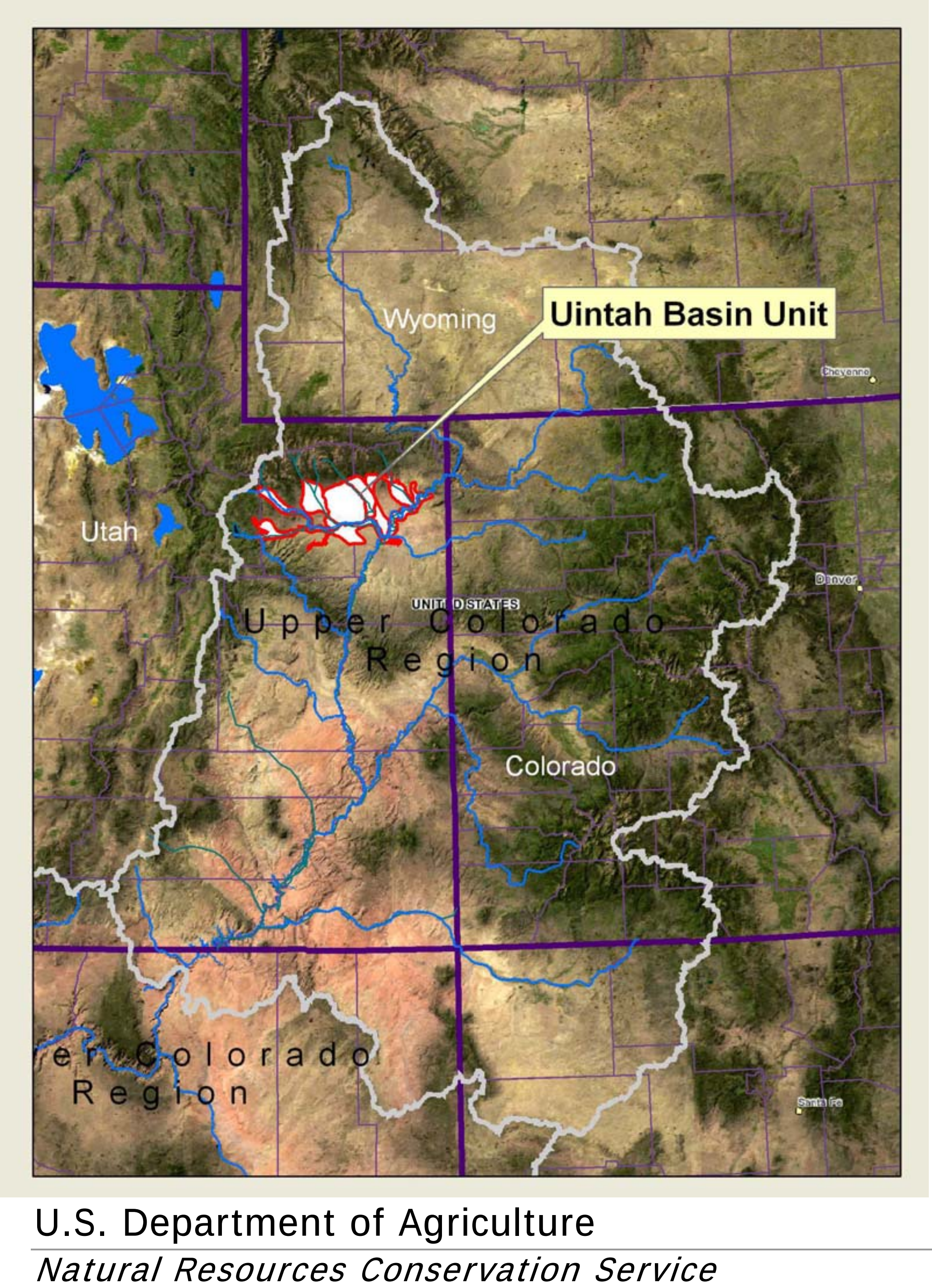
Colorado River Basin Salinity Control Program

Uintah Basin Unit

Monitoring and Evaluation Report, FY2007



U.S. Department of Agriculture

Natural Resources Conservation Service

Executive Summary

Project Status

- NRCS and Reclamation have reviewed and concurred on pre-project agricultural salt load allocation
- Salt load reduction calculation procedures have been revised to assure proportionality and concurrence with EIS projections and salt load reduction has been recalculated back through FY1997
- Of 200,000 irrigated acres, perhaps 80% or 160,000 may ultimately be improved
- Treatments on approximately 148,000 acres have been planned and 142,000 acres applied
- Of approximately 208,000 original on-farm tons, 114,000 tons of salt load reduction has been applied, calculated using revised procedure
- Of approximately 120,000 original off-farm tons, USDA programs have applied 24,000 tons of salt load reduction
- Approximately $76 million dollars nominal ($108 million 2007 dollars) in Federal financial assistance has been obligated by USDA since 1980
- For practices applied in FY2007, the average cost of salt load reduction is $136/ton FA+TA
- The average applied practice cost over the life of the project is $74/ton FA+TA nominal ($116/ton FA+TA in 2007 dollars)

Hydro-salinity

- Studies by USU and UACD confirm that sprinkler condition is largely a result of maintenance and operation practices
- Leaks and damage increase with sprinkler system age
- Increased deep percolation due to system leaks is relatively minor
- More effective and more frequent IWM training for cooperators is essential
- Incentive payments for IWM have resulted in enhanced interest in proper operation and maintenance

Wildlife Habitat and Wetlands

- Conversion of wetlands to uplands is far less than anticipated by the EIS
- Photo points have been established and case studies are ongoing
- A total of 2012 acres wildlife habitat projects were planned and funded and 307 acres wildlife habitat projects were applied in FY2007
- Crystal Ranch LC Case Study is photographically displayed

Economics

- Cooperators generally believe that their increase in production and decrease in labor adequately offsets their participation cost
- Public benefits are perceived to exceed public liabilities for salinity control measures

Table 1, Project progress summary

Uintah Basin Unit				
Practices Applied	**Units**	**FY2007**	**Cumulative**	**Target**
1. Irrigation Systems				
A. Sprinkler System	Acres	5,012	127,477	160,000
B. Improved Surface System	Acres	-	14,347	
C. Drip Irrigation System	Acres	3	93	
2. Irrigation Water Management	Acres	5,015	141,917	
3. Wildlife Wetland Habitat Management	Acres	84	2,613	
4. Wildlife Upland Habitat Management	Acres	223	13,450	
5. Salt Load Reduction, on-farm*	Tons/Year	4,590	114,107	140,500
5a. Salt Load Reduction, off-farm	Tons/Year	-	23,554	
6. Deep Percolation Reduction (Includes seepage) Note: deep percolation is not equal to return flow.	Acre-Ft/Yr			
7. Total Irrigation Contracts (Planned)	Number	62	2,936	
	Dollars, FA	3,890,488	76,160,775	
	Acres	2,152	145,680	

***Note: On-farm Salt Load Reduction has been recalculated using new procedures adopted in FY2007 by three Upper Basin States. In the process, all EQIP and BSPP contracts were reviewed and acres corrected. All cumulative numbers reflect results of this review.**

NRCS Salinity Control Programs			
Program Name	**Acronym**	**Start Year**	**End Year**
Agricultural Conservation Program	ACP	1980	1987
Colorado River Basin Salinity Control Program	CRBSCP	1987	1996
Interim Environmental Quality Incentive Program	IEQIP	1996	1996
Environmental Quality Incentive Program	EQIP	1997	Current
Basin States Parallel Program	BSPP	1998	Current

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Monitoring and Evaluation History and Background

The Colorado River Basin Salinity Control Program was established by the following Congressional Actions:

The Water Quality Act of 1965 (Public Law 89-234) as amended by the Federal Water Pollution Control Act of 1972, mandated efforts to maintain water quality standards in the United States.

- Congress enacted the Colorado River Basin Salinity Control Act (PL 93-320) in June, 1974. Title I of the Act addresses the United States' commitment to Mexico and provided means for the U.S. to comply with provisions of Minute 242. Title II of the Act created a water quality program for salinity control in the United States. Primary responsibility was assigned to the Secretary of Interior and the Bureau of Reclamation (Reclamation). USDA was instructed to support Reclamation's program with its existing authorities.

- The Environmental Protection Agency (EPA) promulgated a regulation in December, 1974, which established a basin wide salinity control policy for the Colorado River Basin and also established a water quality standards procedure requiring basin states to adopt and submit for approval to the EPA, standards for salinity, including numeric criteria and a plan of implementation.

- In 1984, PL 98-569 amended the Salinity Control Act, authorizing the USDA Colorado River Salinity Control Program. Congress appropriated funds to provide financial assistance through Long Term Agreements administered by Agricultural Stabilization and Conservation Service (ASCS) with technical support from Soil Conservation Service (SCS). PL 98-569 also requires continuing technical assistance along with monitoring and evaluation to determine effectiveness of measures applied.

- In 1995, PL 103-354 reorganized several agencies of USDA, transforming SCS into Natural Resources Conservation Service (NRCS) and ASCS into Farm Service Agency (FSA).

- In 1996, the Federal Agricultural Improvement and Reform Act (PL 104-127) combined four existing programs, including the Colorado River Basin Salinity Control Program, into the Environmental Quality Incentives Program (EQIP).

Over the years, Monitoring and Evaluation (M&E) has evolved from a mode of labor/cost intensive detailed evaluation of a few farms and biological sites to a broader, but less detailed evaluation of many farms and environmental concerns, driven by budgetary restraints and improved technology.

M&E is conducted as outlined in "The Framework Plan for Monitoring and Evaluating (M&E) the Colorado River Salinity Control Program", first issued for Uintah Basin Unit in 1980 and revised in 1991 and 2001.

Project Status

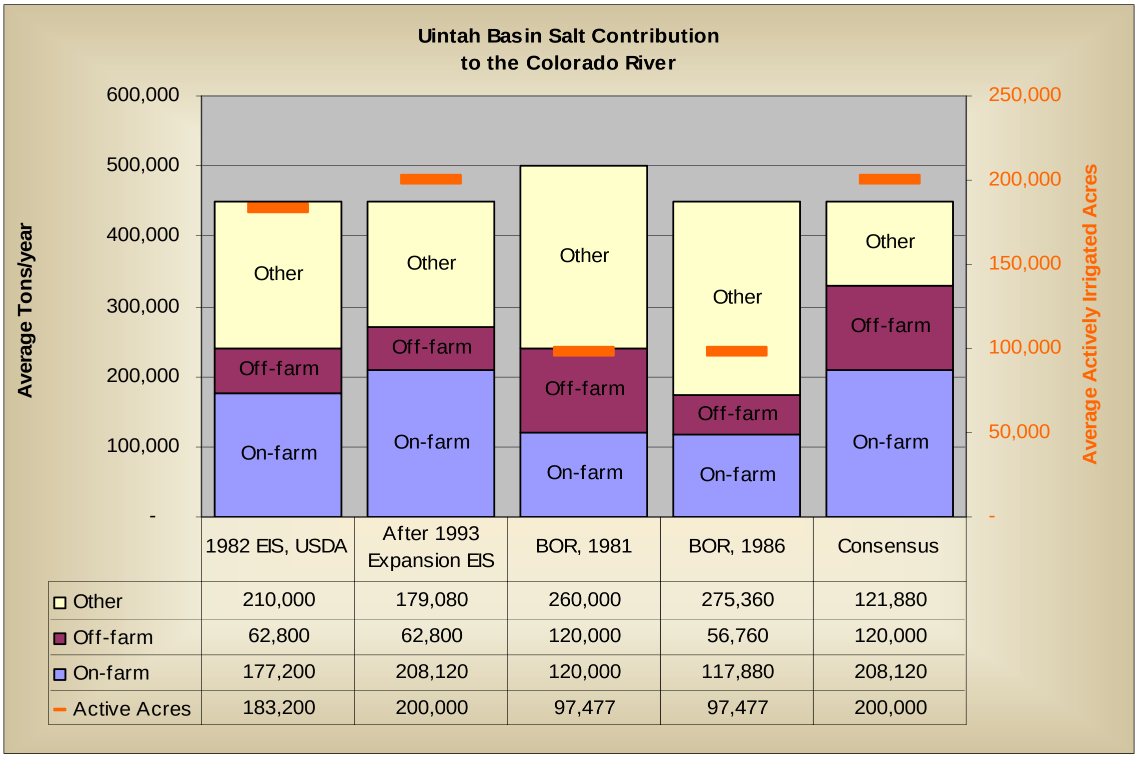
Pre-Project Salt Loading

In 2007, an effort was made, by interested federal agencies, to review available literature and come to a consensus agreement on the most reasonable pre-project salt contribution of agriculture prior to implementing Federal Salinity Control Programs. The result of this effort is depicted in figure 1.

In order to plan and track progress in the Uintah Basin Unit (UB) of the Colorado River Basin Salinity Control Project (CRBSCP), it is necessary to contemplate pre-project conditions.

One of the challenges of salt load evaluation is to quantify how much salt is produced by what source, and what can be done to reduce the amount of salt returning to the river system. Since agriculture is a primary source and completely human induced, therein is great potential to make positive change.

Figure 1, Uintah Basin salt load allocation. The last bar indicates the consensus estimate.



	1982 EIS, USDA	After 1993 Expansion EIS	BOR, 1981	BOR, 1986	Consensus
☐ Other	210,000	179,080	260,000	275,360	121,880
■ Off-farm	62,800	62,800	120,000	56,760	120,000
■ On-farm	177,200	208,120	120,000	117,880	208,120
– Active Acres	183,200	200,000	97,477	97,477	200,000

Between 1975 and 1991, at least six studies were done by federal agencies to quantify the salt contribution of agriculture in the Uintah Basin to the Colorado River System. Three studies by US Department of Agriculture (USDA) Soil Conservation Service and its successor, Natural Resource Conservation Service (NRCS) emphasized the contribution of irrigation systems and attempted to address all irrigated lands in the Uintah Basin. Two studies by US Department of Interior Bureau of Reclamation (Reclamation) focused on canals with the greatest water loss, addressing only half of irrigated lands. This discrepancy in scope has led to ambiguity as to the total salt contribution of agriculture. See figure 2.

Salt load at a given point in a watercourse is generally estimated by multiplying average flow by average salt concentration over a discreet time interval and summing the results to determine an annual average salt load. Since flow rates and concentrations are highly variable, shorter measurement intervals and longer periods of record result in more acceptable estimates.

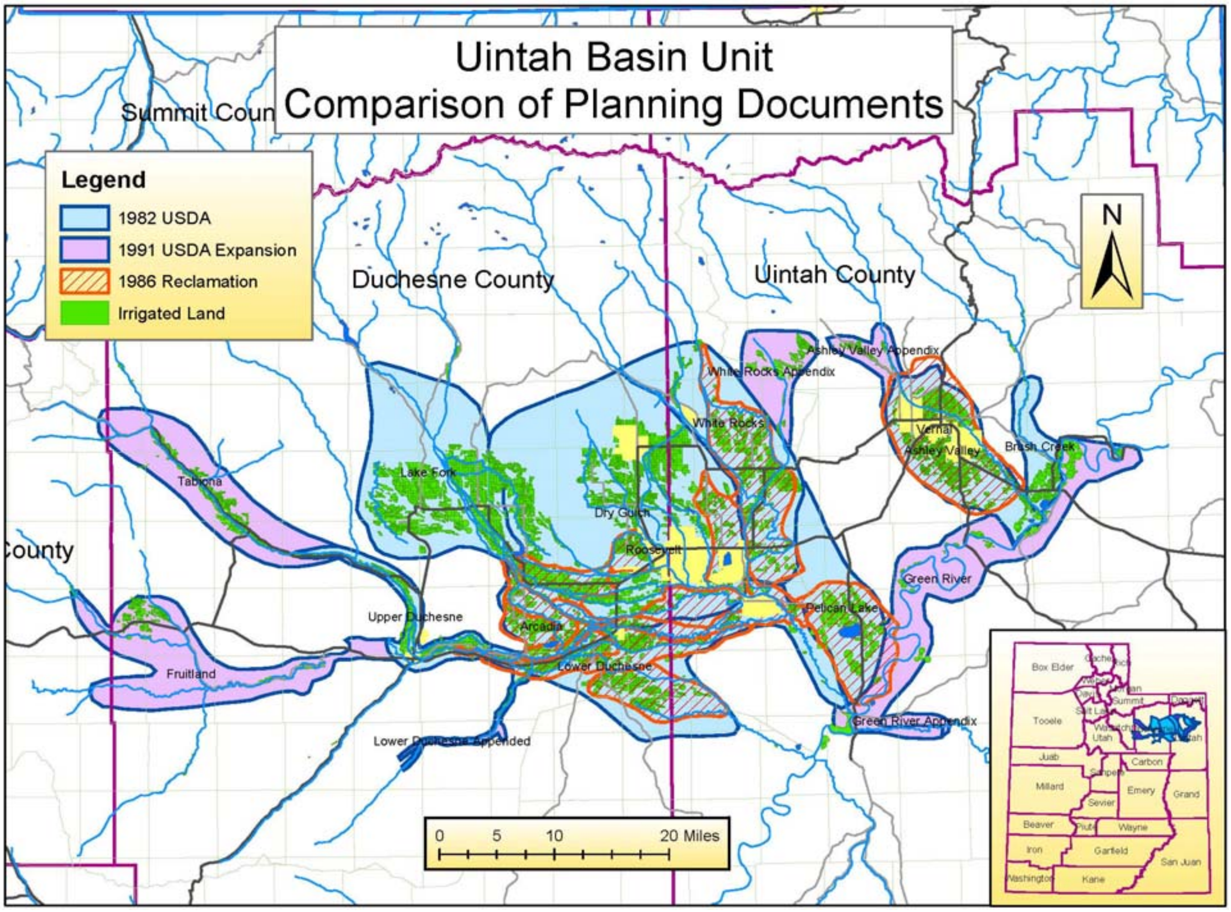
The average salt pickup for a given drainage is the average salt load below the drainage less the average salt load above the drainage.

Salt Pickup has various sources including natural processes, springs, wells, mines, and agricultural activity. A particularly large source is agricultural irrigation, which involves diverting relatively clean water from a watercourse, transporting water to a field and applying water to the soil. Salt pickup occurs when seepage from canals and excess water application on fields allows water to percolate below the plant root zone, carrying salt dissolved from the soil back to the river system.

Progress

In FY2007, all EQIP and BSPP contracts were reviewed, acreage adjusted to correct apparent inaccuracies and salt load reduction recalculated, based on a revised formula agreed to by NRCS offices in Upper Colorado River Basin States (The revised calculation procedure is detailed in Appendix I). Data expressed in this report is adjusted and will not balance to previous reports,

Figure 2, Scope of Uintah Basin Unit planning documents.



but is believed to be more representative of what has actually happened over time.

Table 1 (page 3) is a summary of the cumulative status of all USDA salinity control activities, which began in FY1980, with the Agricultural Conservation Program (ACP) and Long Term Agreements (LTA) with cooperators. Funding for salinity control programs shifted to the Colorado River Salinity Control Program (CRSCP) in FY1987 and the Interim Environmental Quality Incentive Program (IEQIP) in FY1996. All viable contracts issued via these early programs are completed. In FY1997, salinity control efforts were shifted to the Environmental Quality Improvement Program (EQIP) and the Basin States Parallel Program (BSPP).

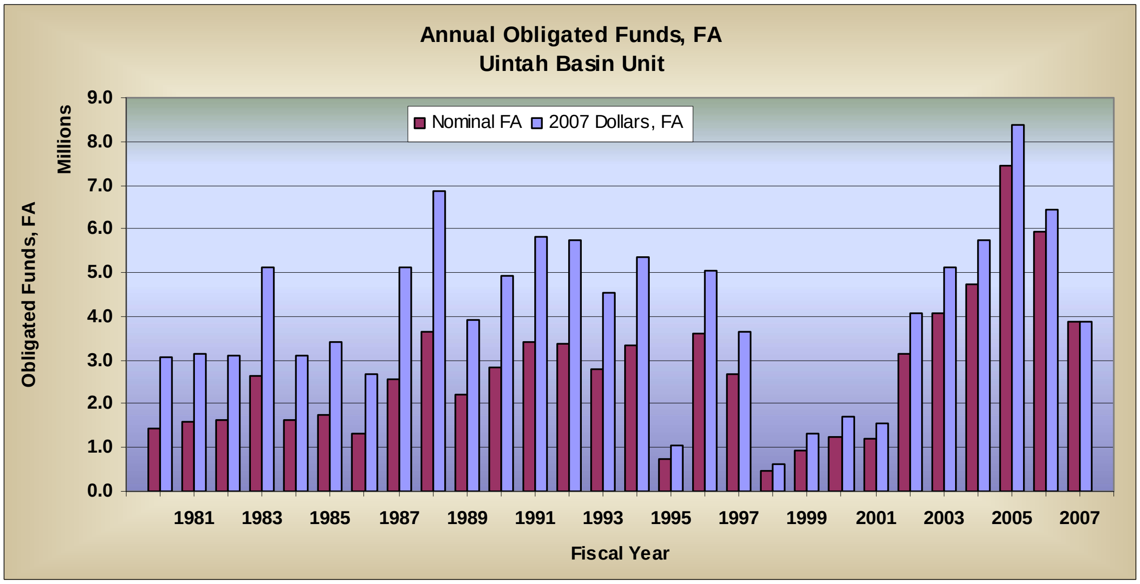
Funding

Of a nominal $76.2 million Financial Assistance (FA) obligated since inception, approximately $70.0 million has been applied. Table 2 summarizes FA funds planned and applied by program. Figure 3 depicts annual FA obligations. Figure 4 illustrates cumulative FA obligated through FY2007 by Program.

Table 2 – Cumulative nominal financial assistance funds planned and applied, by program

Through FY2007	Planned			Applied				
Program	Contracts	FA, $	Acres	FA, $	Acres	$/Acre	Salt Load Reduction, Tons	Salt Load Reduction, Tons/Acre
ACP & CRBSCP	1,984	40,451,590	99,185	40,451,590	99,185	408	89,994	0.91
IEQIP	62	2,224,133	2,581	2,224,133	2,581	862	3,395	1.32
EQIP	786	27,998,572	39,310	23,818,245	36,265	657	38,891	1.07
EQIP WLO	28	1,389,367	5,642	513,670	2,260	227	120	0.05
BSPP	76	4,097,112	4,486	3,035,914	3,755	808	5,261	1.40
Totals	2,936	76,160,774	151,204	70,043,552	144,046	486	137,661	0.96

Figure 3, Annual obligated financial assistance



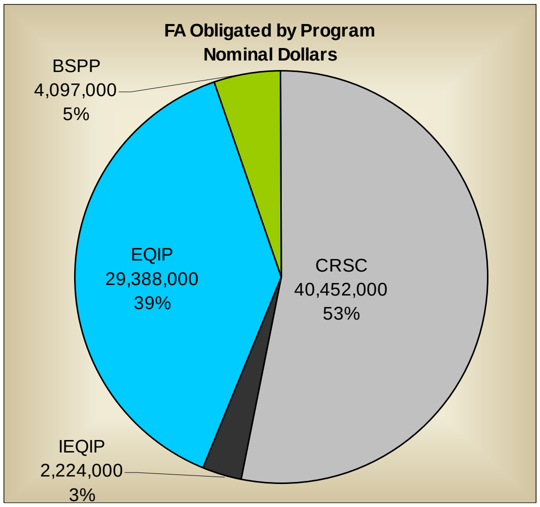
Practices Planned and Applied

Since 1980, about 2,900 contracts have been written with landowners to upgrade irrigation practices on approximately 148,000 acres. As of the end of FY2007, practices are applied on about 142,000 acres. Only 9% of applied systems are improved flood systems, 91% being higher efficiency sprinkler systems.

There are approximately 225,000 acres of irrigated land in the Uintah Basin, of which an average 200,000 acres are irrigated in a given season.

Pre-project planning estimated that 122,200 acres would be treated. About a third of treatments would be improved flood systems. The 1991 approval of the EIS for Uintah Basin Unit Expansion increased the projected area to be treated to 131,100 acres.

Figure 4, Financial assistance obligated by program



With sufficient landowner interest in Salinity Control Programs, participation could exceed 160,000 acres or 80% of average irrigated acres, assuming that acceptable financial assistance is available.

Figure 5 depicts total acres planned to date by program.

Figure 6 depicts cumulative acres planned/applied, by year.

Figure 7 compares progress with projections.

Figure 8 depicts acres planned by practice.

Figure 5, Acres planned by program

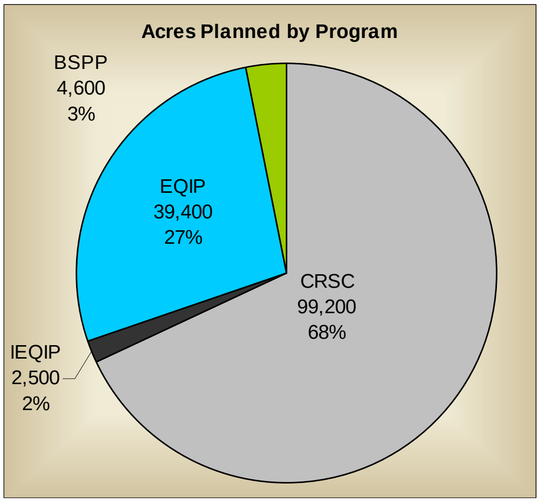


Figure 6, Cumulative planned/treated acres by year.

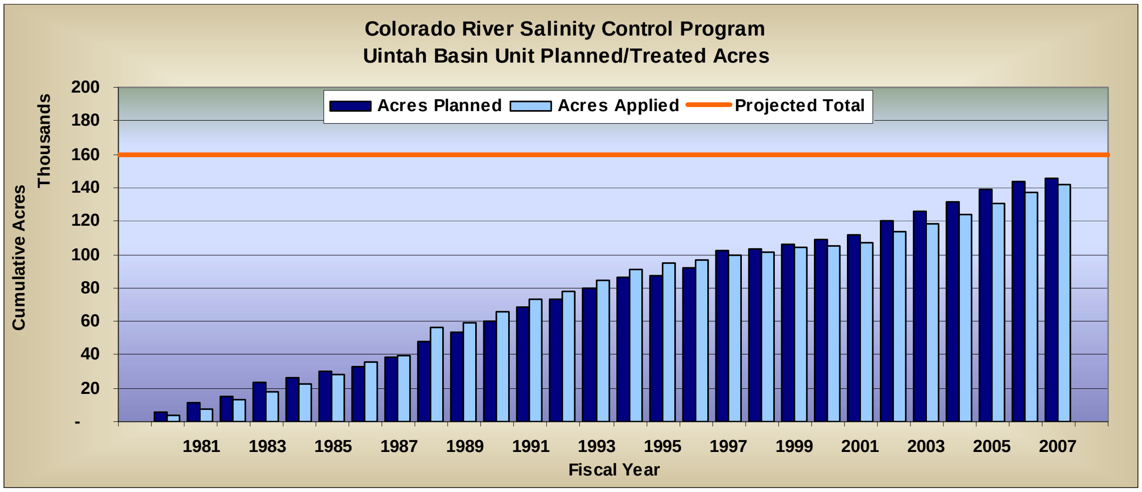
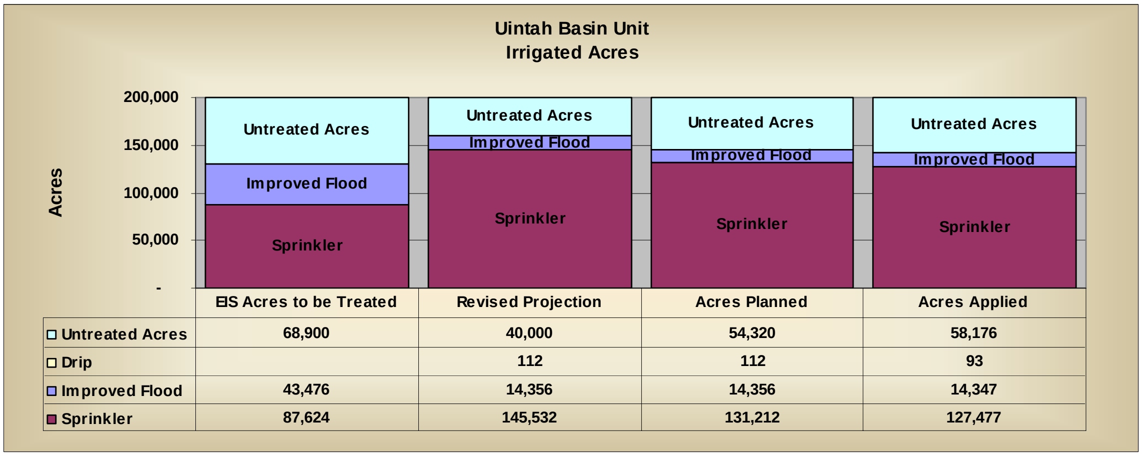
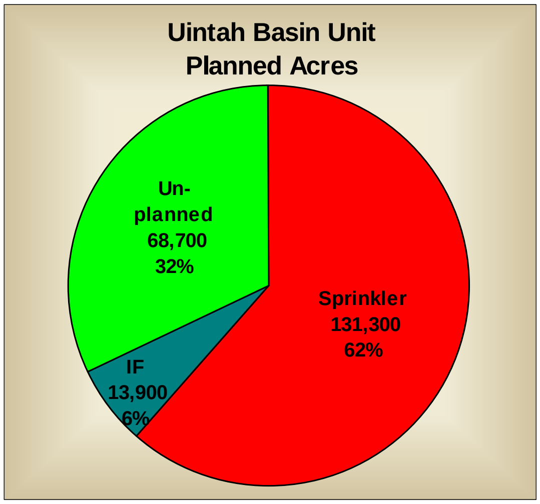


Figure 7, Progress compared to projection.



	EIS Acres to be Treated	Revised Projection	Acres Planned	Acres Applied
□ Untreated Acres	68,900	40,000	54,320	58,176
□ Drip		112	112	93
□ Improved Flood	43,476	14,356	14,356	14,347
■ Sprinkler	87,624	145,532	131,212	127,477

Figure 8, Acres planned by practice



Salt Load Reduction

Calculation of salt load reduction has been enigmatic since early in the Salinity Control Program. Initially, very little data was available to help determine actual rates of deep percolation (water percolating below the root zone) or return flow (the fraction of deep percolation that ultimately picks up salt and returns to the river system).

On-Farm

For on-farm projects total water applied to the field (irrigation and precipitation) must equal total water leaving the field, (evapotranspiration, run-off, non-crop plant consumption, and deep percolation, a fraction of which becomes return flow) adjusted for changes in water storage in the soil. If there is a high water table, additional variables are added to the equation.

Water applied and surface run-off can be measured. Evapotranspiration (ET) is calculated using empirical formulas based on plant research. Water that is applied and does not run off and is not used by crops is deep percolation. Some of the deep percolation is used by other plants on its way back to the river. The balance carries dissolved salts to the river (return flow).

Applying the described water budget to actual irrigation systems assumes that optimal water volumes are available for delivery, which is rarely the case for flood systems in the Uintah Basin. The 1982 Environmental Impact Statement (EIS) for the Uintah Basin Unit implied that only about 44% of optimal irrigation water could be delivered prior to implementation of salinity control measures.

Difficulty in dealing with all potential variables has led to several different methods of calculating salt load reduction. Ideally, the calculation procedure used is expected to produce a result that is proportional and concurrent with salt loading documented in the EIS. Past procedures attempted to determine irrigation efficiency and deep percolation by assessing irrigation assets and operator skills or by utilizing empirical relationships developed from on-farm monitoring in the Grand Valley of Colorado. These empirical calculations worked reasonably well in Grand Valley, but less so for other salinity areas.

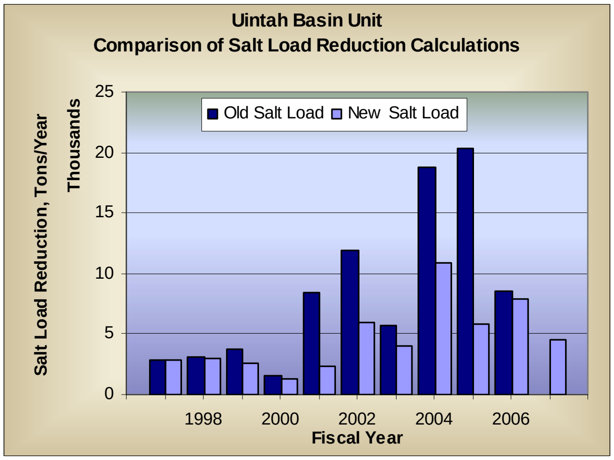
In 2007, NRCS offices in Utah and Colorado agreed to use a new procedure for calculating salt load reduction that assures concurrency and proportionality. Using documented tons/acre from NEPA documents, as agreed to by NRCS and Reclamation, the maximum salt load available is calculated. The percentage of original salt load that can be eliminated is based on the change in practices applied. For example, if 40 acres are upgraded from unimproved flood to a wheel line sprinkler system, 84% of pre-project salt loading will be allocated to salt load reduction. As illustrated in figure 1 (page 3), the Uintah Basin Unit was producing 1.04 tons/acre-year (208,120 tons/year ÷ 200,000 acres) prior to the establishment of salinity control programs. Hence, salt load reduction for a hypothetical 40 acre wheel line would be 1.04 tons/acre–year x 40 acres x 0.84 = 35 tons/year. Development of this procedure is outlined in Appendix 1.

Salt load reductions for all EQIP and BSPP contracts (1997-2007) have been recalculated and numbers reported have been adjusted. A comparison of salt load calculations from the past with calculations using the new procedure is depicted in figure 9. Cumulative salt load reduction is depicted in figure 10.

Off-farm

Deep percolation from ditches and canals is due to seepage (uniform percolation of water through

Figure 9, Comparison of salt load reduction calculations

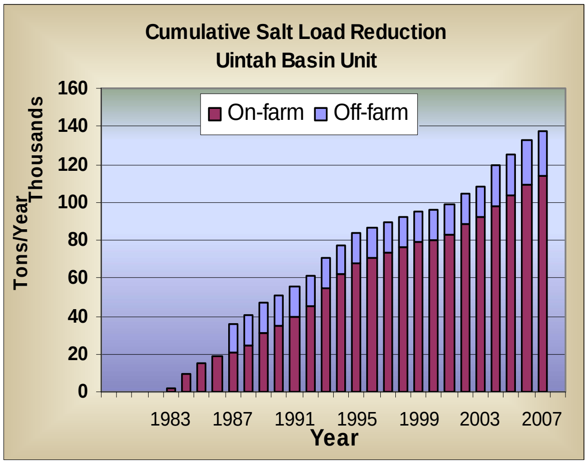


soil layers) and leakage (water losses through fissures, cracks, or other channels, known or unknown). Seepage and leakage can be estimated by measuring channel flow changes, doing pit studies, or various other technical methods. Seepage is often estimated using equations that account for average wetted perimeter, permeability and canal length. For small channels (<10 cfs), in the Uintah Basin Unit, seepage (deep percolation) has historically been estimated by multiplying channel length by a predetermined loss factor expressed in Tons/mile, derived from wetted perimeter – permeability evaluations (Hedlund, 1994).

Once water has seeped/leaked from the channel, it must still be determined how much is used by vegetation, and how much returns to the river system. Traditionally, 50% of deep percolation from canal seepage has been allocated to return flow. Actual return flow is difficult to determine and likely varies widely.

Over past years, USDA has claimed approximately 17,000 Tons of salt load reduction for large pipelines and group laterals. A review of lateral upgrades in January, 1987 resulted in the Soil Conservation Service claiming 15,900tons of salt load reduction for laterals funded by USDA to that date (USDA Holt, 1987). Based on verifiable additions since 1987, NRCS has funded off-farm projects bringing the total to 23,600 tons/year in salt load reduction, based on using existing ton/mile figures established in 1994 (Hedlund, 1994).

Figure 10, Cumulative salt load reduction using revised procedure.



Reclamation is presently reevaluating the allocation of off-farm salt loading, based on their consensus agreement with NRCS. When completed, NRCS' off-farm tons/mile/year may need additional adjustment.

Figure 11 summarizes the status of salt load reduction as of the end of FY2007.

Cost per Ton

For practices planned in FY2007 the average cost was $228/ton FA+TA and $136/ton FA+TA for practices applied in FY2007.

Cost/ton is calculated as follows:

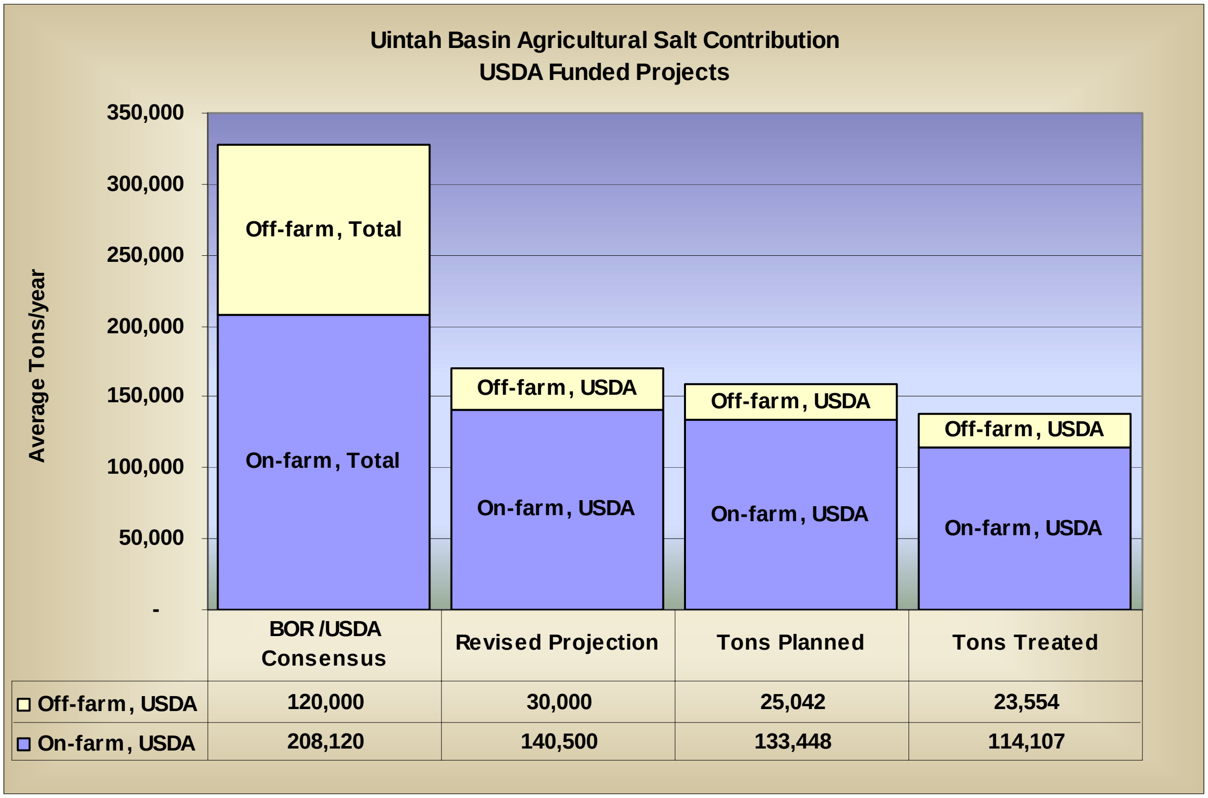
For planned practices, $3.89 million FA was obligated. An additional $2.59 million was committed for TA. The total of $6.48 million amortized at 4.875% over 25 years = $454,000/year.

Planned acres = 2,152. Based on an average salt load reduction of 89%, the total salt load reduction = 2,152 acres x 1.04 tons/acre-year x 0.89 = 1,992 tons/year.

The amortized cost/ton is $454,000/year ÷ 1,992 tons/year = $228/ton.

Figure 12 depicts the annual average cost/acre for planned practices. Note that the average cost of installation in the Uintah Basin has more than quadrupled in the last six years. The quality of projects is relatively constant and does not seem

Figure 11, Tons planned/treated compared to original agricultural salt load



to be a major factor in increasing costs. The cost/ton is proportional to cost/acre and would be expected to increase similarly in all salinity areas.

Why is the cost/acre increasing? Since 1998, the United States average price of crude oil has increased six fold, from about $13/barrel to about $80/barrel. (See figure 13.) The cost of plastic pipe and fuel are directly related to the cost of crude oil. In addition, higher energy prices have launched a new energy boom in the Uintah Basin, driving up labor and equipment costs.

The average cost/ton for applied practices was higher in the late 1980s than in 2007, both nominally and in 2007 dollars. Table 3 and figure 14 depict the annual cost/ton of applied practices, both nominal and in 2007 dollars. The last US oil boom ended in 1986, when President Reagan decontrolled the price of crude oil.

Figure 12, Cost per acre for planned practices

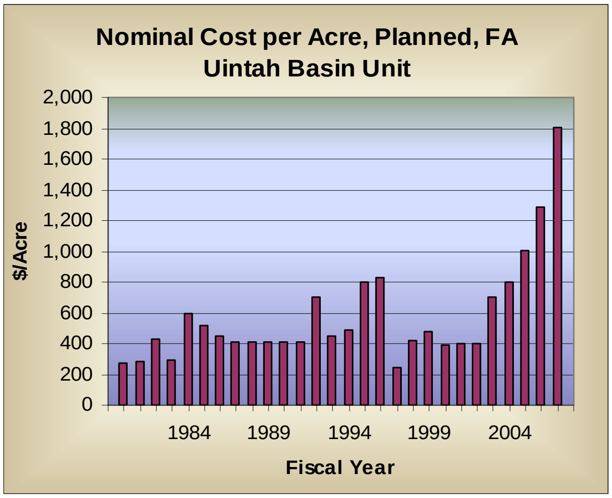


Figure 13, Historical nominal U.S. price of crude oil

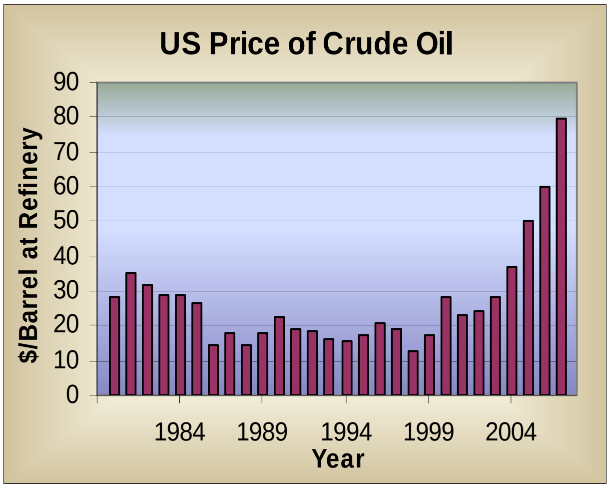
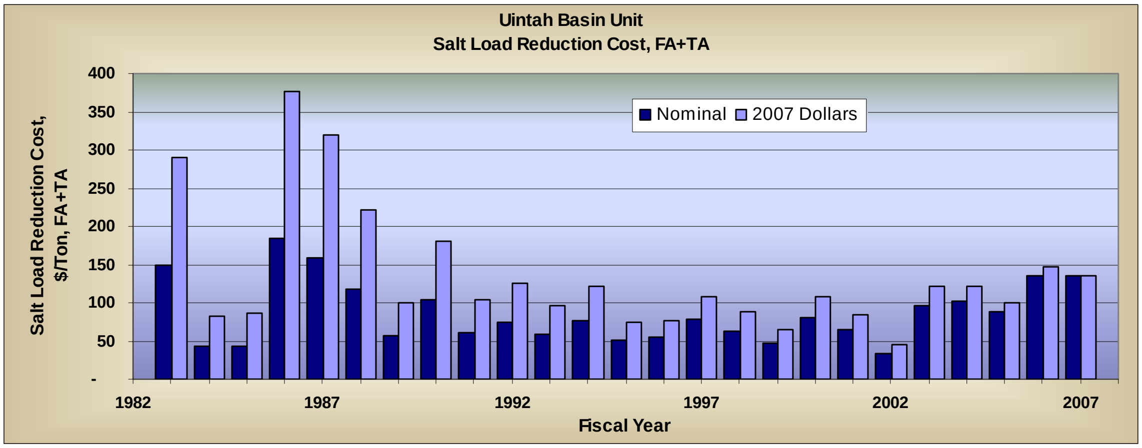


Figure 14, Historical cost/ton, FA+TA, for applied practices, nominal and 2007 dollars



Hydro Salinity

Before implementation of salinity control measures, Uintah Basin Unit agricultural operations contributed an estimated 328,000 tons of salt per year into the Colorado River(on-farm and off-farm). The original EIS cited 177,200 tons, from 204,000 acres of irrigated land. (EIS, April, 1982).

In 1991, the Uintah Basin Unit was expanded to include an additional 20,800 acres contributing 30,920 tons of salt (Expansion EIS, December, 1991). After expansion, an estimated 208,120 tons were contributed from 224,800 irrigated acres of which an average 20,800 acres are idle and assumed to contribute no salt.

Three assumptions guide the calculation of salt load reduction from irrigation improvements:

1. Salt concentration of subsurface return flow from irrigation is relatively constant, regardless of the amount of canal seepage or on-farm deep percolation.

2. The available supply of mineral salts in the soil is essentially infinite and salinity of out-flowing water is dependent only on solubility of salts in the soil. Therefore, salt loading is directly proportional to the volume of subsurface return flow.

3. Water that percolates below the root zone of the crop and is not consumed by plants or evaporation will eventually find its way into the river system. Salt loading into the river is reduced by reducing deep percolation. (Hedlund, 1994).

Deep percolation and salt load reductions are achieved by reducing or eliminating canal/ditch seepage/leakage and by improving the efficiency and uniformity of irrigation. It is estimated that upgrading an uncontrolled flood irrigation system to a well designed and operated sprinkler system will reduce deep percolation and salt load by 84-91%. (See appendix I.)

Table 3, Calculated Cost/ton, Nominal and 2007 Dollars, for Applied Practices

FY	Nominal FA Applied	Nominal FA Applied +67% TA	Federal Water Project Interest Rate	Amortized FA+TA	PPI	Amortized FA+TA 2007 Dollars	Salt Load Reduction, Tons/Year	Nominal $/Ton	$/Ton 2007 Dollars
1980	2,083,060	3,471,767	7.125%	301,276	138.0	644,601	NA		
1981	1,885,668	3,142,780	7.375%	278,856	148.0	556,318	NA		
1982	2,810,780	4,684,634	7.625%	424,880	153.0	819,934	NA		
1983	1,899,239	3,165,398	7.875%	293,371	152.0	569,873	1,959	150	291
1984	2,031,441	3,385,735	8.125%	320,565	155.0	610,645	7,422	43	82
1985	1,578,710	2,631,183	8.375%	254,429	151.0	497,501	5,802	44	86
1986	3,967,001	6,611,669	8.625%	652,768	144.0	1,338,446	3,547	184	377
1987	1,500,879	2,501,465	8.875%	252,090	147.0	506,341	17,487	14	29
1988	3,011,008	5,018,347	8.625%	495,460	157.0	931,780	4,219	117	221
1989	2,327,840	3,879,733	8.875%	390,988	167.0	691,276	6,888	57	100
1990	1,978,927	3,298,212	8.875%	332,384	171.0	573,916	3,177	105	181
1991	1,826,612	3,044,353	8.750%	303,679	174.0	515,311	4,993	61	103
1992	2,509,387	4,182,312	8.500%	408,661	174.0	693,455	5,513	74	126
1993	3,501,833	5,836,388	8.250%	558,468	181.0	911,013	9,410	59	97
1994	3,497,163	5,828,606	8.000%	546,017	183.4	879,045	7,182	76	122
1995	2,057,002	3,428,337	7.750%	314,332	201.7	460,137	6,099	52	75
1996	986,739	1,644,564	7.625%	149,156	210.9	208,819	2,719	55	77
1997	1,492,137	2,486,896	7.375%	220,660	216.4	301,070	2,807	79	107
1998	1,315,122	2,191,869	7.125%	190,208	210.9	266,292	3,015	63	88
1999	852,084	1,420,140	6.875%	120,494	210.9	168,691	2,588	47	65
2000	741,926	1,236,543	6.625%	102,549	220.1	137,586	1,268	81	108
2001	1,087,303	1,812,172	6.375%	146,851	225.6	192,219	2,277	64	84
2002	1,552,068	2,586,780	6.125%	204,765	227.4	265,864	6,017	34	44
2003	3,040,199	5,066,998	5.875%	391,679	234.7	492,659	4,076	96	121
2004	4,096,866	6,828,110	5.625%	515,258	243.9	623,733	10,922	47	57
2005	4,144,480	6,907,467	5.375%	508,683	262.2	572,713	5,766	88	99
2006	6,918,799	11,531,332	5.125%	828,457	271.4	901,227	7,918	105	114
2007	5,349,278	8,915,463	4.875%	624,672	295.3	624,672	4,590	136	136
Totals	70,043,551	116,739,252		10,131,654		15,955,138	137,661	74	116

NRCS salinity control programs focus on helping cooperators improve irrigation systems, better manage water use, and sharply reduce deep percolation/salt loading.

Over the life of the Colorado River Basin Salinity Control program in the Uintah Basin, cooperator preference has made a distinct shift from improved flood to sprinkler systems. In the Uintah Basin, center pivots are the system of choice and account for approximately two-thirds of systems installed on an acreage basis.

Salinity Monitoring Methods

The 1980 and 1991, "*…Framework Plan for Monitoring and Evaluating (M&E) the Colorado River Salinity Control Program*" focused on:

- Intensive instrumentation and analysis on several irrigated farms, requiring expensive equipment and frequent field visits to ensure and validate collected data
- Detailed water budgets to determine/verify deep percolation reductions
- Multi-level soil moisture measured weekly, with a neutron probe
- Detailed sprinkler evaluations, using catch cans, run annually on selected farms
- Crop yields physically measured and analyzed

As a result of labor intensive testing, it was confirmed that irrigation systems installed and operated as originally designed, produced the desired result of improved irrigation efficiencies and sharply reduced deep percolation rates, concurrent with reduced farm labor and improved yields.

Due to budget restraints, field intensive M&E efforts were curtailed in the late 1990s and a new "*Framework Plan for Monitoring and Evaluating (*M&E*) the Colorado River Salinity Control Program*" was adopted in 2001. Having established that properly installed and operated practices yield predictable and favorable results, the 2001 Framework Plan addresses hydro-salinity by:

- Utilizing random cooperator surveys to collect and evaluate cooperator understanding, and impressions concerning contracts and equipment
- Formal and informal Irrigation Water Management (IWM) training and encouragement
- Equipment spot checks and operational evaluations
- Agricultural statistics collected by government agencies

Cooperator questionnaires

From 2002 to 2005, 538 Cooperators were interviewed to determine perceptions and attitudes about salinity control practices installed on their property. In general, those surveyed are pleased with their involvement in salinity control programs. Most respondents claim to be operating within original design parameters and operating procedures. No additional questionnaires were collected by NRCS in FY2006 or FY2007. However, additional surveying was done by Utah State University Extension (USU) in FY2006 and by the Utah Association of Conservation Districts (UACD) in FY2007, which will be discussed below.

Appendix III is a summary of cooperator responses to past NRCS surveys.

USU Study, FY2006

In August, 2005, Utah State University was contracted to study the condition of wheel lines installed under the Colorado River Salinity Control Program (CRSCP) prior to 1995. USU has issued a final report for this study, "Evaluation of Wheelmove Irrigation Systems Nearing End of Practice Life". An executive summary from the final report is in Appendix IV.

Due to the lateness of the season when the contract was signed, very little data was gathered with water in the systems. Consequently, much of the information evaluated is based on imputed flow rates and leakage estimates calculated on the basis of 136 interviews with operators and physical inspection of 477 “dry” irrigation systems.

Statistics from physical inspections include:

- Average age of CRSCP systems was just over 15 years.
- Most of the lines had about 25 heads, 7 short of a ¼ mile line.
- Based on a mathematical index, the authors conclude that a “relatively large number of lines inspected were in disrepair while a fairly small number were well maintained”.
- Adjusted for imputed leaks, the authors projected a Christiansen Uniformity (CU) of 78.8 and a Distribution Uniformity (DU) of 76.2. These uniformity coefficients are mathematical indicators of irrigation uniformity and potential deep percolation. The NRCS minimum standard for deep-rooted crops (like alfalfa) is CU>=75 and DU>=60. It should be noted that no leaks were observed, since there was no water in the system, but potential leaks were estimated, based on observed equipment condition. Without the leak index, calculated CU is 86.6 and DU is 82.3. Uniformity is a reflection on system design, not actual field measurement.

Statistics from interviews include:

- Eighty-one percent of operator’s move their wheel lines twice/day, as designed. Virtually all of the wheel line systems in the Uintah Basin were designed to move twice/day. The implication is that any irrigation beyond 11½ hours will likely result in runoff or deep percolation.
- Of those who answered, 70% used the skip method or taxi method of moving wheel lines. Normal designs anticipated using the taxi method, where the line is moved every 11½ hours from one riser to the next, then taxied back to the beginning before starting another cycle. The skip method improves distribution somewhat, by starting each cycle at a different position relative to the riser, usually one roll backward or forward. The wiper method takes the line to the end of the field, in a normal cycle, then turns around and irrigates on the way back, thus increasing run-off, deep percolation, and inadequate water availability at the ends of the field. Those who use this method to save time or effort hurt themselves and the river. This is an IWM training issue reinforcing the need for more resources to be used for IWM training and cooperator follow-up.
- Grazing livestock was deemed to by a major cause of equipment damage.
- Forty-five percent of respondents do not adjust irrigation timing for weather or season. Since all irrigation systems are designed to fully irrigate the highest consumption potential crop at the hottest time of the year, timing adjustments are required for other crops, weather, or seasons. This is mitigated somewhat by soil water storage considerations. In the spring, the soil-water profile is typically not full, irrigation starts late, and the irrigator then spends the rest of the season in “catch-up” mode. In the fall, irrigation often ends before crop growth, leaving the soil profile reduced.
- About 80% of irrigated fields were used for hay production.
- Respondents felt that an average of 11 years of life remained in their systems.
- Asked what they would do when equipment was totally worn out, 69% would repair or replace with wheel lines and 12% would change to pivot or flood.
- The interviewer did not indicate that any cost share for replacement would be available. Nevertheless, 8% of respondents indicated they would not replace without financial assistance.

UACD Study, FY2007

In April, 2007, the Utah Association of Conservation Districts (UACD) was contracted to study the condition of CRSCP improved irrigation systems for which landowners had applied for EQIP contracts to replace or upgrade aging systems. UACD has issued a final report for this study, "Irrigation System Evaluation and Replacement Study". An executive summary from the final report is in Appendix V.

Field evaluations were started in the spring of 2007 and completed throughout the summer. Fifty-nine wheel line irrigation systems were evaluated during the irrigation season, with equipment operating. Due to lack of water, eight wheel lines were evaluated dry.

Thirty-three operators, spread over Duchesne and Uintah Counties, were interviewed. Six of the systems operated were gated pipe (improved flood) systems and twenty-seven were wheel lines. No center pivots were evaluated.

Statistics from interviews include:

- Landowners were asked, "If or when the present system wears out to the point it can no longer be repaired, how will you continue to irrigate?" Responses indicate that if financial assistance is available, 69% would like to upgrade to a more efficient system, 30% would install a similar system, and 1% would look at returning to flood irrigation.
- Damage to wheel lines was reportedly caused by; wind – 47%, livestock – 41%, and machinery or landowner damage – 2%.

Statistics from inspections include:

- The average wheel line had 3.6 axle pipe repairs. Typically, repairs are made by cutting out a damaged section, swaging one tube end slightly and mechanically pressing the other end into the swaged end with a hydraulic press. These repairs shorten the tube and have some effect on distribution uniformity and irrigation efficiency. The worst case example had 28 tube repairs on two wheel lines, which would likely reduce the overall length of each line by at least 40 feet and result in the addition of an extra wheel, tube, and sprinkler head, increasing total water application by 4-5%.
- The average wheel line had 1.9 damaged wheels.
- The average wheel line had 10.4 leaks, totaling 28 gallons per minute (GPM)/wheel line. When leaking drains, which can be easily repaired, are removed from the equation, the average leak was less than 1 GPM. It can be assumed that all leaked water becomes deep percolation. Assuming an average 20 acre field, deep percolation/salt loading could be increased by 35% from a 28 GPM leak that persisted throughout the irrigation season. Perhaps 5-10% of previously claimed salt load reduction would be lost.
- It can be argued that all leaks are the result of lack of maintenance and could best be addressed with a greater educational effort. Perhaps ranking applications for replacement could have a component related to the quality of past operation and maintenance.
- Underground damage was not a big problem and would likely not figure into like-for-like replacement contracts.
- Some diversion structures, screens, pumps, etc. were in need of improvements.
- Gated pipe systems lay on the ground surface and are susceptible to damage from the elements, livestock, and human activity. Six systems were evaluated. All needed repair. However, those cooperators with gated pipe systems were most interested in upgrading to higher efficiency sprinkler systems, yielding

Figure 15, Wind damage

some incremental salt savings over like-for-like replacement.

- In their report, the authors evaluated the cost/ton of like-for-like replacement and upgrade to a more efficient system, assuming that the present system has sustained a reduction in efficiency of 10%. Table 4 is a copy of Table 10 from the UACD report.

irrigation begins and after irrigation ends, leaving the soil moisture profile partially depleted. Filling the soil with water may require additional water in the spring and fall. (See figure 20). Some over-irrigation and deep percolation is necessary to leach salt buildup from the soil, and is built into system design.

Preventing unreasonable over-irrigation is a contractual obligation of the cooperator. To help cooperators fulfill this obligation they must be educated and coached in the proper use and maintenance of their irrigation systems.

Table 4, Cost for replacement from UACD Study

Current Practice	New Practice	Payment Schedule Cost	Salt Load Reduction	Amortized Cost, FA+TA
		$/Acre	Tons/Year[5]	$/Ton[5]
Worn-out gated pipe	Wheel line[1]	500	0.33	175
	Center pivot[2]	375	0.41	108
	Center pivot[3]	275	0.41	79
Worn-out wheel line	Wheel line[4]	250	0.12	234
	Center pivot[2]	375	0.20	215
	Center pivot[3]	275	0.20	158

[1] Entire new system with above and below ground components
[2] Small Pivot on 70-100 acres
[3] Large Pivot on greater than 100 acres
[4] Replacement of above ground components only
[5] From "Salinity Worksheet for Ranking"

Irrigation Water Management (IWM)

The goal of IWM is to assure that irrigated crops get the right amount of water at the right place at the right time, which will accomplish the goal of minimizing deep percolation and salt loading in the river. Proper IWM is achieved by careful equipment design, cooperator education, and maintenance resulting in implementation of effective water management techniques.

In general, sprinkler systems designed by NRCS are capable of irrigating the most water-consumptive projected crop in the hottest part of the year. When growing crops with lower water needs, or at other times in the growing season, these systems are capable of over-irrigating to some extent.

Over irrigating in early spring and late fall is somewhat mitigated by water storage aspects of the soil. Crops generally use water before

This is achieved by creating financial incentives for IWM, initial IWM training sessions, periodic water conferences, and developing IWM tools that simplify record keeping and help cooperators properly time irrigation cycles. Incentive IWM payments have resulted in a much greater interest in keeping records and understanding soil/water relationships.

To help cooperators with IWM, NRCS demonstrates simple, low-cost approaches:

1. Irrigation record keeping, wherein the cooperator keeps track of water put on the field and compares the volume used to the volume required by the crop (Checkbook method).

2. Training Seminars.

3. IWM Self Certification.

4. Soil moisture monitoring, wherein the cooperator determines when to irrigate, based on the available water content (AWC) of his soil (Water storage method).

Irrigation Record Keeping

To help with irrigation timing, NRCS has developed and provided the, "IWM Self Certification Spreadsheet" which allows cooperators to graphically compare actual irrigation with projected average crop water requirements and/or with modeled crop evapotranspiration (ET). ET is calculated from weather data collected by NRCS and other public agencies, using crop simulation techniques developed by Utah State University. The final output of the spreadsheet is a graph comparing water applied with water required on a seasonal basis. See figures 16 and 17.

Figure 16, is the entry form part of the IWM Self Certification Spreadsheet, on which the irrigator can enter irrigation rates and times. Data entered in the first four columns of the sheet is used to calculate the remaining columns and to create two graphs (see Figure 17). In the first graph, if the red, actual application line is below and to the right of the blue, consumptive use line, the crop is under irrigated. If the red, actual use line is above the blue, consumptive use line, the field is over-irrigated and excessive deep percolation may occur. (A small amount of deep percolation is designed into all irrigation systems to compensate for distribution anomalies and to leach accumulated salt from the root zone.) The second graph estimates water storage in the soil and shows deep percolation below the axis when it occurs.

Training Seminars

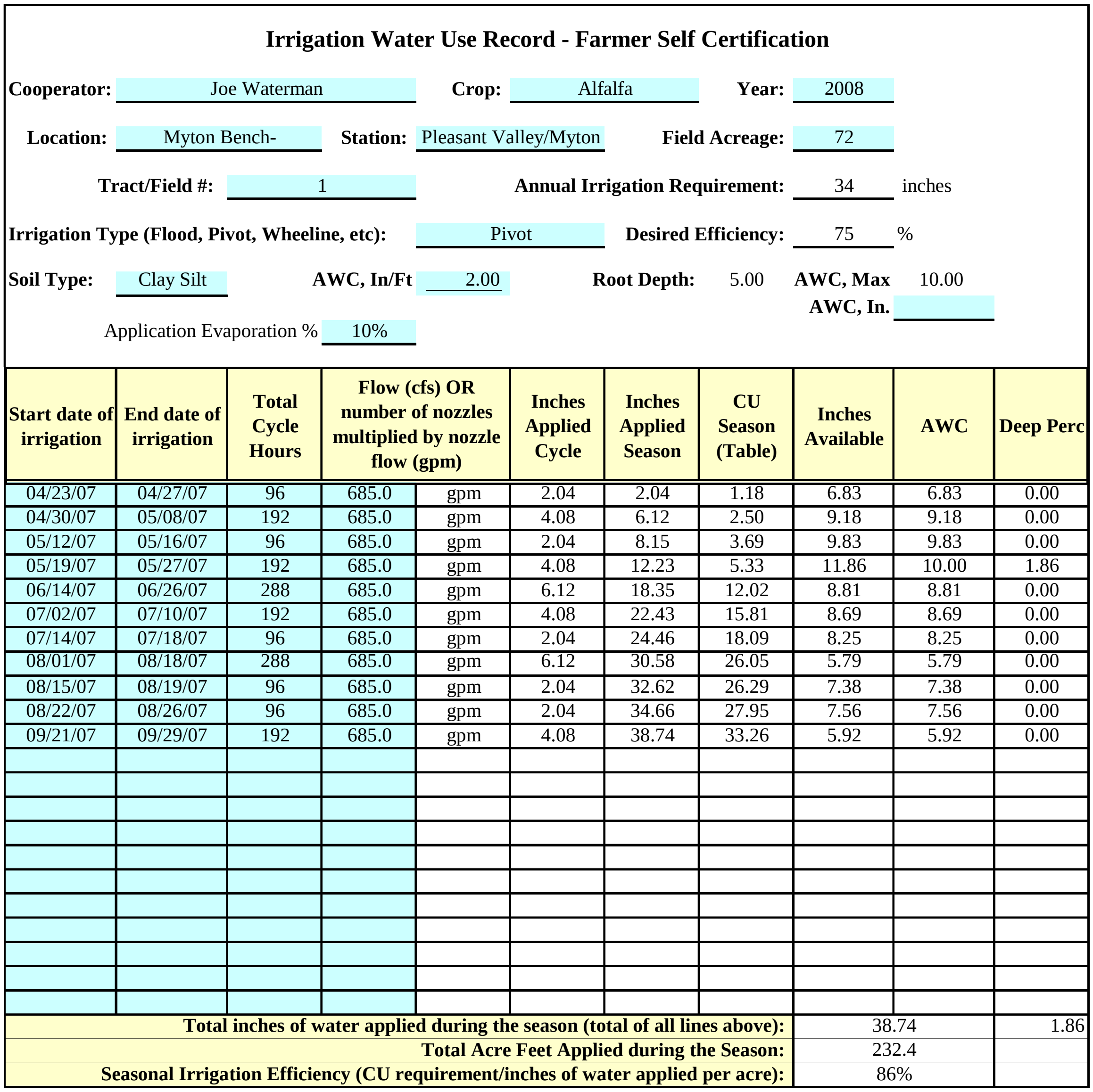
Water management seminars and conventions are sponsored by various government, educational, and commercial groups, encouraging everyone to manage and conserve water. NRCS is a willing and eager participant in these partnership educational endeavors.

Self-certification

In order to receive incentive payment for IWM, each irrigator is required to attend an IWM training seminar, normally for two hours, and to maintain and deliver irrigation records to the NRCS field office, where it is entered into the self-certification spreadsheet. The graphs are printed for the farmer's reference and suggestions are made to improve water management skills. In general, cooperators respond positively to this training and work hard to irrigate more efficiently.

To maximize positive results from IWM incentive payments, it is imperative that irrigators learn correct principles and demonstrate their use in actual operations.

Figure 16, Sample IWM Self Certification Spreadsheet – Data entry page



Irrigation Water Use Record - Farmer Self Certification

Cooperator: Joe Waterman **Crop:** Alfalfa **Year:** 2008

Location: Myton Bench- **Station:** Pleasant Valley/Myton **Field Acreage:** 72

Tract/Field #: 1 **Annual Irrigation Requirement:** 34 inches

Irrigation Type (Flood, Pivot, Wheeline, etc): Pivot **Desired Efficiency:** 75 %

Soil Type: Clay Silt **AWC, In/Ft** 2.00 **Root Depth:** 5.00 **AWC, Max** 10.00

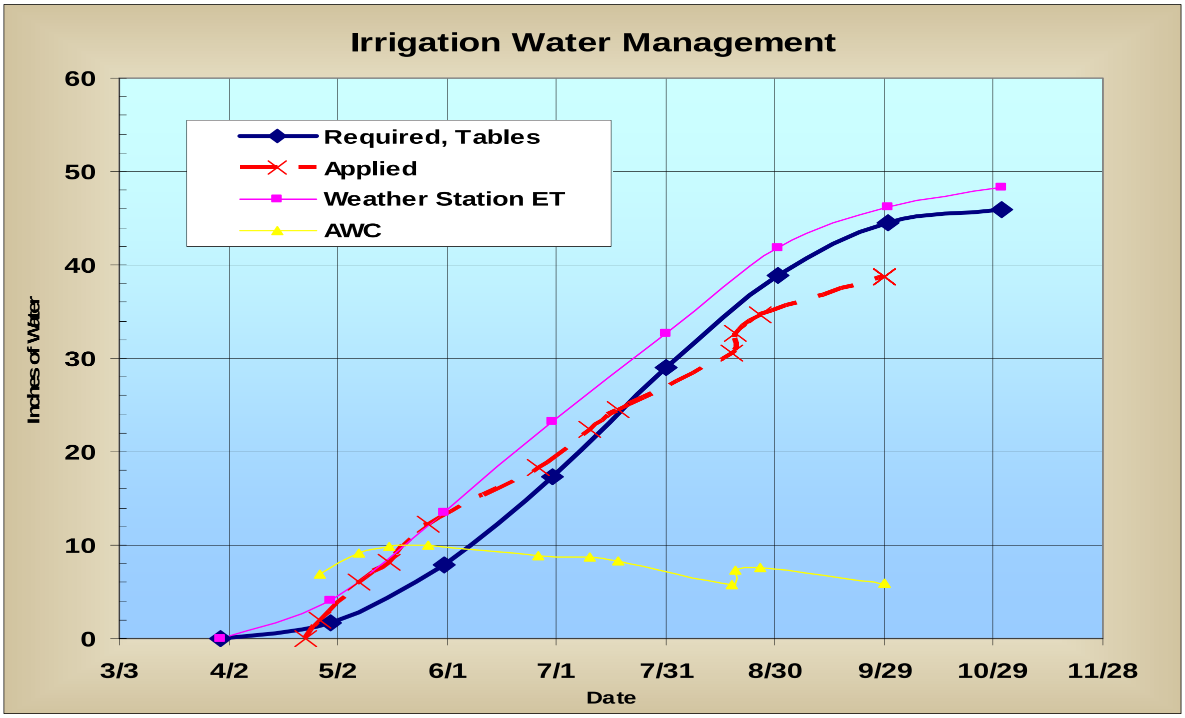
AWC, In.

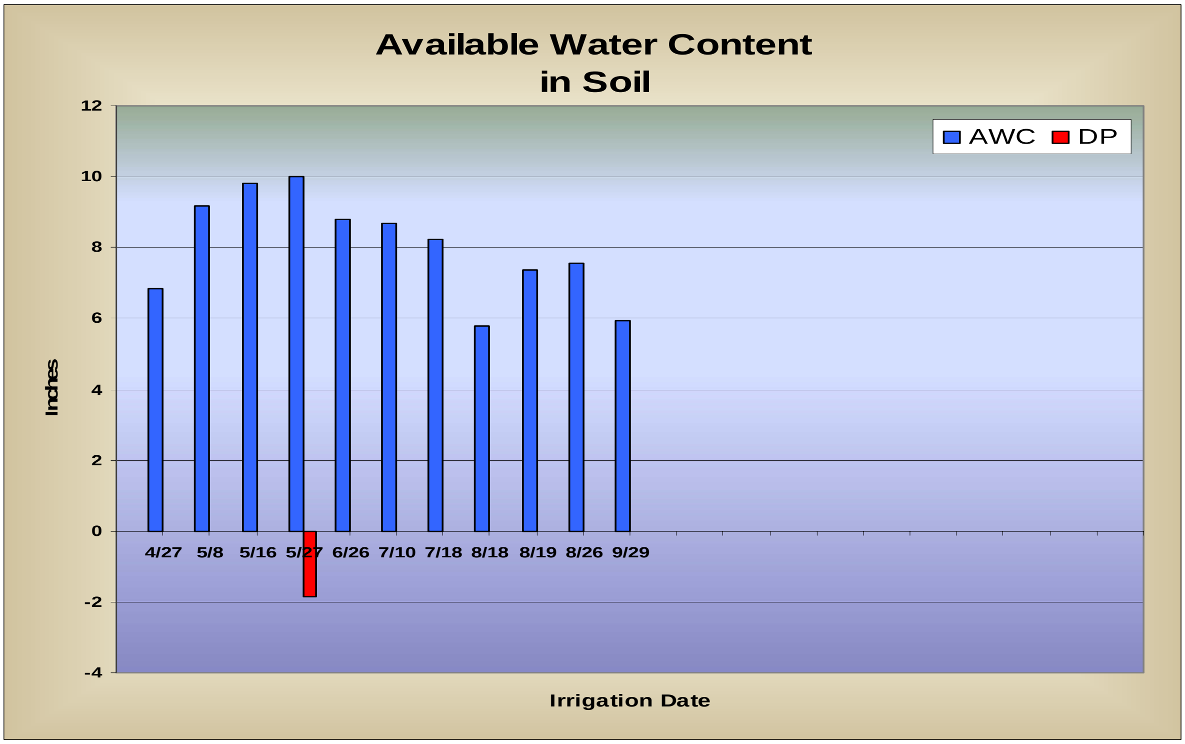
Application Evaporation % 10%

Start date of irrigation	End date of irrigation	Total Cycle Hours	Flow (cfs) OR number of nozzles multiplied by nozzle flow (gpm)		Inches Applied Cycle	Inches Applied Season	CU Season (Table)	Inches Available	AWC	Deep Perc
04/23/07	04/27/07	96	685.0	gpm	2.04	2.04	1.18	6.83	6.83	0.00
04/30/07	05/08/07	192	685.0	gpm	4.08	6.12	2.50	9.18	9.18	0.00
05/12/07	05/16/07	96	685.0	gpm	2.04	8.15	3.69	9.83	9.83	0.00
05/19/07	05/27/07	192	685.0	gpm	4.08	12.23	5.33	11.86	10.00	1.86
06/14/07	06/26/07	288	685.0	gpm	6.12	18.35	12.02	8.81	8.81	0.00
07/02/07	07/10/07	192	685.0	gpm	4.08	22.43	15.81	8.69	8.69	0.00
07/14/07	07/18/07	96	685.0	gpm	2.04	24.46	18.09	8.25	8.25	0.00
08/01/07	08/18/07	288	685.0	gpm	6.12	30.58	26.05	5.79	5.79	0.00
08/15/07	08/19/07	96	685.0	gpm	2.04	32.62	26.29	7.38	7.38	0.00
08/22/07	08/26/07	96	685.0	gpm	2.04	34.66	27.95	7.56	7.56	0.00
09/21/07	09/29/07	192	685.0	gpm	4.08	38.74	33.26	5.92	5.92	0.00
Total inches of water applied during the season (total of all lines above):								38.74		1.86
Total Acre Feet Applied during the Season:								232.4		
Seasonal Irrigation Efficiency (CU requirement/inches of water applied per acre):								86%		

Figure 17, Sample graphs from the IWM Self Certification Spreadsheet.

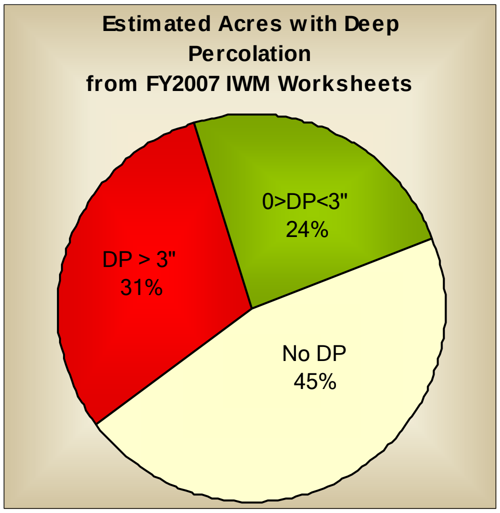
The blue line is the long-term average water requirement, based on location and crop. The red line is the actual water applied. Where data is available, the purple line is modeled from actual data collected at a nearby weather station, using a USU evapotranspiration model.





In FY2007, 157 IWM analyses were delivered to the M&E team, representing 5,100 acres. On an acreage basis 45% had no deep percolation, 24% were between 0 and 3 inches of deep percolation, and 31% exceeded 3 inches of deep percolation (after compensating for average soil moisture storage effects). See Figure 18.

Figure 18, Acres with deep percolation from IWM Certification Spreadsheets



IWM incentive payments have created the opportunity to meet with sprinkler owners, discuss IWM principles, and graphically illustrate how they can reduce deep percolation and increase production, by properly timing irrigation and keeping good records. NRCS personnel anticipate that nearly all new sprinkler owners will improve their IWM in future years, based on training and their expressed interest in this technique.

Soil Moisture Monitoring

A proven method for timing irrigation involves augering a hole and determining the water content of the soil to decide when to apply the next irrigation. This may well be the best method available for irrigation timing, both simple and inexpensive. However, it seems to be among the first practices abandoned when ordinary people are forced to allocate a limited amount of time.

NRCS is demonstrating and guiding cooperators in the use of another tool for timing irrigation - modern soil moisture monitoring systems utilizing electronic probes and data recorders. Such systems can now be installed for about $600, giving the cooperator information, at a glance, about the water content of his soil at multiple depths.

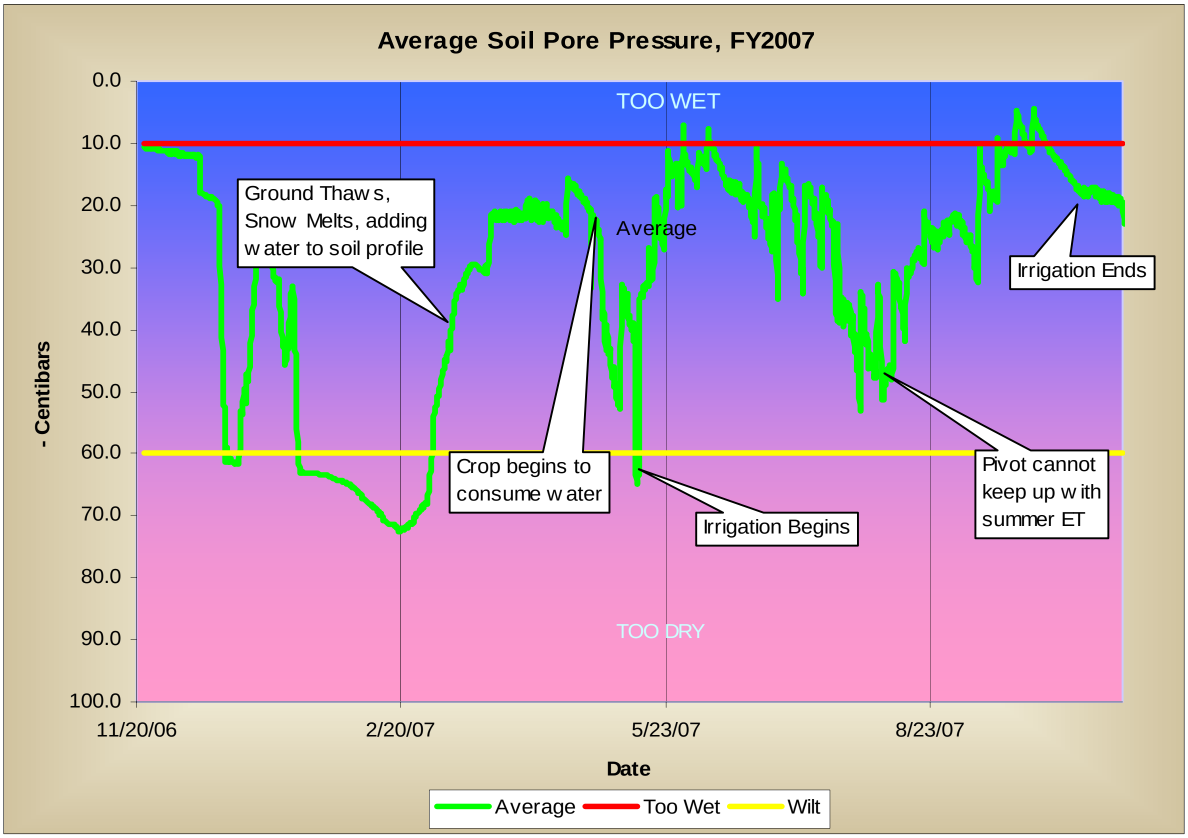
In a typical case, electronic probes are installed at three or more different depths, such as 12", 24" and 48". Using a simple data recorder, indicated soil pore pressure (implied soil moisture content) is read and recorded multiple times per day. With some recorders, soil pore pressure is presented graphically on an LCD display in the field, making it a simple matter to estimate when the next irrigation will be required. See figures 19 and 20.

Since soil does not generally drain water unless it is saturated, it is assumed that deep percolation is not occurring if the deepest probe reading is greater than -2 centibars. In the Uintah Basin, five installed data recorders indicate that deep percolation occurs less than 5% of the time on monitored fields.

Figure 19, Soil Moisture data recorder with graphing

Figure 20, Soil Moisture Data downloaded from recorder and graphed in Microsoft Excel.

This rich loam soil absorbs moisture readily and has good water storage characteristics. In winter, the soil freezes and sensor readings become irrelevant. As the soil thaws and the snow melts, soil moisture rises. Alfalfa starts to grow, pulling stored moisture from the soil. Irrigation begins, filling the soil profile with water. As summer heat increases, center pivot irrigation is unable to keep up with evapotranspiration (ET_C) of the crop. When weather starts to cool, the soil profile begins to fill until irrigation ends in autumn.



Equipment Spot Checks and Evaluations

Catch-can Testing

In FY2007, no catch-can tests were ran, due to limitations described in the FY2005 M&E report. As reported in the FY2005 M&E Report, the most useful aspects of catch-can testing on wheel lines were observations made before the test was ran. With sprinkler systems running, an assessment of leaks and malfunctioning heads can be made very quickly, often without leaving the vehicle.

Operating Sprinkler Condition Inventory

Based on the premise that 50-100 operating sprinkler systems can be observed by one person in a day, an inventory was devised to collect as much data as possible during 2006 and 2007 irrigation seasons. Thirteen hundred and eighty-four systems were logged in the two year period, of which nine hundred, fifty-nine were operating wheel lines.

Sprinklers were logged using a laptop computer running ArcGIS 8.3, connected to a simple field mapping GPS (Garmin GPSMap 76). Using the National Agricultural Imaging Program (NAIP) 1 meter true color image as a background, each observed system was sketched into a shapefile and attributes recorded. The following rules were used for data collection:

1. Age was estimated visually and rated: 1 = 0-3 yrs, 2 = 4-10 yrs, 3 = >10 yrs
2. Condition was rated visually: 1 = no repairs needed, 2 = repairs needed, 3 = not useable without major repair
3. Leaks from hoses, drains, heads, and other sources were estimated visually and the total gallons per minute (GPM) leakage estimated for the system
4. Sprinkler length was calculated from the shapefile
5. Acres were estimated by assuming a 660' long field (approximately 11 sets/irrigation cycle)
6. Net irrigation requirement was estimated to be 8 GPM/acre
7. The leak % represents the GPM from leaks ÷ GPM for the system
8. Only wheel lines in operation were considered. Idle systems were not a target of this study. However 27 idle wheel lines were noted.
9. Figures 21 through 24 depict the results of the inventory

Unlike limited observations from the past, from this larger sampling it appears that age is a major factor in system condition and overall leakage. However, even with the oldest systems, average

Figure 21, Wheel line condition rating

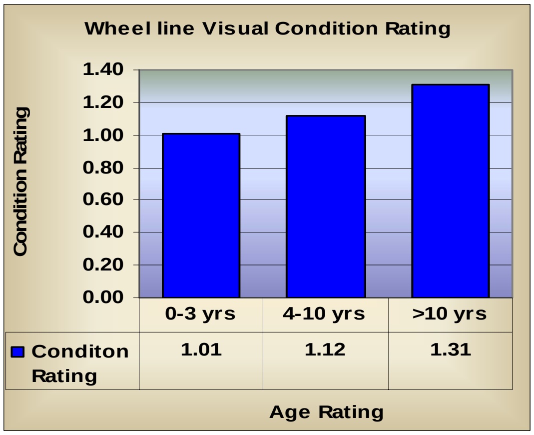


Figure 22, Wheel line leaks vs. age

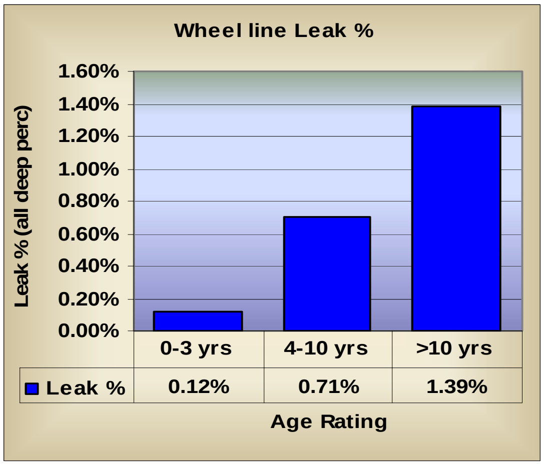


Figure 23, Rated age of sprinkler systems, based on field estimate.

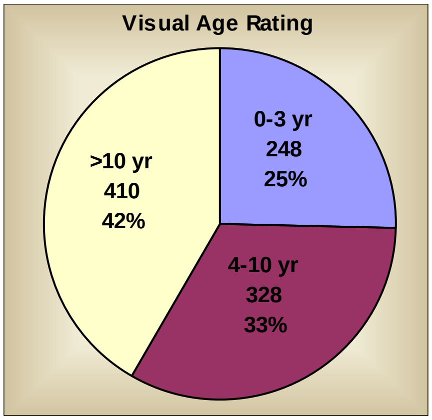
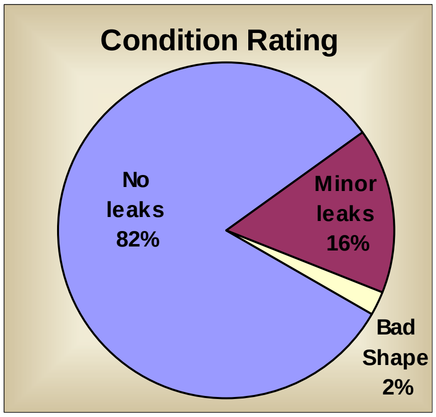


Figure 24, Rated condition of sprinkler systems, based on field estimate.



leakage amounts to only 1.39% of the applied water, much smaller than evaporation, and somewhat minor in the overall scheme of things. Most needed repairs could be avoided with consistent, high quality maintenance. There are more than a few 25 year old systems operating without leaks.

Still, the implication is that in time, these sprinkler systems will need to be replaced, either one part at a time through scheduled maintenance, or on a larger scale basis.

Figure 25, Drain leaks are the most common type of leak – and the most prolific

Figure 26, Hose leaks are rare but prolific and expensive to repair

Figure 27, End cap leaks are also frequently observed

It is apparent that many cooperators would like to upgrade to more advanced systems and/or newer technology when the projected life of their equipment is reached.

Long-term Sprinkler Water Budgets

Three farms are monitored with recording flow meters. Measured water use is compared to crop requirements, computed from data gathered at nearby weather stations, using a crop simulation program developed by USU in the 1980's.

Based on data collected, none of the directly monitored sites is exceeding designed levels of deep percolation, nor have they for many years.

Wildlife Habitat and Wetlands

Background

In accordance with "*The Framework Plan for Monitoring and Evaluating (M&E) the Colorado River Salinity Control Program" (USDA-NRCS 2002),* first issued in 1980 and later revised in 1991 and 2002, wildlife habitat monitoring in the Uintah Basin was performed from 1984 to 1999 at 90 selected sites throughout the area. These 90 sites were monitored on a three-year rotation by visiting 30 sites each year. A monitoring team collected data on site for habitat quality to be evaluated, utilizing Habitat Evaluation Procedures (HEP, 1980).

Along with 90 HEP sites, 18 vegetative transects were monitored using species frequency sampling methods and a Daubenmire cover class frame. These transects are located on various parts of the landscape, and were also evaluated on a three year rotation period by evaluating six transects per year. The purpose of the information gathered from these transects was to provide insight on changes occurring in habitat composition and also changes in wetland plant communities.

Due to a decrease of funding, wildlife habitat monitoring efforts were reduced in 1997 and discontinued in 1999. Two new employees, a biologist and a civil engineer, were hired in September 2002 as the new Monitoring and Evaluation (M&E) team.

In 2002 "The Framework Plan for Monitoring and Evaluating (M&E) the Colorado River Salinity Control Program" was revised and as mentioned in the previous section M&E evolved from a labor/cost intensive, detailed evaluation of a few biological sites, to a broader, less detailed evaluation of large areas and many resource concerns. This change is primarily driven by budget constraints and improved technology.

Methodology adopted in 2002 was to utilize remotely sensed images (Landsat), analyze them with commercial geospatial imagery software, classify, map, and measure vegetation extents, to quantify losses or gains of wetlands and wildlife habitat. It was also anticipated that with the use of Landsat images NRCS could extrapolate results from current images back in time to images acquired prior to implementation of the Colorado River Salinity Control Program. Thus NRCS could compare wetland/wildlife habitat extents from pre-Colorado River Salinity Control Program to current date.

In FY2005 it was determined by the M&E Team that use of Landsat images alone was not sufficient to accurately monitor and track small narrow wetlands within Salinity Units.

Classification of 30-meter Landsat images is an efficient tool for quantifying and assessing land cover classes on large scale projects where there are large tracts of similar vegetation. The M&E team has found it difficult to accurately interpret subtle differences in vegetation types at smaller scales such as presented by small, narrow wetlands found in arid Salinity Units. Landsat images help locate areas of potential wetlands and wildlife habitat areas; once located, detailed mapping of actual features is required to accurately identify and define real losses or gains of wetland/wildlife habitat. This can be accomplished with the help of current year, high resolution, aerial photograph interpretation and on-site visits.

A photographic history would also be useful in documenting changes in vegetation type. Remote sensing alone will not achieve desired results sought by NRCS to report concurrency and proportionality of wildlife habitat replacement.

In 2005 the M&E team decided to redirect its methodology to include more precise measurements of actual habitat extents by incorporating detailed mapping, establishment of permanent photo points, and smaller-scale case studies. As this is more labor intensive, the M&E team believes it necessary to acquire additional workforce to assist in gathering data needed to create the most accurate and reliable land cover maps and detailed case studies.

At the end of FY2007 no additional workforce had been acquired to assist the M&E team in data gathering. Photo points have been established and will be displayed when relevant information can be extrapolated from photos. Case studies are on-going and will be reported in future versions of this document.

Basin Wide Wildlife Habitat Monitoring

Detailed cover maps are not available for inclusion in this report. Permanent photo points, representative locations throughout the Uintah Basin of wetlands, wildlife habitat, agricultural areas, and areas where pipelines have recently been built have been selected and a protocol established to compare across the years. The initial years will be baseline data as there will be no comparison photos. Photographs will be taken near the same date annually, and compared approximately every five years in a visual display in the M&E Reports. Historical photos are still being sought for comparison.

Wildlife Habitat Contract Monitoring

Seven Environmental Quality Incentive Program (EQIP) Wildlife Only projects were planned and funded in the Uintah Basin in FY2007 for a total of 2,012 acres. There were no Basin States Parallel Program (BSPP) or Wildlife Habitat Incentives Program (WHIP) projects planned or funded in FY2007 (Table 5).

Funds from FY2005 Basin States Parallel Project (BSPP) Request for Proposals (RFP) for accelerated habitat replacement have not been awarded. A total of $250,000 in the BSPP RFP program is still available for wildlife habitat replacement projects.

One EQIP Wildlife Only prior year project was fully applied in FY2007 for a total of 37 acres. Thirty-four acres are allocated to wetland/riparian habitat types and 3 acres are primarily upland in nature. One BSPP prior year project was fully applied in FY2007 for a total of 270 acres, 50 acres are allocated to wetland/riparian habitat types and 220 acres are primarily upland in nature. A total of 307 acres were applied in FY2007 (Table 6).

Voluntary Habitat Replacement

NRCS continues to encourage replacement of wildlife habitat on a voluntary basis. Federal and State funding programs are in place to promote wildlife habitat replacement. This information is advertised annually in local newspapers, in local workgroup meetings, and Soil Conservation District meetings throughout the Salinity Areas. The Utah NRCS Homepage also has information and deadlines relating to Farm Bill programs.

1980 Water Related Land Use (WRLU)

In 1980, the Center for Remote Sensing and Cartography of the University of Utah Research Institute completed a Land Use Inventory for the Uintah Basin of Utah. This study was done in cooperation with Utah Division of Water Resources (Water Resources), USDA Soil Conservation Service, and National Aeronautics and Space Administration. This study is the second in a series of land use inventories that has evolved into Water Resources' Water Related Land Use (WRLU), a GIS layer updated every five

Table 5, Wildlife habitat acres planned

Acres of Wildlife Habitat Creation or Enhancement Planned and Funded by Program and County Uintah Basin, FY2007							
	EQIP		WHIP		BSPP		Total (acres)
Management Type	Wetland (*644)	Upland (*645)	Wetland (*644)	Upland (*645)	Wetland (*644)	Upland (*645)	
Duchesne County	1,751	169	0	0	0	0	1,920
Uintah County	43	49	0	0	0	0	92
2007 Basin Totals	**1,794**	**218**	**0**	**0**	**0**	**0**	**2,012**

* Practice 644 is Wetland Wildlife Habitat Management; practice 645 is Upland Wildlife Habitat Management.

Table 6, Wildlife habitat acres applied

Acres of Wildlife Habitat Creation or Enhancement Applied by Program and County Uintah Basin, FY2007							
	EQIP		WHIP		BSPP		Total (acres)
Management Type	Wetland (*644)	Upland (*645)	Wetland (*644)	Upland (*645)	Wetland (*644)	Upland (*645)	
Duchesne County	34	3	0	0	0	0	37
Uintah County	0	0	0	0	50	220	270
2007 Basin Totals	**34**	**3**	**0**	**0**	**50**	**220**	**307**

* Practice 644 is Wetland Wildlife Habitat Management; practice 645 is Upland Wildlife Habitat Management

years and made available to the public. While the 1980 WRLU focused specifically on wetlands, later versions emphasize crops and have little wetland data.

The 1980 WRLU was developed by categorizing land use on the basis of a Color Infrared (CIR) image shot from a U2 reconnaissance aircraft and overlaid onto a contemporary 60 meter Landsat image. The stated objective of the study was to "…classify and map the wetlands and "water-related" land use of the Uinta Basin". Thirty-eight USGS 7½ minute quadrangles were mapped. The final product included data tables and a Mylar overlay for each quadrangle, depicting polygons of each category, to be overlaid on USGS 7½ minute Quadrangle maps. The Mylar overlays were to be kept on file at Water Resources. When attempting to access overlays, none could be found at Water Resources. NRCS' M&E team has located copies of all but one of the overlays (Myton Quadrangle). Thirty-seven overlays have been digitized for use in evaluating changes in habitat associated with salinity control projects.

Land cover mapping is a subjective science. It is unlikely that multiple detailed land cover maps of the same area and time would yield reproducible results. Past attempts by M&E at creating new land cover maps using Landsat images and remote sensing techniques proved futile, largely because typical wetlands were relatively small compared to the 30 meter resolution of newer Landsat images, but also because the landscape is continually changing and one good rain storm can immeasurably alter the landscape and its associated image. That is to say that a large rainfall would greatly increase detected wetlands on the next image, if the same digital signatures were used for categorization.

It is believed, but not proven, that the 1980 WRLU was used by Soil Conservation Service in preparing the 1982 EIS for the Uintah Basin Unit of the Colorado River Basin Salinity Control Program. With the ability to electronically overlay the 1980 WRLU on modern aerial images, it is possible to detect changes from 1980 to later images. A detected difference in land use must indicate either a change in use or an error in the original classification.

For the Uintah Basin, ortho-imagery is available in gray scales from the early to mid 1990s. Color and CIR imagery is available for later dates, the best being the one meter National Agricultural Image Program (NAIP) from 2006, available in true color and CIR. Pre 1980 images are available, but require orthorectification and assembly into a mosaic, at some appreciable expense, to be straightforwardly useable. Having a pre 1980 image would allow direct comparison with contemporary images to detect changes in raster imagery, in support of the polygon overlay. Although it would be extremely interesting, such expense is probably not justifiable for this effort.

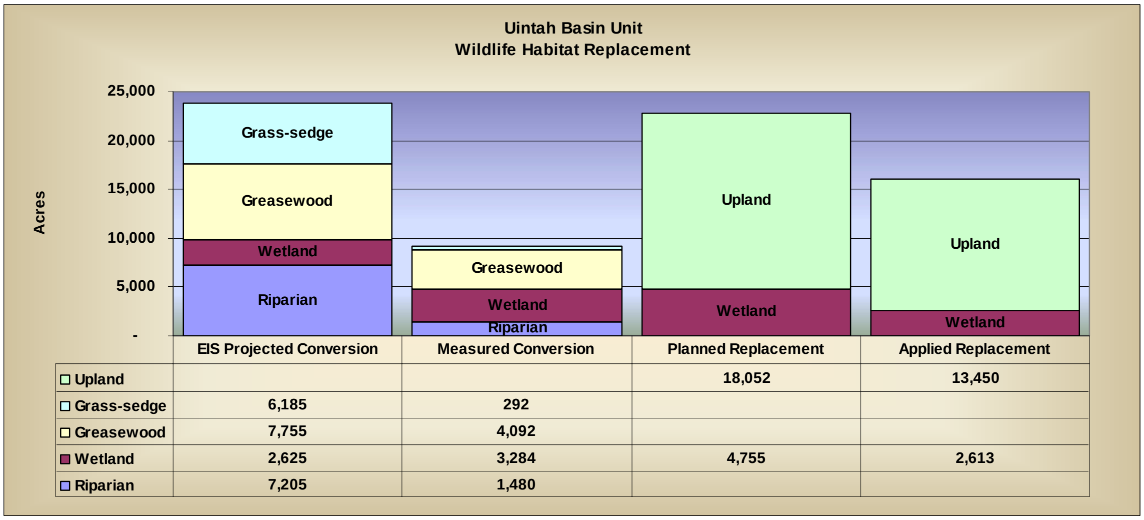
By overlaying the 1980 WRLU on the 2006 NAIP, it is reasonably simple to determine if a polygon classified as wetland in 1980 is no longer wetland in 2006. However, without an older image, it is impossible to verify that it was indeed wetland in

1980. M&E has made the comparison on four quadrangles; Bridgeland, Hancock Cove, Vernal NE, and Altonah.

The 1982 EIS for the Uintah Basin Unit combined eleven wetland types into 4 categories, greasewood, riparian, wetland, and grass-sedge. The EIS indicated that in the worst case, 37% of acres in these 4 categories might be converted to upland habitat as the result of irrigation system improvements. The four quadrangles studied by M&E contain 17% of 1980 WRLU wetland acres in the same 4 categories.

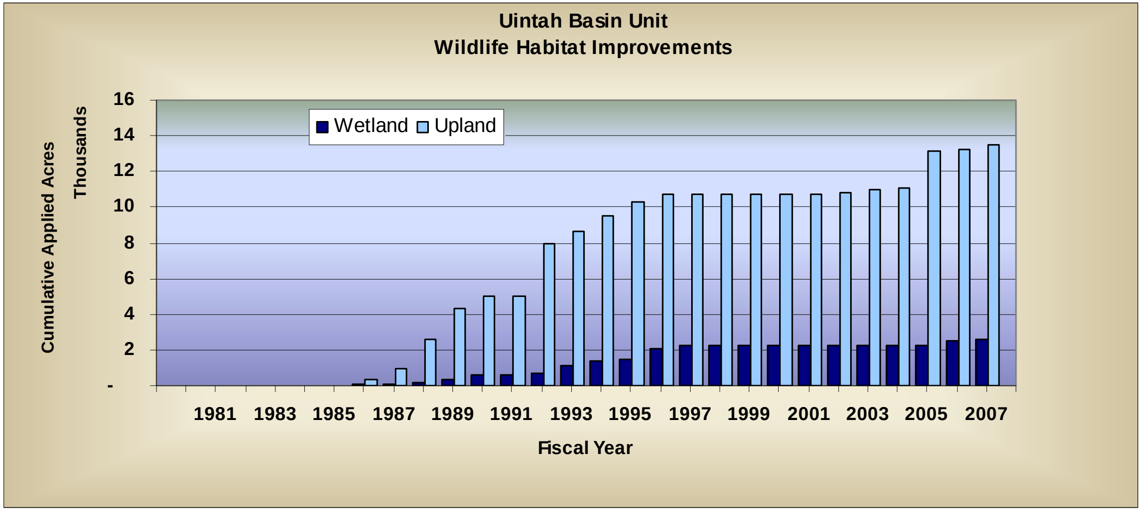
Through FY2007, 142,000 acres have been treated with improved irrigation systems, 116% of the 122,200 acres originally projected for treatment. Based on the four quadrangles analyzed, an estimated 9,100 acres have been converted from wetland to upland habitat, compared to 22,200 acres projected by the original EIS. In the same time frame, 4,400 acres of wetland replacement/improvement has been planned along with 18,600 acres of upland habitat improvement. The first two bars of figure 28 compare EIS projected wetland conversion to upland with measured conversion. The second two bars depict funded mitigation, planned and applied. The wetland category includes both riparian and wetland practices. Figure 29 summarizes cumulative progress with respect to wildlife habitat management and improvement.

Figure 28, Wildlife habitat management cumulative status



	EIS Projected Conversion	Measured Conversion	Planned Replacement	Applied Replacement
□ Upland			18,052	13,450
□ Grass-sedge	6,185	292		
□ Greasewood	7,755	4,092		
■ Wetland	2,625	3,284	4,755	2,613
■ Riparian	7,205	1,480		

Figure 29, Wildlife habitat management, cumulative progress, applied acres

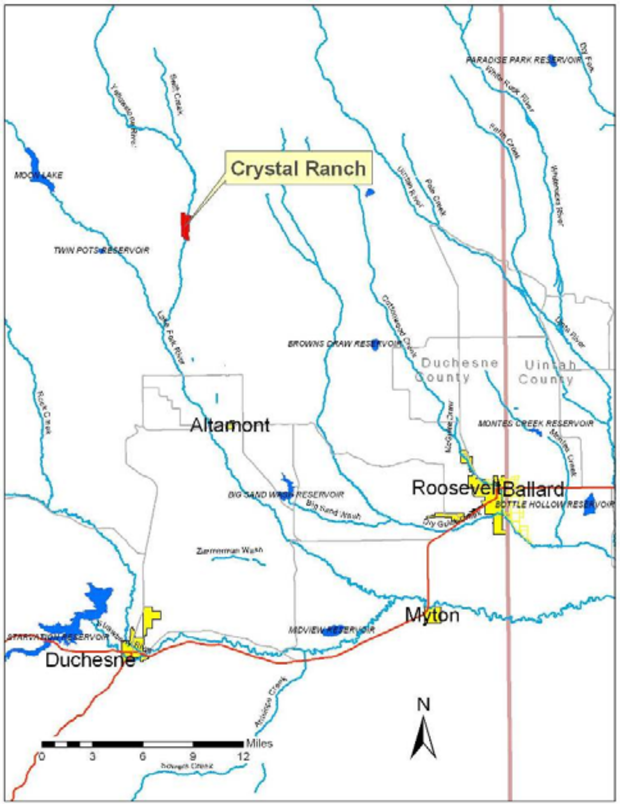


Case Study: Crystal Ranch LC

Background

Wildlife habitat replacement in the Uintah Basin Salinity Unit increased in Fiscal Year 2007, with the addition of a few large riparian restoration projects. Crystal Ranch LC, addressed in this case study, was referred to NRCS by Utah Division of Wildlife Resources (DWR) biologists Randall Thacker and Brian Maxfield. Crystal Ranch LC is located along the Yellowstone River as a private land in-holding in the Ashley National Forest, in Duchesne County, UT (Figure 30). The Yellowstone River is one of the seven major waterways that drain the south slope of the Uinta Mountains. The ranch has been owned by the Crystal family since early settlement days in the Uintah Basin. Traditional land use was sheep grazing and later cattle. In 2005 Crystal Ranch was purchased by David Ludlow, Salt Lake City businessman and avid fly fisherman. Mr. Ludlow purchased the land for its prime location as it flanks both sides of the Yellowstone River for approximately 1.5 miles. In total, Crystal Ranch comprises approximately 492 acres; 240 ac. in riparian corridor habitat, and 252 ac. in upland vegetation. Upon purchase Mr. Ludlow and his partner created the Limited Corporation, Crystal Ranch LC, conserving the name of the Crystal family and the history of the land.

Figure 30, Crystal Ranch Location map



Objectives

Crystal Ranch LC has a comprehensive Conservation Plan with multiple objectives. Aspects of this project that facilitated funding were: location in the landscape, nature of the habitat (riparian/wetland), noxious weeds, sensitive species (Colorado River Cutthroat (CRC), Lewis's woodpecker, sage grouse, river otter, etc.), range and pasture management, and nutrient loading in the Yellowstone River. Objectives revolve around these circumstances.

Protected spawning areas for CRC are few and far between in this section of the Yellowstone River. One of the primary objectives was to create slower water gravel beds for CRC reproduction. This was accomplished by creating 700 feet of meandering stream through an adjacent meadow, inside a riparian fence.

The riparian area has been overgrazed in the past and many understory plant species have been extirpated or severely hedged. A riparian fence was built to help preserve riparian habitat. Behind the fence there are 1,100 native trees and shrubs scheduled for planting in spring 2008 to accelerate vegetation regeneration, and native grasses and forbs have been seeded in places of disturbance behind implemented practices.

Confining cattle grazing to the western "upland" portion of the ranch will help address water quality issues, and habitat regeneration. The pasture on the western side was also divided into paddocks allowing a rotational grazing system to be implemented to improve forage quality and quantity for livestock and wildlife. Noxious weeds are also addressed throughout the entire ranch with a three year treatment/re-treatment schedule.

Conservation Plan

Reviewing the application for funding, it became apparent that there were two separate objectives to meet; wildlife habitat restoration and agriculture. This presented the need to prepare two separate contracts; wildlife habitat restoration, and pasture and rangeland improvement.

On the ground meetings were performed in the fall of 2006 with DWR, U.S. Forest Service (USFS) and NRCS to assess the resource concerns, and landowner concerns/objectives. Mr. Ludlow had clear and defined objectives for the future of his property.

From these meetings consensus was achieved and the following practices were included in the Conservation Plan (see also Figure 31):

- 23,150 feet of wildlife friendly fence
- two shallow water ponds
- 1,100 trees and shrubs
- 400 wetland plant “plugs”
- 700 feet of created stream
- 308 acres of weed spraying (Pest Management) over three years
- 301 acres of wildlife habitat management incentive payments
- Two watering facilities
- 2700 feet pipeline
- 192 acres prescribed grazing

Separate from the NRCS Conservation Plan, the USFS has conducted prescribed burns in the sagebrush areas to enhance understory growth and sage grouse brooding habitat.

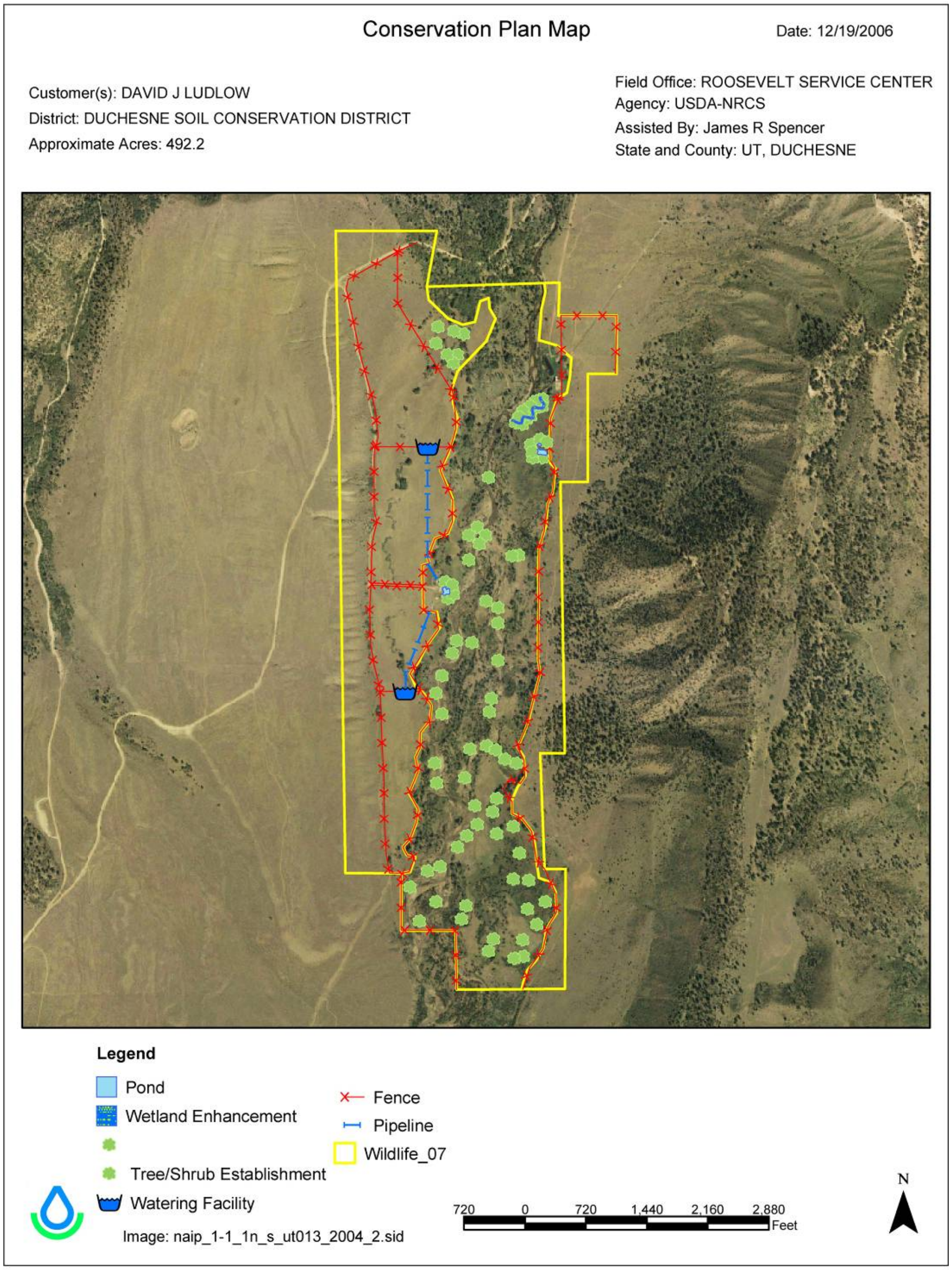
Discussion

Although most of the practices in Crystal Ranch’s Conservation Plan were scheduled for 2008-2011, the majority are already completed. The contract is running on or ahead of schedule. It is anticipated that the structural practices will be complete by the end of FY2008, leaving only the management practices to be completed in their scheduled years. The Crystal Ranch LC Conservation Plan addresses all six resource concerns in the NRCS’ Conservation Planning Model: Soil, Water, Air, Plants, Animals, and Human aspects, and the needs for each acre have been considered in the planning process. It is anticipated that this project will be a success and a great asset to the entire watershed.

As a side note, Crystal Ranch LC is now in negotiations with The Nature Conservancy, DWR, and Rocky Mountain Elk Foundation to develop a Conservation Easement to perpetually protect the ranch from future development

Below are the Conservation Plan Map (Figure 31) and a gallery of photos taken during the twelve month implementation process that occurred from December 2006 through December 2007.

Figure 31, Crystal Ranch Conservation Plan Map.



Conservation Plan Map

Date: 12/19/2006

Customer(s): DAVID J LUDLOW
District: DUCHESNE SOIL CONSERVATION DISTRICT
Approximate Acres: 492.2

Field Office: ROOSEVELT SERVICE CENTER
Agency: USDA-NRCS
Assisted By: James R Spencer
State and County: UT, DUCHESNE

Image: naip_1-1_1n_s_ut013_2004_2.sid

Crystal Ranch Photo Gallery

Figure 32, December 7, 2006, pre-contract field visit looking NE from road W of Crystal Ranch.

Figure 33, December 7, 2006 looking ESE from road W of Crystal Ranch.

Figure 34, May 7, 2007 looking NE from road W of Crystal Ranch.

Figure 35, May 7, 2006 looking SE from road W of Crystal Ranch (portion of fence visible south of cabin).

Figure 36, May 7, 2007, site of inlet to new stream course.

Figure 37, May 7, 2007, proposed stream course across wetland.

Figure 38, June 11, 2007, newly constructed inlet to "Arrowhead Creek" looking north.

Figure 39, June 11, 2007, newly constructed "Arrowhead Creek" looking SSW.

Figure 40, June 11, 2007, “riffle, pool, run” strategy.

Figure 41, June 11, 2007, “riffle, pool, run” strategy.

Figure 42, May 7, 2007, newly constructed "Crystal Pond".

Figure 43, June 11, "Crystal Pond".

Figure 44, June 11, 2007, newly constructed “Mosby Pond” wetland enhancement.

Figure 45, June 11, 2007, newly constructed “Mosby Pond” wetland enhancement.

Figure 46, September 7, 2007, USFS prescribed burn, east of Crystal Ranch.

Figure 47, September 7, 2007, USFS future burn site on north end of Crystal Ranch completed fall 2007.

Figure 48, September 7, 2007, rested pasture behind riparian fence (Stan Baker NWTF Regional Biologist pictured).

Figure 49, September 7, 2007, aspen regeneration behind riparian fence.

Figure 50, September 7, 2007, proposed riparian fence corridor.

Figure 51, September 7, 2007, completed portion of riparian fence looking N.

Figure 52, September 7, 2007, riparian fence corridor looking S.

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Figure 53, September 7, 2007, riparian fence corridor looking S.

Figure 54, July, 2006 pre-project.

Figure 55, August 24, 2007, view of new pasture fence to improve grazing efficiency.

Figure 56, June, 2007, watering facility to straddle pasture fence to provide livestock water to both pastures.

Figure 57, June, 2007, watering facility for holding corral.

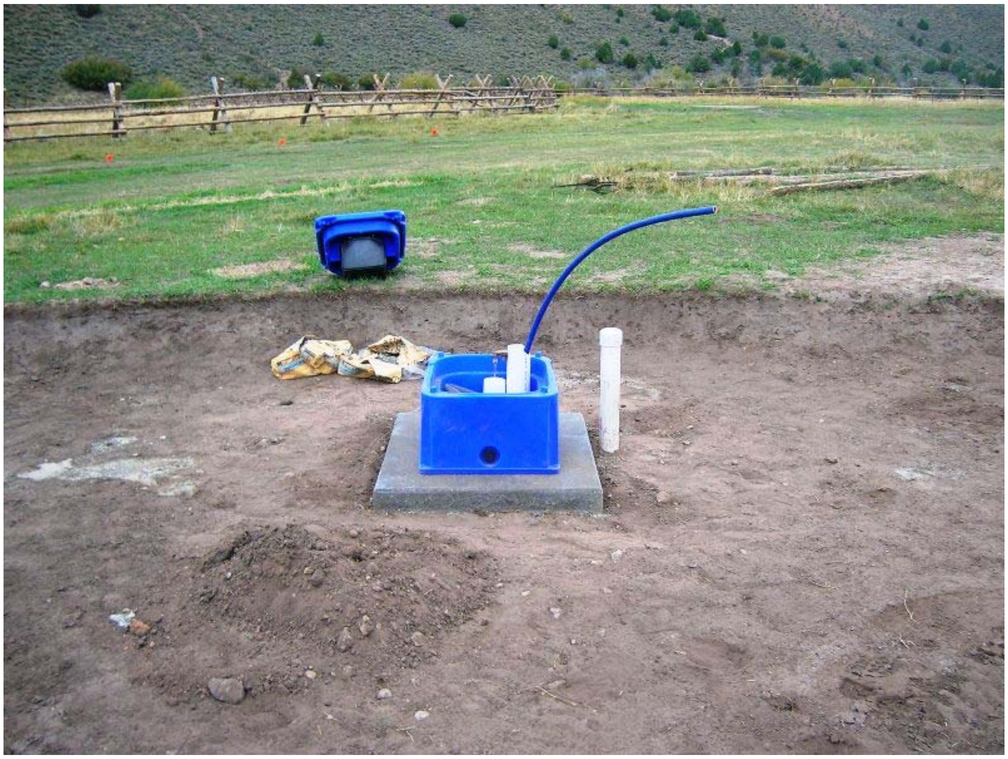


Figure 58, Mule deer in pasture.

Figure 59, Brook trout from spring ponds.

Figure 60, Wild turkey in riparian area.

Figure 61, Rainbow trout in “Crystal Pond”.

Figure 62, Cutthroat trout from mainstem of Yellowstone River.

Figure 63, Beaver activity in riparian area.

Figure 64, Large 17” cutthroat trout in Yellowstone River.

Figure 65, Another cutthroat trout from Yellowstone River.

Figure 66, Brown trout on the Yellowstone River.

Figure 67, Bull moose crossing Yellowstone River.

Figure 68, Fall color on the Yellowstone River.

Economics

Cooperator Economics

Production Information

Field studies completed in 1995 concluded that upgrading from unimproved flood irrigation to either improved flood or sprinklers improved alfalfa crop yields from about 2.5 tons/acre to about 4.5 tons/acre. This magnitude of increase is consistent with anecdotal information from diligent cooperators.

Alfalfa production data downloaded from the National Agricultural Statistics Service (NASS) indicates that yields from the entire Uintah Basin Unit have increased from about 3.5 tons/acre to about 4.0 tons/acre since 1980, based on a linear regression of the data set. With 142,000 acres treated out of 200,000 acres originally producing, the projected yield increase would be expected to be nearer one ton/acre than two.

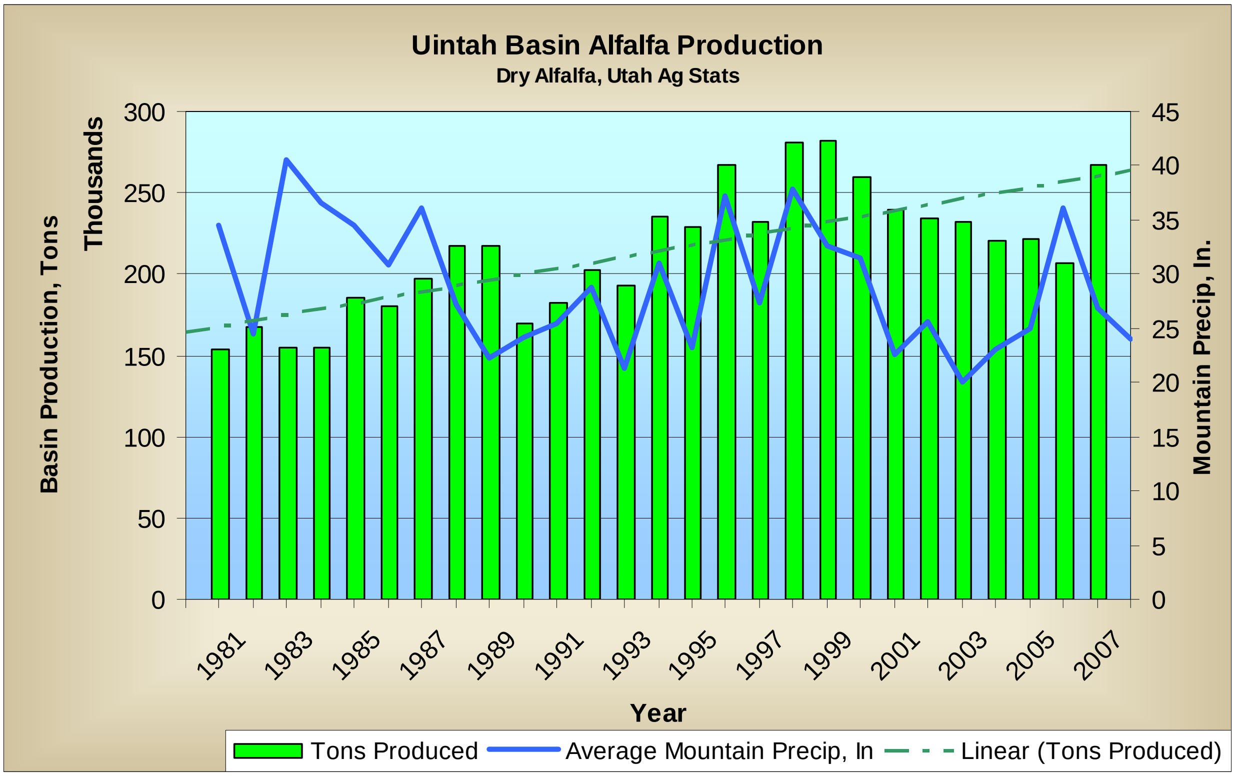
However, more interesting than yields, are total production data. Total tons of alfalfa produced in the Uintah Basin has increased over 58% since 1980, while alfalfa acreage has increased about 41%. From 1980 to 2006, production increased from 161,000 tons to 253,000 tons, while alfalfa acreage increased from 47,000 acres to 66,000 acres (the Water Related Land Use layer indicates an acreage change from 41,000 to 93,000 acres for all hay land), implying a yield on the order of 4.9 tons/acre for acreage upgraded to alfalfa production from another crop, most often grass pasture (based on linear regression of the data).

Figure 69 is a graph of Uintah Basin alfalfa production and mountain precipitation. Source data is tabulated in Appendix VI.

Labor Information

From NASS data, labor benefits are elusive as both *Hired Farm Labor* and *Total Farm Production Expenses,* have increased steadily over the 1987, 1992, 1997, and 2002 Agricultural Censuses.

Figure 69, Uintah Basin alfalfa production



(Data from the 2007 Agricultural Census will be available in the fall of 2008.)

While numerical data seems inconclusive, anecdotal information is positive.

Since the majority of farmers (69%) reported in the 2002 Agricultural Census, do not hire outside labor, it is assumed that most cooperators are satisfied with their own personal labor savings. The 2002 Agricultural Census also reports that 68% of Uintah Basin farmers work at off-farm jobs more than 200 days/year. The local labor market is hot, due to booming energy prices and a rapidly expanding petroleum business. It seems logical that landowners will be spending even more time in off-farm employment.

Another perceived labor benefit concerns an aging farmer population. Definitive data is not available, but it appears that most Uintah Basin farmers are beyond middle age, and are simply not willing or able to take water turns at night. A distinct preference for Center Pivot Systems has developed -- further evidence of a desire to reduce personal labor commitments.

Public Economics

Ninety-nine percent of survey respondents believe that salinity control programs have a positive economic affect on the area and region.

Companies in the sprinkler supply business are now a significant part of the local economy and other sprinkler related businesses appear to be thriving. The availability of a strong local sprinkler business also simplifies purchase, installation, and maintenance of sprinkler systems for the cooperator, and improves local competition and pricing.

Positive public perceptions of the Salinity Control Program include:

- Reduced salinity in the Colorado River
- Increased flows in streams and rivers
- Economic lift to the entire community from employment and broadened tax base
- Local availability of expertise, information, and materials for public conservation

- Aesthetically pleasing, green fields, denser, for longer periods of time
- Improved safety and control of water resources, with a reduction in open streams

Negative public perceptions of the Salinity Control Program include:

- "Greening" of desert landscape
- Conversion of artificial wetlands to upland habitat and other shifts in wildlife habitat
- Changes in Land Use

Water Related Land Use (WLRU)

The State of Utah Division of Water Resources tracks land use on a regular basis. Figure 70 is a graphical presentation of land use changes in the Uintah Basin Unit from past WRLU reports. The goal of the WRLU report is to account for all agricultural lands in the State along with immediately adjacent lands.

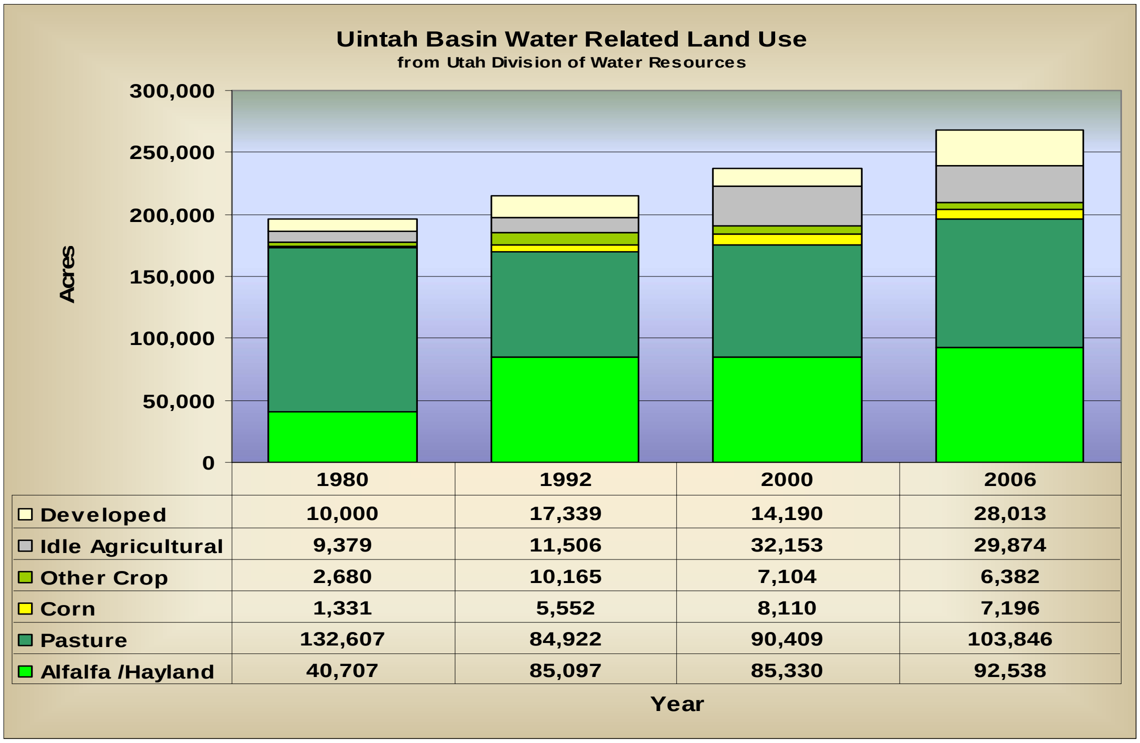
Summary

Local land owners are willing and able to participate in salinity control programs. At present funding levels, ample opportunities exist to install improved irrigation systems and reduce salt loading to the Colorado River system. Participants are apparently satisfied with results and generally positive about salinity control programs.

Irrigation installation costs are escalating. Increased world energy prices have resulted in much higher costs for pipe, transportation, labor, and equipment. In addition, the local economy is in a boom, and upward pressure on labor and equipment prices is considerable.

With labor, material, and equipment prices rising, it is expected that the cost/ton of salinity control measures will also increase. In addition, recent refinements in methods used to calculate salt load reduction are expected to result in upward adjustments of calculated cost/ton. However, the FY2007 average cost of $136/ton for applied practices is not the highest over the life of the program, nor does it approach the cost of downstream damages from excess salt. Colorado River Basin Salinity Control Programs are successful and cost effective in reducing salt load in the Colorado River.

Figure 70, Water Related Land Use



	1980	1992	2000	2006
☐ Developed	10,000	17,339	14,190	28,013
☐ Idle Agricultural	9,379	11,506	32,153	29,874
🟩 Other Crop	2,680	10,165	7,104	6,382
🟨 Corn	1,331	5,552	8,110	7,196
🟩 Pasture	132,607	84,922	90,409	103,846
🟩 Alfalfa /Hayland	40,707	85,097	85,330	92,538

Appendices

COLORADO RIVER BASIN
SALINITY CONTROL PROGRAM

CALCULATING SALT LOAD REDUCTION

MODIFICATION OF PROCEDURE
JULY 30, 2007

Prepared by
Natural Resources Conservation Service

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NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Executive Summary

The Salinity Worksheet for Ranking has been modified to simplify use, assure proportionality with the EIS/EA and to make calculations uniform in Utah and Colorado by making the following changes:

- Inputs for net irrigation requirement and seasonal irrigation factor have been eliminated.
- Minimum initial efficiency has been increased to 32%.
- Salt Load Factors have been developed that express a percentage of original salt load for a given irrigation efficiency.
- The original salt load has been determined for each salinity area from the EIS/EA or reasonable proxy data where EIS data is inconclusive.
- The salt load reduction calculation is greatly simplified. The salt load reduction is calculated by multiplying the original salt load by a factor related to the initial and final irrigation practice.
- As an example, a 20 acre flooded field has an irrigation efficiency of 32% and a salt load factor of 100%. The salinity area has an original salt load of 2.0 Tons/acre/year. It is proposed to install wheel lines with an efficiency of 65% and a salt load factor of 16%. The change in salt load is (100%-16%) x (2.0 tons/acre/year) x (20 acres) = 34 tons/year.
- Since the difference in salt load factor is always less than 100%, the cumulative tons/acre/year due to on-farm irrigation will never be exceeded, relative to the EIS/EA.
- The original salt load, SL_0 is unique to each salinity area. All salinity areas in Colorado and Utah will use the same salt load factors, SLF_e. The derived cost/ton will have the same computational basis for all salinity areas.

SALT LOAD CALCULATION

Salt loading from on-farm irrigation is the result of excess irrigation water percolating through the soil, dissolving salt, carrying it to the river.

On-farm salt load is reduced by improving irrigation efficiency, reducing the amount of excess water that deep percolates, dissolves salt from the soil, and returns to the river. Improving irrigation practices for salinity control in the Colorado River Basin began in the late 1970s and continues today.

There are or have been salinity control programs in four states, Arizona, Colorado, Utah, and Wyoming. In order to evaluate the effectiveness of treatment, it is desirable to have an evaluation procedure that is broadly applicable and that can be used for all CRSCP installations, allowing reasonable comparisons across State and Salinity Area Boundaries.

Since the inception of the CRBSCP, several different procedures have been used to estimate salt load for salinity control practices. Most procedures involved the input of numerous variables, based on the judgment of the technician doing the analysis. The expectation was that values derived from the procedures would be similar and reasonable, and would, over time, be proportional to salt load reductions anticipated by the EIS/EA upon which program economics were based, approved, and publicly accepted.

Reality is that dozens of variables affect salt pickup and transport and the confidence of any calculation cannot be determined. The potential cost of measuring each variable to develop discreet solutions is not viable. In addition, human nature is such that field staff evaluating salt load frequently move toward a worst case solution, maximizing calculated salt load reduction. While various procedures have worked well for ranking projects within specific salinity areas, the level of detail and variability in actual field computations compromised their usefulness for comparing with projects in other salinity areas and/or states.

Since discreet solutions to the salt load reduction problem are financially daunting, it makes sense to start with publicly accepted values from the EIS/EA, or a reasonable proxy for them. Using EIS/EA derived basin wide ton/acre values as a starting point and reducing ranking complexity makes this problem an accounting issue, rather than a technical issue.

By dividing the EIS anticipated salt load due to on-farm practices in tons/year, by the average irrigated acres, a maximum initial value for tons/year/acre is derived.

$$SL_0 = \frac{Tons_0}{Acres_0}$$

Where

SL_0 = The Salt Load before any treatment

$Tons_0$ = Total ton/year contributed by on-farm practices from the EIS/EA

$Acres_0$ = The average number of irrigated acres, pre-project

To determine salt load at any given efficiency, SL_e, SL_0 is multiplied by a salt load factor, SLF_e appropriate for that efficiency.

Where

SLe = the salt load at a given efficiency

SLFe = a salt load factor that is a function of efficiency

The Salt Load Factor (SLF_e) is derived using the following formula:

$$SLF_e = \frac{\left(\frac{1}{eff} - 1\right)^{1.33} \times 0.25}{\left(\frac{1}{eff_0} - 1\right)^{1.33} \times 0.25} = \left(\frac{\left(\frac{1}{eff} - 1\right)}{\left(\frac{1}{eff_0} - 1\right)}\right)^{1.33}$$

Where

eff_0 = the average efficiency of the salinity area, prior to any treatment under CRSCP.

eff = Irrigation efficiency at the time of evaluation

Values for SLF_e may be obtained from the table in figure 1.

By multiplying SL_0, by SLF_e and the number of treated acres in the project, the total tons attributed the subject acres are derived for specific irrigation efficiency.

$$SL_e = \mathrm{SL}_0 \times \mathrm{A} \times SLF_e$$

Where

A = Area in acres

Knowing the on-farm salt load before and after practice installation, a simple difference is the Salt Load Reduction, SLR, for the project.

$$SLR = SL_1 - SL_2 = (SLF_1 - SLF_2) \times SL_0 \times A$$

Where

SL_1 = the beginning salt load

SL_2 = the final salt load

SLF_1 = the beginning salt load factor

SLF_2 = the final salt load factor

Natural Resources Conservation Service (NRCS) for Colorado and Utah have agreed to use an initial irrigation efficiency of 32% for all salinity areas in both states.

Salt Load Factor, SLF_e

	Efficiency	SLF_e	SLR due to Upgrade from UF
Unimproved Flood	32%	100%	
Improved Flood PC	40%	63%	37%
Improved Flood +	45%	48%	52%
Improved Flood M	55%	28%	72%
Wheel line	65%	16%	84%
Center Pivot	75%	9%	91%
High Tech	85%	4%	96%

Figure 1. Salt Load Factors vs. Irrigation Efficiency. Last column reflects salt load reduction for improving irrigation from flood at 32% efficiency to an appropriate new efficiency from the second column, marked Efficiency.

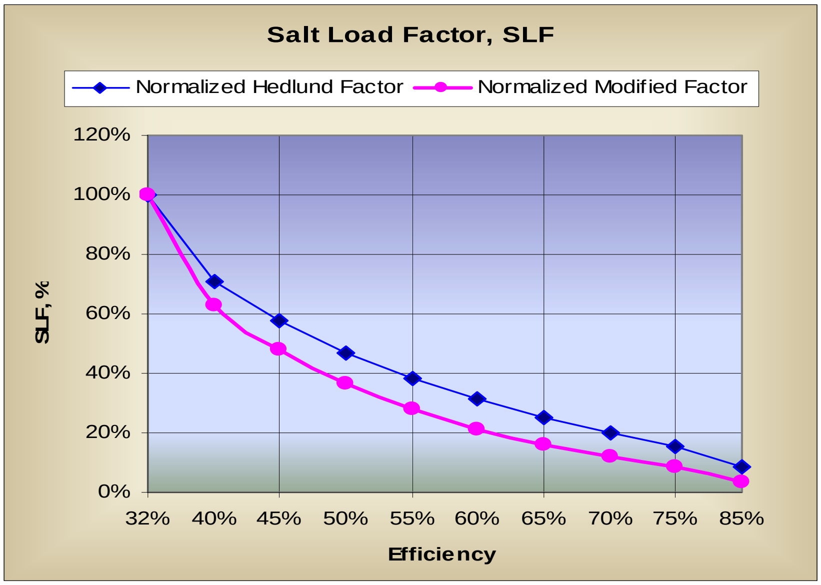

Figure 2 Graph of salt load factor, SLF. The upper line was used in the Ranking Worksheet FY2004 – FY2007. The lower line is used in new Salinity Worksheets for Ranking, beginning with FY2008 contracts and is mathematically defined above.

The adoption of this procedure will result in the following improvements from past procedures:

1. Assure that salt load reduction claims will not exceed EIS/EA expectations
2. Calculations from Colorado and Utah will use the same procedure and results will be comparable
3. Worksheet user inputs have been minimized, also minimizing opportunity for error

Appendix II, Salt Load Reduction Worksheet for Ranking

COLORADO RIVER BASIN SALINITY CONTROL PROGRAM

Utah NRCS

WATER AND SALT SAVING WORKSHEET for Ranking

Version 070824

Client:		**Date:**	
Salinity Area:	**Dry Gulch**	**Planner:**	

Irrigation System Changes

System Before	Eff	System After	Eff	Acres	EIS Salt Load Tons/Ac	Effective Salt Load Reduction	Salt Load Reduction Tons
UF	32%	**Wheel Line**	65%	**40**	1.04	84%	35
		System Totals		**40**			**35**

Ditch Losses, Off-farm

	Feet Replaced		Tons /Mile	Tons Salt
			80.0	-

Contracts - On-farm

Contract Number	Date	Amount	Treatment Description	Treated Area	Interest Rate	FA	Amortized $/Acre FA+TA
		$		Acres	%	$/Acre	$/Acre
748D43yyXnnn	06/01/07	30,000	Pivot	**40**	4.875%	750	88
						-	-
						-	-
						-	-
						-	-
						-	-
Totals	**1**	**30,000**		**40**		**$750**	**$88**
						Tons/Ac	0.87

Amortized $/Ton, FA+TA	**$100**

Appendix III, 2002 – 2005 Cooperator's Survey Summary.

Random Selection Number					
Operation Name	**Uintah Basin Totals***				
Contract Number or Year	**2002-2005**				
Irrigated Acres	**Flood**	**Wheel Line**	**Hand Line**	**Pivot**	**Total**
Is the contract active and the land being cropped? (Circle One)	**Yes**	**No**			
	439	**17**			
Crop Acres	**alfalfa**	**pasture**	**grains**	**other**	
	19,816	**11,402**	**3,500**	**6,765**	
Is the current irrigation system the same as designed and planned at start of contract? (Circle one)	**Substantially improved**	**Slightly improved**	**Same as designed**	**Slightly degraded**	**Substantially degraded**
	26	**50**	**376**	**4**	**0**
Describe any changes to and the general condition of sprinkling equipment:					
Is water measured? (Circle one)	**Yes**	**No**			
	278	**176**			
If Yes, acre-ft/acre applied?					
Is soil moisture monitoring used for irrigation scheduling? (Circle one)	**Yes**	**No**			
	225	**225**			
If yes, what type? (Circle all that apply)	**"Feel" method**	**Tensio-meters**	**Gypsum blocks**	**Neutron probe**	**Remote sensing**
	168	**0**	**0**	**7**	**5**
Are Evapotranspiration calculations used for irrigation timing? (Circle one)	**Yes**	**No**			
	4	**29**			
Have you attended any irrigation water management classes, workshops, or demonstrations? (Circle one)	**In the last 12 months?**	**In the last 2 years?**	**In the last 5 years?**	**Never?**	
	33	**24**	**48**	**336**	
Do you employ or use a consultant or service that advises irrigation scheduling? (Circle one)	**Yes**	**No**			
	5	**453**			
Have the changes in yield, labor used, irrigation operation and maintenance cost as well as other pre-harvest and harvest costs offset your share of the practice costs? (Circle one)	**Yes**	**No**			
	403	**44**			
My initial investment for the new system resulted in: (Circle one)	**Substantial economic gain**	**Minor economic gain**	**No economic change**	**Minor economic loss**	**Substantial economic loss**
	311	**95**	**37**	**5**	**2**
Do you feel that there is an effect economically overall to your area and region from this program? (Circle one)	**Substantial positive effect**	**Slight positive effect**	**No effect**	**Slight negative effect**	**Substantial negative effect**
	396	**43**	**10**	**3**	**1**
Has this project changed the quantity and quality of wildlife on your property? (Circle one)	**Substantial positive effect**	**Slight positive effect**	**No effect**	**Slight negative effect**	**Substantial negative effect**
	7	**10**	**12**	**2**	**1**

Evaluation of Wheelmove Irrigation Systems Nearing End of Practice Life

Colorado River Salinity Control Program

Final Report - Draft

November 29, 2006

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EXECUTIVE SUMMARY

This report presents the findings of an evaluation of the condition of improved irrigation systems (wheelmove sprinklers) installed under the USDA Colorado River Salinity Control Program (CRSCP). The primary focus was on wheelmove systems installed with CRSCP funds administered through contracts signed in the period 1980-1995 with emphasis on those 15 years old or older as of 2005 (ie. installed in 1991 or earlier). The evaluation was conducted in close collaboration and full cooperation with farmers and NRCS personnel in the Uintah Basin.

Information from 136 farmer interviews and 477 field inspections of wheelmove and handline irrigations systems was analyzed to determine maintenance, management and operation condition of on-farm systems nearing the end of the contract life. Summary findings from 128 responses to the interview question "If or when the present system wears out to the point it can no longer be repaired, how will you continue to irrigate?" indicated that: 88 (69%) would repair or replace with wheel lines, 10 (7.8%) would only replace with financial assistance, 16 (12.4%) would not replace with a wheel line but would change to pivot or flood, and 14 (10.9%) had other responses. The interviewer did not indicate that any cost-share money would be available. Other responses to interview questions suggest that hay is by far the most common crop (more than 80% of the fields) with pasture. As a result, most of the water is used to support livestock enterprises. Livestock commonly use the fields where the sprinkler systems are located but the amount of time varies by field and producer. For example, about 16% of the fields are not used by livestock while livestock use 41 % of the fields 4 months per year, 21% from 4 to 6 months a year and 22% of the fields are used more than 6 months a year. The amount of mechanical damage to the wheelmove systems closely followed the length of time stock were in the field (eg., the number of bent spokes averaged 25 for the lines inspected) The wheelmove systems were designed for twice per day moves. Users adhere fairly close to this with 81% moving the lines twice a day, 15 % once and the remaining 4% mixed. The average nozzle pressure was thought to be 42 psi, although many had not measured it.

The average rating for mover condition was 4.76 (1 = new, 10 = worn out), the overall wheelmove condition averaged a rating of 5.11 and the owners thought that there were 11 years of service life remaining. Of the three move sequencing for the lines (wiper, skip, and taxi), 28% used the wiper method, 27% skip, and 38% taxi. The rest were not specified or there were some combination(s). The wiper method may have the greatest implications for salt loading. In this moving sequence, at the end of the field when the move direction is reversed, the wheelmove may be moved one or two positions back towards the start position and then irrigation recommences. Thus, an almost double amount of irrigation water may be applied where irrigation was completed only a day earlier.

In the 88 responses to the question "How does the weather or the season or time of year affect your irrigation schedule?" almost half (45%) indicated no change, 24% changed the schedule to better fit the conditions and 30% sometimes adjusted the schedule. This also has implications for salt loading, as the opportunity for extra deep percolation is highest in the spring and fall, when crop water use is lower than system design capacity.

The field inspections yielded some interesting results. The average age of the wheelines that were inspected was just over 15 years of age. The ratings of the wheelmoves averaged 4.6 (1= new, 10 = nonuseable) while the lines averaged 4.13. This is similar to the ratings for the drains (average condition of 1.18), swivels (average condition of 1.88) and vertical head (1.74 average condition) on a ranking of 1 to 3 with 1 being essentially new. Most of the lines had about 25 heads, about seven heads short of a standard ¼ mile line with 32 heads.

A coefficient of uniformity (CU) and a corresponding distribution uniformity (DU) were calculated for each line based on the variation in nozzle discharge at 40 psi. The CU for all the lines averaged 86.6% with a DU of 82.3%. An adjusted CU (average 78.8%) and an adjusted DU (average 76.2%) were also computed from factoring in the imputed flow rate of leaks associated with ratings of gaskets, horizontal swivel play, and vertical head movement. These values were used to derive an estimate of the average discharge per head, which was 8.6 gallons per minute. The amount of variation between the lines was relatively large with a high of 19 and a low of 4.3 gpm per head. About 66% of the lines delivered between 6 and 10 gpm (adjusted). This suggests that the once a day moving schedule and the common “wiper” method of moving the lines can result in excessive application of water for some fields and that water management based on empirical data needs to be practiced to a greater degree.

An index was also developed that characterized the status of the inspected wheelmoves. This index placed one-third of the weight on the ratings for the drains, swivels, and heads; one-third on the score for the riser and wheel lines and one-third on the adjusted DU. The index of the wheelmoves inspected averaged 4.83 (1= essentially new and 10= unuseable) with a standard deviation of 1.14. This index however was not normally distributed. This indicates that about 10% of the lines that were inspected had an index that was greater than 6.2 while 10 percent had an index that was less than 3.2. This suggests that a relatively large number of the lines inspected were in disrepair while a fairly small number were well maintained. However, a large number of the inspected systems were in about the same state---most lines were better than average because those lines that were poorly maintained yielded a fairly high average.

ACKNOWLEDGMENTS

We appreciated the close cooperation and generous sharing of data and ideas by NRCS Salinity staff: Karyl Fritsch, Bret Prevedel, Gary Roeder, and Ed Whicker. We are especially grateful for the field interviews and system inspections performed by Garth Leishman, Jeff McKee, and Ed Rowley and for the data analysis work of Scott Taylor, USU Economics Department student. Gratitude is extended to Megan Poulton for her word processing skills and effort in completing the final publication.

IRRIGATION SYSTEM EVALUATION AND REPLACEMENT STUDY

COLORADO RIVER BASIN SALINITY CONTROL PROJECT

Final Report

December 27, 2007

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EXECUTIVE SUMMARY

This report represents the findings of an evaluation on the condition of improved irrigation systems installed under the USDA Colorado River Salinity Control Program (CRSCP). The focus was on improved irrigation systems installed with CRSCP funds prior to 1995. Systems evaluated were selected based on applications for replacement. The evaluation was conducted in close collaboration and full cooperation with farmers and NRCS personnel in the Uintah Basin.

Field evaluations were started in the spring of 2007 and completed throughout the summer. Most systems were evaluated during the irrigation season. Inspections and evaluations of wheel move sprinklers included, but were not limited to: drains, sprinkler heads, gaskets, pipes, wheels, hoses, and valve openers. Inspections of structural equipment for sprinkler and gated pipe systems included: pipelines, diversion structures, settling ponds, pumps, etc. No irrigation pivots were evaluated in this study.

Information from thirty-three farmer interviews and seventy eight associated inspections was analyzed to evaluate maintenance, management and operating condition of on-farm systems nearing the end of their contract life. A summary of these findings is included in Appendix B.

Most sprinklers were designed to be moved twice per day, with 87% of landowners following this recommendation.

In response to the question, “If or when the present system wears out to the point it can no longer be repaired, how will you continue to irrigate?,” if cost-share funds were available, 69% of respondents would like to upgrade to a more efficient system, 30% would install a similar system, and 1% would consider returning to flood irrigation. If no cost-share assistance is available, 32% would use other programs or loans to upgrade their systems, 62% would simply replace their systems, and 6% would consider flood irrigation.

Sprinkler system condition varied greatly from farm to farm. Age did not seem to be a major factor. However, maintenance seems to have a greater impact on life of the system than any other single factor. Wind and livestock were identified as the main contributors to system degradation with 47% having received damage by wind, 41% by livestock, and 2% by farm equipment. The average rating for mover condition = 7.2 and overall wheel move condition = 7.1 (1 = new and 10 = worn-out).

In regards to sprinkler nozzle variation, the average sprinkler line evaluated had 27.5 sprinklers and used 4.5 different nozzle sizes. Of the sprinkler lines evaluated, 6% had 10 or more different nozzle sizes, while 29% had 2 or less.

The average leak equaled 2.73 gpm (gallon per minute). With an average of 10.35 leaks per line, this equates to 28.36 gpm of water lost per sprinkler line. It should be pointed out that 37% of the total sprinkler leaks were less than 10 gpm per line, while 10% had leaks in excess of 75 gpm. The highest was calculated at 191.38 gpm, or 70% of the designed flow for the sprinkler line.

Most drains seemed to be in good condition. The majority of leaking drains were caused by trash or debris. Some brands of drains work very well while others require more maintenance and repairs.

Most hoses were in fair to good repair with only 12% having significant leaks.

Several landowners have had to replace the inside claw in the valve openers and most have replaced gaskets. Almost all valve openers did leak; however, most leaks were small.

Most structures were in good repair. It was noticed, however, that several were designed too small to meet the needs of the system as installed or have become inadequate as landowners have expanded their system.

Converting gated pipe to sprinklers, and wheel move to pivot are the systems with the most potential for salt load reduction and increased efficiency.

Appendix VI, Uintah Basin Alfalfa Production

Uintah Basin Alfalfa Production
Dry Alfalfa, Utah Ag Stats

Year	Producing Acres	Tons Produced	Yield Tons/Acre	Average Mountain Precip, In
1980	47,494	154,000	3.24	34.5
1981	49,488	167,900	3.39	24.5
1982	44,122	154,500	3.50	40.5
1983	45,412	154,400	3.40	36.6
1984	51,000	186,000	3.65	34.4
1985	50,467	180,500	3.58	30.8
1986	51,469	197,000	3.83	36.1
1987	53,511	217,000	4.06	27.1
1988	58,996	217,000	3.68	22.3
1989	51,498	169,800	3.30	24.2
1990	54,969	182,000	3.31	25.4
1991	54,251	202,500	3.73	28.8
1992	53,127	192,600	3.63	21.3
1993	55,712	235,600	4.23	31.0
1994	60,289	229,100	3.80	23.3
1995	63,857	267,000	4.18	37.1
1996	63,947	232,600	3.64	27.4
1997	66,461	281,000	4.23	37.8
1998	66,806	282,000	4.22	32.6
1999	61,502	260,000	4.23	31.5
2000	64,649	240,000	3.71	22.6
2001	61,802	234,000	3.79	25.5
2002	62,507	232,000	3.71	20.1
2003	62,949	221,000	3.51	23.1
2004	64,500	222,000	3.44	25.0
2005	58,000	207,000	3.57	36.1
2006	64,000	267,000	4.17	26.8

Glossary and Acronyms

Average salt pickup – The increase in the amount of salt carried by a stream as it flows as a result of inflows containing increase salt from dissolution of the soil. Usually expressed as tons/acre-foot.

Annual average salt load – The average estimated annual salt load carried by a stream, based on a period of record of several years. Usually expressed as tons/year.

Application efficiency – The portion of the irrigation water delivered to the field that is consumed by the crop, expressed as a percentage of the total delivery volume.

Applied Practices – Functioning practices for which Federal cost share dollars have been expended.

BSPP – Basin States Parallel Program

Bureau of Reclamation (Reclamation) – A branch of the U.S. Department of Interior charged with water interests in the United States. Reclamation is the lead agency for salinity control in the Colorado River.

Catch can testing – a procedure whereby dozens of containers are spread out under a sprinkler system in an array, to determine how much water is being applied to different spots of ground under the sprinkler to evaluate uniformity.

cfs – Cubic feet per second or second-feet.

Cover Map – a map categorizing land use based on surface cover, e.g. urban, crop type, wetlands, etc.

Crop Consumptive Use (CU) – The amount of water required by the crop for optimal production. It is dependant on many factors including altitude, temperature, wind, humidity, and solar radiation.

CRSCP – Colorado River Salinity Control Program

Daubenmire cover class frame – An instrument used to quantify vegetation cover and species frequency occurrences within a sampling transect or plot.

Deep Percolation – The amount of irrigation water that percolates below the root zone of the crop, usually expressed in acre-feet.

Dissolved salt or Total Dissolved Solids (TDS) – The amount of cations and anions in a sample of water, usually expressed in milligrams/liter, but often expressed in Tons/Acre-foot for salinity control programs.

Distribution Uniformity (DU) – A measure of how evenly the irrigation water is applied to the field. If DU is poor, more water is needed to assure that the entire crop has an adequate supply.

EQIP – Environmental Quality Improvement Program

Evapotranspiration (ET) - The amount of water used by the crop. ET is generally synonymous with CU and is frequently mathematically modeled from weather station data.

Financial Assistance (FA) – The Federal cost share of conservation practices. FA is normally 60% of total cost of conservation practices.

Gated Pipe – Water delivery pipe with individual, evenly spaced gates to spread water evenly across the top of a field.

Hand line – An irrigation system composed of separate joints of aluminum pipe, each with one sprinkler, designed to irrigate for a period of time and be moved to the next parallel strip of land.

Improved Flood – Increasing the efficiency of flood irrigation systems with control and measurement structures, corrugations, land-leveling, gated pipe, etc.

Irrigation Water Management (IWM) – Using practices and procedures to maximize water use efficiency by applying the right amount of water at the right place at the right time.

Leakage – Water loss from ditches and canals through fissures, cracks or other channels through the soil, either known or unknown.

National Agricultural Statistics Service (NASS) - A branch of the U.S. Department of Agriculture (USDA)

Natural Resource Conservation Service (NRCS) A branch of the U.S. Department of Agriculture (USDA) charged with providing technical assistance to agricultural interests and programs.

NEPA – National Environmental Policy Act which sets out requirements for Federal Agencies to evaluate the effect of a Federal project on the environment, prior to initiating the project.

Periodic Move – A sprinkler system designed to irrigate in one position for a set amount of time, then be periodically moved to a new position by hand or on wheels repeatedly until the field is covered.

Pivot or Center Pivot – A sprinkler system that uses moving towers to rotate a sprinkler lateral about a pivot point.

Planned Practices – Practices for which Federal cost share dollars have been obligated by contract.

Ranking – A process by which applications for federal funds are prioritized based on their effectiveness in achieving Federal goals.

Return Flow – The fraction of deep percolation that is not consumed by plants, animals, or evaporation and returns to the river system, carrying salt.

Salt Budget – Balancing the inflow and outflows of a salinity project to estimate unknown salt pickup.

Salts – Any chemical compound that is dissolved from the soil and carried to the river system by water. Salt concentration is frequently expressed as “Total Dissolved Solids” measured in parts per million (ppm) or milligrams per liter (mg/l). For salinity control work, it is often converted to Tons per acre-foot of water.

Salt load – The amount of dissolved salt carried by a flowing stream

Seepage – Fairly uniform percolation of water into the soil from ditches and canals.

Salt Load Reduction – A measure of the annual tons of salt prevented from entering the waters of the Colorado River. As applied to agriculture, salt load reduction is achieved by reducing seepage and deep percolation from over-irrigating.

Soil Conservation Service – The predecessor agency to NRCS.

Technical Assistance (TA) – The cost of technical assistance provided by Federal Agencies to design, monitor, and evaluate practice installation and operation, and to train and consult with cooperators. TA is generally assumed to be 40% of the total cost of conservation practices.

Uniformity – A mathematical expression representing how evenly water is applied to a plot of ground by a sprinkler system. The two most common measures used by NRCS are Christiansen Uniformity (CCU) and Distribution Uniformity (DU).

Utah Division of Wildlife Resources (UDWR or DWR) – The State of Utah's agency for managing wildlife resources.

Water Budget – Balancing the inflow and outflows of a salinity project to estimate unknown deep percolation and return flow.

Wheel line, Wheeline, Sideroll – A sprinkler system designed to be moved periodically by rolling the sprinkler lateral on large wheels.

WHIP – Wildlife Habitat Incentives Program, a Farm bill program instituted in 1997, designed to create, restore, and enhance wildlife habitat.

Water Budget – An accounting for the amount of water entering (irrigation and precipitation) and the amount of water leaving (evaporation, CU, deep percolation) a given plot of land to determine efficiency and estimate deep percolation.

Yield (or Crop Yield) – The amount of a given crop harvested from an acre of ground. Yield is usually expressed as Tons/Acre or Bushels/Acre, depending on the crop.

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