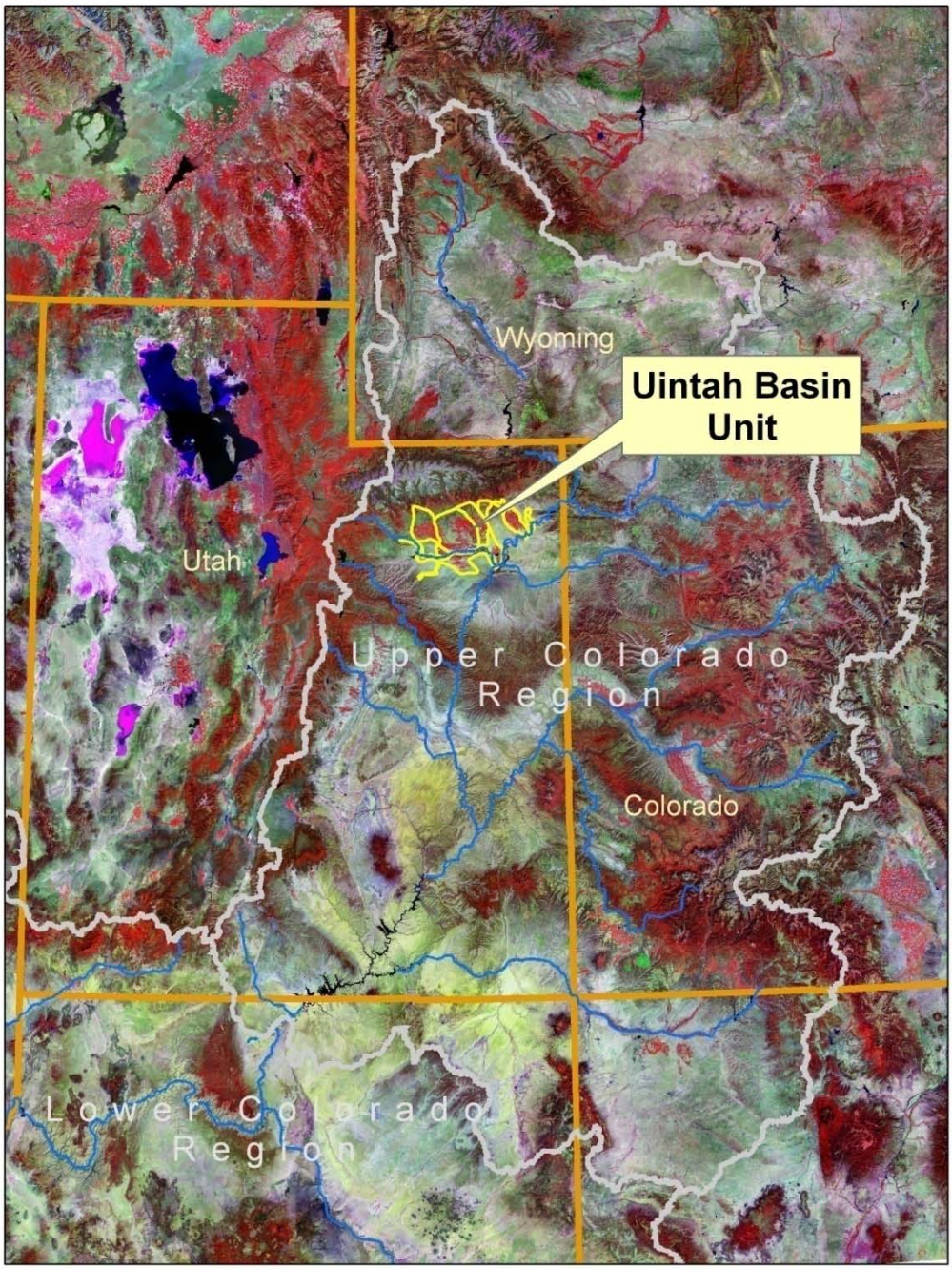
Colorado River Basin Salinity Control Program

Uintah Basin Unit

Monitoring and Evaluation Report, FY2009



U.S. Department of Agriculture

Natural Resources Conservation Service

Executive Summary

Project Status

- Of 200,000 irrigated acres, perhaps 80% or 160,000 acres may ultimately be improved.
- Treatments on approximately 149,900 acres have been planned and 136,400 acres applied.
- Of approximately 208,000 original on-farm tons, 119,900 tons of salt load reduction has been applied, calculated using revised procedures.
- Of approximately 120,000 original off-farm tons, USDA programs have applied 25,100 tons of salt load reduction.
- Approximately $137 million in 2009 dollars ($86.6 million nominal) in Federal financial assistance has been obligated by USDA since 1980.
- In 2009 dollars, pre-project NEPA documents anticipated $160/ton to $167/ton. Cumulative planned cost is $136/ton, and cumulative applied cost is $124/ton.
- For FY2009 the annual planned cost is $108/ton.
- The cumulative applied cost is $124/ton (2009 dollars).
- Deep percolation due to system leaks, inadequate IWM, and poor system maintenance is relatively minor. New sprinkler operators are more likely to under-irrigate than to over-irrigate.
- Consistent training and emphasis on IWM results in a better outcome for the government and the participant.
- Incentive payments for IWM have resulted in enhanced interest in IWM and quality system maintenance.
- Passage of the 2008 Farm Bill has extended EQIP through 2012.

Wildlife Habitat and Wetlands

- Conversion of wetlands to uplands is far less than anticipated by the EIS.
- A total of 240 acres wildlife habitat creation/enhancement were planned and funded and 2,054 acres wildlife habitat creation/enhancement were applied in FY2009.
- Lower Duchesne River Project (LDRP) Case Study is photographically displayed.

Economics

- From the 2007 Census of Agriculture, two-thirds of Uintah Basin farmers have full-time occupations other than farming.
- Cooperators generally believe that their increase in production and decrease in labor adequately offset their participation cost.
- Public benefits are perceived to exceed public liabilities for salinity control measures.

Table 1, Project progress summary

Uintah Basin Unit, All Programs				
Practices Planned	**Units**	**FY2009**	**Cumulative**	**Target**
Contracts (Planned)	**Number**	62	2,780	
	2009 $, FA	2,791,994	137,036,465	
	Acres	2,402	149,906	160,000
	Tons	2,932	147,616	140,500
	2009 $/Ton	108	135	
Applied Irrigation Practices	**Units**	**FY2009**	**Cumulative**	**Target**
Expenditures	**2009 $ FA**	3,919,406	122,892,629	
Sprinkler Systems	**Acres**	2,600	135,873	160,000
Improved Surface Systems	**Acres**	33	14,380	
Drip Irrigation Systems	**Acres**	7	73	
Salt Load Reduction, on-farm*	**Tons/Year**	2,380	119,874	140,500
Salt Load Reduction, off-farm	**Tons/Year**	532	25,191	
Federal cost	**2009 $/ton**	153	124	

***Note: On-farm Salt Load Reduction has been recalculated using the procedure adopted in FY2007 by three Upper Basin States. All EQIP and BSPP contracts were reviewed and acres corrected. All cumulative numbers reflect results of recalculation.**

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

For further information, please contact:

Jim Spencer, Wildlife Biologist
USDA-NRCS
240 West Highway 40 (333-4)
Roosevelt, UT 84066
(435)722-4621 ext 128
jim.spencer@ut.usda.gov

Ed Whicker, Civil Engineer
USDA-NRCS
240 West Highway 40 (333-4)
Roosevelt, UT 84066
(435)722-4621 ext 124
ed.whicker@ut.usda.gov

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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 required 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).

- The Farm Security and Rural Investment Act of 2002 and the Food, Conservation, and Energy Act of 2008 reauthorized and amended EQIP, continuing opportunities for USDA funding of salinity control measures.

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

Annual Project Results

FY2009 project results are summarized in table 2.

Cumulative Project Results

Cumulative results through FY2009 are tabulated in Table 3, along with EIS projections and an estimated projection of project completion. Off-farm activities are excluded from this table. Dollar amounts are expressed in 2009 dollars.

With respect to planning documents, salt load reduction has exceeded projections at a lower amortized cost/ton than anticipated. Cooperators continue to apply for salinity control contracts and opportunities still exist to further reduce salt loading at a lower average cost/ton than expected at project inception.

Table 2, FY2009 results

FY2009	Units	Planned	Applied
Irrigation Practices	Acres	2,402	2,640
Federal Cost Share, FA	2009 $	2,791,994	3,919,406
Amortized Federal Cost Share, FA+TA	2009 $	317,866	446,220
Salt Load Reduction	Tons /year	2,932	2,912
Federal Cost/Ton, FA+TA	2009 $	108	153

Table 3, Project goals and cumulative status, on-farm only

Cumulative Improvements [3]	Units	EIS[1]	Projected[2]	Planned	Applied
Irrigation Improvements	Acres	137,000	160,000	149,900	149,500
Federal Cost Share, FA+TA	2009 $	183,600,000	240,800,000	228,400,000	204,800,000
Amortized Fed Cost, FA+TA	2009 $	17,800,000	22,300,000	20,000,000	18,000,000
Total Salt Load Reduction	Tons /Year	106,800	140,500	147,600	145,100
Federal Cost/Ton, FA+TA	2009 $	167	160	136	124

[1] Combined data from 1987 Holt Letter and 1991 expansion EIS.

[2] $33 million nominal FA added for on-farm practices on 23,000 acres.

[3] FA+TA is used in this table only, to conform to procedures used in the EIS'.

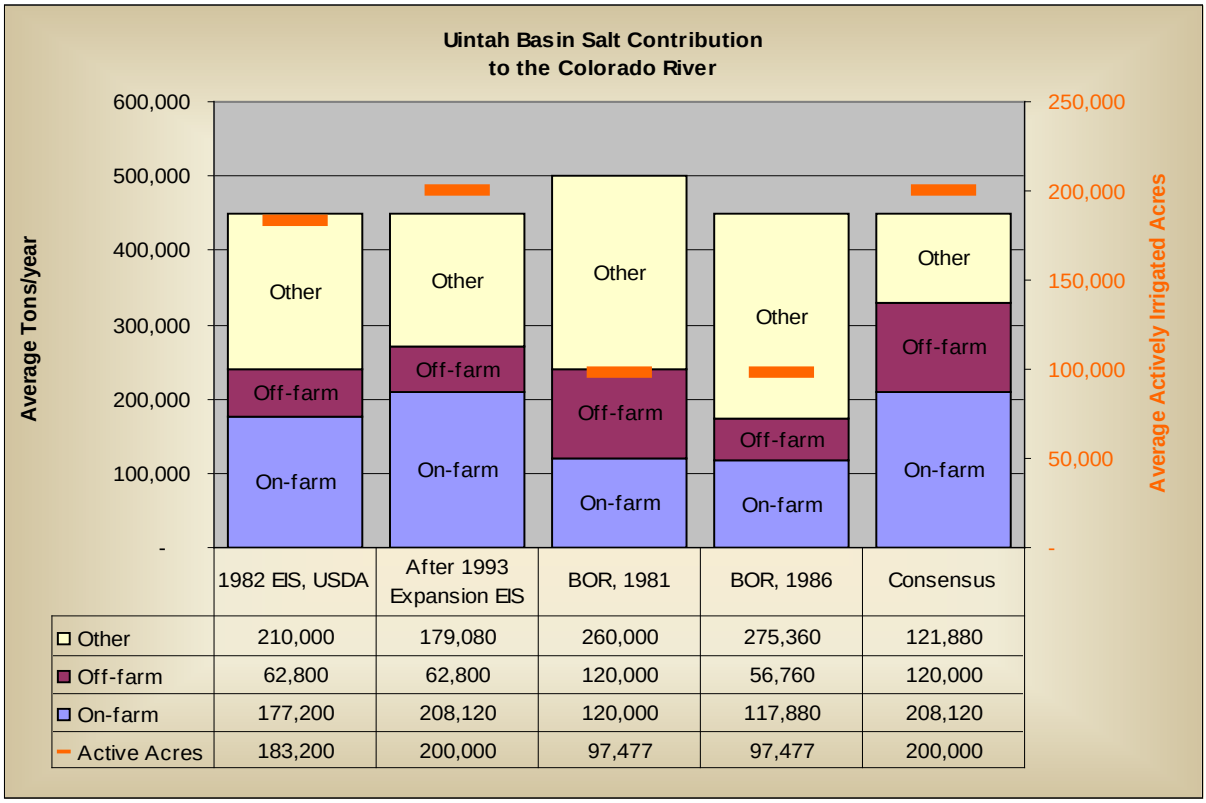
Detailed Analysis of Status

Pre-Project Salt Loading

Agricultural irrigation is a major source of salt loading into the Colorado River and is completely human induced. Irrigation improvements have great potential to control salt loading.

In 2007 NRCS and Reclamation reviewed available literature and came to a consensus agreement on the most reasonable pre-project salt contribution from agriculture in the Uintah Basin, prior to implementing Federal Salinity Control Programs. The result of this effort is depicted in figure 1.

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

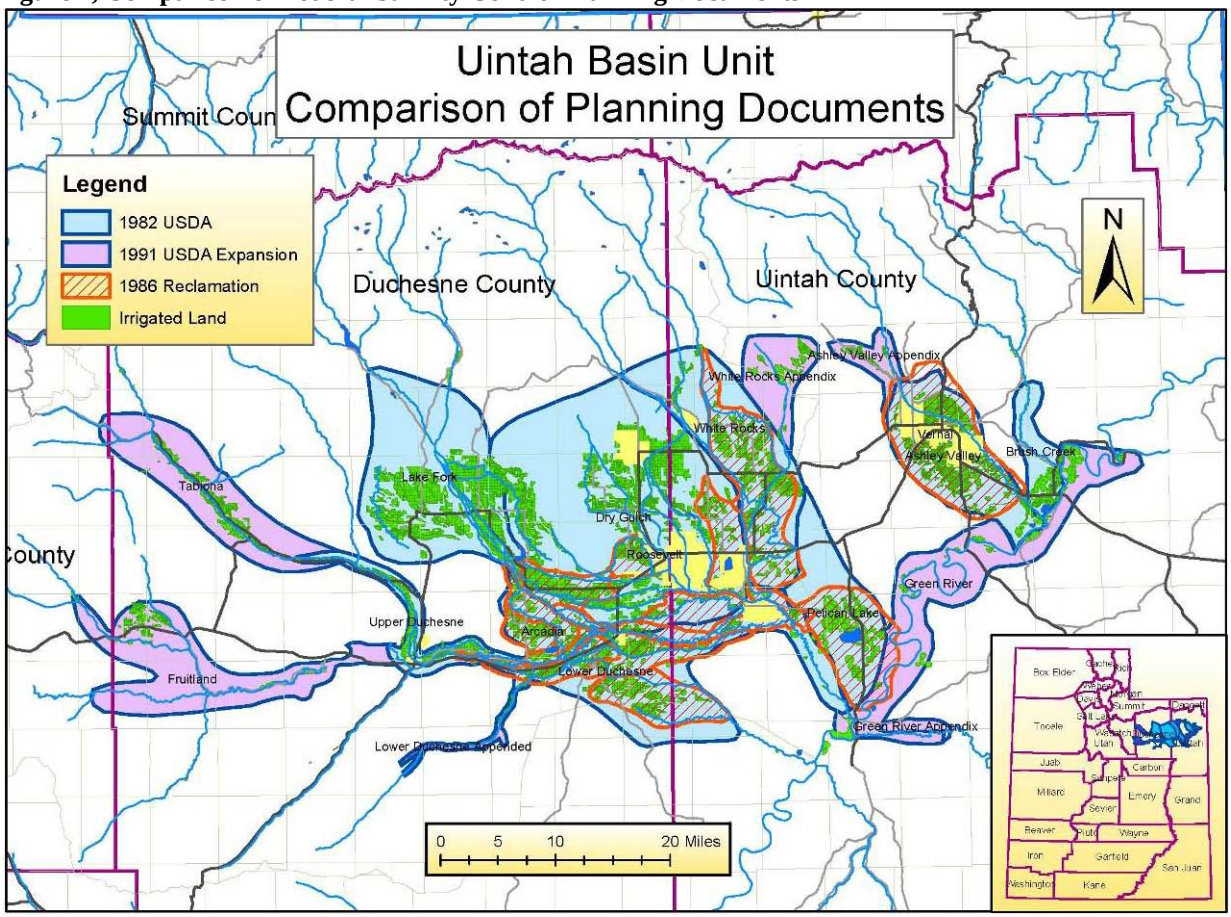
Between 1975 and 1991, at least six studies were done by federal agencies to quantify the salt contribution of Uintah Basin irrigation to the Colorado River System. Three studies by US Department of Agriculture (USDA) Soil Conservation Service, predecessor to Natural Resource Conservation Service (NRCS) emphasized the contribution of on-farm 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. Please refer to the map in 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. Agricultural irrigation, a particularly large source, involves diverting relatively clean water from a watercourse, channeling diverted water to fields and applying the water to the soil. Agricultural 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.

Figure 2, Comparison of Federal Salinity Control Planning Documents



Colorado River Basin Salinity Control Project (CRBSCP)

The CRBSCP encompasses multiple federal agencies and programs intended to reduce salt loading to the Colorado River. USDA on-farm salinity control programs started about 1980, with the Agricultural Conservation Program (ACP) and Long Term Agreements (LTA). Contracts were made with agricultural land owners to install improved irrigation practices for salinity control purposes. In 1987, ACP and LTA were replaced by the Colorado River Salinity Control Program (CRSCP), which functioned until 1996. In 1996, the Interim Environmental Quality Incentive Program (IEQIP) operated for one year, until the current Environmental Quality Incentive Program (EQIP) was established. Salinity control on the Colorado River has been a part of EQIP through the 1996, 2002, and the 2008 Farm bills.

Salinity Control Practices

On-farm practices used to reduce salt loading include improved flood systems, sprinkler systems, and advanced irrigation systems, along with diversions, water delivery systems, pumps, ponds, etc., required for the efficient operation of irrigation systems. Salt load reduction is achieved by reducing over-irrigation and deep percolation.

Off-farm practices used to reduce salt loading are associated with the reduction and/or elimination of canal/ditch seepage, usually by installing pipelines.

Planning Documents

A careful review of planning documents indicates that the cost of treatment is generally less than anticipated pre-project. Table 4 summarizes planning estimates of salt load reduction costs.

Table 4, Comparison of Project Cost Estimates

FA+TA	Units	EIS, 1982	Holt Letter, 1987	EIS, 1991	2002 Adjustment
Additional Irrigation Improvements	Acres		5,900	8,900	23,000
Irrigation Improvements	Acres	122,200	128,100	137,000	160,000
Incremental federal cost share	Nominal Dollars	64,474,200		7,148,700	40,000,000
Total federal cost share	Nominal Dollars	64,474,200	76,000,000	83,148,700	123,148,700
Federal water project discount rate	%	7.625%	8.625%	8.750%	6.125%
Amortized incremental treatment cost	Nominal Dollars	5,847,581	7,503,455	713,093	3,166,331
Total amortized treatment cost	Nominal Dollars	5,847,581	7,503,455	8,216,548	11,382,879
Total treatment cost	2009 Dollars	136,015,278	170,350,833	183,611,672	240,847,675
Total amortized treatment cost	2009 Dollars	12,336,103	16,475,442	17,798,230	22,328,934
Incremental total salt load reduction	tons /year	76,600	21,600	8,600	33,700
Total salt load reduction	tons /year	76,600	98,200	106,800	140,500
Total Cost/Ton	2009 Dollars	161	168	167	160

The Environmental Impact Statement (EIS) for the Uintah Basin Unit of the Colorado River Basin Salinity Control Project (CRBSCP) was published in April, 1982. The EIS contemplated treating 122,200 acres with improved irrigation practices at a cost of $64.5 million FA ($136 million in 2009 dollars), reducing salt loading by 76,600 tons/year. It was anticipated that 35% of treatments would be improved flood irrigation.

Amortizing $136 million at 7.625% (the federal water project discount rate for FY1982) over 25 years results in an expected average cost of $161/ton (FA+TA) in 2009 dollars.

By 1987, it was apparent that USDA was installing more off-farm practices than anticipated and that 5,900 acres in the Whiterocks area, excluded from the initial EIS, would likely be treated after all. By a letter from the Utah State Conservationist, Francis T. Holt, dated July 14, 1987, projected treatments were increased to 128,100 acres and salt load reduction to 98,200 tons/year of which 82,300 tons/year were on-farm. The letter cites a total federal cost of $76 million at 70% cost-share (1986 dollars), a 50 year project life, and 8.625% discount rate.

While the practice life of buried pipelines may be on the order of 25-50 years, sprinkler and improved flood irrigation systems have a 15 year practice life (NRCS standards). Amortizing costs over 25 years or less seems more appropriate for on-farm practices than a 50 year amortization and a 25 year amortization has

been widely used in recent years for cost/ton analysis. Amortizing $76.0 million at 8.625% over 25 years yields an expected salt load reduction cost of $168/ton in 2009 dollars.

In December, 1991, a second EIS was completed, expanding the Uintah Basin Unit by 20,800 acres, of which 8,900 acres would be treated (7.5% improved flood) at a cost of $7.15 million FA+TA ($13.3 million in 2009 dollars) to reduce salt load by 8,600 tons/year. Using the same reasoning as above, the amortized cost is $154/ton (FA+TA) for the incremental acres and $167/ton for the entire project described by the Holt letter and the expansion EIS.

By 2002, it was obvious that improved flood installations were out of favor and nearly all future installations would be sprinklers. It is now anticipated that 160,000 acres may ultimately be treated, with a total salt load reduction of 140,500 tons/year, on-farm. Salt load reduction costs may settle around $160/ton, 2009 dollars, for the entire project, slightly less than estimated in the Holt letter in 1987 and after the 1991 expansion EIS.

Distribution of Salt Concentration

Through the 1980s and 1990s, salt loads, for individual contracts, were calculated using a predetermined salt load factor, expressed in tons of salt/acre-foot, multiplied by the return flow to the river. Return flow was calculated by using a water budget to estimate deep percolation and subtracting estimated phreatophyte consumption prior to ground water returning to the river system. The salt load factor was determined as part of the EIS, by measuring and comparing salt concentrations in water diverted from the rivers and groundwater flowing from seeps below irrigated lands. Salt load factors were always suspect, because they were derived from too few samples over too great an area and because there is no evidence that any ground water potential studies were made to determine the likely flow paths of return flow.

In FY2007, in an attempt to simplify salt accounting and minimize arbitrary estimates, new procedures were established to calculate salt load reductions on the basis of estimated original salt in place and potential salt load reduction based on years of intense monitoring of salt and water budgets on individual fields. In the Uintah Basin, original salt load was averaged over the entire basin with a pre-project load of 1.04 tons/acre.

SPARROW (Spatially Referenced Regressions on Watershed Attributes)

In 2009, USGS released Scientific Investigations Report 2009-5007,"Spatially Referenced Statistical Assessment of Dissolved-Solids Load Sources and Transport in Streams of the Upper Colorado River Basin". This report, which includes a user-interfaced GIS model to access and review data, provides opportunity to compare past salt-loading estimates with state-of-the-art, computerized efforts to numerically model salt transport in the river and its tributaries. A brief review of the data indicates that SPARROW estimates overall average agricultural salt loading in the Uintah Basin to be about 1.12 tons/acre, which compares favorably with the 1.04 tons/acre derived from the EIS.

Figure 3, Salt Load Evaluation Comparison

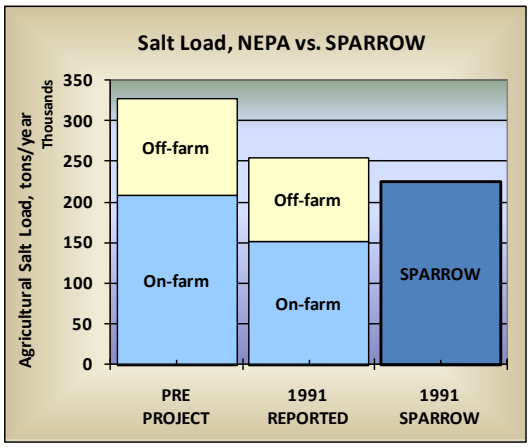


Figure 3 compares reported salt load from pre-project NEPA evaluations, progress reports, and the SPARROW model.

The SPARROW report estimated the agricultural salt load remaining in 1991, in the Uintah Basin Unit, to be about 225,000 tons/year. Pre-project, the total agricultural salt load, on-farm and off-farm was estimated to be 328,000 tons/year. As of the end of FY1991, USDA programs had reported on-farm and off-farm salt load reductions of 72,000 tons. Reclamation programs in the Uintah Basin had not begun as of January, 1995, when "QUALITY OF WATER COLORADO RIVER BASIN, Progress Report No. 17",

was published. The SPARROW estimate of agricultural salt loading is about 13% less than salt loading derived from the various NEPA documents and USDA progress reports.

Distribution of salt loading is of special interest, in that the SPARROW model indicates an entirely different distribution than the does the EIS. Figures 4 and 5 show salt distribution from the EIS and from SPARROW.

The authors of this report would be pleased to see additional SPARROW evaluations that represent other years between 1980 and the present.

Figure 4, Salt loading distribution estimated by EIS.

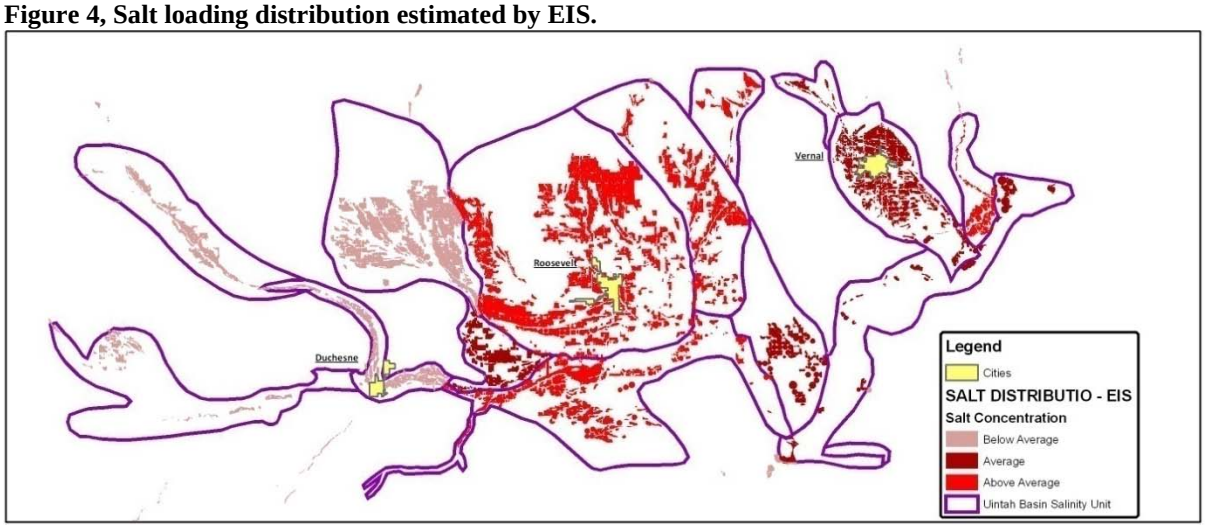
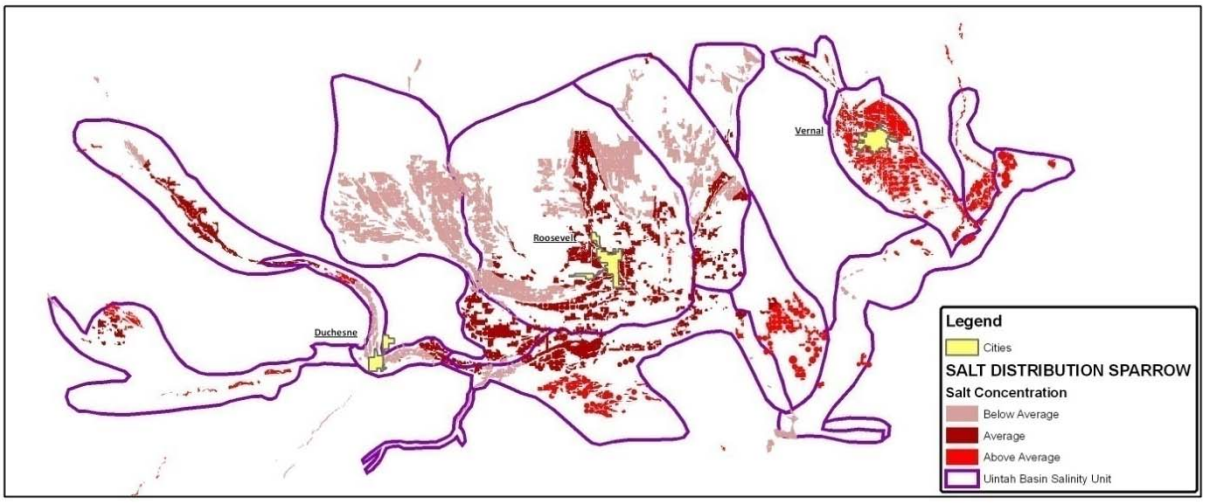


Figure 5, Salt loading distribution estimated by SPARROW.



Planned Practices (Obligations)

Planned practices (obligations) represent contracts with participants to apply improved irrigation practices to the participant's agricultural endeavors. Only the federal share of project cost is analyzed in this section.

The installation of salinity control practices is voluntary on the part of landowners. An incentive to participate is created by cost-sharing installation using federal grants. In essence, federal cost-share

purchases salt load reductions in the Colorado River, while the participants' cost-share buys them reduced operating costs and increased production.

Federal cost-share is obligated when a contract is signed with the participant, assuring timely installation to federal standards, of salt load reducing irrigation practices. A few of these contracts are never completed, for various reasons, making tracking of the cumulative federal obligation problematic in that it decreases over time, as contracts are modified or cancelled.

FY2009 Obligation

In FY2009, $2.79 million was obligated in 62 contracts to treat 2,402 acres with improved irrigation. Of that amount, $123,000 was for wildlife habitat improvements.

Salt Load Reduction Calculation

The estimated salt load reduction from FY2009 planned practices is 2,932 tons/year. The on-farm portion, 2,210 tons/year, is calculated by multiplying the original tons/acre for the entire basin, by the acres to be treated and a percentage reduction based on change in irrigation practice. For the Uintah Basin, the consensus estimate of on-farm irrigation salt loading is 1.04 tons/acre-year. As an example, if 40 acres are converted from wild flood to wheel line sprinkler, an estimated 84% of the original salt load will be controlled. Hence, 40 acres x 1.04 tons/acre-year x 84% = 46 tons/year salt load reduction. Salt load reduction in this report is calculated using this method, as outlined in "*Calculating Salt Load Reduction*", July 30, 2007, found in appendix I. In addition to on-farm salt load reduction, when ditches that cross non-irrigated acres are put in pipe, as part of the irrigation project, additional off-farm salt loading is also reduced, 722 tons/year in 2009.

Cost/Ton Calculation

The federal cost/ton for salt load reduction is calculated by amortizing the federal cost over 25 years at the federal discount rate for water projects (4.625% for FY2009). Two-thirds of the federal financial assistance (FA) is added for technical assistance (TA) (the average federal cost of planning, design, construction inspection, monitoring and evaluation, etc.) and the amortized total cost is divided by tons/year to yield cost/ton. Conversion of past obligations/expenditures to 2009 dollars is done by using the Producer Price Index (PPI) for agricultural equipment purchased.

For FY2009 the amortized cost of obligated planned projects is $108/ton (FA+TA).

Obligation Analysis

In 2009 dollars, cumulative obligation thru FY2009 is $137 million, planned on 149,900 acres, with a salt load reduction of 147,600 tons (on-farm and off-farm), resulting in an overall cost of $135/ton. Note that in 2009 dollars, the overall cost/ton has been relatively constant throughout the life of the project. Current cost/ton is not out of line with respect to past years performance or planning document projections.

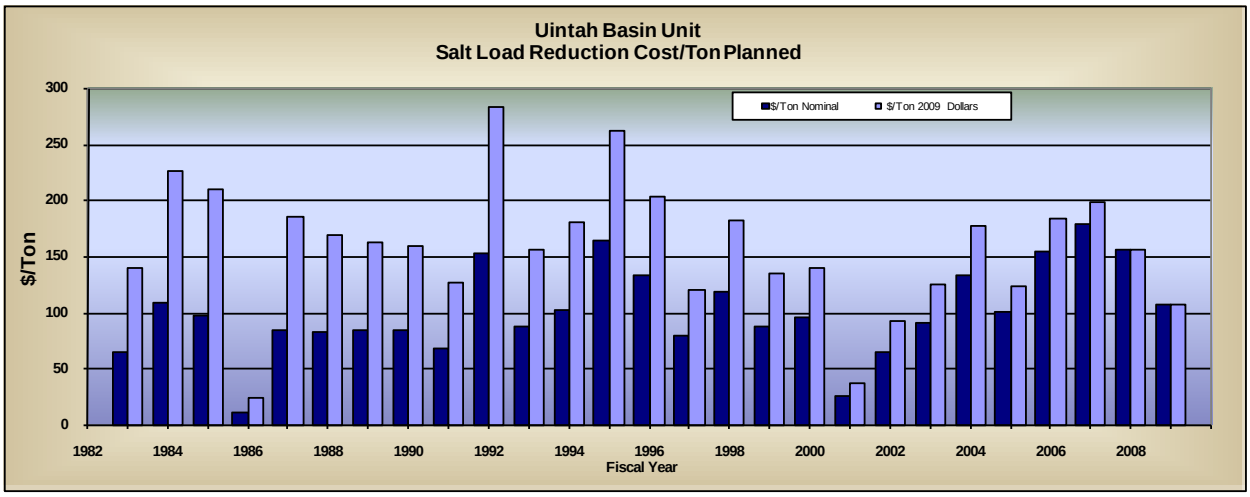
Table 5 depicts the historical cost/ton of planned practices, in nominal and 2009 dollars.

Figure 6 compares cost/ton by year, in nominal and 2009 dollars.

Table 5, Cost/Ton of annual obligations since 1980, in nominal and 2009 dollars

FY	Federal Water Project Interest Rate	Contracts Planned	FA Planned Nominal	Irrigation Acres Planned	Salt Load Reduction Tons/Year	Amortized FA+TA Nominal	$/Ton Nominal	2009 PPI Factor	FA Planned 2009 Dollars	Amortized FA+TA 2009 Dollars	$/Ton 2009 Dollars	Cum $/Ton, 2009 Dollars
1980	7.125%	84	1,848,864	5,000	3,735	267,404		234%	4,324,332	625,435		
1981	7.375%	95	1,899,073	6,000	4,482	280,839		218%	4,141,647	612,475		
1982	7.625%	76	1,782,461	5,000	3,735	269,438		211%	3,760,294	568,409		
1983	7.875%	108	2,641,958	8,282	6,187	408,097	66	212%	5,610,163	866,588	140	147
1984	8.125%	36	1,107,903	2,152	1,608	174,829	109	208%	2,307,083	364,062	226	154
1985	8.375%	70	1,536,585	3,368	2,516	247,640	98	214%	3,284,527	529,343	210	160
1986	8.625%	39	1,176,359	2,885	18,055	193,569	11	224%	2,636,760	433,877	24	99
1987	8.875%	63	797,629	2,121	1,584	133,971	85	220%	1,751,365	294,162	186	102
1988	8.625%	127	6,153,570	16,362	12,223	1,012,567	83	206%	12,650,878	2,081,695	170	118
1989	8.875%	87	2,111,397	5,614	4,194	354,634	85	193%	4,080,812	685,420	163	121
1990	8.875%	75	2,963,581	7,880	5,887	497,768	85	189%	5,593,889	939,559	160	125
1991	8.750%	132	3,358,040	10,968	8,194	558,282	68	186%	6,229,164	1,035,614	126	125
1992	8.500%	284	3,382,799	4,826	3,605	550,898	153	186%	6,275,092	1,021,916	283	132
1993	8.250%	156	2,780,712	6,750	5,042	443,465	88	178%	4,958,732	790,813	157	134
1994	8.000%	113	3,317,415	6,741	5,036	517,952	103	176%	5,838,397	911,557	181	137
1995	7.750%	27	720,561	899	672	110,109	164	160%	1,153,076	176,202	262	138
1996	7.625%	161	5,840,101	6,816	6,634	882,794	133	153%	8,937,930	1,351,064	204	142
1997	7.375%	24	610,282	1,197	1,120	90,250	81	149%	910,255	134,610	120	142
1998	7.125%	16	635,323	777	770	91,888	119	153%	972,324	140,629	183	142
1999	6.875%	22	770,211	1,250	1,232	108,916	88	153%	1,178,762	166,690	135	142
2000	6.625%	44	1,620,953	2,351	2,332	224,048	96	147%	2,377,407	328,605	141	142
2001	6.375%	58	1,565,536	2,398	8,022	211,441	26	143%	2,240,126	302,550	38	134
2002	6.125%	125	3,694,643	7,816	7,497	487,436	65	142%	5,244,031	691,847	92	132
2003	5.875%	141	4,573,887	7,057	6,467	589,269	91	138%	6,289,120	810,248	125	131
2004	5.625%	137	4,973,633	5,099	4,667	625,528	134	132%	6,581,676	827,769	177	133
2005	5.375%	159	7,045,494	7,106	8,593	864,746	101	123%	8,671,412	1,064,307	124	132
2006	5.125%	116	6,202,616	4,996	4,782	742,701	155	119%	7,376,114	883,216	185	134
2007	4.875%	74	4,515,245	2,594	2,947	527,276	179	111%	5,029,630	587,345	199	136
2008	4.875%	69	3,861,241	3,198	2,866	450,904	157	99%	3,839,472	448,362	156	136
2009	4.625%	62	2,791,994	2,402	2,932	317,866	108	100%	2,791,994	317,866	108	135
Totals		2,780	86,280,066	149,906	147,616	12,236,524	83		137,036,465	19,992,235	135	

Figure 6, Nominal planned cost/ton and cost/ton in 2009 dollars



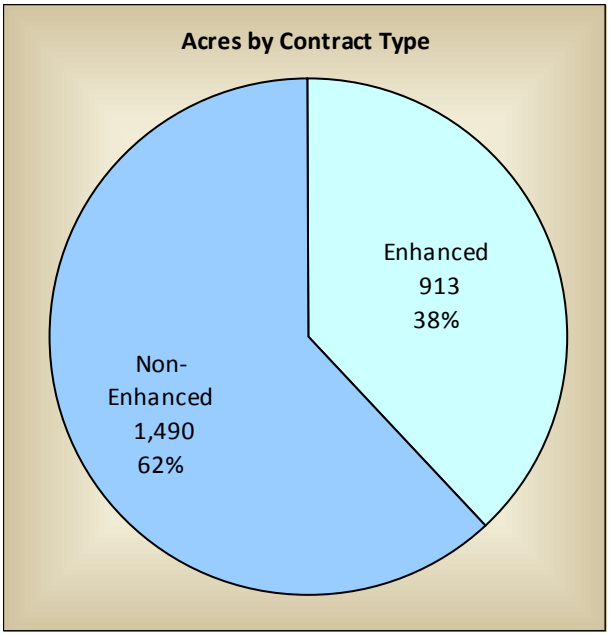
Cost Share Enhancement

Typical federal cost share, over the last several years, has been 75% of total installation cost. A feature of the 2002 and 2008 Farm Bills is a cost share enhancement of the federal share, from 75% to 90% of the total cost, for beginning farmers (those who have not claimed agricultural deductions on income tax for 10 years), limited resource farmers (a farmer with a gross farm income below a specified limit), and historically underserved minorities.

In the Uintah Basin, a cumulative total of 142 contracts on 4,561 acres for $6.44 million (2009 dollars) are cost-share enhanced. Estimated salt load reduction is 4,918 tons on-farm and off farm. The incremental cost of enhancement is $1.07 million, less than 1% of total FA, but it has all been accumulated in the last six years. A preponderance of enhanced contracts are with beginning farmers, at an approximate ratio of four to one compared to limited resource farmers or historically underserved minorities.

For FY2009 contracts, the average salt load reduction cost for cost-share enhanced contracts is $155/ton, compared to $108/ton for all contracts (Wildlife only contracts excluded). It is not possible to determine how many of the enhanced contracts would be done without the incentive cost-share increase. Assuming that the enhancement did not incentivize any additional contracts, the salt load reduction cost without the 2009 added incentive of $185,000 would be $129/ton. Figure 7 depicts the ratio of enhanced contract acres to unenhanced (normal) contract acres. Figure 8 depicts the cost/ton for each contract type for FY2009 contracts.

Figure 7, FY2009 planned acres by contract type



System Upgrades

In the Uintah Basin Unit, many salinity funded irrigation systems have reached their intended practice life. In FY2009, some improved flood practices that had exceeded their useful life, were upgraded to wheel line or center pivot systems. It was assumed that the application efficiency of these systems had declined from 55% to 45% and that the average salt loading of these systems was 48% of original salt loading (0.50 tons/acre). Systems upgraded to wheel lines would therefore reduce salt loading by 36% of the original loading (0.37 tons/acre), and center pivots by 45% of the original load (0.47 tons/acre).

In FY2009, 2 contracts for $269,200 FA were planned to upgrade irrigation practices on 300 acres. Salt load reduction is 136 tons on-farm and 78 tons off-farm. The amortized cost is $143/ton FA+TA.

Replacement of Prior Treated Practices

Some worn-out sprinkler systems, installed prior to salinity funding, have claimed no federal cost-share and no salt load reduction. In FY2009 12 contracts for $464,700 were planned on 557 acres with a salt load reduction of 548 tons/year. A reduced federal cost share of approximately 65% was applied to these systems. The planned cost is $97/ton FA+TA.

Figure 8 compares the relative cost/ton for FY2009 Enhanced, Upgrade, Prior Treated, and All other contracts (does not include Wildlife Only contracts).

Applied Practices

FY2009 Expenditures

In FY2009, $3.92 million FA was expended applying 2,640 acres of irrigation improvements. The estimated salt load reduction is 2,912 tons/year, on-farm and off-farm, at an amortized cost of $153/ton (includes WLO). This calculation is unreliable in that FA expended cannot be directly correlated to contract completion.

When is a contract completed? The cooperator may receive several partial payments in the course of construction. He/she may complete construction, commence operation, be reimbursed for 99% of FA and still have two years of IWM left in the contract before it is officially completed. For this document, all salinity reducing practices in contracts are arbitrarily assumed to be applied in proportion to dollars paid out.

Cumulative expenditure FY1980-FY2009 is $122.9 million FA (2009 dollars), applied to 135,900 sprinkler acres, 14,400 improved flood acres, and 73 acres of drip irrigation, reducing salt loading by 119,900 tons/year on-farm and 25,200 tons off-farm at an average cost of $153/ton (2009 dollars).

Application of salinity control lags planning by the time needed for practice installation. Between planning and application, a few contracts are de-obligated for various reasons such as design modification, change in ownership or cancellation.

Figure 9 relates cumulative obligated FA to cumulative applied FA, in 2009 dollars.

Figure 10 depicts cumulative applied salt load reduction, on-farm and off-farm, by year.

Table 6 summarizes annual expenditures and cost/ton calculations for applied practices.

Table 7 is a detailed summary of applied practices since project inception.

Figure 8, FY2009 cost/ton by contract type

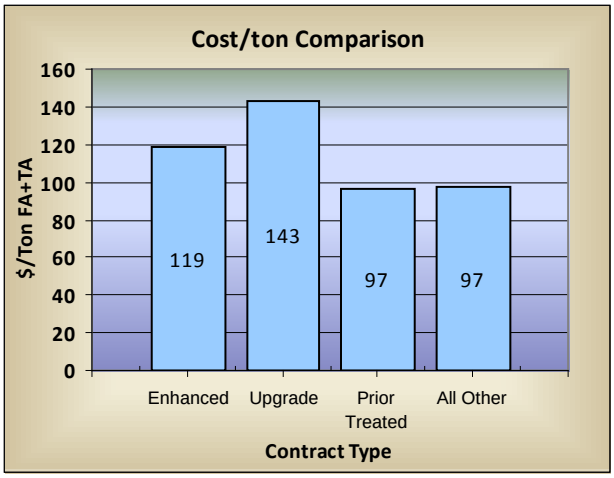
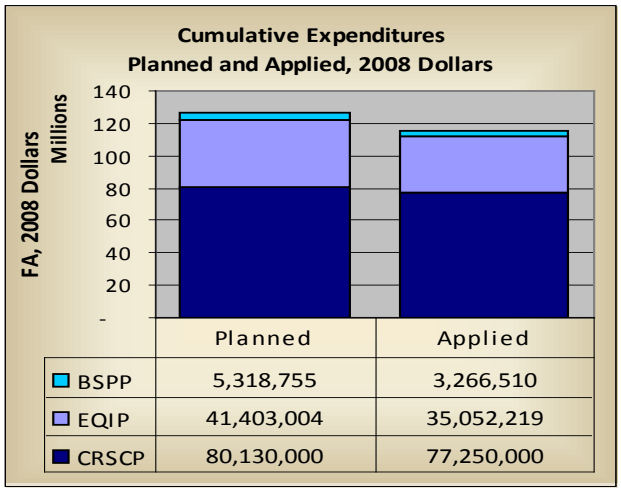


Figure 9, Comparison of Obligated and Expended funds.



	Planned	Applied
BSPP	5,318,755	3,266,510
EQIP	41,403,004	35,052,219
CRSCP	80,130,000	77,250,000

Figure 10, Cumulative applied salt load reduction.

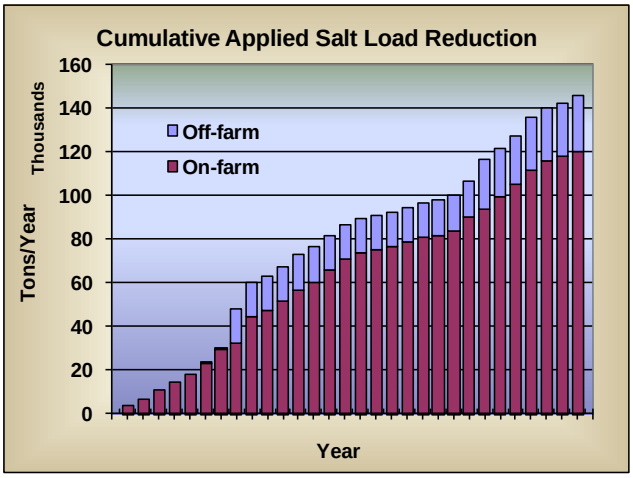


Table 6, Annual applied cost/ton, nominal and 2009 dollars.

FY	Federal Water Project Interest Rate	FA Applied Nominal	Irrigation Acres Applied	Salt Load Reduction Applied Tons/Year	Amortized FA+TA Applied Nominal	$/Ton Applied Nominal	2009 PPI Factor	FA Applied 2009 Dollars	Amortized FA+TA 2009 Dollars	$/Ton 2009 Dollars	Cum $/Ton, 2009 Dollars
1980	7.125%	-	4,329	3,234	-	-	234%	-	-	-	-
1981	7.375%	1,450,506	3,919	2,928	214,504	73	218%	3,163,377	467,806	160	76
1982	7.625%	1,450,506	5,801	4,333	219,260	51	211%	3,059,999	462,552	107	89
1983	7.875%	1,899,239	4,823	3,603	293,371	81	212%	4,033,009	622,969	173	110
1984	8.125%	1,746,366	5,040	3,765	275,580	73	208%	3,636,610	573,863	152	119
1985	8.375%	1,324,218	6,131	5,405	213,414	39	214%	2,830,582	456,184	84	111
1986	8.625%	3,491,444	8,285	6,395	574,515	90	224%	7,825,927	1,287,752	201	131
1987	8.875%	1,500,879	3,711	17,847	252,090	14	220%	3,295,501	553,518	31	93
1988	8.625%	3,011,008	16,675	12,457	495,460	40	206%	6,190,211	1,018,596	82	91
1989	8.875%	2,327,840	3,400	2,540	390,988	154	193%	4,499,143	755,684	298	99
1990	8.875%	1,978,927	6,313	4,716	332,384	70	189%	3,735,312	627,389	133	102
1991	8.750%	2,823,067	6,922	5,171	469,342	91	186%	5,236,789	870,629	168	106
1992	8.500%	3,382,799	4,834	3,611	550,898	153	186%	6,275,092	1,021,916	283	115
1993	8.250%	2,752,919	6,750	5,042	439,032	87	178%	4,909,169	782,909	155	117
1994	8.000%	2,749,248	6,741	5,036	429,244	85	176%	4,838,467	755,436	150	119
1995	7.750%	4,071,491	3,965	2,962	622,167	210	160%	6,515,395	995,622	336	126
1996	7.625%	882,617	1,902	1,421	133,417	94	153%	1,350,793	204,187	144	127
1997	7.375%	4,277,813	1,991	1,703	632,611	371	149%	6,380,492	943,559	554	135
1998	7.125%	1,273,064	2,127	2,048	184,125	90	153%	1,948,350	281,793	138	135
1999	6.875%	852,084	2,481	2,220	120,494	54	153%	1,304,065	184,409	83	133
2000	6.625%	1,134,422	1,840	1,239	156,800	127	147%	1,663,825	229,974	186	134
2001	6.375%	1,087,303	2,218	2,100	146,851	70	143%	1,555,822	210,129	100	133
2002	6.125%	1,513,372	6,576	6,186	199,660	32	142%	2,148,021	283,389	46	128
2003	5.875%	3,040,199	4,470	9,918	391,679	39	138%	4,180,291	538,561	54	122
2004	5.625%	4,096,866	5,581	5,452	515,258	95	132%	5,421,439	681,848	125	122
2005	5.375%	4,144,480	6,309	5,782	508,683	88	123%	5,100,919	626,074	108	121
2006	5.125%	6,918,799	6,952	8,109	828,457	102	119%	8,227,794	985,196	121	121
2007	4.875%	5,349,278	5,271	4,590	624,672	136	111%	5,958,678	695,836	152	122
2008	4.875%	3,709,063	2,328	2,341	433,133	185	99%	3,688,152	430,691	184	123
2009	4.625%	3,919,406	2,640	2,912	446,220	153	100%	3,919,406	446,220	153	124
Totals		78,159,223	150,326	145,065	11,094,308	76		122,892,629	17,994,690	124	

Table 7, Summary of Applied Practices by Year

Applied Practices									
FY	Nominal FA Applied	Sprinkler Acres	Improved Surface Acres	Drip Acres	Total Irrigation Acres	WL Wetland Habitat Mgmt	WL Upland Habitat Mgmt	Salt Load Reduced On-farm	Salt Load Reduced Off-farm
Projected					160,000			177,200	30,000
1980	-	3,651	698	(20)	4,349	-	550	3,234	-
1981	1,450,506	3,371	548	-	1,454,425	-	281	2,928	-
1982	1,450,506	4,452	1,349	-	1,456,307	-	377	4,333	-
1983	1,899,239	2,905	1,918	-	1,904,062	-	-	3,603	-
1984	1,746,366	3,122	1,918	-	1,751,406	-	-	3,765	-
1985	1,324,218	4,155	1,976	-	1,330,349	-	-	4,580	825
1986	3,491,444	6,642	1,643	-	3,499,730	102	-	6,395	-
1987	1,500,879	3,162	529	20	1,504,570	17	600	2,772	15,075
1988	3,011,008	15,201	1,474	-	3,027,683	15	1,638	12,457	-
1989	2,327,840	3,027	372	1	2,331,239	181	1,814	2,540	-
1990	1,978,927	6,060	253	-	1,985,240	252	625	4,716	-
1991	2,823,067	6,709	212	1	2,829,988	394	-	5,171	-
1992	3,382,799	4,666	160	8	3,387,625	154	3,004	3,611	-
1993	2,752,919	6,597	145	8	2,759,661	415	21,909	5,042	-
1994	2,749,248	6,581	150	10	2,755,979	213	868	5,036	-
1995	4,071,491	3,934	17	14	4,075,442	95	755	2,962	-
1996	882,617	1,856	42	4	884,515	655	404	1,421	-
1997	4,277,813	1,990	-	1	4,279,803	92	34	1,703	-
1998	1,273,064	1,970	156	1	1,275,190	24	17	1,854	194
1999	852,084	2,478	-	3	854,562	-	3	2,195	25
2000	1,134,422	1,725	115	-	1,136,262	1	17	1,180	59
2001	1,087,303	2,105	113	-	1,089,521	-	-	2,012	88
2002	1,513,372	6,322	254	-	1,519,948	-	2,010	6,006	180
2003	3,040,199	4,387	80	3	3,044,666	-	19	4,091	5,827
2004	4,096,866	5,472	108	1	4,102,446	1	36	5,108	344
2005	4,144,480	6,277	32	-	4,150,789	-	91	5,774	8
2006	6,918,799	6,863	85	4	6,925,747	-	85	6,285	1,824
2007	5,349,278	5,268	-	3	5,354,546	-	-	4,590	-
2008	3,709,063	2,324	-	4	3,711,387	50	(50)	2,131	210
2009	3,919,406	2,600	33	7	3,922,039	-	-	2,380	532
Totals	78,159,223	135,873	14,380	73	149,545	2,661	35,087	119,874	25,191

Evaluation by Program

Since 1980, about 2,800 contracts have been written with landowners to upgrade irrigation practices on approximately 150,000 acres. As of the end of FY2009, practices are applied on about 149,500 acres. Only 10% of applied systems are improved flood systems, 90% being higher efficiency sprinkler systems.

Table 8 summarizes contract data by funding program, in 2009 dollars.

Figure 11 depicts acres planned by program.

Figure 12 depicts planning status. Of 14,400 acres of improved flood, about 700 acres have since been converted to sprinkler systems.

Table 8, Contracts Applied by Program

FY2009	Planned			Applied				
Program	Contracts	FA, 2009 $	Irrigated Acres	FA, 2009 $	Irrigated Acres	$/Acre	Salt Load Reduction, Tons	Salt Load Reduction, Tons/Acre
ACP & CRSCP	1,671	80,130,000	99,185	77,250,000	101,575	761	91,985	0.91
IEQIP	62	3,400,000	2,480	3,360,000	2,581	1,302	2,362	0.92
EQIP	953	46,770,000	43,675	38,020,000	41,360	919	45,206	1.09
EQIP WLO	34	1,690,000		750,000				
BSPP	94	6,730,000	4,566	4,260,000	4,029	811	5,511	1.37
Totals	2,814	138,720,000	149,906	123,640,000	149,545	827	145,065	0.97

Hydro Salinity Monitoring

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.)

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

Figure 11, Acres planned by program

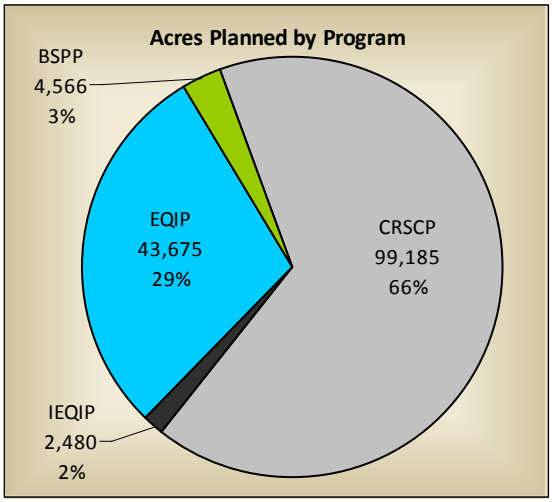
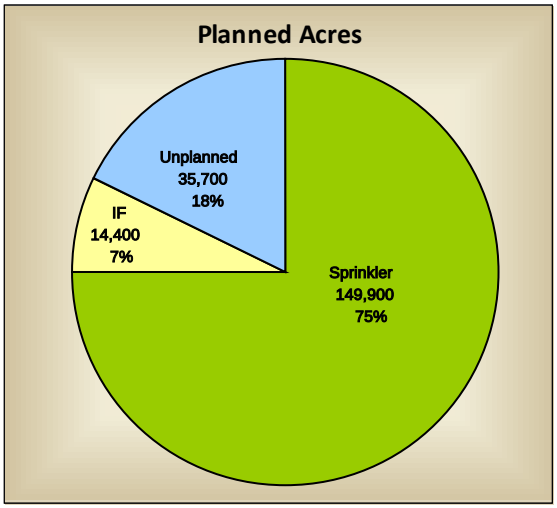


Figure 12, Planned/Unplanned acres



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 now account for approximately two-thirds of acres obligated each year.

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 many irrigated farms, requiring expensive equipment and frequent field visits to ensure and validate collected data.
- Detailed water budgets were required to determine/verify deep percolation reductions.
- Multi-level soil moisture was measured weekly with a neutron probe.
- Detailed sprinkler evaluations, using catch cans, were run annually on selected farms.
- Crop yields were 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 efficiency and sharply reduced deep percolation, 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 2002. Having established that properly installed and operated practices yield predictable and favorable results, the 2002 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.

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.

This report was summarized in the FY2007 M&E report.

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.

This report was summarized in the FY2007 M&E Report.

Irrigation Water Management (IWM)

The goal of IWM is to assure that irrigated lands receive 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 potential crop in the warmest months of the year. When growing crops with lower water needs, or at other times in the growing season, these systems are capable of limited over-irrigation.

Over irrigating in early spring and late fall is somewhat mitigated by water storage aspects of the soil. Crops generally use water before 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 14). Some over-irrigation and deep percolation is necessary to leach salt buildup from the soil (leaching fraction), and is designed into the system.

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

Cooperator interest is enhanced by creating financial incentives for IWM. To collect payment for the IWM practice (449), a cooperator must:

1. Attend a two hour IWM training session or attend an approved water conference,
2. Keep detailed irrigation records using the IWM Self-certification spreadsheet, and
3. Review the records with an NRCS employee or contractor trained to evaluate and explain IWM principals.

Starting in FY2008, an additional "intensive" IWM practice was made available that pays a higher rate if the cooperator also purchases, installs, and utilizes a soil moisture monitor.

Most operators are keenly interested in learning to understand IWM principals and operate their irrigation systems professionally, and profitably.

Irrigation Record Keeping

To help with irrigation timing, NRCS - Utah has developed and provided the, "IWM Self Certification Spreadsheet" which allows cooperators to graphically compare actual irrigation with mathematically modeled crop evapotranspiration (ET), using either long-term averages or real-time climate data. ET is calculated from climate data collected by NRCS and other public agencies, using Penman-Montieth procedures outlined by the Food and Agriculture Organization of the United Nations (FAO). The spreadsheet creates two graphs, the first showing available water content (AWC) and deep percolation and the second comparing water applied with water required on a seasonal basis. See figures 13 and 14.

Figure 13, is the entry form part of the IWM Self Certification Spreadsheet, on which the irrigator can record irrigation dates and application rates. Data entered in the first four columns of the sheet is used to calculate the remaining columns and to create two graphs (see Figure 14).

Figure 13, 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%

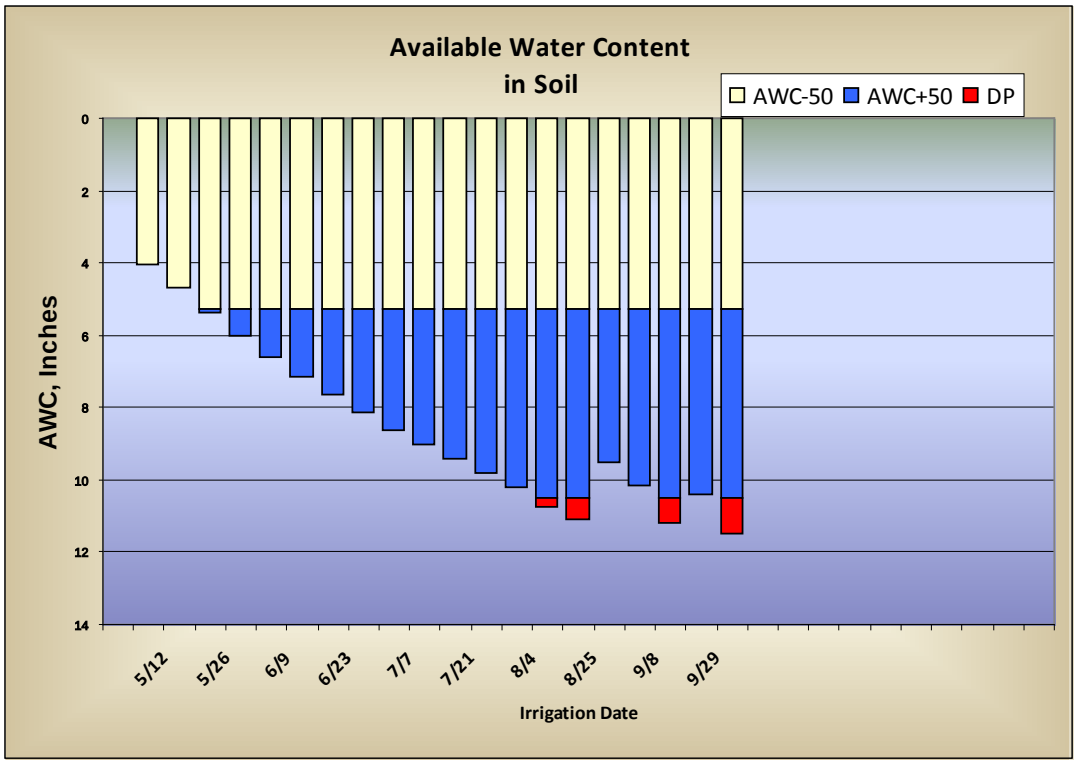
Start date of irrigation	End date of irrigation	Total Cycle Hours	Flow (cfs) OR number of nozzles multiplied by nozzle flow (gpm)		Inches Applied Cycle	Inches Applied Season	CU Season (Table)	Inches Available	AWC	Deep Perc
04/23/07	04/27/07	96	685.0	gpm	2.04	2.04	1.18	6.83	6.83	0.00
04/30/07	05/08/07	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%		

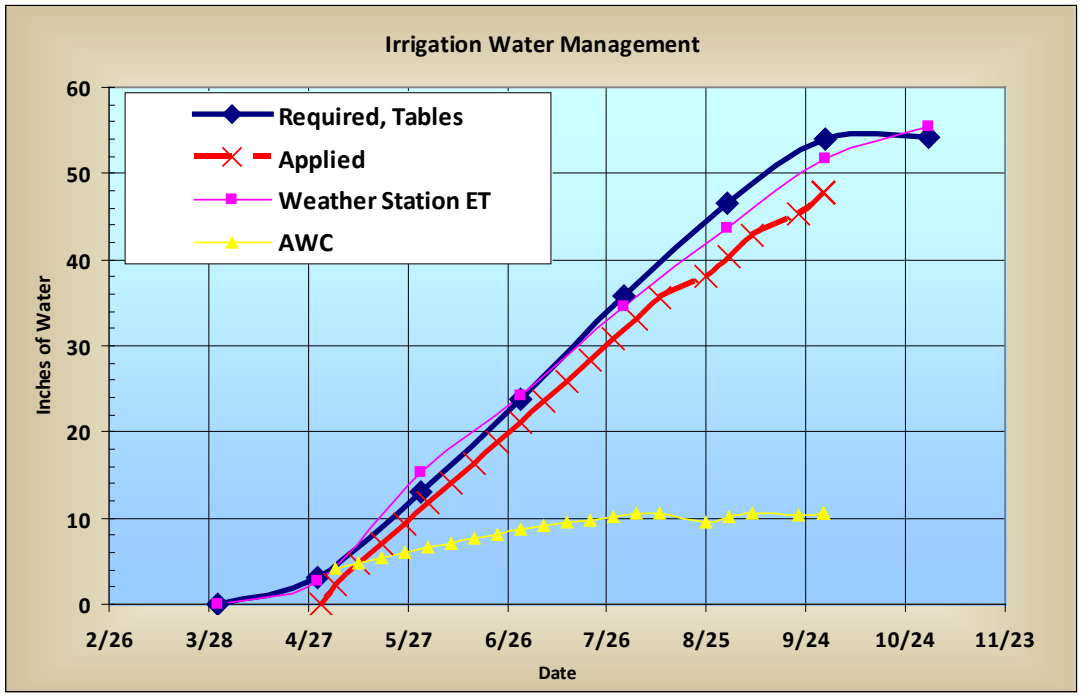
For maximum crop growth, AWC must be maintained in the upper 50% of its range. Some deep percolation is designed into each system as a leaching fraction to avoid buildup of salts in the soil. The first graph in figure 14 estimates water storage in the soil, indicating the preferred range of 50 – 100% of AWC in blue, and showing deep percolation in red, below capacity bars when it occurs.

On the second 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-application line is above the blue consumptive-use line, the field is over-irrigated and excessive deep percolation has occurred.

Figure 14, Sample graphs from the IWM Self Certification Spreadsheet.

In the top graph, the blue zone is the preferred AWC for the soil and crop. Red bars are deep percolation. In the bottom graph, 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 near real-time data collected at a nearby weather station, using FAO's Penman-Montieth evapotranspiration model. The yellow line indicates AWC.





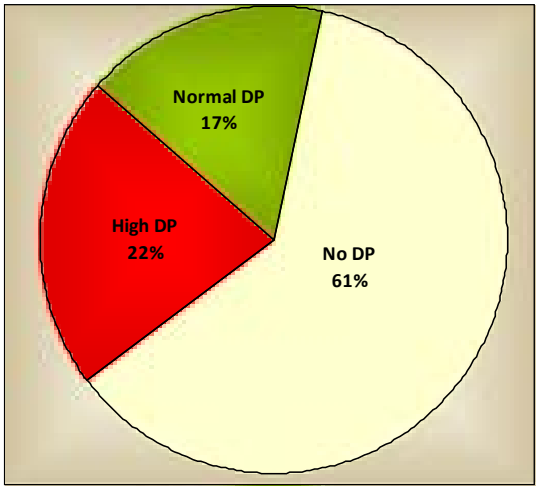
This spreadsheet is used by the cooperator to self-certify his irrigation records when presented to and discussed with NRCS employees or contractors.

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 IWM training and their expressed interest in irrigation water management.

In FY2009, 189 completed IWM self certification spreadsheets were delivered to the M&E team, representing 5,000 acres. On an acreage basis 61% had no deep percolation, 17% were within design limits of deep percolation for their irrigation system, and 22% exceeded their design limits of deep percolation (after compensating for average soil moisture storage effects). See Figure 15.

Four years of IWM Self-certification data indicates that the total actual volume of deep percolation is about 83% of the expected amount, based on normal leaching fractions.

Figure 15, Acres with deep percolation from IWM Certification Spreadsheets



Soil Moisture Monitoring

A historically proven method for timing irrigation involves augering a hole and determining the water content of the soil to help decide when the next irrigation should be applied. This may well be the best method available for irrigation timing, both simple and inexpensive. However, few operators take time to do it.

NRCS is demonstrating and guiding operators in the use of another tool for timing irrigation - modern soil moisture monitoring systems utilizing electronic probes and data recorders. The IWM incentive payment is higher for participants that elect to install soil moisture monitors. Such systems can be installed for as little as $600, giving the operator 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", along with a single temperature probe. Using a simple data recorder, indicated soil pore pressure (implied soil moisture content) is sampled 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 figure 16.

Figure 16, Soil Moisture data recorder with graphing

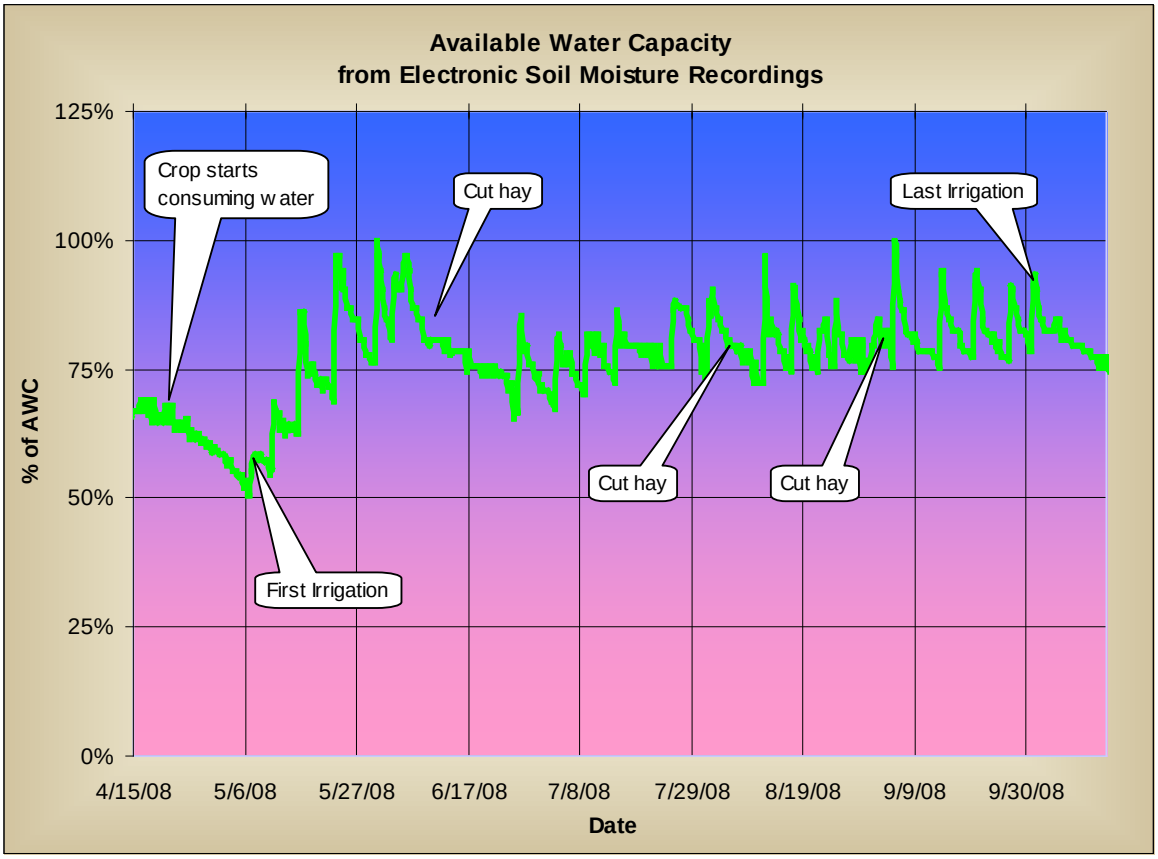
Since gravimetric drainage generally does not occur unless the soil horizon is nearly saturated (above field capacity), it is assumed that deep percolation is not occurring if the deepest probe reading is greater than -10 centibars. In the Uintah Basin, five installed data recorders indicate that deep percolation occurs less than 5% of the time on monitored fields.

If soil characteristics are known, recorded soil moisture data can be used to estimate AWC. The lower limit of the Readily Available Water Content (RAW) may fall in the range of -80 to -120 centibars. Assuming a linear relationship from 0 to -200 centibars, and knowing the AWC/foot of soil, the soil profile can be divided into layers and total AWC estimated for each layer, knowing soil pore pressure (and derived saturation), layer thickness, and capacity. Summing AWC for all layers yields total AWC for the soil profile.

Figure 17 is a typical graph of estimated AWC for one set of three soil moisture probes in an alfalfa field.

Figure 17, AWC from Soil Moisture Data graphed in Microsoft Excel.

This rich loam soil absorbs moisture readily and has good water storage characteristics. In early spring, alfalfa starts to grow, pulling stored moisture from the soil. Irrigation begins, adding water to the soil profile. Each pass of the pivot is a peak in the curve. It is simple to pick cutting times and down times where peaks are missed and total soil moisture declines then peaks because the cut hay uses less water than applied. At the end of the season, irrigation ends, but the crop continues to draw water from the soil profile for a few weeks, leaving soil moisture partially depleted. The soil moisture profile was kept in the MAD zone from 50% to 100% of AWC, through the entire irrigation season, yielding a satisfying crop.



Since actual water storage characteristics are highly variable, based on soil properties, calibrating a soil moisture monitor to accurately reflect actual AWC is tedious. However, the soil moisture monitor is still a

useful tool to indicate when water is needed, if the operators pay enough attention to get a sense for what it is telling them.

Equipment Spot Checks and Evaluations

Catch-can Testing

Since FY2005, catch-can tests have only been ran on request, due to limitations described in the FY2005 M&E report. As reported in the FY2005 M&E Report, for wheel lines, catch-can testing is most useful to evaluate design, but is not particularly useful in determining condition, since the best operating three adjacent sprinkler heads are typically picked to run the test, assuring an optimum outcome.

Operating Sprinkler Condition Inventory

In FY2006-FY2008 irrigation seasons two thousand and sixty systems were visually evaluated for age, leaks, and general condition. Sixteen hundred, eighty-eight were operating wheel lines, pod-lines, or hand-lines.

This study concluded that age is a major factor in system condition and overall leakage, as would be expected. However, even with the oldest systems, average leakage amounts to only 1.45% of water applied, much smaller than evaporation, and somewhat minor in the overall scheme of things. Most needed repairs could be avoided with consistent, quality maintenance. There are more than a few 25 year old systems operating without leaks.

A detailed report of the study was included in the FY2008 M&E Report.

Long-term Sprinkler Water Budgets

Long term monitoring of water budgets on fields has ended. No additional, useful data has been collected for several years. The effectiveness of irrigation improvements on salinity control is well established.

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 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 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 the present.

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 FY2009 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.

1980 Utah Division of Water Resources Water Related Land Use (WRLU)

In 1971, the Utah Division of Water Resources published Water Related Land Use in the Uinta Hydrologic Area, which was the source document for indentifying wetlands in the original EIS.

In 1980, the Center for Remote Sensing and Cartography of the University of Utah Research Institute updated the Water Related Land Use inventory for the Uintah Basin. This update was done in cooperation with Utah Division of Water Resources (Water Resources), USDA Soil Conservation Service, and National Aeronautics and Space Administration. The 1980 update 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 years and made available to the public.

While the 1971 and 1980 WRLUs focused specifically on wetlands, later versions emphasize crops and have little wetland data. The 1980 version is deemed to be more relevant to salinity projects, installation of which began in 1980.

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.

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, orthoimagery is available in gray scales from the early to mid 1990s. Color imagery is available for later dates, the most recent being the one meter National Agricultural Image Program (NAIP) from 2009. The 2006 NAIP is also available in CIR and high resolution (one foot) for agricultural areas. Pre-1980 images are available in hard copy, but require digitizing, orthorectification and assembly into a mosaic, at some appreciable expense, to be readily 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 may not be justifiable for this effort.

By overlaying the 1980 WRLU on the NAIP, it is reasonably straight forward to determine if a polygon classified as wetland in 1980 is no longer wetland presently. However, without an older image, it is impossible to verify that it was indeed wetland in 1980. Using the 2006 NAIP, M&E evaluated wetland

changes on four quadrangles; Bridgeland, Hancock Cove, Vernal NE, and Altonah. Additional quadrangles will be evaluated as time permits.

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 FY2009, 150,000 acres have been treated with improved irrigation systems, 123% 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, 5,500 acres of wetland replacement/improvement has been planned along with 18,300 acres of upland habitat improvement. The first two bars of Figure 18 compare EIS projected wetland conversion to upland with measured conversion. The second two bars depict funded habitat replacement, planned and applied. The

Table 9, FY2008 Wildlife habitat acres planned and applied

Acres of Wildlife Habitat Creation or Enhancement by Program				
FY2009				
Program	Acres Planned		Acres Applied	
	Wetland *	Upland	Wetland *	Upland
BSPP	-	-	-	-
EQIP	52	188	1,290	764
WHIP	-	-	-	-
Total	**52**	**188**	**1,290**	**764**

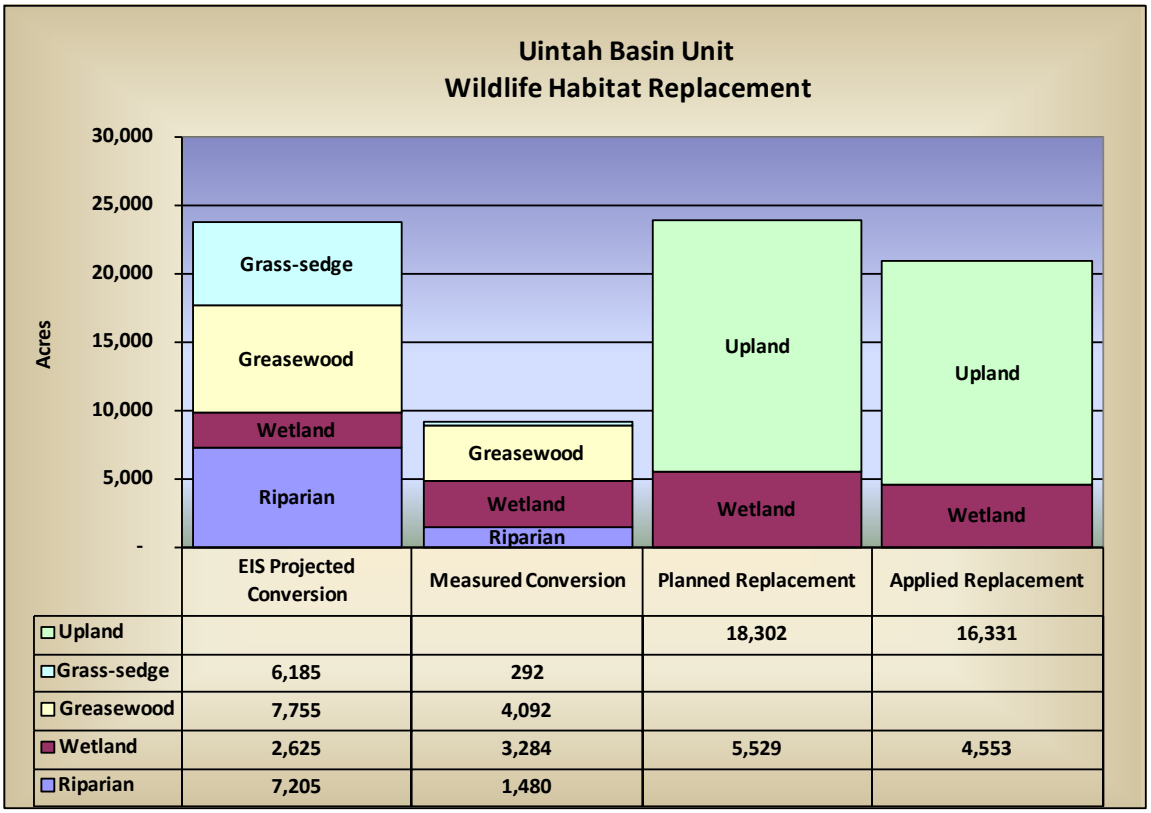
* Wetland habitat type includes riparian areas

Table 10, Cumulative Wildlife habitat acres planned and applied by program

Acres of Wildlife Habitat Creation or Enhancement by Program				
Cumulative practices planned and applied				
Program	Acres Planned		Acres Applied	
	Wetland *	Upland	Wetland *	Upland
CRSCP	2,600	12,799	2,600	12,799
IEQIP	1	1	1	1
BSPP	150	239	80	239
EQIP	2,542	3,817	1,643	3,030
WHIP	236	1,446	229	262
Total	**5,529**	**18,302**	**4,553**	**16,331**

* Wetland habitat type includes riparian areas

Figure 18, Wildlife habitat management cumulative status



wetland category includes both riparian and wetland practices. Figure 18 summarizes cumulative progress with respect to wildlife habitat management and improvement.

Basin Wide Wildlife Habitat Monitoring

Permanent photo points, representative locations throughout the Uinta Basin of wetlands, wildlife habitat, agricultural areas, and areas where pipelines have recently been built were selected in FY2007 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 this document.

Wildlife Habitat Contract Monitoring

Three Environmental Quality Incentive Program (EQIP) Wildlife Only projects were planned and funded in the Uinta Basin in FY2009 for a total of 240 acres. No Wildlife Habitat Incentives Program (WHIP) or Basin States Parallel Program (BSPP) projects planned or funded in FY2009 (Table 9).

For this document, all wildlife habitat creating/enhancing practices (acres applied) in contracts are arbitrarily assumed to be applied in proportion to dollars paid out (Table 9).

Cumulative wildlife habitat replacement/enhancement is summarized, by program, in table 10.

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.

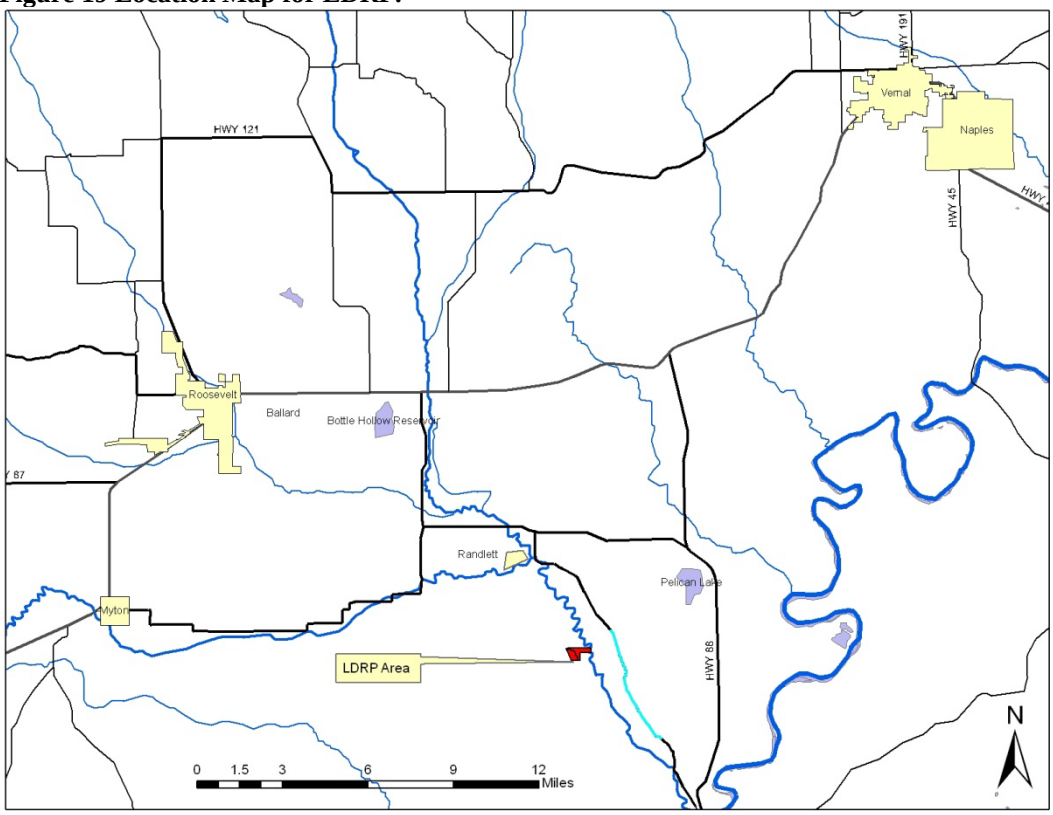
Case Study: Lower Duchesne River Project

Background

Wildlife habitat replacement in the Uinta Basin Salinity Unit increased in Fiscal Year 2007, with the addition of a few large riparian restoration projects. The Lower Duchesne River project (LDRP) was one of these funded in 2007. The LDRP is owned by a private individual who read about Wildlife Habitat Development Plans on the USDA-NRCS website. A Plan and Contract were developed and nearly complete when the land was sold to another private individual in 2009, with similar conservation interests. The LDRP is located approximately four miles south of Randlett, UT, within the Duchesne River corridor (Figure 19). The Duchesne River is a major waterway that drains most of the Uinta Basin and eventually flows into the Green River. The river flows though most all land ownerships (Federal, State, Private, and Tribal). Due to the large drainage area the river is subject to extremely high runoff flows during springtime snow-melt from the Uinta Mountains. This runoff and the subsequent erosion is one if the reasons the landowner sought the help of the federal government as portions of his land along the river were being washed downstream (see photo gallery). Traditional land use was cattle grazing and initially the landowner held approximately 150 acres, including the last agricultural field under irrigation on the South/West side of the Duchesne River before it's confluence with the Green River. The new landowner has since purchased additional land south of the project area and wishes to expand the Conservation Plan to include his new holdings.

The Duchesne River, especially the lower reaches, is an area of special concern for wildlife populations. The proximity to the Green River provides access to native endangered fishes found in the Colorado and Green River drainages. The Colorado Pike-minnow, the Bonytail Chub, the Razorback Sucker and the Humpback Chub, may occur in the river along the LDRP. There are also several other Utah State Sensitive species that could occur in the project area such as: Lewis' woodpecker, American White Pelican, flannel mouthed sucker, bluehead sucker, round-tail chub, and River Otter

Figure 19 Location Map for LDRP.



Objectives

The LDRP is 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), range and pasture management, noxious weeds, upland and big game species, and sensitive species (mentioned above). Objectives revolve around these circumstances and are listed below, in no particular order:

- **Control and effective use of irrigation water flowing (almost year round) on the property.** Once the irrigation season is over, water continues to run down the canal and into a diversion ditch which drains back into the Duchesne River. Poor "wild flood irrigation" was facilitating erosion, weed propagation, and mosquito production. It was also not effectively irrigating the agricultural land.

- **Re-vegetate banks of the Duchesne River to slow or stem erosion of agricultural fields.** The riparian area was being severely eroded from large influxes of spring run-off water damaging infrastructure and washing part of the agricultural soil downstream (see photo gallery).

- **Control land degradation by livestock and improper grazing practices.** Year-round grazing above carrying capacity practiced by previous landowners resulted in erosion, land degradation, noxious weed infestation, sickness and death of livestock.

- **Eliminate or greatly reduce noxious weeds throughout the property.** Large quantities of Russian Knapweed (*Centaurea repens*), Perrenial pepperweed (*Lepidium latifolium*), Tamarisk (*Tamarix chinensis*), Canada thistle (*Cirsium arvense*), and Russian olive (*Eleagnus angustifolia*), exist on the property to the detriment of the land and the exclusion of native species.

- **Reduce soil erosion and promote water conservation of "tail water" on agricultural fields.** Wild flood irrigation was producing large pools of standing water at the bottom of ag-fields creating dangerous mire for cattle, and a mosquito breeding ground. Standing water would also saturate the banks of the Duchesne River and cause stream bank erosion, gully formation, sedimentation and turbidity issues in the river.

- **Increase wildlife food, shelter, and cover through woody and herbaceous vegetation planting.** Woody vegetation along the Duchesne River primarily consists of Tamarisk, Russian olive and scattered, ancient, Fremont cottonwood trees. Little or no recruitment of native woody riparian vegetation was present before project inception. Herbaceous vegetation was dominated by noxious weeds.

- **Improve agricultural fields for best potential production.** Ag-fields had been poorly managed in the past. Water dispersion (wild flood irrigation) was not effective to cover production land. Alfalfa stand was 25+ years old with no crop rotation, and year-long grazing was practiced on ag-fields.

Results

Reviewing the application for funding, it became apparent that there were two overarching objectives to meet; wildlife habitat restoration and agriculture. As a consequence, two separate Conservation Plans/Contracts were written to address both wildlife and agricultural land uses.

On-the-ground meetings were performed in fall 2006 through spring 2007 with the National Wild Turkey Federation (NWTF), the landowner, Uintah County Soil Conservation District, and NRCS to assess the resource concerns/objectives.

From these meetings consensus was achieved and the following practices (Figure 20) were included in the Wildlife Habitat Conservation Plan:

- 40 acres improved flood irrigation system
- 3,970 feet riparian buck and pole fence
- 800 trees and shrubs
- Three structures for water control, (two to facilitate irrigation system, one to control gully formation)
- 40 acres native grass/forb seeding
- 89 acres of weed spraying (pest management) over three years
- 89 acres of wildlife habitat management incentive payments over three years

The following are practices (Figure 21) included in the Agricultural Conservation Plan:

- 51 acres improved flood irrigation system w/ appurtenances
- 51 acres irrigation water management
- One irrigation regulating reservoir w/ compacted clay lining
- 1,565 feet 12' PVC pipe w/ appurtenances

In summary, combining the two contracts, landowner and NRCS objectives were addressed as follows:

- Irrigation water was controlled by the use of pipelines, irrigation regulating reservoir, a tailwater collection structure, and more efficient gated pipe irrigation system. (Due to the remote location and lack of energy resources, pumping for sprinklers was impractical.)

- Trees and shrubs were planted and are still being planted to help stem erosion and create wildlife food, cover, and shelter.

- Under the new management livestock grazing has been reduced to approximately 1.5 months in late summer and early fall on the agricultural land. The riparian area has been excluded and will only be grazed for about two weeks every other year.

- A three year weed spraying program was completed in fall, 2009 eliminating most of the Russian knapweed, and perennial pepperweed. The treated area will be re-seeded to native grasses and forbs in spring 2010.

- The improved irrigation system will distribute water to all ag-fields and wildlife plantings, thus improving production and habitat quality. It has also helped control the amount of water that collects at the bottom of the fields to reduce the saturation of the banks of the Duchesne River. A collection structure was also created to drain excess water and deliver it through a pipe into the river, eliminating the gully formed by previous irrigation water mismanagement.

- With newly planted pasture, trees, shrubs, native grass and forbs, there will be abundant food and forage for wildlife species as even the ag-fields are managed for wildlife benefit.

Discussion

Spring, 2010 will begin the first full year with the new irrigation system in operation. The fence was constructed in winter, 2007-2008, and most of the planting of trees, shrubs, native grasses and forbs will be completed in 2010. It is anticipated that the project will be complete by September, 2010. The LDRP is an excellent example of how agriculture and wildlife needs can be met on the same piece of property. The landowners have been attentive of all resource concerns from wildlife to production agriculture and have been willing to give and take as needed.

NRCS will continue to monitor the progress of applied practices and supply the landowner with technical assistance as well as additional financial assistance on newly acquired land immediately south of the project area.

The Conservation Plans have addressed 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 Duchesne River watershed.

Figure 20 Wildlife Habitat Development Plan Conservation Plan Map for LDRP.

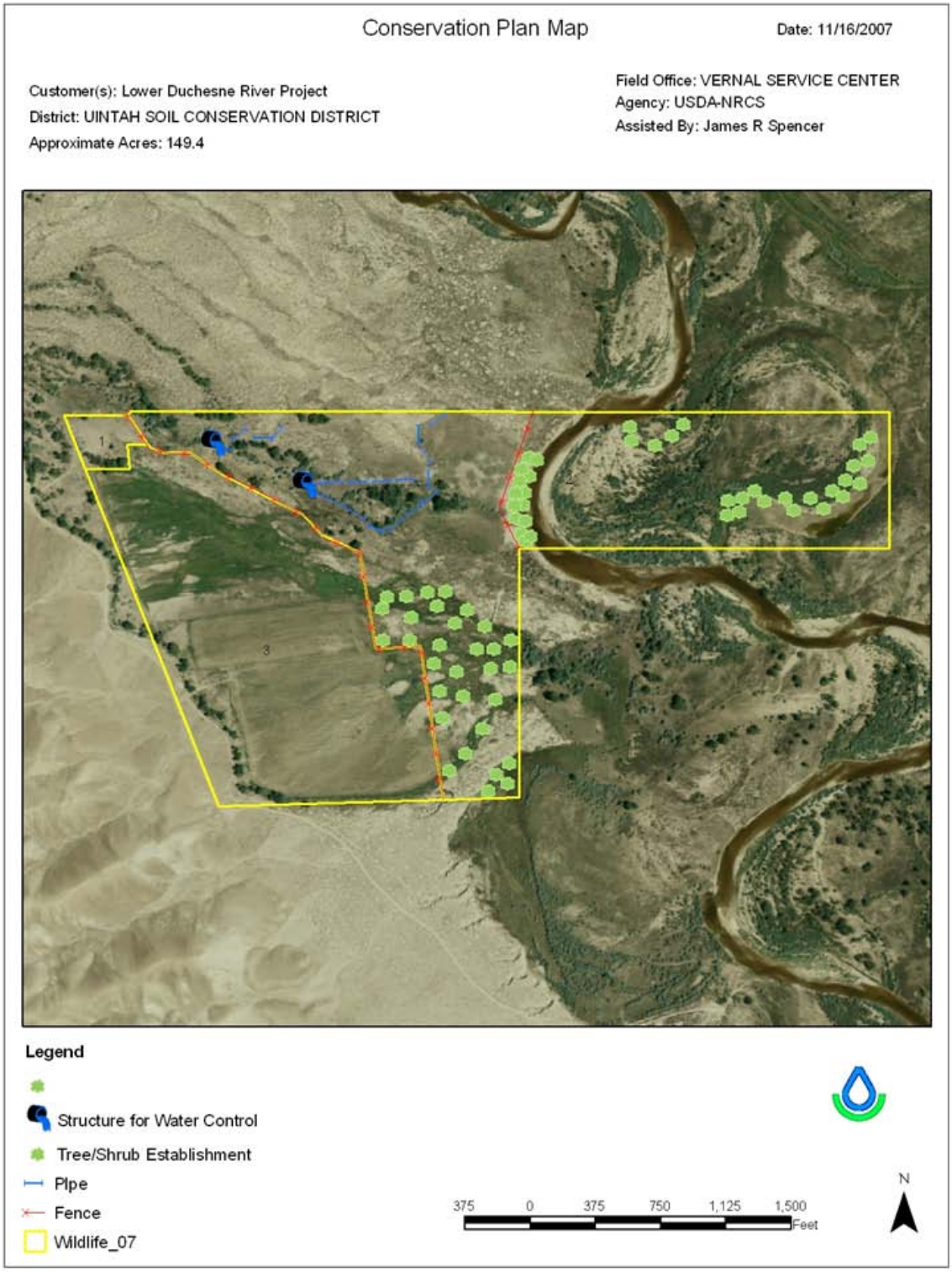
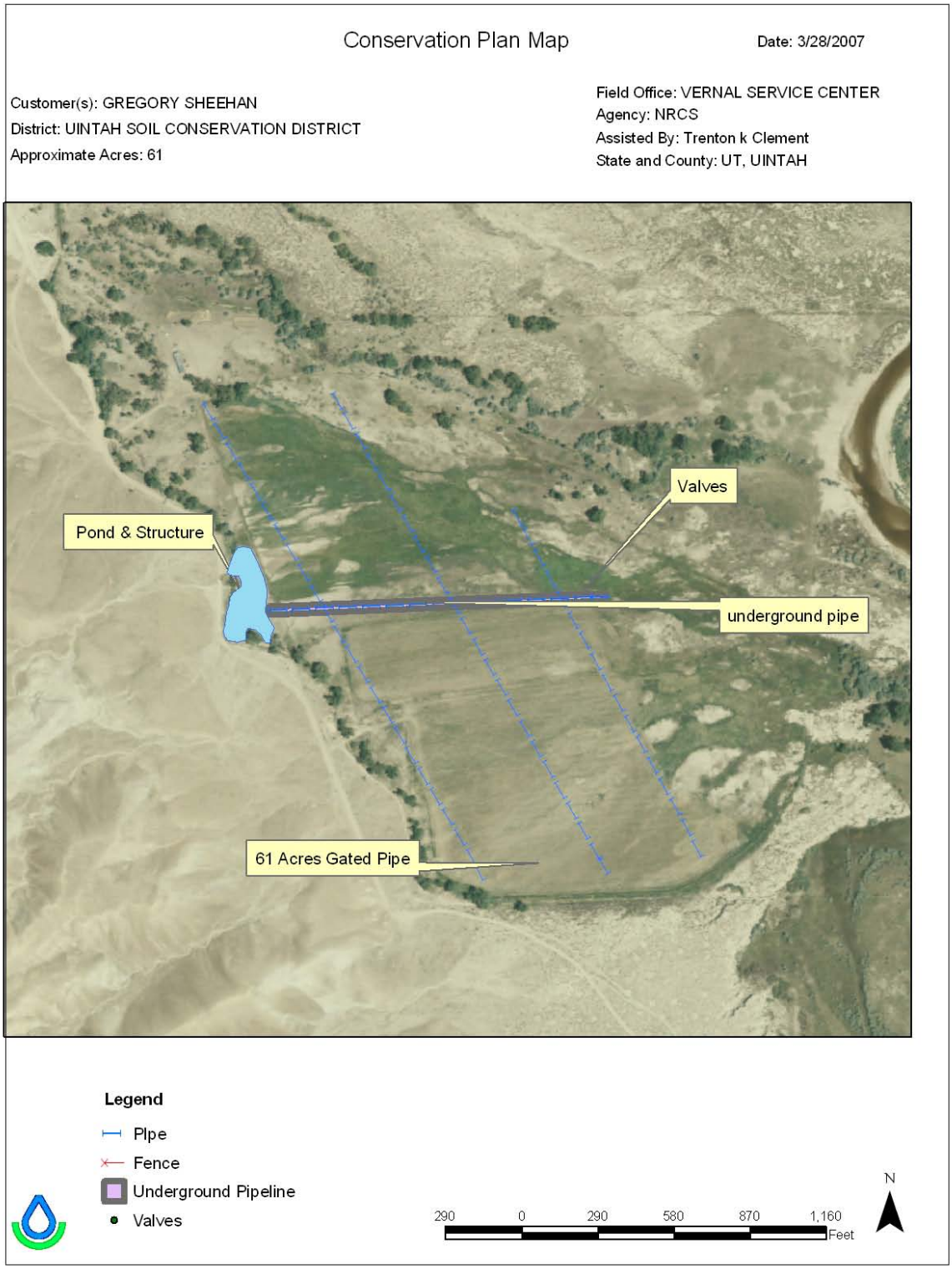


Figure 21 Irrigation Conservation Plan Map for LDRP.



LDRP Photo Gallery

Figure 22, March 30, 2006; pre-contract field visit looking WSW from edge of Duchesne River.

Figure 23, March 28, 2006; pre-contract field visit looking ESE from the western boundary.

Figure 24, June 2, 2005; overview of LDRP looking E.; irregular distribution of water.

Figure 25, June 2, 2005; spring runoff removed approximately 50 feet of riverbank.

Figure 26, June 2, 2005, 20+ ft high cut-banks with Russian knapweed as stabilizing vegetation.

Figure 27, December 6, 2006; landowner attempt to stabilize stream banks (same view as above).

Figure 28, December 6, 2006; landowner attempt to stabilize stream banks (downstream view).

Figure 29, September 20, 2007, one full year after bank stabilization practices.

Figure 30, February 15, 2008, riparian fencing was completed in freezing fog and snow.

Figure 31, September 26, 2008; irrigation regulating reservoir is completed; designed to provide maximum water edge area for wetland fringe to benefit wildlife.

Figure 32, May 29, 2009, completed pond with fence looking NW.

Figure 33, June 9, 2009, **riparian** fence and vegetation growth after knapweed treatments.

Figure 34, June 9, 2009, first string of gated pipe installed looking SSW.

Figure 35, June 9, 2009, first string of gated pipe installed looking NNE.

Figure 36, June 9, 2009, understory growth behind fence, without weeds, and under new grazing regime.

Figure 37, December 6, 2006, moose cow and calf on property.

Figure 38, July 31, 2006, flock of wild turkey; abundant throughout the property.

Figure 39, May 29, 2009, State sensitive species, American white pelican on the Duchesne River along property.

Figure 40, October 21, 2005, elk numbers have increased each year on the property.

Figure 41, May 1, 2009, beaver thrive and are even a nuisance throughout the property.

Figure 42, April 30, 2009, cottonwood galleries are dwindling with little or no recruitment throughout the floodplain.

Figure 43, May 9, 2009, parting shot of the pond.

Economics

Cooperator Economics

Production Information

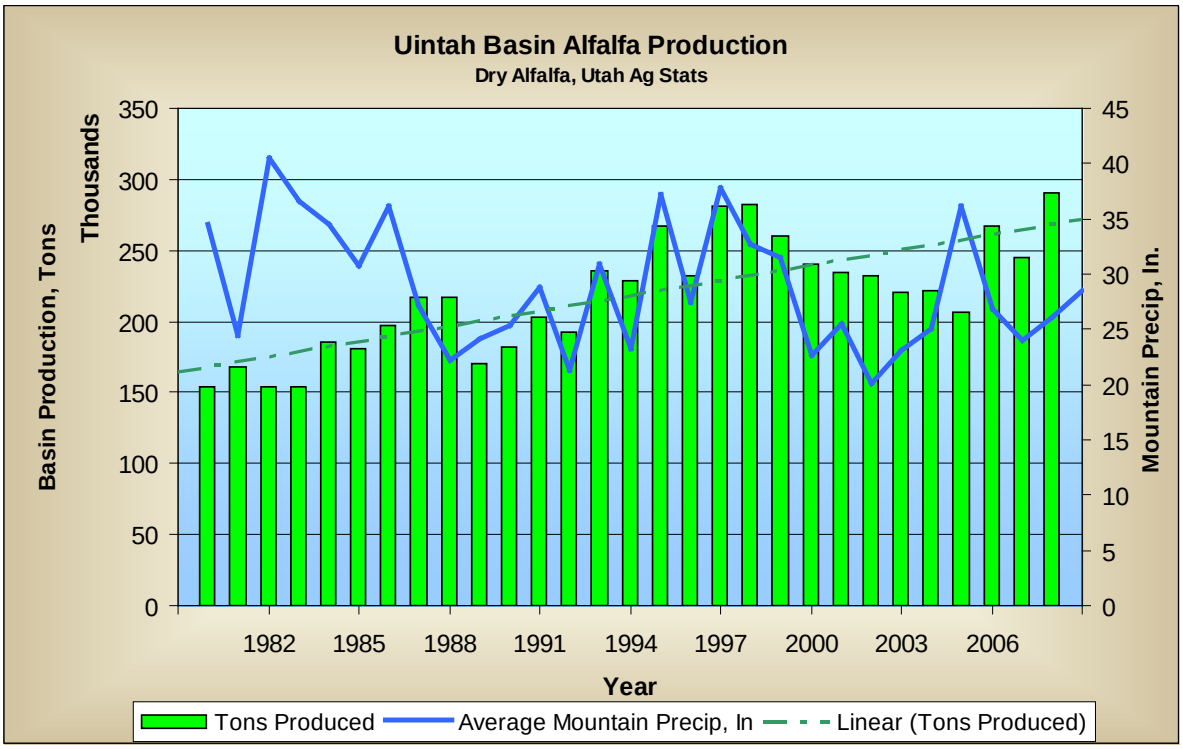
Field studies completed in 1995 concluded that upgrading from unimproved flood irrigation to improved flood or sprinklers, increased alfalfa crop yields from about 2.5 tons/acre to about 4.5 tons/acre. This magnitude of increase is consistent with anecdotal information from diligent cooperators.

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 150,000 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 74% since 1980, while alfalfa acreage has increased about 80%. From 1980 to 2008, average production increased from 161,000 tons to 270,000 tons, while alfalfa acreage increased from 47,000 acres to 85,000 acres (Utah Division of Water Resource's Water Related Land Use data 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 39 is a graph of Uintah Basin alfalfa production and mountain precipitation. Source data is tabulated in Appendix VI.

Figure 44, Alfalfa Production and Annual average mountain precipitation



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, 2002, and 2007 Agricultural Censuses.

While numerical data seems inconclusive, anecdotal information is positive.

Since the majority of farmers (77%) reported in the 2007 Agricultural Census, do not hire outside labor, it is assumed that most cooperators are satisfied with their own personal labor savings. The 2007 Agricultural Census also reports that 66% of Uintah Basin farmers have full-time occupations other than farming. The local labor market has weakened, as the energy business seeks to understand its future under a new administration. Under the circumstances, it seems logical that landowners may be spending less time in off-farm employment.

Another perceived labor effect 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.

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 FY2009 average cost of $153/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.

Positive public perceptions of the Salinity Control Program include:

- Reduced salinity in the Colorado River and its tributaries
- 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

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. The local economy has leveled out, and upward pressure on labor and equipment prices is waning.

Appendices

Appendix I, Revised salt load reduction calculation.

COLORADO RIVER BASIN
SALINITY CONTROL PROGRAM

CALCULATING SALT LOAD REDUCTION

MODIFICATION OF PROCEDURE
JULY 30, 2007

Prepared by
Natural Resources Conservation Service

Ed Whicker, Civil Engineer, Roosevelt, Utah, Email: ed.whicker@ut.usda.gov

Frank Riggle, Assistant State Conservationist for Water Resources, Lakewood, CO, Email: frank.riggle@co.usda.gov

Travis James, Salinity Coordinator, Salt Lake City, Utah, Email: travis.james@ut.usda.gov

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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.

$$SL_e = SL_0 \times A \times SLF_e$$

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.

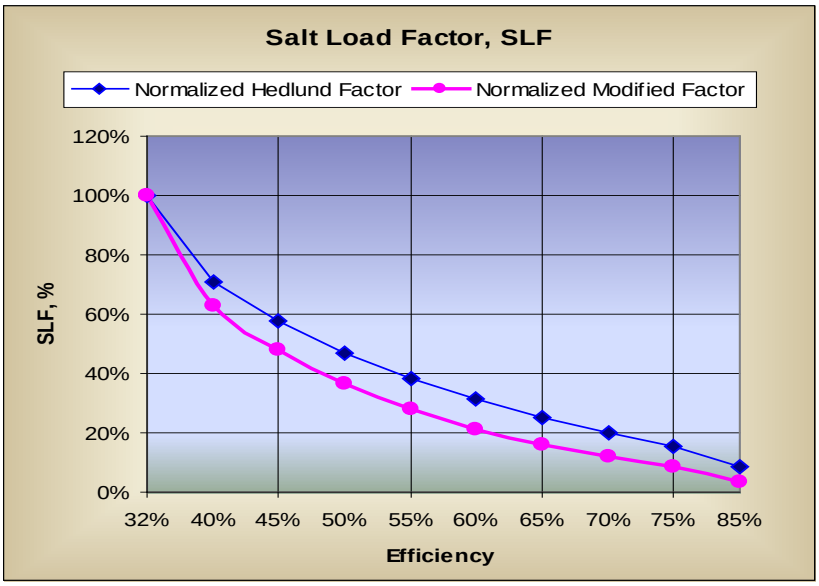

Figure 2 Graph of salt load factor, SLF. The upper line was used in the Ranking Worksheet FY2004 – FY2007. The lower line is used in new Salinity Worksheets for Ranking, beginning with FY2008 contracts and is mathematically defined above.

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**

Appendix IV, USU CRBSCP – Wheel line study

Evaluation of Wheelmove Irrigation Systems Nearing End of Practice Life

Colorado River Salinity Control Program

Final Report - Draft

November 29, 2006

Prepared by:
Robert W. Hill, E. Bruce Godfrey, Boyd Kitchen, and Troy Cooper
Cooperative Extension Service
Utah State University
Logan, Utah

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.

Appendix V, Summary of UACD Study of Replacement Applications

IRRIGATION SYSTEM EVALUATION AND REPLACEMENT STUDY

COLORADO RIVER BASIN SALINITY CONTROL PROJECT

Final Report

December 27, 2007

Prepared by:
Darrell Gillman,
William Merkley,
and Craig Poulson
Utah Association of Conservation Districts
Roosevelt, Utah

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
2007	64,300	245,000	3.81	24.0
2008	85,200	291,000	3.42	26.1
				28.5

Glossary and Acronyms

Available Water Content (AWC) – Water contained in the soil that can be utilized by the plant, defined to be the difference between Field Capacity and Permanent Wilting Point, usually expressed as inches/foot.

Average salt pickup – The increase in the amount of salt carried by a stream as it flows as a result of inflows containing increased 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 stored in the soil, 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.

CRBSCP – Colorado River Basin 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.

Field Capacity – The total volume of water contained in the soil after gravimetric drainage has occurred. The soil pore pressure is 0 to -33 cb.

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.

Gravimetric drainage – The volume of water that will drain from a saturated soil profile due to gravity alone.

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.

Management Allowed Depletion (MAD) – The fraction of AWC that allows for maximum production. Typically 50%, only the top 50% of AWC should be used for crop growth.

National Agricultural Statistics Service (NASS) - A branch of the U.S. Department of Agriculture (USDA) charged with keeping agricultural statistical data.

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 impacts of Federal projects 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.

Permanent Wilting Point (PWP) – The volume of water in a soil profile that cannot be extracted by the plant. Normally, watering a plant at this point will not restore its vitality. Soil pore pressure is about -1,500 cb at the pwp.

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.

Readily Available Water (RAW) – The volume of water in the soil profile that should be used for normal plant growth.

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 the Christiansen Coefficient of Uniformity (CCU) and Distribution Uniformity (DU).

Utah Division of Wildlife Resources (UDWR or DWR) – Managing division for wildlife resources in the State of Utah.

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.

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.

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

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