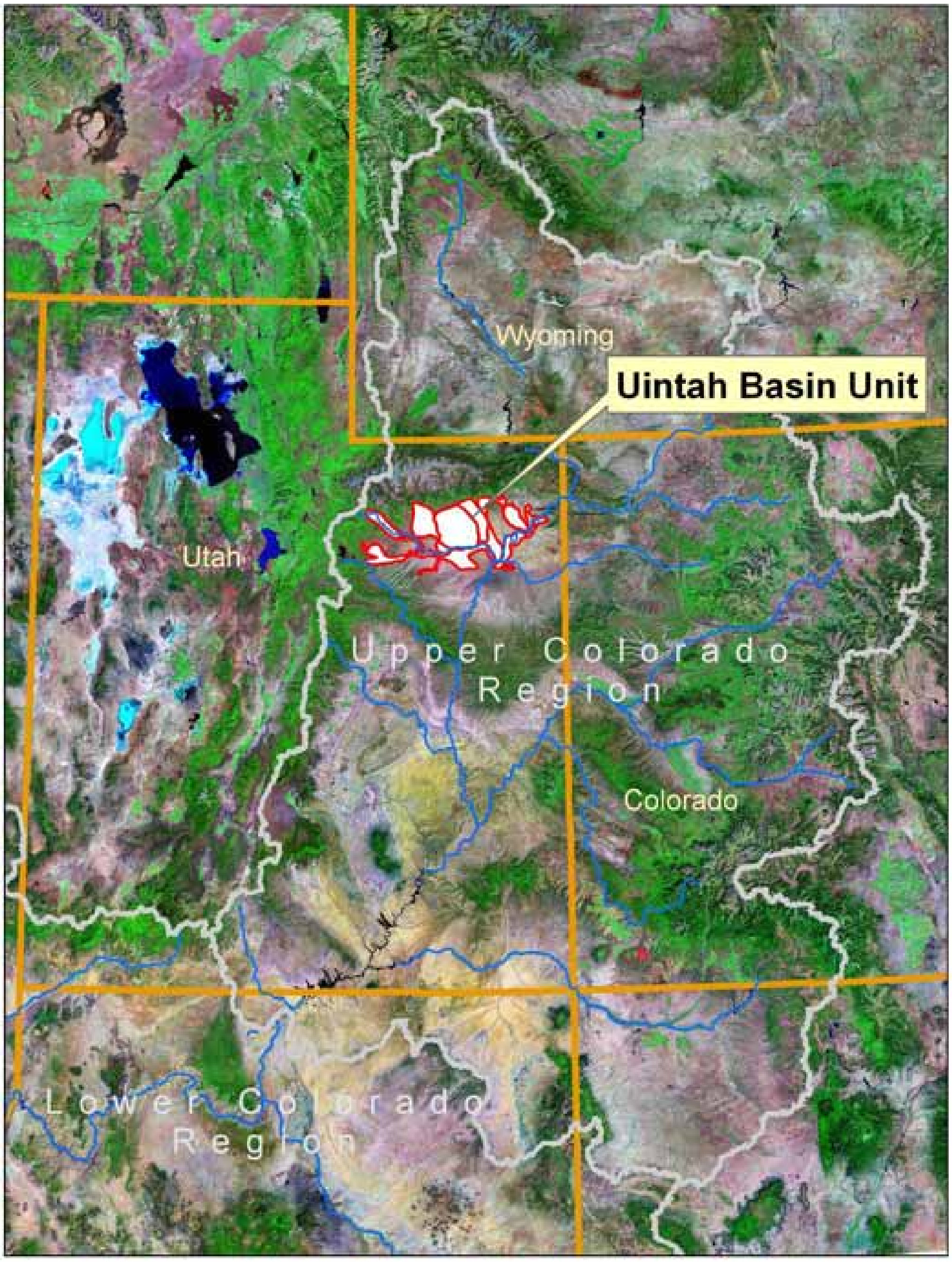
Colorado River Basin Salinity Control Program

Uintah Basin Unit

Monitoring and Evaluation Report, FY2008



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 147,100 acres have been planned and 144,400 acres applied.
- Of approximately 208,000 original on-farm tons, 115,500 tons of salt load reduction has been applied, calculated using revised procedures.
- Of approximately 120,000 original off-farm tons, USDA programs have applied 25,000 tons of salt load reduction.
- Approximately $139.2 million in 2008 dollars ($83.6 million nominal) in Federal financial assistance has been obligated by USDA since 1980.
- In 2008 dollars, planning documents anticipated $160/ton to $173/ton. Cumulative planned cost is $141/ton, and cumulative applied cost is $131/ton.
- For FY2008 the annual planned cost is $178/ton. Without contracts for wildlife, system replacements, beginning farmers, and limited resource farmers, the annual planned cost is $123/ton.
- The cumulative applied cost is $131/ton (2008 dollars).
- Deep percolation due to system leaks, poor 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.

Wildlife Habitat and Wetlands

- Conversion of wetlands to uplands is far less than anticipated by the EIS.
- Photo points have been established and case studies are ongoing.
- A total of 700 acres wildlife habitat projects were planned and funded and 348 acres wildlife habitat projects were applied in FY2008.
- M Bar V Ranch (Avintaquin Canyon) 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 Applied	**Units**	**FY2008**	**Cumulative**	**Target**
1. Irrigation Systems				
A. Sprinkler System	Acres	2,324	130,102	160,000
B. Improved Surface System	Acres	-	14,347	
C. Drip Irrigation System	Acres	4	76	
2a. Salt Load Reduction, on-farm*	Tons/Year	2,131	115,505	140,500
2b. Salt Load Reduction, off-farm	Tons/Year	210	24,659	
3. Total Contracts (Planned)	Number	77	2,732	
	Dollars, FA	4,364,084	83,624,907	
	Acres	3,198	147,062	

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

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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

FY2008 project results are summarized in table 2.

Table 2, FY2008 results

FY2008	Planned	Applied
Irrigation Improvements, Acres	3,198	2,328
Federal Cost Share, FA, 2008 Dollars	4,364,084	4,010,914
Amortized Federal Cost Share, FA+TA, 2008 Dollars	509,624	468,382
Salt Load Reduction, Tons/Year	2,866	2,341
Federal Cost/Ton, FA+TA, 2008 Dollars	178	200

Cumulative Project Results

Cumulative results through FY2008 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 2008 dollars to make comparisons more appropriate.

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

Cumulative Improvements	EIS[1]	Projected[2]	Planned	Applied
Irrigation Improvements, Acres	137,000	160,000	147,100	144,500
Federal Cost Share, FA+TA[3], 2008 Dollars	190,900,000	250,400,000	232,000,000	206,900,000
Amortized Fed Cost, FA+TA, 2008 Dollars	18,500,000	23,200,000	20,400,000	18,300,000
Total Salt Load Reduction, Tons/Year	106,800	140,500	144,700	140,200
Federal Cost/Ton, FA+TA, 2008 Dollars	173	170	141	131

[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'.

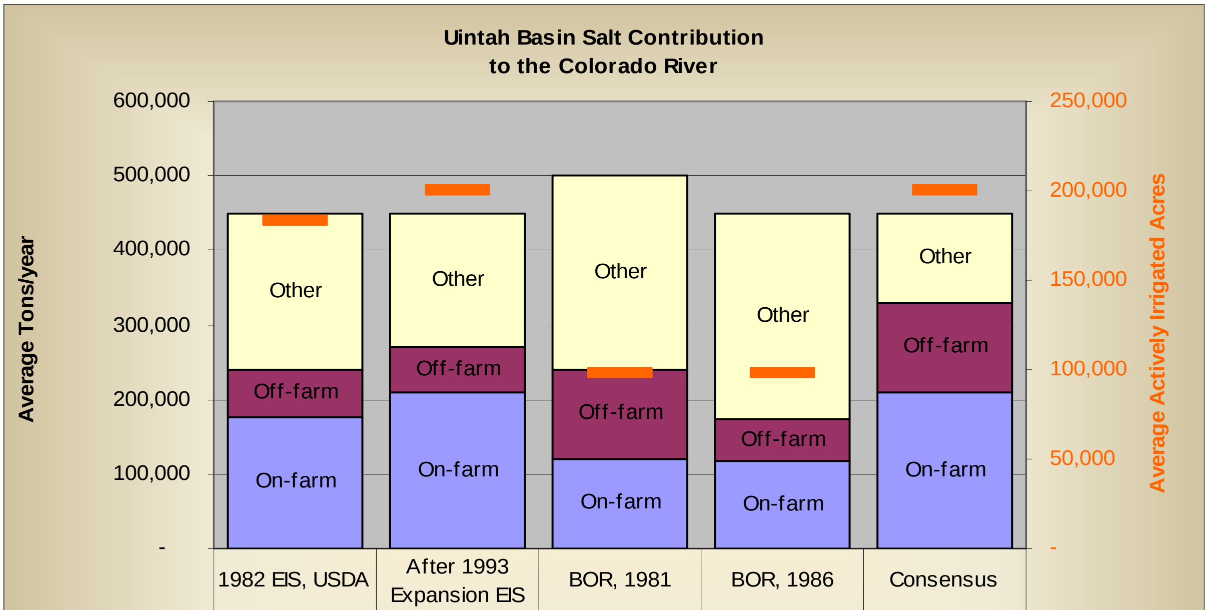
Detailed Analysis of Status

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

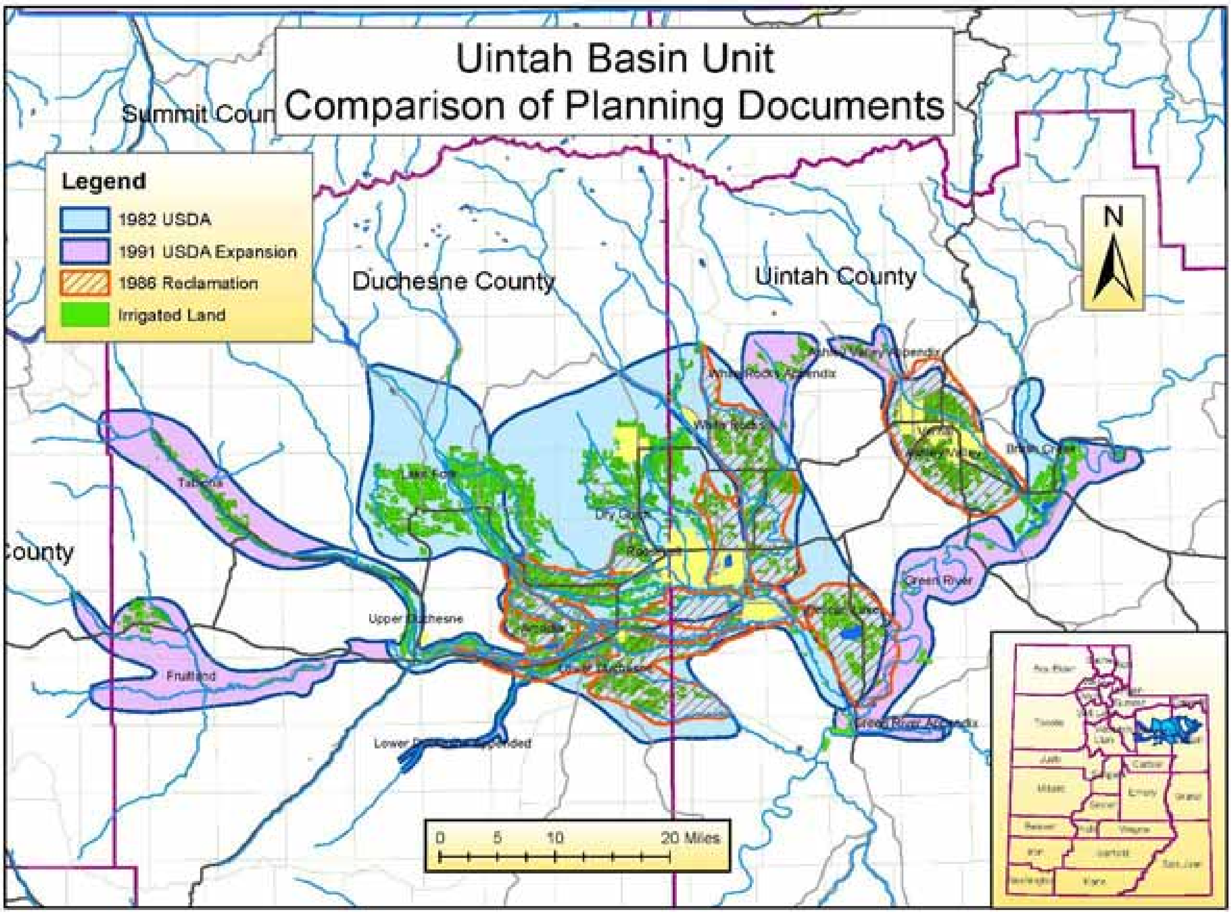
Between 1975 and 1991, at least six studies were done by federal agencies to quantify the salt contribution of Uintah Basin irrigation to the Colorado River System. Three studies by US Department of Agriculture (USDA) Soil Conservation Service, predecessor to Natural Resource Conservation Service (NRCS) 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. A particularly large source is agricultural irrigation, which involves diverting relatively clean water from a watercourse, channeling diverted water to a field 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 now 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 proper 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

Table 4 summarizes planning estimates of salt load reduction costs.

The Environmental Impact Statement (EIS) for the Uintah Basin Unit of the Colorado River Basin Salinity Control Project (CRBSCP) was published in April, 1982. It contemplated treating 122,200 acres with improved irrigation practices at a cost of $64.5 million FA ($141.4 million in 2008 dollars), reducing salt loading by 76,600 tons/year. It was anticipated that 35% of treatments would be improved flood irrigation.

Amortizing $141.4 million at 7.625% (the federal water project discount rate for FY1982) over 25 years results in an expected average cost of $167/ton (FA+TA) in 2008 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 $174/ton, in 2008 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 ($13.79 million in 2008 dollars) to reduce salt load by 8,600 tons/year. Using the same reasoning as above, the amortized cost is $160/ton (FA+TA) for the incremental acres and $173/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 $170/ton, 2008 dollars, for the entire project, slightly less than estimated in the Holt letter in 1987 and after the 1991 expansion EIS.

Table 4, Comparison of Project Cost Estimates

FA+TA	EIS, 1982	Holt Letter, 1987	EIS, 1991	2002 Adjustment
Added 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	64,474,200		7,148,700	40,000,000
Total federal cost share, nominal	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	5,847,581	7,503,455	713,093	3,166,331
Total amortized treatment cost, nominal	5,847,581	7,503,455	8,216,548	11,382,879
Total treatment cost, 2008 dollars	141,426,054	177,127,500	190,915,863	250,428,752
Total amortized treatment cost, 2008 Dollars	12,826,841	17,130,846	18,506,255	23,217,193
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 2008 Dollars	167	174	173	170

Planned Practices (Obligations)

Planned practices (obligations) represent contracts with participants to apply improved irrigation practices to the participant's agricultural activities. 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 participant's cost-share buys him/her 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.

FY2008 Obligation

In FY2008, $4.40 million was obligated in 77 contracts to treat 3,198 acres with improved irrigation. Of that amount, $432,000 was for wildlife habitat improvements.

Salt Load Reduction Calculation

The estimated salt load reduction from FY2008 planned practices is 2,866 tons/year, 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.

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 (4.875% for FY2008). 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 2008 dollars is done by using the Producer Price Index (PPI) for agricultural equipment purchased.

For FY2008 the amortized cost of obligated planned projects is $178/ton (FA+TA). (About 10% of the cost or $18/ton is for Wildlife Habitat practices to help compensate for wildlife values foregone, in the spirit of the National Environmental Protection Act (NEPA).)

Table 5 depicts the historical cost/ton of planned practices, in nominal and 2008 dollars.

Obligation Analysis

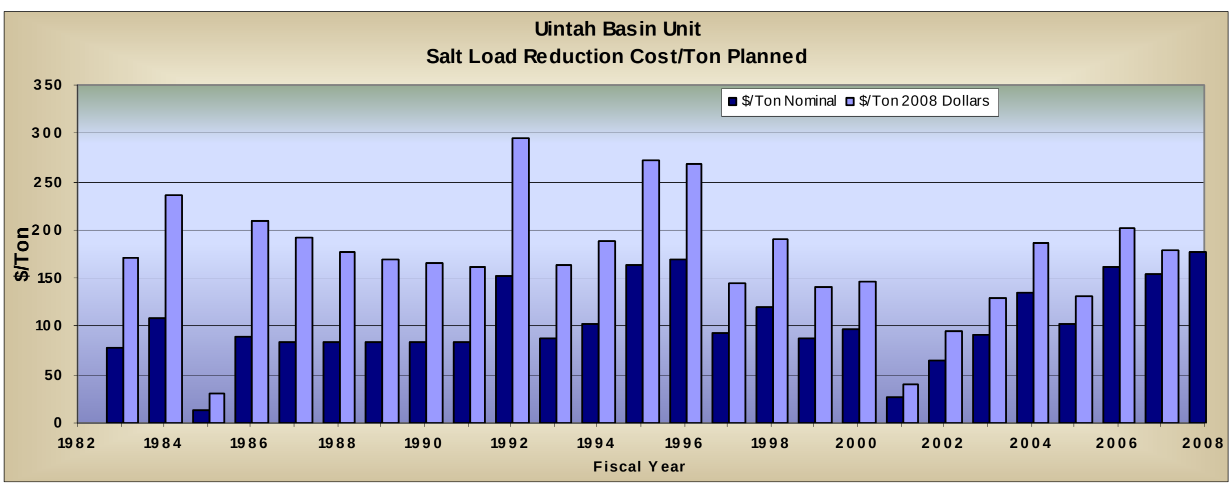
In 2008 dollars, cumulative obligation thru FY2008 is $139.2 million, planned on 147,000 acres, with a salt load reduction of 144,700 tons (on-farm and off-farm), resulting in an overall cost of $141/ton. Note that in 2008 dollars, the overall cost/ton has been relatively constant throughout the life of the project. Current cost/ton is not out of line with respect to past years performance or planning document projections.

Figure 3 compares cost/ton by year, in nominal and 2008 dollars.

Table 5, Cost/Ton of annual obligations since 1980, in nominal and 2008 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	2008 PPI Factor	FA Planned 2008 Dollars	Amortized FA+TA 2008 Dollars	$/Ton 2008 Dollars	Cum $/Ton, 2008 Dollars
1980	7.125%	84	1,622,444	5,000	3,735	234,657		243%	3,945,713	570,675		
1981	7.375%	95	1,899,073	6,000	4,482	280,839		227%	4,306,405	636,839		
1982	7.625%	76	1,782,461	5,000	3,735	269,438		219%	3,909,881	591,020		
1983	7.875%	108	2,641,958	8,282	6,187	408,097	66	221%	5,833,339	901,062	146	149
1984	8.125%	36	1,107,903	2,152	1,608	174,829	109	217%	2,398,860	378,544	235	156
1985	8.375%	70	1,536,585	3,368	18,416	247,640	13	222%	3,415,187	550,400	30	95
1986	8.625%	39	1,176,359	2,885	2,155	193,569	90	233%	2,741,652	451,137	209	101
1987	8.875%	63	797,629	2,121	1,584	133,971	85	228%	1,821,036	305,864	193	105
1988	8.625%	127	6,153,570	16,362	12,223	1,012,567	83	214%	13,154,138	2,164,506	177	121
1989	8.875%	87	2,111,397	5,614	4,194	354,634	85	201%	4,243,149	712,686	170	125
1990	8.875%	75	2,963,581	7,880	5,887	497,768	85	196%	5,816,418	976,935	166	128
1991	8.750%	132	3,358,040	10,968	8,194	558,282	68	193%	6,476,964	1,076,811	131	129
1992	8.500%	284	3,382,799	4,826	3,605	550,898	153	193%	6,524,719	1,062,569	295	137
1993	8.250%	156	2,780,712	6,750	5,042	443,465	88	185%	5,155,993	822,272	163	138
1994	8.000%	113	3,317,415	6,741	5,036	517,952	103	183%	6,070,652	947,819	188	141
1995	7.750%	27	720,561	899	672	110,109	164	166%	1,198,946	183,212	273	142
1996	7.625%	99	3,615,968	4,336	3,239	546,592	169	159%	5,754,173	869,805	269	147
1997	7.375%	87	2,835,765	3,677	4,515	419,358	93	155%	4,397,890	650,368	144	147
1998	7.125%	16	635,323	777	770	91,888	119	159%	1,011,004	146,223	190	147
1999	6.875%	22	770,221	1,250	1,232	108,918	88	159%	1,225,670	173,323	141	147
2000	6.625%	44	1,620,953	2,351	2,332	224,048	96	153%	2,471,982	341,677	147	147
2001	6.375%	58	1,565,536	2,398	8,022	211,441	26	149%	2,329,239	314,586	39	139
2002	6.125%	125	3,694,643	7,816	7,497	487,436	65	148%	5,452,642	719,369	96	136
2003	5.875%	141	4,573,887	7,057	6,467	589,269	91	143%	6,539,306	842,481	130	136
2004	5.625%	140	5,038,155	5,099	4,667	633,643	136	138%	6,932,279	871,864	187	138
2005	5.375%	165	7,176,416	7,106	8,593	880,815	102	128%	9,183,912	1,127,210	131	137
2006	5.125%	123	6,488,611	4,996	4,782	776,946	162	124%	8,023,173	960,694	201	139
2007	4.875%	63	3,892,858	2,152	2,947	454,596	154	116%	4,508,842	526,529	179	140
2008	4.875%	77	4,364,084	3,198	2,866	509,624	178	100%	4,364,084	509,624	178	141
Totals		2,732	83,624,907	147,062	144,684	11,923,289	82		139,207,249	20,386,107	141	

Figure 3, Nominal planned cost/ton and cost/ton in 2008 dollars



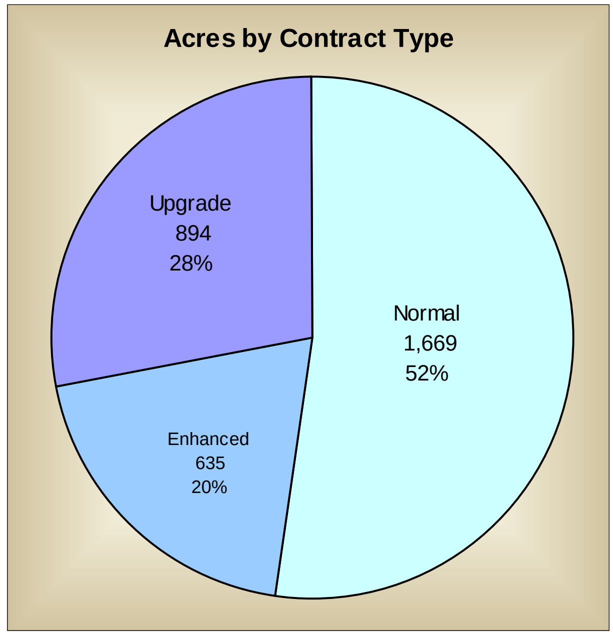
Cost Share Enhancement

Typical federal cost share, over the last several years, has been 75% of total installation cost. A feature of the 2002 Farm Bill 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) and limited resource farmers (a farmer with gross farm income less than $106,400 for each of the last two years).

In the Uintah Basin, a cumulative total of 111 contracts on 3,487 acres for $5.77 million (2008 dollars) are cost-share enhanced. Estimated salt load reduction is 3,708 tons on-farm and off farm. The incremental cost of enhancement is $1.15 million, less than 1% of total FA, but it has all been accumulated in the last five years. Ninety-three contracts are with beginning farmers and 18 are with limited resource farmers.

For FY2008 contracts, the average salt load reduction cost for cost-share enhanced contracts is $190/ton, compared to $160/ton for all contracts (Wildlife only contracts excluded).

Figure 4, FY2008 planned acres by contract type



System Upgrades

In the Uintah Basin Unit, many salinity funded irrigation systems have reached their intended practice life. In FY2008, 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 FY2008, 19 contracts for $924,500 FA were planned to upgrade irrigation practices on 894 acres. Salt load reduction is 392 tons on-farm and 24 tons off-farm. The amortized cost is $260/ton FA+TA.

Figure 5, FY2008 cost/ton by contract type

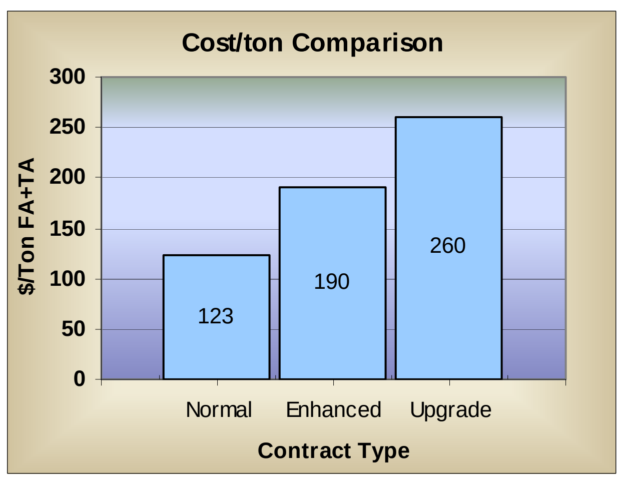


Figure 4 depicts the acres planned for each contract type.

Figure 5 compares the cost/ton for FY2008 normal contracts (does not include Wildlife Only contracts), enhanced contracts, and upgraded system contracts.

Excluding wildlife habitat contracts, enhanced contracts, and system upgrades results in a normal cost of $123/ton.

Applied Practices

FY2008 Expenditures

In FY2008, $4.01 million FA was expended applying 2,328 acres of sprinklers. The estimated salt load reduction is 2,341 tons/year, on-farm and off-farm, at an amortized cost of $200/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. She/he 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 when 50% or more of contract funds have been expended, implying that construction is well underway and the contract is likely to be completed.

Cumulative expenditure FY1980-FY2008 is $124.2 million FA (2008 dollars), applied to 130,800 sprinkler acres, 14,300 improved flood acres, and 98 acres of drip irrigation, reducing salt loading by 114,500 tons/year on-farm and 24,900 tons off-farm at an average cost of $131/ton (2008 dollars).

Application of salinity control practices lags planning by the time needed for installation. Between planning and application, a few contracts are de-obligated for various reasons such as design modification, change in ownership or cancellation. De-obligating alters total obligation reported in past years, but is captured in the current year, where cumulative nominal obligation is the total current obligation of all active or completed contracts.

Figure 6, Comparison of Obligated and Expended funds.

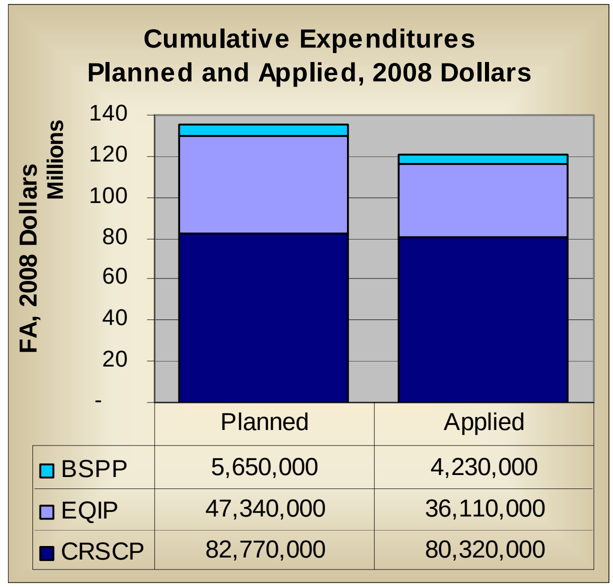


Figure 7, Cumulative salt load reduction.

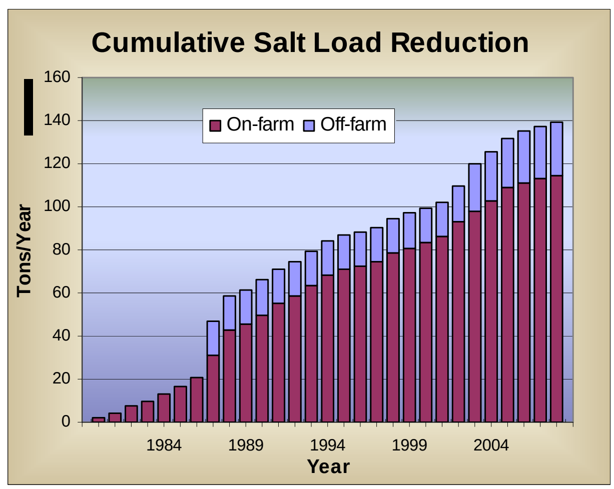


Figure 6 relates cumulative obligated FA to cumulative applied FA to, in 2008 dollars.

Figure 7 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 annual applied practices since project inception.

Table 6, Annual Cost/Ton of practices applied since 1980, in nominal and FY2008 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	2008 PPI Factor	FA Applied 2008 Dollars	Amortized FA+TA 2008 Dollars	$/Ton 2008 Dollars	Cum $/Ton, 2008 Dollars
1980	7.125%	-	4,329	3,234	-	-	243%	-	-	-	-
1981	7.375%	1,450,506	3,919	2,928	214,504	73	227%	3,289,218	486,416	166	79
1982	7.625%	1,450,506	5,801	4,333	219,260	51	219%	3,181,728	480,952	111	92
1983	7.875%	1,899,239	4,823	3,603	293,371	81	221%	4,193,445	647,751	180	115
1984	8.125%	1,746,366	5,040	3,765	275,580	73	217%	3,781,277	596,692	158	124
1985	8.375%	1,324,218	6,131	5,405	213,414	39	222%	2,943,184	474,331	88	115
1986	8.625%	3,491,444	8,561	6,395	574,515	90	233%	8,137,248	1,338,980	209	136
1987	8.875%	1,500,879	3,711	17,847	252,090	14	228%	3,426,599	575,537	32	97
1988	8.625%	3,011,008	16,675	12,457	495,460	40	214%	6,436,461	1,059,116	85	94
1989	8.875%	2,327,840	3,400	2,540	390,988	154	201%	4,678,122	785,745	309	103
1990	8.875%	1,978,927	6,313	4,716	332,384	70	196%	3,883,905	652,347	138	106
1991	8.750%	2,823,067	6,922	5,171	469,342	91	193%	5,445,112	905,263	175	111
1992	8.500%	3,382,799	4,834	3,611	550,898	153	193%	6,524,719	1,062,569	294	119
1993	8.250%	2,752,919	6,750	5,042	439,032	87	185%	5,104,459	814,053	161	122
1994	8.000%	2,749,248	6,741	5,036	429,244	85	183%	5,030,944	785,488	156	124
1995	7.750%	4,071,491	3,965	2,962	622,167	210	166%	6,774,582	1,035,229	350	131
1996	7.625%	882,617	1,902	1,421	133,417	94	159%	1,404,529	212,310	149	132
1997	7.375%	4,279,163	1,991	1,703	632,811	372	155%	6,636,406	981,404	576	140
1998	7.125%	1,323,064	2,137	2,048	191,357	93	159%	2,105,422	304,511	149	140
1999	6.875%	852,084	2,481	2,220	120,494	54	159%	1,355,941	191,745	86	139
2000	6.625%	955,064	1,315	1,239	132,009	107	153%	1,456,489	201,316	162	139
2001	6.375%	1,087,303	2,218	2,100	146,851	70	149%	1,617,714	218,488	104	138
2002	6.125%	1,513,372	6,576	6,102	199,660	33	148%	2,233,470	294,663	48	133
2003	5.875%	3,040,199	4,470	9,918	391,679	39	143%	4,346,585	559,985	56	127
2004	5.625%	4,109,885	5,581	5,457	516,895	95	138%	5,655,020	711,225	130	127
2005	5.375%	4,251,934	3,644	3,794	521,872	138	128%	5,441,350	667,857	176	128
2006	5.125%	7,121,799	6,952	8,186	852,764	104	124%	8,806,111	1,054,443	129	128
2007	4.875%	5,400,376	5,015	4,590	630,639	137	116%	6,254,901	730,428	159	129
2008	4.875%	4,010,914	2,328	2,341	468,382	200	100%	4,010,914	468,382	200	131
Totals		74,788,231	144,525	140,164	10,711,077	76		124,155,854	18,297,226	131	

Table 7, Annual detail summary of Applied Practices

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)	4,329	-	-	3,234	-
1981	1,450,506	3,371	548	-	3,919	-	-	2,928	-
1982	1,450,506	4,452	1,349	-	5,801	-	-	4,333	-
1983	1,899,239	2,905	1,918	-	4,823	-	-	3,603	-
1984	1,746,366	3,122	1,918	-	5,040	-	-	3,765	-
1985	1,324,218	4,155	1,976	-	6,131	-	-	4,580	825
1986	3,491,444	6,917	1,643	-	8,561	-	-	6,395	-
1987	1,500,879	3,162	529	20	3,711	-	-	2,772	15,075
1988	3,011,008	15,201	1,474	-	16,675	-	-	12,457	-
1989	2,327,840	3,027	372	1	3,400	-	-	2,540	-
1990	1,978,927	6,060	253	-	6,313	-	-	4,716	-
1991	2,823,067	6,709	212	1	6,922	-	-	5,171	-
1992	3,382,799	4,666	160	8	4,834	-	-	3,611	-
1993	2,752,919	6,597	145	8	6,750	-	-	5,042	-
1994	2,749,248	6,581	150	10	6,741	1,743	11,592	5,036	-
1995	4,071,491	3,934	17	14	3,965	95	755	2,962	-
1996	882,617	1,856	42	4	1,902	655	404	1,421	-
1997	4,279,163	1,990	-	1	1,991	101	41	1,703	-
1998	1,323,064	1,970	156	11	2,137	24	17	1,854	194
1999	852,084	2,478	-	3	2,481	-	3	2,195	25
2000	955,064	1,200	115	-	1,315	1	17	1,180	59
2001	1,087,303	2,105	113	-	2,218	-	-	2,012	88
2002	1,513,372	6,322	254	-	6,576	-	2,010	5,922	180
2003	3,040,199	4,387	80	3	4,470	-	19	4,091	5,827
2004	4,109,885	5,472	108	1	5,581	31	120	5,113	344
2005	4,251,934	3,612	32	-	3,644	68	160	3,786	8
2006	7,121,799	6,863	85	4	6,952	67	468	6,362	1,824
2007	5,400,376	5,012	-	3	5,015	243	183	4,590	-
2008	4,010,914	2,324	-	4	2,328	16	(50)	2,131	210
Totals	74,788,231	130,102	14,347	76	144,525	3,044	15,739	115,505	24,659

Table 8, Contract summary by program, 2008 dollars

FY2008	Planned			Applied				
Program	Contracts	FA, 2008 $	Irrigated Acres	FA, 2008 $	Irrigated Acres	$/Acre	Salt Load Reduction, Tons	Salt Load Reduction, Tons/Acre
ACP & CRSCP	1,671	82,770,000	99,185	80,320,000	99,185	810	89,994	0.91
IEQIP	62	3,450,000	2,480	3,490,000	2,480	1,407	2,270	0.92
EQIP	891	45,600,000	41,273	35,340,000	38,730	912	42,381	1.09
EQIP WLO	31	1,740,000		770,000				
BSPP	77	5,650,000	4,124	4,230,000	4,029	1,050	5,511	1.37
Totals	2,732	139,210,000	147,062	124,150,000	144,424	860	140,156	0.97

Evaluation by Program

Table 8 summarizes contract data by funding program, in 2008 dollars.

Figure 8 depicts acres planned by program.

Since 1980, about 2,700 contracts have been written with landowners to upgrade irrigation practices on approximately 147,100 acres. As of the end of FY2008, practices are applied on about 144,500 acres. Only 10% of applied systems are improved flood systems, 90% being higher efficiency sprinkler systems.

Figure 9 depicts planning status.

Figure 8, Acres planned by program

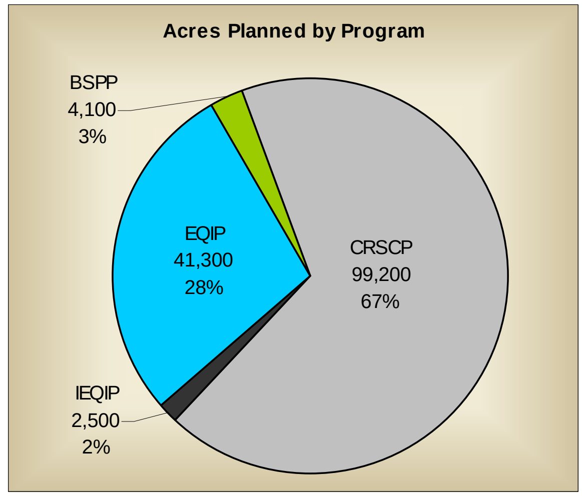
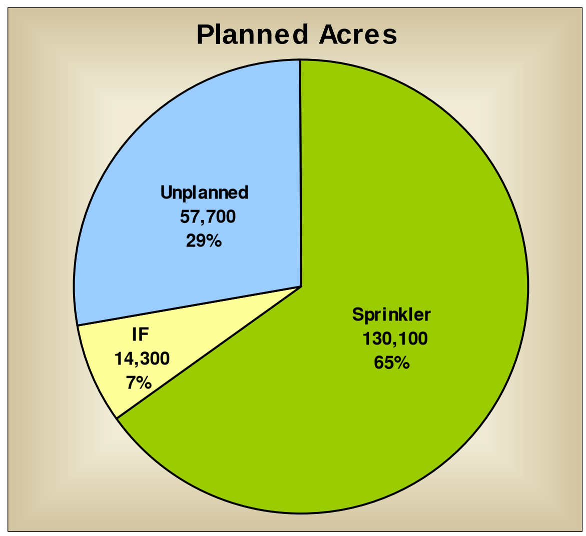


Figure 9, Planned/Unplanned acres



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.

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

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 2001. Having established that properly installed and operated practices yield predictable and favorable results, the 2001 Framework Plan addresses hydro-salinity by:

- Utilizing random cooperator surveys to collect and evaluate cooperator understanding and impressions concerning contracts and equipment,
- Formal and informal Irrigation Water Management (IWM) training and encouragement,
- Equipment spot checks and operational evaluations, and
- 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 crops 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 with the additional compensation.

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 comparing water applied with water required on a seasonal basis and the second showing available water content (AWC) and deep percolation. See figures 10 and 11.

Figure 10, is the entry form part of the IWM Self Certification Spreadsheet, on which the irrigator can record irrigation rates and times. Data entered in the first four columns of the sheet is used to calculate the remaining columns and to create two graphs (see Figure 11).

Figure 10, 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%

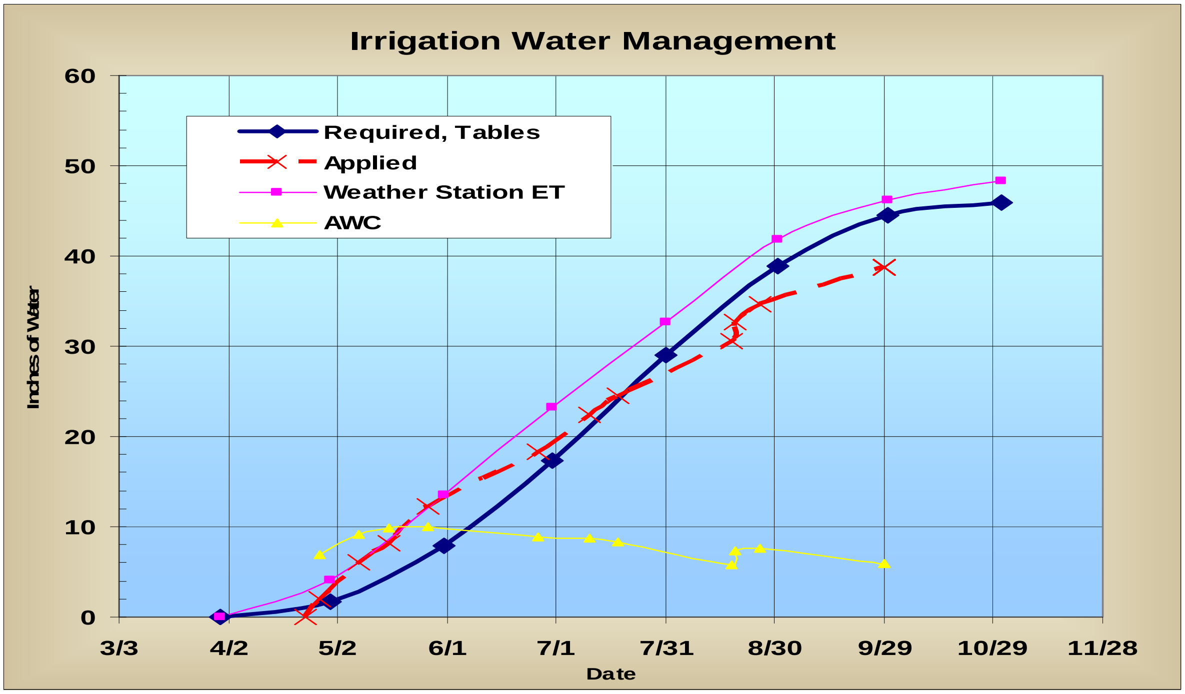
Start date of irrigation	End date of irrigation	Total Cycle Hours	Flow (cfs) OR number of nozzles multiplied by nozzle flow (gpm)		Inches Applied Cycle	Inches Applied Season	CU Season (Table)	Inches Available	AWC	Deep Perc
04/23/07	04/27/07	96	685.0	gpm	2.04	2.04	1.18	6.83	6.83	0.00
04/30/07	05/08/07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

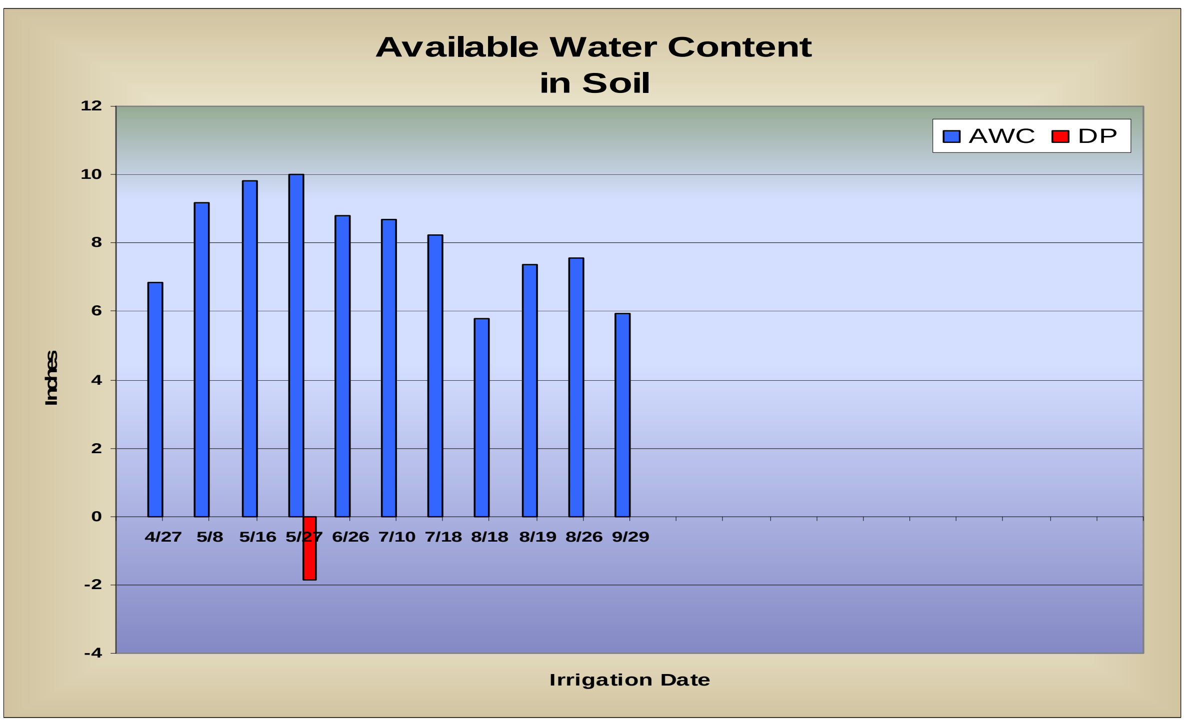
In the first graph, if the red, actual-application line is below and to the right of the blue, consumptive use line, the crop is under irrigated. If the red, actual-application line is above the blue consumptive-use line, the field is over-irrigated and excessive deep percolation has occurred. A modest amount of deep percolation is designed into all irrigation systems to compensate for distribution anomalies and to leach accumulated salt from the root zone.

The second graph estimates water storage in the soil and shows deep percolation below the axis when it occurs. For maximum crop growth, AWC must be maintained in the upper 50% of its range. Some deep percolation is designed into each system as leaching fraction to avoid the buildup of salts in the soil.

Figure 11, Sample graphs from the IWM Self Certification Spreadsheet.

The blue line is the long-term average water requirement, based on location and crop. The red line is the actual water applied. Where data is available, the purple line is modeled from actual data collected at a nearby weather station, using a FAO's Penman-Montieth evapotranspiration model. The yellow line indicates AWC, which is detailed in the second bar graph.



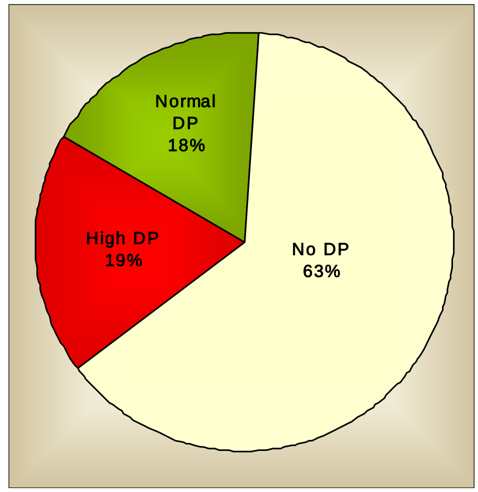


This spreadsheet is used by the farmer to self-certify his irrigation records when presented to and discussed with NRCS employees or contractors.

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 this technique.

In FY2008, 95 completed IWM self certification spreadsheets were delivered to the M&E team, representing 2,900 acres. On an acreage basis 63% had no deep percolation, 18% were within design limits of deep percolation for their irrigation system, and 19% exceeded their design limits of deep percolation (after compensating for average soil moisture storage effects). See Figure 12.

Figure 12, Acres with deep percolation from IWM Certification Spreadsheets



Soil Moisture Monitoring

A proven method for timing irrigation involves augering a hole and determining the water content of the soil to help decide when to apply the next irrigation. This may well be the best method available for irrigation timing, both simple and inexpensive. However, few operators take the 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 read and recorded multiple times per day. With some recorders, soil pore pressure is presented graphically on an LCD display in the field, making it a simple matter to estimate when the next irrigation will be required. See figure 13.

Figure 13, Soil Moisture data recorder with graphing

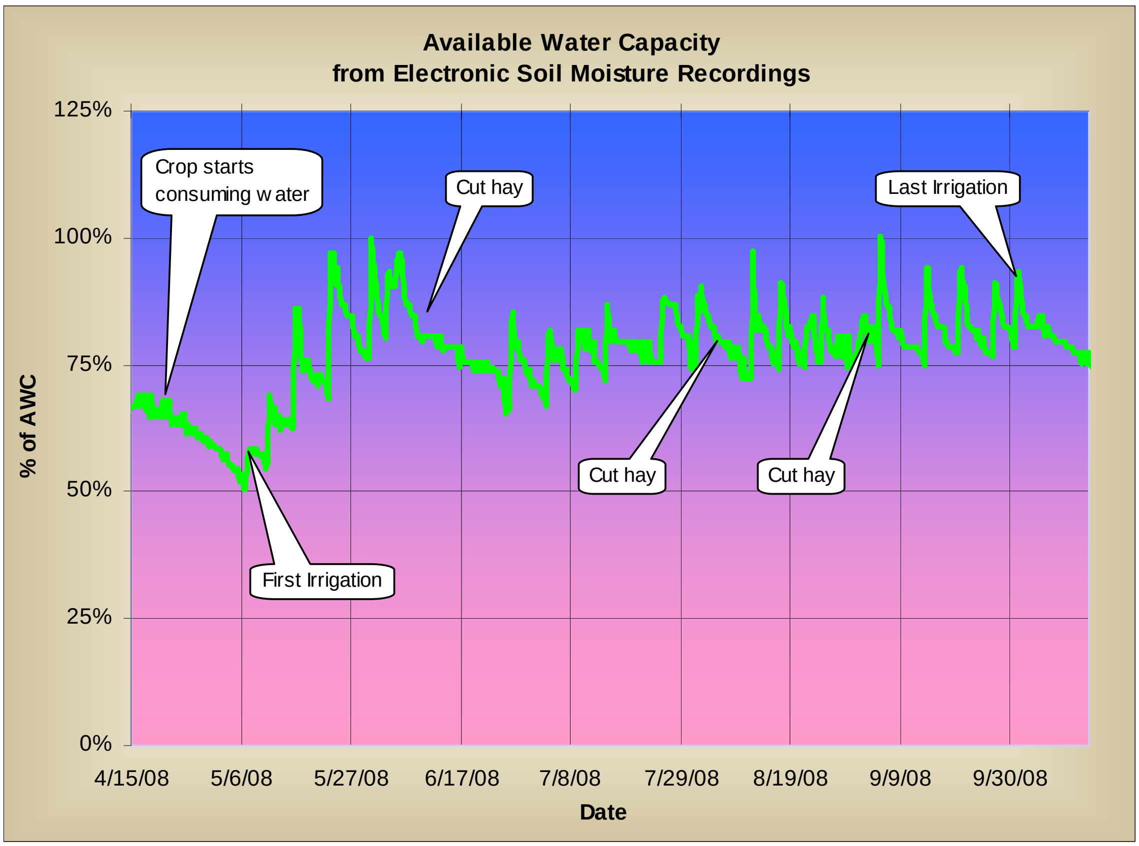
Since gravimetric drainage generally does not occur unless the soil horizon is nearly saturated (above field capacity), it is assumed that deep percolation is not occurring if the deepest probe reading is greater than -10 centibars. In the Uintah Basin, five installed data recorders indicate that deep 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 vertical zones and total AWC estimated for each zone, knowing soil pour pressure (and derived saturation), zone thickness, and capacity. Summing AWC for all zones yields total AWC for the soil profile.

Figure 14 is a typical graph of estimated AWC for one set of three soil moisture probes in an alfalfa field.

Figure 14, 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 great 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 great tool to indicate when water is needed, if the operator pays enough attention to get a sense for what it is telling her.

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 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

With sprinkler systems operating, an assessment of leaks and malfunctioning heads can be made very quickly, generally without leaving the vehicle. Based on the premise that 50-100 operating sprinkler systems can be observed by one person in a day, an inventory was devised to collect as much data as possible during FY2006-FY2008 irrigation seasons. Two thousand and sixty systems were logged in the three year period, of which sixteen hundred, eighty-eight were operating wheel lines, k-lines, or hand-lines.

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

1. Age was estimated visually and rated: 1 = 0-3 yrs, 2 = 4-10 yrs, 3 = >10 yrs.
2. Condition was rated visually: 1 = no repairs needed, 2 = repairs needed, 3 = not useable without major repair.
3. Leaks from hoses, drains, heads, and other sources were evaluated visually and the total gallons per minute (GPM) leakage estimated for the system.
4. Sprinkler length was calculated from the shapefile.
5. Acres were estimated by assuming a 660' long field (approximately 11 sets/irrigation cycle).
6. Net irrigation requirement was assumed to be 8 GPM/acre.

Figure 15, Wheel line leaks vs. age

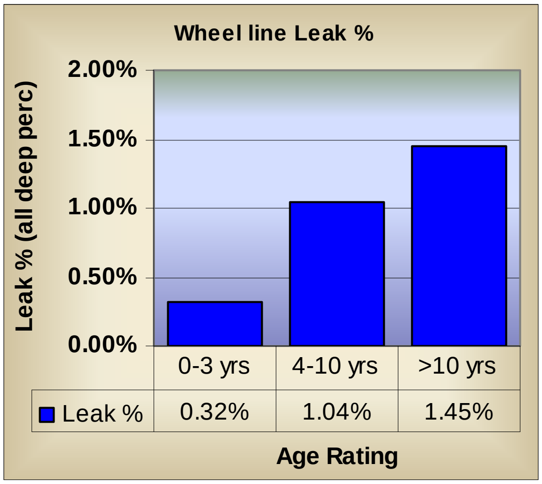


Figure 16, Rated age of sprinkler systems, based on field estimate.

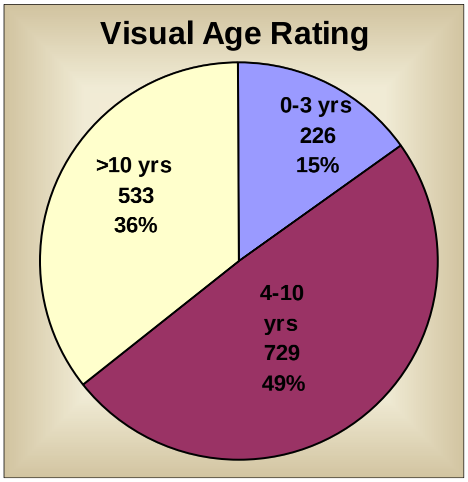
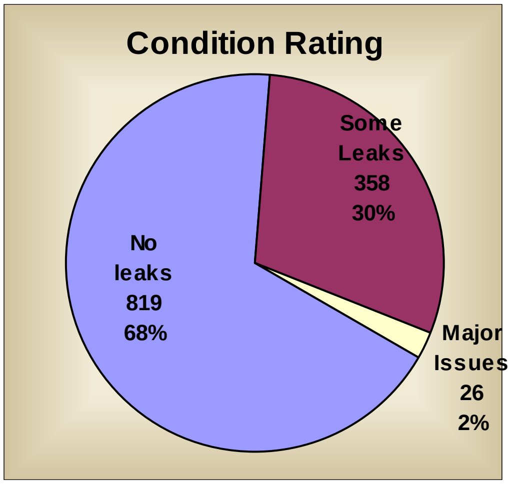


Figure 17, Wheel line condition rating



7. The leak % represents the GPM from leaks ÷ GPM for the system.

8. Only wheel lines in operation were considered. Idle systems were not a target of this study. However 27 idle wheel lines were noted.

9. Figures 15 through 17 depict the results of the inventory.

Unlike limited observations from catch-can testing, this larger sampling suggests 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.

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

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

Long-term Sprinkler Water Budgets

Three farms are monitored with recording flow meters. Measured water use is compared to crop requirements, computed from data gathered at nearby weather stations, using the FAO Penman-Montieth procedure.

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

Wildlife Habitat and Wetlands

Background

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

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

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

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

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

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

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

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

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

1980 Water Related Land Use (WRLU)

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

In 1980, the Center for Remote Sensing and Cartography of the University of Utah Research Institute completed a Land Use Inventory for the Uintah Basin of Utah. This study was done in cooperation with Utah Division of Water Resources (Water Resources), USDA Soil Conservation Service, and National Aeronautics and Space Administration. This study is the second in a series of land use inventories that has evolved into Water Resources' Water Related Land Use (WRLU), a GIS layer updated every five years and made available to the public. While the 1980 WRLU focused specifically on wetlands, later versions emphasize crops and have little wetland data.

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

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

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

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

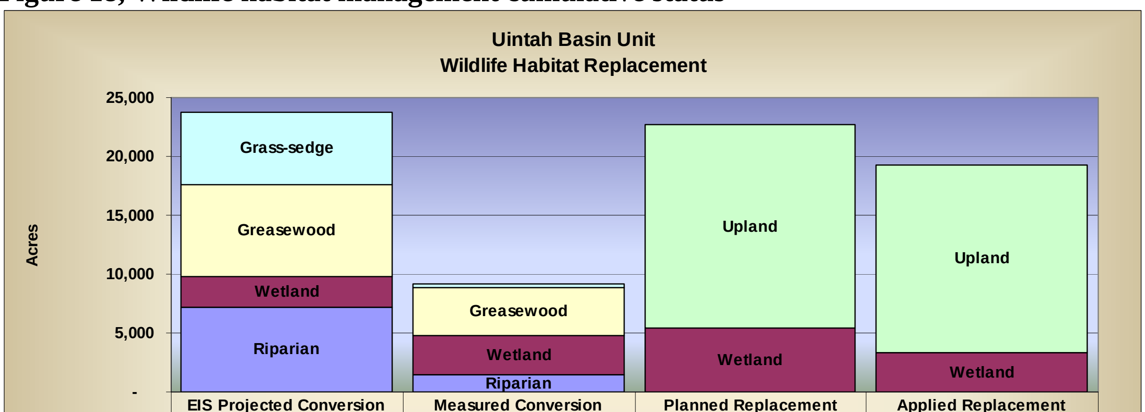
By overlaying the 1980 WRLU on the 2006 NAIP, it is reasonably simple to determine if a polygon classified as wetland in 1980 is no longer wetland in 2006. However, without an older image, it is impossible to verify that it was indeed wetland in 1980. M&E has made the comparison on four quadrangles; Bridgeland, Hancock Cove, Vernal NE, and Altonah.

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

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

This review will be expanded and updated when the next NAIP is released.

Figure 18, Wildlife habitat management cumulative status



	EIS Projected Conversion	Measured Conversion	Planned Replacement	Applied Replacement
Upland			17,321	16,013
Grass-sedge	6,185	292		
Greasewood	7,755	4,092		
Wetland	2,625	3,284	5,416	3,289
Riparian	7,205	1,480		

Basin Wide Wildlife Habitat Monitoring

Permanent photo points, representative locations throughout the Uintah Basin of wetlands, wildlife habitat, agricultural areas, and areas where pipelines have recently been built have been selected and a protocol established to compare across the years. The initial years will be baseline data as there will be no comparison photos. Photographs will be taken near the same date annually, and compared approximately every five years in a visual display in the M&E Reports.

Wildlife Habitat Contract Monitoring

Seven Environmental Quality Incentive Program (EQIP) Wildlife Only projects were planned and funded in the Uintah Basin in FY2008 for a total of 600 acres. No Wildlife Habitat Incentives Program (WHIP) projects planned or funded in FY2008 (Table 9).

One application from FY2005, BSPP Request for Proposals (RFP) for accelerated habitat replacement, was awarded funding in FY2008, treating 100 acres of wetland, for a total of $71,074 (Table 9). The remainder of $178,926 in the BSPP RFP fund has been petitioned for obligation to the Hatt Ranch Project in Emery County. The outcome of this petition is unknown at this time.

Five EQIP Wildlife Only prior year projects were fully applied in FY2008 for a total of 348 acres; 243 acres are allocated to wetland/riparian habitat types and 105 acres are primarily upland in nature (Table 9).

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

Table 9, FY2008 Wildlife habitat acres planned and applied

Acres of Wildlife Habitat Creation or Enhancement by Program — FY2008 practices planned and applied				
Program	Acres Planned		Acres Applied	
	Wetland (*644)	Upland (*645)	Wetland (*644)	Upland (*645)
BSPP	100	-	-	-
EQIP	458	142	243	105
WHIP	-	-	-	-
Total	**558**	**142**	**243**	**105**

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

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 (*644)	Upland (*645)	Wetland (*644)	Upland (*645)
CRSCP	2,600	12,799	2,600	12,799
IEQIP	1	1	1	1
BSPP	150	239	50	239
EQIP	2,490	3,629	353	2,266
WHIP	236	493	229	262
Total	**5,477**	**17,161**	**3,233**	**15,567**

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

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: Avintaquin Canyon

Background

Wildlife habitat replacement in the Uintah Basin Salinity Unit increased in Fiscal Year 2007, with the addition of a few large riparian restoration projects. The Avintaquin Canyon project, hereafter referred to as M Bar V Ranch, addressed in this case study, was referred to NRCS by Utah Division of Wildlife Resources (DWR) biologists Randall Thacker and Miles Hanberg. Avintaquin Canyon is a large drainage that runs NNE and SSW and drains into the Strawberry River in the vicinity of “The Pinnacles” in the southwestern portion of Duchesne County (Figure 20). Avintaquin Creek is a perennial stream that drains approximately 80 square miles of surrounding U.S. Forest Service, Ute and Ouray Indian Reservation, DWR, and private lands. Traditional land use was cattle grazing. Approximately 6,900 acres of Avintaquin Canyon (M Bar V Ranch) is privately owned by Michael Vanderhoof, a private businessman and outdoorsman from Oakely, UT. M Bar V Ranch includes approximately 12 miles of the bottomland on Avintaquin Creek, comprising approximately 1,500 acres of “riparian area” land. Avintaquin Creek is also home to a pure strain of the Colorado River Cutthroat trout (CRCT), a Conservation Agreement species of concern. The DWR holds a Conservation Easement on the lower portion of Avintaquin creek on M Bar V Ranch. DWR is also petitioning Mr. Vanderhoof to conserve the rest of his riparian property in a similar Conservation Easement.

Objectives

M Bar V Ranch has a comprehensive Conservation Plan with multiple objectives. Aspects of this project that facilitated funding were: location in the landscape, nature of the habitat (riparian/wetland), range and pasture management, noxious weeds, and sensitive species (CRCT, and other Neotropical migrant songbirds). Objectives revolve around these circumstances.

There are two main irrigation water diversions on Avintaquin Creek on M Bar V Ranch. These diversions create precipitous waterfalls that impede most CRCT and other fishes from reaching the headwaters of the creek. One objective is to create fish passage structures to enable fish to move freely to the headwaters of the creek system. Another threat to CRCT is hybridization with non-native rainbow trout. To remedy this threat a fish barrier is planned on the creek at the northern end of M Bar V Ranch to isolate the majority of Avintaquin Creek from the Strawberry River where rainbow trout are present. These practices are anticipated to be complete in fall 2009.

The riparian area has been overgrazed in the past and many understory plant species have been extirpated or severely hedged. A riparian fence was built to help preserve most of the riparian habitat. Behind the fence 2,025 trees and shrubs have been planted to accelerate vegetation regeneration, and native grasses and forbs have been seeded in places of disturbance behind implemented practices.

Mr. Vanderhoof has dramatically reduced the number of cattle that graze the range of M Bar V Ranch. With the construction of the riparian fence, a rotational grazing system can be implemented to improve forage quality and quantity for livestock and wildlife.

Noxious weeds are also addressed throughout the entire ranch by the implementation of a pest management plan with a three year treatment/re-treatment schedule that started in summer 2007.

Reduced soil erosion and water conservation objectives will be realized through sediment control basins (gully plugs), brush management, wildlife watering facilities, and a pipeline that replaces about a mile of leaky ditch (see items in next section).

Conservation Plan

Reviewing the application for funding, it became apparent that there were two separate objectives to meet; wildlife habitat restoration and agriculture.

On the ground meetings were performed in the fall of 2006 and spring 2007 with DWR, the National Wild Turkey Federation (NWTF), the landowner, and NRCS to assess the resource concerns/objectives. Mr. Vanderhoof had clear and defined objectives for the future of his property.

From these meetings consensus was achieved and the following practices were included in the Conservation Plan (see also Figure 21):

- 90 acres of Brush Management
- two Fish Passage Structures and one Fish Barrier
- 2025 trees and shrubs
- Seven “Gully Plugs” to stem gully forming erosion
- 21,324 feet Riparian Buck and Pole Fence
- 491 acres of weed spraying (Pest Management) over three years
- 1,800 acres of wildlife habitat management incentive payments over three years
- Two wildlife watering facilities (guzzlers)
- 5,100 feet pipeline
- 134 acres native grass/forb seeding

Separate from the NRCS Conservation Plan, DWR has conducted electro-shock fish surveys in Avintaquin Creek and created a fish inventory. There has also been an American Black Bear study conducted by DWR biologists and subsequent monitoring of collared bears. In winter 2009 DWR released 30 Rocky Mountain Bighorn Sheep in Lake Canyon, just one canyon North of Avintaquin canyon. Some of these sheep have crossed though M Bar V Ranch and it anticipated that habitat improvements from the Conservation Plan will help increase the probability of their survival. Mr. Vanderhoof is currently working in conjunction with DWR and NWTF to have wild turkeys released on to M Bar V Ranch

Discussion

The M Bar V Ranch project in Avintaquin Canyon has been a partnership effort with technical and financial contributions from, NRCS, DWR, NWTF, Utah Partners for Conservation and Development (UPCD) and the landowner. It is the single largest wildlife habitat development plan ever funded in the Uintah Basin Salinity Control Unit since the inception of the Colorado River Salinity Control Program. The benefits from conserving the natural resources found on the M Bar V Ranch are a great contribution toward NRCS' responsibilities in implementing the conditions and terms if the EIS. There are practices in the Conservation Plan that are innovative and progressive; some of which are new to Utah NRCS.

Most of the practices in M Bar V Ranch's Conservation Plan are scheduled for completion in 2008-2011. The contract is running slightly behind schedule due to complexities and novelties required for engineering design, and permitting processes It is anticipated that most structural practices will be complete by the end of FY2010, leaving only the management practices to be completed in their scheduled years.

The Conservation Plan addresses all six resource concerns in the NRCS' Conservation Planning Model: Soil, Water, Air, Plants, Animals, and Human aspects, and the needs for each acre have been considered in the planning process. It is anticipated that this project will be a success and a great asset to the entire watershed.

Figure 19, M Bar V Ranch Location map

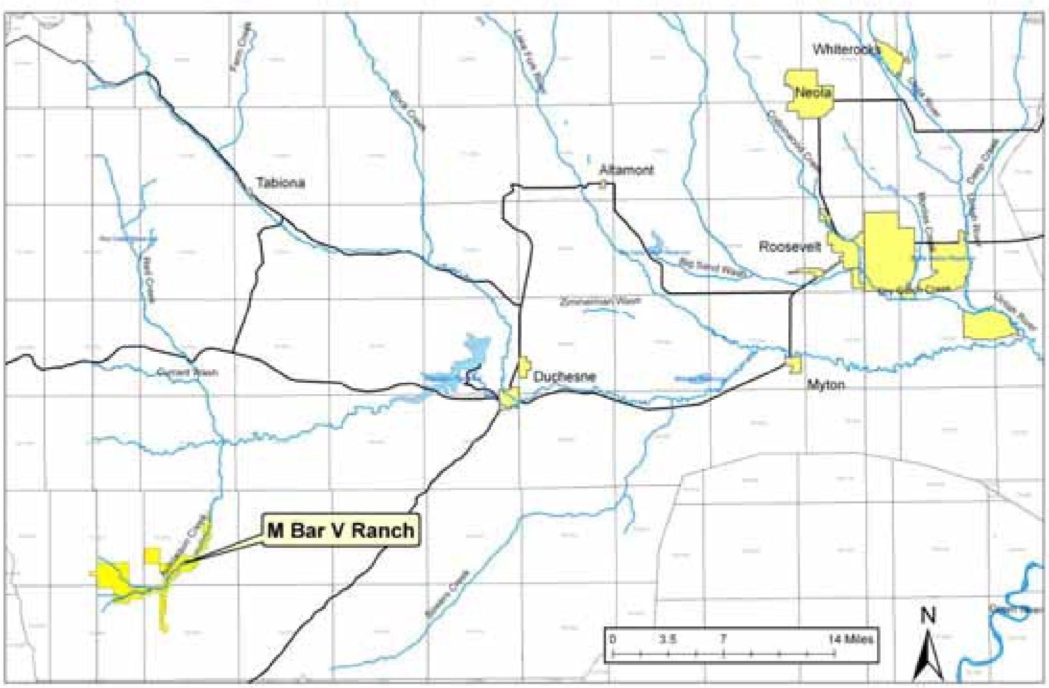
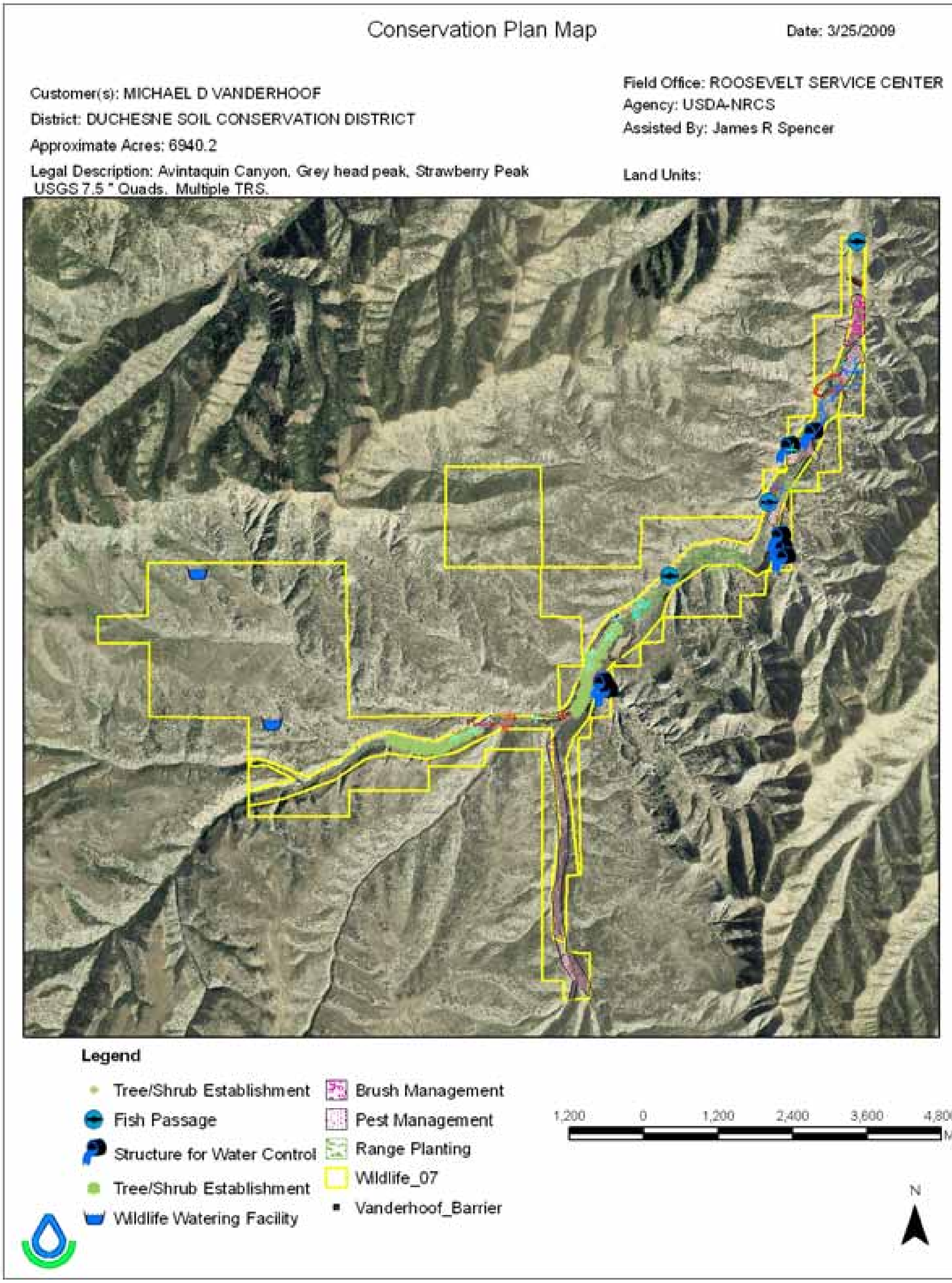


Figure 20, M Bar V Ranch (Avintaquin Canyon) Plan Map



M Bar V Ranch (Avintaquin Canyon) Photo Gallery

Figure 21, October 11, 2000; pre-contract field visit looking S from road on M Bar V Ranch.

Figure 22, December 19, 2008; looking S just E of previous photo.

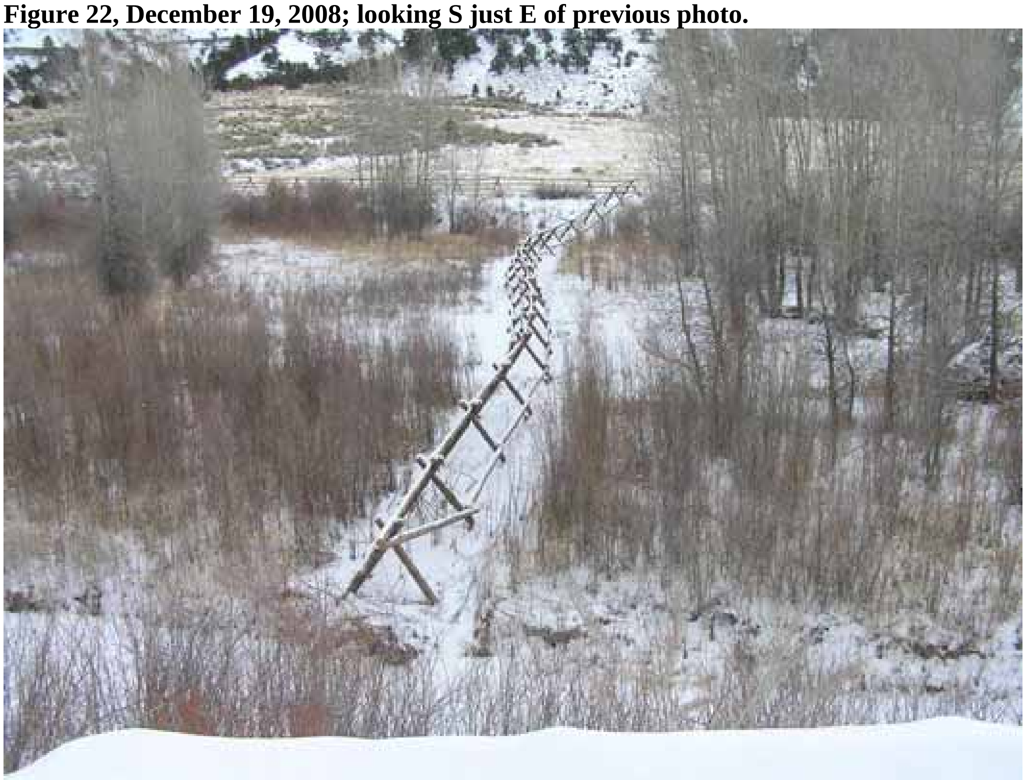


Figure 23, May 21, 2008; spring runoff through lower diversion where fish passage is planned.

Figure 24, May 21, 2008; spring runoff through lower diversion where fish passage is planned.

Figure 25, September 15, 2008; riparian fence looking NNE.

Figure 26, September 15, 2008; riparian fence & weed spraying looking NNE.

Figure 27, September 15, 2008; beaver dam behind riparian fence looking W.

Figure 28, September 15, 2008; wetland behind riparian fence looking SE.

Figure 29, September 15, 2008; riparian fence looking NE.

Figure 30, September 15, 2008; riparian fence looking SSW.

Figure 31, September 15, 2008; brush management looking SW.

Figure 32, September 15, 2008; Dixie harrow clogged w/ heavy brush.

Figure 33, September 15, 2008; area to be seeded looking S.

Figure 34, September 15, 2008; Native seed provided by UPCD, WRI.

Figure 35, September 15, 2008; brush control (greasewood) looking S.

Figure 36, September 15, 2008; Colorado River Cutthroat in Avintaquin Creek.

Figure 37, September 15, 2008; Mountain Lion track in creek bed.

Economics

Cooperator Economics

Production Information

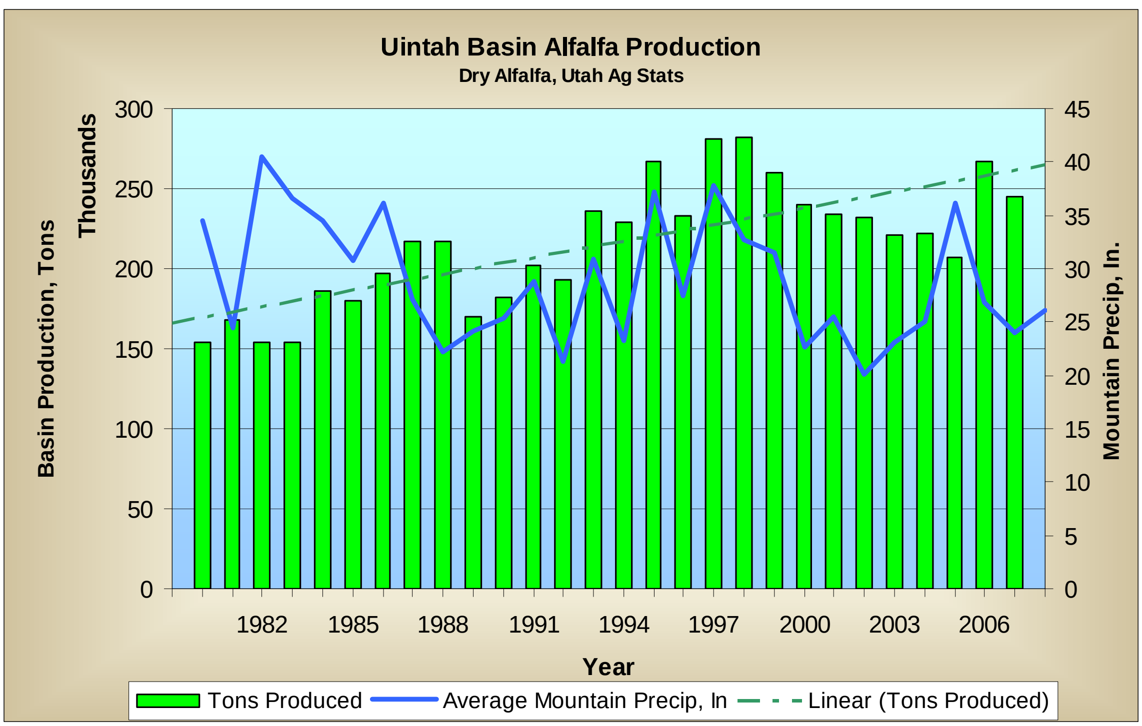
Field studies completed in 1995 concluded that upgrading from unimproved flood irrigation to either improved flood or sprinklers improved alfalfa crop yields from about 2.5 tons/acre to about 4.5 tons/acre. This magnitude of increase is consistent with anecdotal information from diligent cooperators.

Alfalfa production data downloaded from the National Agricultural Statistics Service (NASS) indicates that yields from the entire Uintah Basin Unit have increased from about 3.5 tons/acre to about 4.0 tons/acre since 1980, based on a linear regression of the data set. With 145,000 acres treated out of 200,000 acres originally producing, the projected yield increase would be expected to be nearer one ton/acre than two.

However, more interesting than yields, are total production data. Total tons of alfalfa produced in the Uintah Basin has increased over 58% since 1980, while alfalfa acreage has increased about 41%. From 1980 to 2007, average production increased from 161,000 tons to 253,000 tons, while alfalfa acreage increased from 47,000 acres to 64,000 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 38, 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 continues to be strong, due to a booming energy business. It seems logical that landowners will be spending even more time in off-farm employment.

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

Public Economics

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

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

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

<u>Positive public perceptions of the Salinity Control Program include:</u>

- Reduced salinity in the Colorado River
- Increased flows in streams and rivers
- Economic lift to the entire community from employment and broadened tax base
- Local availability of expertise, information, and materials for public conservation
- Aesthetically pleasing, green fields, denser, for longer periods of time
- Improved safety and control of water resources, with a reduction in open streams

<u>Negative public perceptions of the Salinity Control Program include:</u>

- "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. In addition, the local economy is in a boom, and upward pressure on labor and equipment prices is considerable.

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

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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.

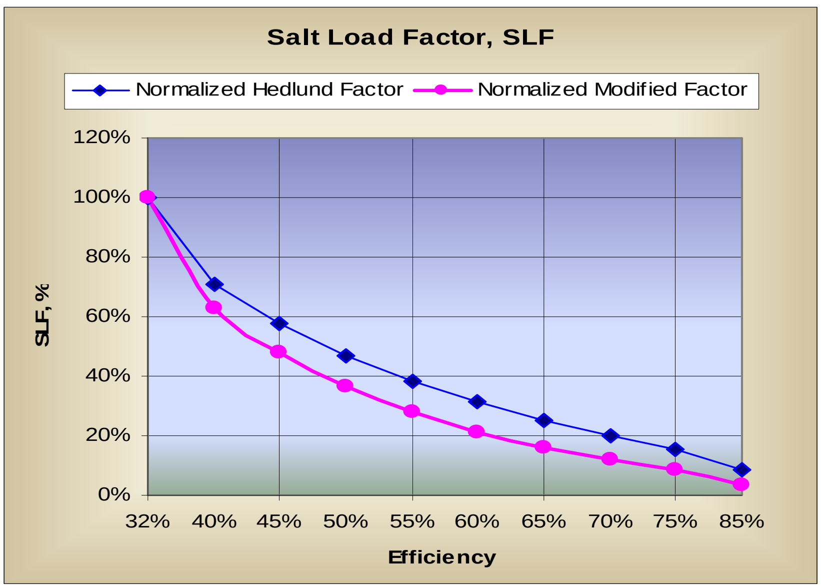

Figure 2 Graph of salt load factor, SLF. The upper line was used in the Ranking Worksheet FY2004 – FY2007. The lower line is used in new Salinity Worksheets for Ranking, beginning with FY2008 contracts and is mathematically defined above.

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

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EXECUTIVE SUMMARY

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

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

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

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

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

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

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

ACKNOWLEDGMENTS

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

IRRIGATION SYSTEM EVALUATION AND REPLACEMENT STUDY

COLORADO RIVER BASIN SALINITY CONTROL PROJECT

Final Report

December 27, 2007

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EXECUTIVE SUMMARY

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix VI, Uintah Basin Alfalfa Production

Uintah Basin Alfalfa Production
Dry Alfalfa, Utah Ag Stats

Year	Producing Acres	Tons Produced	Yield Tons/Acre	Average Mountain Precip, In
1980	47,494	154,000	3.24	34.5
1981	49,488	167,900	3.39	24.5
1982	44,122	154,500	3.50	40.5
1983	45,412	154,400	3.40	36.6
1984	51,000	186,000	3.65	34.4
1985	50,467	180,500	3.58	30.8
1986	51,469	197,000	3.83	36.1
1987	53,511	217,000	4.06	27.1
1988	58,996	217,000	3.68	22.3
1989	51,498	169,800	3.30	24.2
1990	54,969	182,000	3.31	25.4
1991	54,251	202,500	3.73	28.8
1992	53,127	192,600	3.63	21.3
1993	55,712	235,600	4.23	31.0
1994	60,289	229,100	3.80	23.3
1995	63,857	267,000	4.18	37.1
1996	63,947	232,600	3.64	27.4
1997	66,461	281,000	4.23	37.8
1998	66,806	282,000	4.22	32.6
1999	61,502	260,000	4.23	31.5
2000	64,649	240,000	3.71	22.6
2001	61,802	234,000	3.79	25.5
2002	62,507	232,000	3.71	20.1
2003	62,949	221,000	3.51	23.1
2004	64,500	222,000	3.44	25.0
2005	58,000	207,000	3.57	36.1
2006	64,000	267,000	4.17	26.8
2007	64,300	245,000	3.81	24.0
				26.1

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 increase salt from dissolution of the soil. Usually expressed as tons/acre-foot.

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

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

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

BSPP – Basin States Parallel Program

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

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

cfs – Cubic feet per second or second-feet.

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

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

CRSCP – Colorado River Salinity Control Program

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

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

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

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

EQIP – Environmental Quality Improvement Program

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

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.

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

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

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

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

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 about -1,500 cb.

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 Christiansen Uniformity (CCU) and Distribution Uniformity (DU).

Upland Wildlife Habitat Management (645) – An NRCS Conservation Practice that is concerned with management issues and assurances. It assures that other structural practices are applied correctly and it is also a way to monitor their effectiveness. Such as the practice of leaving at least six inches of vegetation growth on a field for wildlife use. As this standard is met then the incentive payment can be made.

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

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

Wetland Wildlife Habitat Management (644) – An NRCS Conservation Practice that is concerned with management issues and assurances. It assures that other structural practices are applied correctly and it is also a way to monitor their effectiveness. One example is the practice of maintaining different depths of water in a wetland to maximize plant and animal species diversity. As this standard is met then the incentive payment can be made.

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

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

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

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

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