish, waterfowl, and other animals. Also, maintenance flows at the Jackson Lake Dam have been agreed to by the U.S. Bureau of Reclamation in order to provide sufficient flow in the Snake River for fish during the winter months. Additional information on these topics can be found in the Technical Memorandum prepared by Sunrise Engineering entitled "Snake/Salt River Basin Plan, Basin Water Use Profile – Environmental".

Future Conservation Opportunities:

In general, the Snake/Salt River basin has adequate water to serve the needs of basin residents. For the most part, water shortages are seasonal, and their effects can be magnified by drought conditions. In spite of the adequate availability of water, and perhaps because of it, conservation methods can be used in virtually every form of water use.

Agricultural Conservation Opportunities:

The largest water savings by quantity are generally realized by conservation in the agricultural sector, as it represents the largest use of water in the basin. For this reason, much of the focus of water conservation is on irrigation practices. According to Ron Vore, Conservationist with the Wyoming Water Development Commission, seepage losses for canals in other basins can range up to 0.27 to 2.89 acre-feet per foot of canal. This rate of water loss during conveyance is dependent upon many variables including the quantity of water being transported, canal materials, and so forth. As part of a previous WWDC study, spot readings conducted on the Strawberry North Canal indicated that problem areas had conveyance losses of approximately 0.26 acre-feet per foot of canal, while other areas had losses of less than 0.1 acre-feet per foot of canal.

In order to determine what future conservation efforts will be effective, an inventory of existing facilities is necessary. Major items of interest in this inventory include conveyance facilities and irrigation methods. An inventory of major agricultural irrigation facilities in the Snake/Salt River basin is shown in **Appendix A**. A summary of this data is presented in **Table 1**. Data for this inventory was taken from the technical memorandum prepared by Sunrise Engineering entitled "Snake/Salt River Basin Plan, Irrigation Diversion Operation and Description". Only major irrigation diversions with adequate accompanying data were included in this memorandum. Major ditches were classified for this basin plan as those which supply 10 cubic feet per second of water or more. As a result, roughly 60 percent of the irrigated land in the entire Snake/Salt River basin is included in these calculations.

Table 1. Major Ditch Conveyance and Irrigation Methods Summary

Sub-Basin	Canal (miles)	Pipe (miles)	Irrigated Acreage	% Flood Irrigated	% Sprinkler Irrigated	Acres Flood Irrigated	Acres Sprinkler Irrigated
Upper Salt River	29.0	54.0	19,239	32.4	67.6	6,237	13,002
Lower Salt River	54.5	22.5	17,210	17.8	82.2	3,070	14,140
Upper Snake River	6.6	0.0	2,927	100.0	0.0	2,927	0
Lower Snake River	62.5	3.8	14,160	97.7	2.3	13,830	331
Teton River	18.9	0.0	8,742	0.0	100.0	0	8,742
Total=	**171.5**	**80.3**	**62,278**	**41.8**	**58.2**	**26,063**	**36,215**

A significant portion of water diverted for irrigation can be lost during conveyance to the field through seepage, deep percolation, phreatophytes, evaporation, and so forth. Water is typically diverted from the river or stream into a canal or ditch, which is generally of earth construction and unlined. The soils in the Snake/Salt River basin are predominantly gravelly loams as they were formed on the alluvium of the many rivers, streams, and washes that are present in the valleys. Naturally, water will quickly percolate through these granular soils. Essentially none of the canals and ditches in the basin are lined, yet many have been somewhat sealed over time with the deposition of fine material. Losses though unlined canals and ditches have been estimated at up to 40 percent of the diverted flow, however there are no extensive studies that have evaluated ditch conveyance losses in the Snake/Salt River basin.

Irrigation methods also present an opportunity for water conservation. In the Snake/Salt River basin, historically flood irrigation was the most popular method used in spite of its low efficiency.

However, since the early 1970's many areas, particularly in the Salt River basin, have converted to sprinkler irrigation that utilize hand lines or wheel lines. There are a few isolated areas that have incorporated center pivot irrigation. For the most part, the conversion from flood to sprinkler irrigation has had a positive effect, as crop yields have increased considerably. Also, more acres of cropland can be irrigated late in the summer when there is less water available. However, some positive aspects of flood irrigation have been reduced with the conversion to sprinkler, such as groundwater recharge and delay of the peak runoff.

A summary of estimated water losses and potential water savings through conservation is presented in **Table 2**. In light of the conveyance loss estimates discussed previously, a conservatively low estimate for total seasonal seepage losses of 0.1 acre feet per foot of canal is used in this table. Actual loss rates for canals and ditches in the basin are highly variable depending upon the diverted flow rate, canal construction and maintenance, soil types, and so forth. Therefore, the calculated quantity of potentially conserved water is only for reference purposes, and would vary greatly depending upon participation and extent of conservation measures. For conservation related to irrigation methods, the overall efficiency of flood irrigation is estimated to be approximately 50%, while the overall efficiency of typical sprinkler lines is estimated to be approximately 75%. Again, the quantity of water that could actually be conserved can vary greatly depending upon what conservation methods are employed, as well as the management and operation of a system. For example, ditches could be lined or converted to pipes, sprinklers could be installed, or both.

Table 2. Estimated Annual Water Conservation - Conveyance & Irrigation Method

	Conveyance			Irrigation Method			
Sub-Basin	Canal (miles)	Reduced Loss (AF/Mi)	Water Conserved (AF)	Acres Flood Irrigated	Efficiency Increase	Water Conserved (inches)	(AF)
Upper Salt River	29.0	528.0	15,312	6,237	25%	9.82	5,104
Lower Salt River	54.5	528.0	28,776	3,070	25%	9.21	2,357
Upper Snake River	6.6	528.0	3,485	2,927	25%	10.74	2,620
Lower Snake River	62.5	528.0	33,000	13,830	25%	12.31	14,183
Teton River	18.9	528.0	9,979	0	25%	8.93	0
Total =	**171.5**		**90,552**	**26,063**			**24,263**

Municipal Conservation Opportunities:

Municipal water use is the next significant use of water in the basin following agricultural water use. Conservation measures for these types of systems generally consist of individual customer meters that track actual water use. Meters can also help determine if there are major losses in the distribution system through leaks. Some municipal water systems have implemented water restrictions, both voluntary and mandatory, during the summer over the past two years of drought. These restrictions effected irrigation of lawns and landscaping during high use times, and encouraged the use of automatic sprinkler systems. A summary of community water systems in the basin is presented in **Appendix A**. Conservation efforts on municipal systems have been shown to reduce indoor use by over 20 gallons per capita per day. Outdoor water use for irrigation of lawns and landscaping can be significant, and can be greatly reduced by utilizing plants with lower water requirements and installing sprinkler systems and timers. Perhaps the largest municipal or domestic use of water is sprinklers and hoses left running around the clock during the summer. Also, due to water systems that are shallow and subject to frost, many communities encourage water use such as running a constant stream of water in the winter to prevent frozen pipes. Due to the variables associated with municipal conservation, such as metering, indoor and outdoor use, and freeze protection, an estimate of the quantity of potential municipal water conservation is not included.

Recreation and Environmental Conservation Opportunities:

Much of the use of water in the Snake/Salt River basin is related to recreational and environmental uses. While these are generally non-consumptive uses, water is still key to many of these activities. Conservation efforts in these areas generally do not conserve the quantity of water used, but rather focus on conservation of a fishery, wetland, or other resource that serves to improve the water use opportunity. Water storage can serve an important role in meeting these water needs by providing increased management of the available water supply for these uses. Storage can also serve to conserve water by meeting the needs of the resource while holding over surplus water for later use. For another example, fencing to keep cattle off of a stream bank can help reduce erosion, improve water quality, and maintain habitat. In these circumstances, an off-stream location for stock watering must be developed. Without an alternative water source, fencing may also mean that an irrigated crop, either by natural or artificial means, may not be harvested or grazed. Also, water utilized for wetlands may be considered conservation of bird or fish habitat, although more water is used than if the wetland was not maintained.

Conservation Programs:

There are many conservation assistance programs available to the water user public from local, state and federal agencies and organizations. Information regarding these programs has been compiled into a document by the Wyoming State Engineer's Office entitled "Wyoming Water Management & Conservation Assistance Programs Directory" that is available in hard copy or on-line through the WWDC or WRDS web sites. A brief description of available programs and contact information such as program manager, telephone, and web site is presented in the document. Due to the number of conservation programs described and the extent of information available, a listing of these programs will not be included in this technical memorandum, and the reader is instead referred to the above mentioned document for further details.

Conclusion:

In order for conservation methods to be successfully implemented, there must often be an incentive or benefit for those involved. This incentive may be in various forms, such as increased crop yields, improved fishing, reduced costs, and so forth. Reduction of conveyance losses and improvement of irrigation efficiency does not necessarily equate to less water used. In areas of deficit, conservation measures may result in the conserved water being applied to additional acres or providing a full supply of water throughout the season without a decrease in the water diverted. However, this improvement in efficiency will likely result in an increase in the crop quality and yield. Prior to implementation of conservation improvements, the system should be studied to see how conservation is addressing the issue and to make sure that the program will have the intended result.

References:

Farm Service Agency, Conservation Reserve Program, Fact Sheet, October 1999, www.fsa.usda.gov/pas/publications/facts/html/crp99.htm.

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Wyoming State Engineer's Office, Water Management & Conservation Assistance Programs Directory, Second Edition, October 2001.

Appendix A

Water Conservation

Table 1. Major Ditch Inventory - Conveyance and Irrigation Methods by Sub-Basin

UPPER SALT RIVER	Canal (miles)	Pipe (miles)	Acreage	% Flood	% Sprinkler	Flood Acres	Sprinkler Acres
Afton Canal		9	1,816		100	0	1,816
Cottonwood Creek Irrigation District Pipeline		27	4,608		100	0	4,608
Crow Creek Canal	7		1,830	90	10	1,647	183
Dry Creek Irrigation District Pipeline		18	3,502		100	0	3,502
Halling Ditch	2		1,030	80	20	824	206
Idaho Boundary Line Ditch	3		1,079	50	50	540	540
North Canal	7		2,794	85	15	2,375	419
Salt River Canal	10		2,580	33	67	851	1,729
Subtotal =	**29**	**54**	**19,239**	**32.4**	**67.6**	**6,237**	**13,002**
LOWER SALT RIVER							
Alto Canal	7		942	32	68	301	641
Ames & Gould Canal	2		1,089	100		1,089	0
Baker & Heap Canal	5		625	10	90	63	563
Dana Ditch	3	3.5	718		100	0	718
East Side Canal	15		4,862	10	90	486	4,376
Freedom Canal	2.5		819	40	60	328	491
Hardman Canal	11		1,623		100	0	1,623
Kirkbride Canal	2		1,483	5	95	74	1,409
Porto Canal		12	1,535		100	0	1,535
Stewart Creek Pipeline		7	1,084		100	0	1,084
Strawberry North Canal	7		2,430	30	70	729	1,701
Subtotal =	**54.5**	**22.5**	**17,210**	**17.8**	**82.2**	**3,070**	**14,140**
UPPER SNAKE RIVER							
Black Rock	2.8		734	100		734	0
Gaffney	1.9		770	100		770	0
Wolff	1.9		1,423	100		1,423	0
Subtotal =	**6.6**	**0**	**2,927**	**100.0**	**0.0**	**2,927**	**0**
LOWER SNAKE RIVER							
Adams	18		1,336	100		1,336	0
Cyclone	1.1		661	50	50	331	331
Enterprise	1		1,336	100		1,336	0
Hobo	1		633	100		633	0
Hot Springs	1		910	100		910	0
Spring Gulch Irrigation	6.8		1,975	100		1,975	0
South Park Supply	15.2	3.8	3,494	100		3,494	0
Last Chance	5.7		615	100		615	0
Pioneer	4.2		667	100		667	0
Granite Creek Supplemental			932	100		932	0
Iron Rock	3.8		884	100		884	0
Prosperity	4.7		717	100		717	0
Subtotal =	**62.5**	**3.8**	**14,160**	**97.7**	**2.3**	**13,830**	**331**
TETON							
Todd Ditch	3.8		2,227		100	0	2,227
South Side Canal	3.8		1,421		100	0	1,421
North Side Canal	5.7		1,666		100	0	1,666
Wyoming & Darby Bench Canal	2.8		1,828		100	0	1,828
Squirrel Creek Irrigation	2.8		1,600		100	0	1,600
Subtotal =	**18.9**	**0**	**8,742**	**0.0**	**100.0**	**0**	**8,742**

Table 2. Irrigation Method Potential Conservation

Irrigation Efficiency = 75%
Flood Efficiency = 50%

Sub-Basin	Acres Flood Irrigated	Efficiency Increase	CIR (inches)	Water Used (inches)		Water Conserved	
				Flood	Sprinkler	(inches)	(AF)
Upper Salt River	6,237	25%	14.73	29.46	19.64	9.82	5,104
Lower Salt River	3,070	25%	13.82	27.64	18.43	9.21	2,357
Upper Snake River	2,927	25%	16.11	32.22	21.48	10.74	2,620
Lower Snake River	13,830	25%	18.46	36.92	24.61	12.31	14,183
Teton River	0	25%	13.39	26.78	17.85	8.93	0
Total =	**26,063**						**24,263**

Table 3. Municipal & Community System Inventory

Name	Population Served	Avg Day Use (gpcpd)	Peak Day Use (gpcpd)	Percent Metered
Alta Community Pipeline Spring	50	120	420	
Aspens I/II Water and Sewer District	1,800	222	500	10
Bar-B-Bar Subdivision	120	120	420	
Buffalo Valley Water District				0
C-V Ranches	80	120	420	
Evans Mobile Home Court	150	120	420	
Gros Ventre North Subdivision	230	165	700	
Gros Ventre (West) Butte	270	120	420	
High Country Subdivision	75	120	420	
Highland Park Subdivision	50	120	420	
Indian Paintbrush	200	120		0
Indian Springs	75	120	420	
Jackson Hole Golf & Tennis	350	116		0
J-W Subdivision	50	120	420	
Little Horsethief Canyon	50	120	420	
Melody Ranch	1,300	120	388	
Millward Trailer Park	40	120	420	
Rafter J	1,500	660	660	
River Meadows H.O.A.	160	120		
Saddle Butte Subdivision	60	120		
Skyline Ranch Improvement and Service Dist.	160	120	420	
Snake River Mobile Home Park	60	120	420	
South Park Village Subdivision	70	120	420	
Spring Creek Improvement District	500	165	75	33
Squaw Creek	225	120	420	
Targhee Towne	80	120	420	
Targhee Village	90	120	420	
Teton Shadows	180	120	420	0
Teton Village Water and Sewer District	5,240	293		98
Town of Jackson	15,000	467	885	100
Wilson Meadows	180	120	420	
Town of Afton	1,640	760	2,865	0
Town of Alpine	288	291	873	98
Bedford Water and Sewer District	560	350	425	100
Etna Water & Sewer District	85	80	160	0
Fairview Water & Sewer District	360	55	109	100
Freedom Water and Sewer District	120	1,450	2,000	100
Grover Water and Sewer District	280	200	400	100
Happy Valley Pipeline Co.	60	3,600		0
Kennington Springs Pipeline Company	63	100		0
Nordic Ranches Subdivision	180	171		
Osmond	200	95	150	100
North Alpine Special Service District	40	80		
Smoot Water & Sewer District	500	250		100
Star Valley Ranch Association	1,800	685	730	28
Star Valley Ranch RV Park/Bridger View	900	75	190	
Star Valley Trailer Court	100	80		
Town of Thayne	318	500	2,000	0
Westview Village	70	50		
Willow Creek Pipeline Company	50	200		