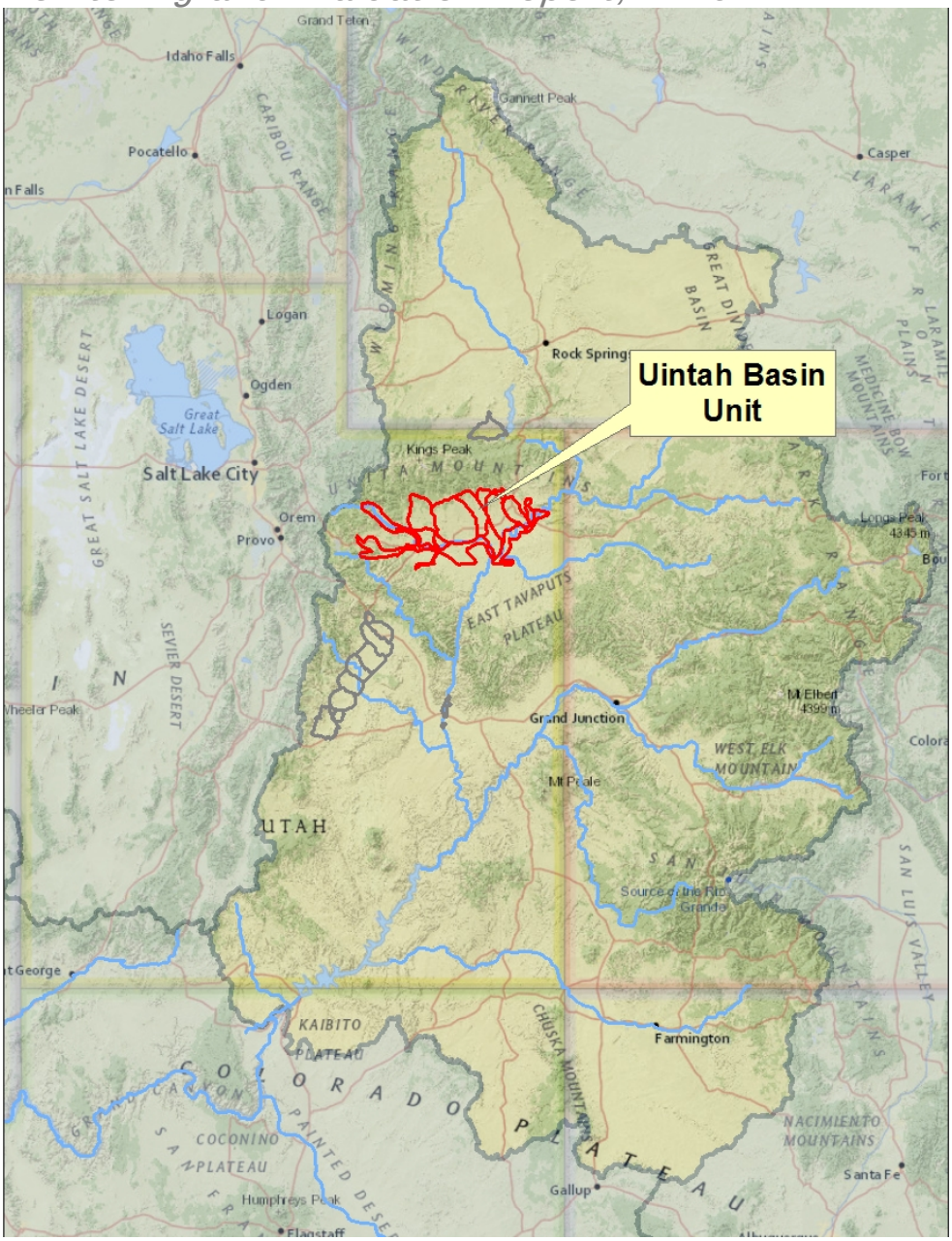
Colorado River Basin Salinity Control Program

Uintah Basin Unit

Monitoring and Evaluation Report, FY2014



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Project Synopsis

The 1974 Salinity Control Act (PL-93-320) (SCA) and subsequent related legislation authorizes the U.S. Department of Agriculture (USDA), acting through the Natural Resources Conservation Service (NRCS), to implement salinity control throughout the Colorado River Basin. The NRCS' Uintah Basin Salinity Control Unit (UB), in northeastern Utah, encompasses 225,000 irrigated agricultural acres irrigated with water diverted from tributaries of the Duchesne and Green Rivers south of the Uinta Mountains and north of Ouray, Utah. This area, approximately 95 miles east to west by 40 miles north to south, is a source of dissolved solids from Tertiary saline lacustrine deposits. The pre-project agricultural salt load was estimated to be 208,000 ton/year, on-farm and 120,000 tons/year off-farm. Water diverted to irrigate cropland and pasture, deep percolates through saline sediment, transporting dissolved salts to the river system. The 1974 SCA named four specific salinity control projects (Paradox Valley Unit, Grand Valley Unit, Crystal Geyser Unit, Las Vegas Wash Unit) and directed expedited planning reports for irrigation source control in Uinta Basin, Lower Gunnison, Colorado River Indian Reservation, and Palo Alto Irrigation District. After multiple studies, UB was established by a 1982 environmental impact statement, although USDA funding of salinity control projects started in 1980 using grant programs already in place. Salt load reduction is achieved by improving irrigation efficiency and reducing deep percolation. The 1982 EIS anticipated treating 122,200 acres, controlling 76,600 tons/year of salt at a cost of $197/ton (2014 dollars). Initial success of the program resulted in the preferred treatment shifting from improved flood to more efficient sprinkler systems. A second EIS was written in 1991 expanding UB. Treatment options have been continuously reevaluated. It is now expected that more than 70% of the original 225,000 irrigated acres will ultimately be treated. As of the end of FY2014, USDA had funded control of 128,000 tons/year of on-farm salt and 28,000 tons/year of off-farm salt, treating 157,000 acres of irrigated land, at a cost of $156/ton (2014 dollars). Of the original 225,000 irrigated acres, 63,300 acres or 29% have yet to be planned for irrigation improvements. As prescribed by the SCA, impacts to wildlife habitat foregone, resulting from salinity control implementation, are evaluated to assure that replacement of habitat is "concurrent and proportional" to installation of salinity control measures. With concurrence from U.S. Fish and Wildlife Service, habitat replacement acreage is to exceed two percent of improved irrigation acreage, or 3,100 acres through FY2014. Actual cumulative habitat replacement in UB is about 21,000 acres, or 14% of improved irrigation acres. Opportunities remain for additional salt control. NRCS will continue to use its resources to implement salt control consistent with its authorities and resources.

Executive Summary

Project Status

- **TREATED ACRES:** Of 224,800 irrigated acres, 63,000 acres (28% if irrigated acres) have not yet been planned for irrigation improvements. Since 1980, treatments on approximately 161,500 acres have been planned and 157,200 acres applied. In FY2014, 1,297 acres were planned and 1,640 acres applied.
- **ON-FARM SALT LOAD REDUCTION:** Of approximately 208,000 original on-farm tons/year of salt load, 129,000 tons/year salt load reduction has been planned and 127,500 tons/year has been applied, calculated using procedures revised in 2007. In FY2014, 1,205 tons were planned and 1,551 tons applied on-farm.
- **OFF-FARM SALT LOAD REDUCTION:** Of approximately 120,000 original off-farm tons/year, USDA programs have planned 28,000 tons/year and applied about 27,700 tons/year of salt load reductions. In FY2014, no off-farm tons were planned and 144 off-farm tons were applied.
- **PLANNED OBLIGATIONS:** For FY2014, NRCS obligated $2.40 million in financial assistance (FA). Cumulative obligations total $101.3 million FA nominal ($188.0 million 2014 dollars).
- **APPLIED EXPENDITURES:** For FY2014, NRCS expended $2.66 million, FA. Cumulative expenditures total $93.2 million FA nominal ($170.5 million 2014 dollars).
- **COST/TON:** Planned salt load reduction cost for FY2014 contracts is $202/ton, FA+TA. The cumulative cost is $170/ton, FA+TA (2014 dollars) for planned practices. For practices applied in FY2014 the cost is $159/ton FA+TA, with a cumulative cost of $156/ton FA+TA (2014 dollars).
- **NEPA PROJECTED COST/TON:** In 2014 dollars, pre-project NEPA documents anticipated salt load reduction costs of $204/ton. Cumulative planned cost is $170/ton, and cumulative applied cost is $156/ton.
- **DEEP PERCOLATION** due to system leaks, inadequate irrigation water management (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.
- **THE 2014 FARM BILL** funds EQIP through FY2018.

Wildlife Habitat and Wetlands

- **CONVERSION OF WETLANDS TO UPLANDS** is far less than anticipated by the EIS.
- **WILDLIFE HABITAT CREATION/ENHANCEMENTS** were planned and funded on total of 23 acres and applied on 187 acres in FY2014. Cumulative habitat replacement in UB is about 21,000 acres, or about 13.5% of improved irrigation acres.
- **Farm Creek Fire Restoration Project (FCFRP)** Case Study is photographically displayed.

Economics

- From the 2012 Census of Agriculture, two-thirds of Uinta Basin farmers have full-time occupations other than farming.
- Cooperators generally believe that their increase in production and decrease in labor costs adequately offset their participation cost.

Table 1. Project progress summary

Uintah Basin Unit, All Programs				
CONTRACTS PLANNED	UNITS	CURRENT FY	CUMULATIVE	TARGET
1. CONTRACT STATUS				
A. Contracts Approved	Number	44	3,076	
	Dollars	$2,404,606	$101,286,403	
	Acres	1,297	161,490	160,000
On-farm	Tons/Year	1,205	129,030	140,500
Off-farm	Tons/Year	-	27,987	
B. Active EQIP Contracts	Number		149	
Obligated dollars not expended	Dollars		$2,776,782	
Planned acres not treated	Acres		1,779	
Planned salt load reduction not reported On-farm	Tons/Year		1,169	
Planned salt load reduction not reported Off-farm	Tons/Year		-	
PRACTICES APPLIED	UNITS	CURRENT FY	CUMULATIVE	TARGET
2. EXPENDITURES				
Financial Assisstance (FA)	Dollars	$2,661,334	$93,451,693	
3. IRRIGATION SYSTEMS				
A. Sprinkler	Acres	1,637	143,523	160,000
B. Improved Surface System	Acres	(1)	13,550	
C. Drip System	Acres	4	96	
4. SALT LOAD REDUCTION				
A. Salt load reduction, on-farm	Tons/Year	1,551	127,515	140,500
B. Salt load reduction, off-farm	Tons/Year	144	27,725	
C. Tons of salt controlled prior to EQIP	Tons/Year		93,389	

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	2012
Basin States Program	BSP	2012	Current

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Historical Background

With settlement of the Colorado River Basin, demands on the Colorado River grew rapidly. In the late 1800s and early 1900s, scores of canal companies were created and millions of acres of land were irrigated to sustain growing populations. In the mid-1900s, dozens of dams and water projects were constructed on the Colorado River and its tributaries.

By the 1960s, concern over increasing water consumption and decreasing water quality led to a national effort to direct environmental policy at the federal level. In 1969, the National Environmental Protection Act (NEPA) was signed into law, requiring extensive public involvement and analysis of environmental impacts when planning federally funded as (federal actions). As part of NEPA, the Council on Environmental Quality (CEQ) was created in the Executive Branch.

In 1970, the Environmental Protection Agency (EPA) was created by a Nixon executive order, Reorganization Plan No. 3 of 1970, which also created National Oceanic and Atmospheric Administration. In the early 1970s, salinity control was managed by EPA.

The Colorado River Basin Salinity Control Forum (Forum) was created in 1973, when the governors of the seven Colorado River Basin States each appointed three water resource professionals to coordinate salinity control efforts among the states, federal agencies, and other major water management entities. The Forum has been instrumental in promoting salinity control to the benefit of all.

In the 1960s, more than two-thirds of water taken from the Colorado River was used to irrigate agricultural lands. Nearly all of this irrigation was by flooding, resulting in massive amounts of salt being dissolved by excess irrigation water and carried back to the river. With irrigation being the largest contributor to salt load in the river, irrigation improvements, both on-farm and off-farm, provide the most cost-effective opportunity to reduce salt loading by improving irrigation efficiencies and reducing deep percolation and seepage.

In the Uinta Basin, salinity funding by USDA began in 1980. Environmental impact statements were completed in 1982 and 1996.

Congressional Authority for the Salinity Control Program

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 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 to EPA for approval, 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 (M&E) 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, and the Agricultural Act of 2014 reauthorized and amended EQIP, extending opportunities for USDA funding of salinity control measures.

Over the years, 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 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

FY2014 project results are summarized in table 2.

Cumulative Project Results

Cumulative planned and applied results are in line with NEPA expectations and costs. (Table 3)

With respect to NEPA 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 an average cost/ton in line with that expected at project inception.

Table 2. FY2014 results

FY2014	Planned	Applied
Irrigation Improvements, Acres	1,297	1,640
Federal Cost Share, FA, 2014 Dollars	$2,405,000	$2,661,000
Amortized Federal Cost Share, FA+TA, 2014 Dollars	$405,300	$448,500
Salt Load Reduction, Tons/Year	1,205	1,695
Federal Cost/Ton, FA+TA, 2014 Dollars	$202	$159

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

Off-farm activities are excluded from this table. Dollar amounts are expressed in 2014 dollars.

Cumulative Improvements	Units	EIS[1]	Projected[2]	Planned	Applied
Irrigation Improvements	Acres	137,000	160,000	161,500	157,200
Federal Cost Share, FA+TA[3]	2014$	$220,600,000	$293,900,000	$313,300,000	$284,100,000
Amortized Fed Cost, FA+TA	2014$	$21,800,000	$27,600,000	$26,700,000	$24,300,000
Total Salt Load Controlled	Tons /year	106,800	140,500	157,000	155,200
Federal Cost/Ton, FA+TA	2014$ /ton	$204	$196	$170	$156

[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 to conform to procedures used in the EIS'.

Detailed Analysis

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 2006, NRCS and the Bureau of Reclamation (Reclamation) reviewed available literature and came to a consensus agreement concerning the most reasonable pre-project salt contribution from agriculture in the Uintah Basin, prior to implementing Federal Salinity Control Programs. (Figure 1)

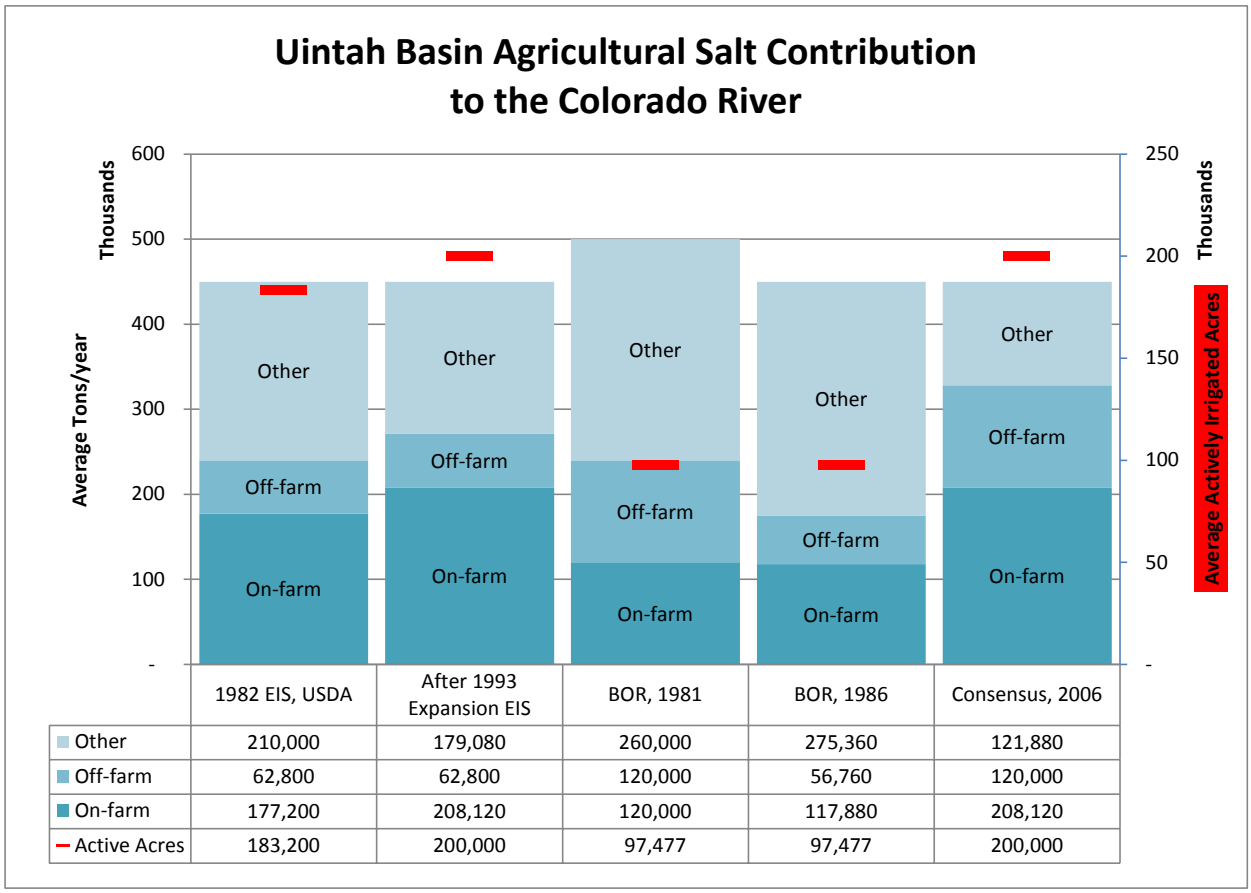


Figure 1. Uintah Basin Salt Load Allocation. The last bar indicates the consensus estimate.

Between 1975 and 1991, at least six studies were completed 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 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. (Figure 2)

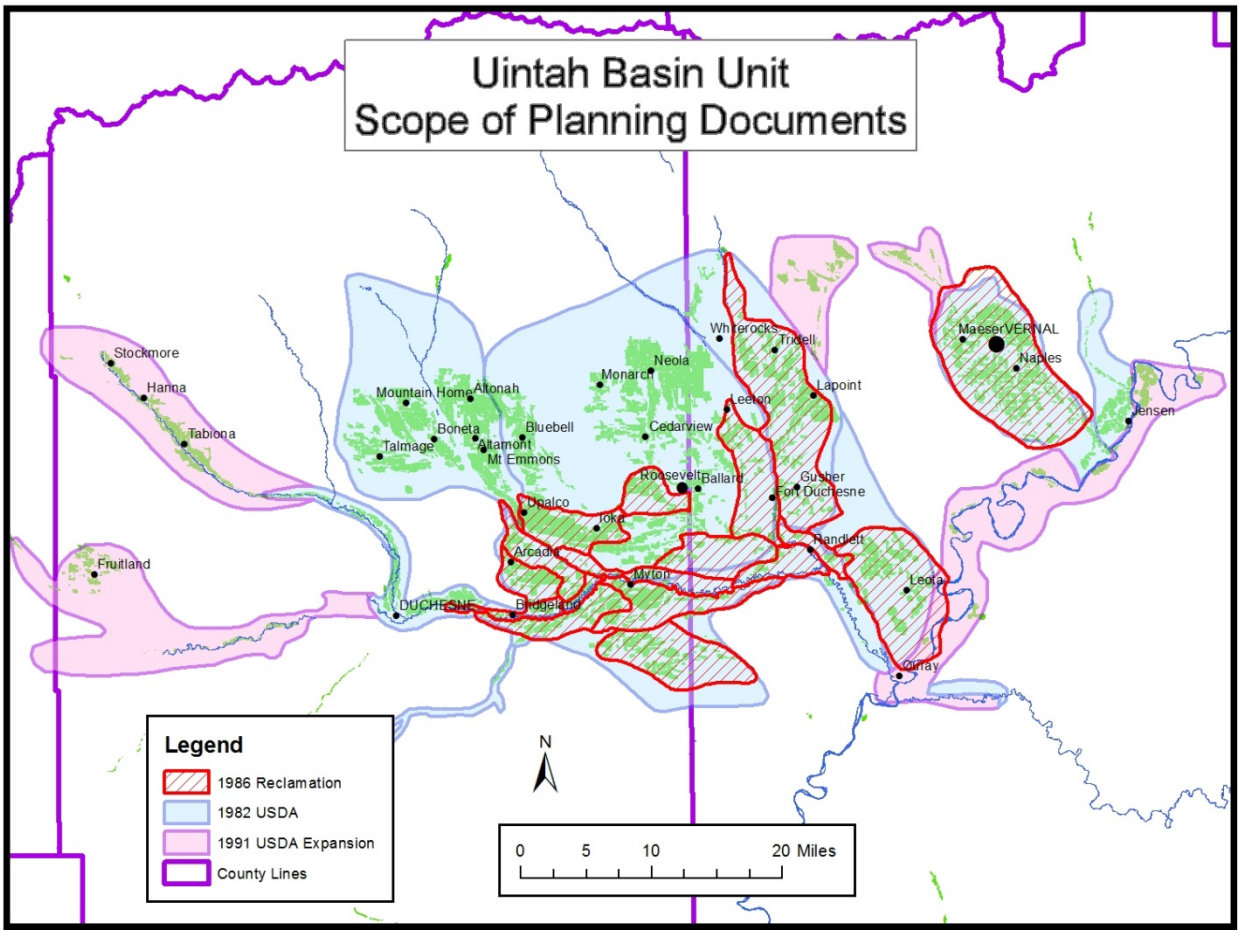


Figure 2. Scope of Federal Salinity Control Planning Documents

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 average salt load. Since flow rates and concentrations are highly variable, shorter measurement intervals and longer periods of record result in improved estimates.

Average salt pickup for a given drainage is the average salt load below the drainage minus the average salt load above the drainage.

Salt Pickup has various sources including natural processes, springs, wells, mines, and agricultural activity. Agricultural irrigation, a particularly large source, involves diverting relatively clean water from a watercourse, transporting diverted water to fields and applying 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.

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 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 1984, 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 1997, 2002, 2008, and 2014 Farm bills.

Salinity Control Practices

When more water is applied to the soil than can be absorbed by soil above the depth of the plant roots (root zone), excess water percolates below the roots and is lost forever (deep percolation). On-farm practices used to reduce salt loading include improved flood systems, sprinkler systems, and advanced irrigation systems, along with diversions, water delivery systems, pumps, ponds, etc., required for the efficient operation of irrigation systems. Salt load reduction is achieved by reducing over-irrigation and deep percolation.

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

Planning Documents

A review of NEPA planning documents indicates that the actual cost of treatment is generally less than anticipated pre-project. (Table 4)

The Environmental Impact Statement (EIS) for the Uintah Basin Unit of the Colorado River Basin Salinity Control Project (CRBSCP) was published in April, 1982. The EIS contemplated treating 122,200 acres with improved irrigation practices at a cost of $64.5 million FA ($167 million in 2014 dollars), reducing salt loading by 76,600 tons/year. It was anticipated that 35% of treatments would be improved flood irrigation. The nominal projected cost was $76/ton, FA+TA. (TA, technical assistance, pays for NRCS services, including outreach, taking applications, contracting, designing, construction inspection, and monitoring.)

Amortizing $64.5 million at 7.625% (the federal water project discount rate for 1982) over 25 years and normalizing to 2014 dollars, using the Producer Price Index for farm equipment purchased (PPI), results in a projected average cost of $197/ton (FA+TA) in 2014 dollars.

By 1987, it was apparent that USDA was installing more off-farm practices than anticipated and that 5,900 on-farm acres in the Whiterocks area, excluded from the initial EIS, would likely be treated after all. By letter from Utah State Conservationist, Francis T. Holt, dated July 14, 1987, (Holt Letter) 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.

Table 4. Comparison of Project Cost Estimates

FA+TA	EIS, 1982	Holt Letter, 1987	EIS, 1991	2002 Adjustment
Added Irrigation Improvements, Acres	122,200	5,900	8,900	23,000
Cumulative Irrigation Improvements, Acres	122,200	128,100	137,000	160,000
Incremental federal cost share, nominal	$64,474,200	$11,525,800	$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	$5,848,000	$7,503,000	$713,000	$3,166,000
Total amortized treatment cost, nominal	$5,848,000	$7,503,000	$8,216,000	$11,382,000
Total treatment cost, 2014 $	$166,591,000	$204,387,000	$220,629,000	$293,919,000
Total amortized treatment cost, 2014 $	$15,109,000	$20,179,000	$21,799,000	$27,601,000
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 2014 $	$197	$205	$204	$196

While the practice life of buried pipelines may be on the order of 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 NRCS' cost/ton analysis. Amortizing $76.0 million at 8.625% over 25 years yields an expected salt load reduction cost of $205/ton FA+TA, in 2014 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 ($16.2 million in 2014 dollars) to reduce salt load by 8,600 tons/year. Using the same reasoning as above, the amortized cost is $188/ton (FA+TA) for the incremental acres and $204/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 anticipated that more than 160,000 acres will ultimately be treated, with a total salt load reduction exceeding 140,500 tons/year, on-farm. Salt load reduction

costs may settle around $196/ton, in 2014 dollars, for the entire project, marginally less than costs estimated in the Holt letter in 1987 and after the 1991 expansion EIS.

The Uintah Basin Unit is mapped in red on the cover page of this report.

Distribution of Salt Concentration

Through the 1980s and 1990s, salt loads, for individual contracts, were calculated using a predetermined salt load factor, expressed in tons of salt/acre-foot, multiplied by the estimated return flow to the river in acre-feet/year. Return flow was calculated by using a water budget to estimate deep percolation and subtracting estimated phreatophyte consumption prior to ground water returning to the river system. The salt load factor was determined as part of the EIS, by measuring and comparing salt concentrations in water diversions to groundwater flowing from seeps below irrigated lands over just one irrigation season. Salt load factors were always suspect, because they were derived from too few samples over too great an area over too short of time. There is no evidence that any ground water potential studies were done to determine the likely subsurface flow paths of return flow. The salinity sub-units in the EIS do not reflect surface drainage paths defined by hydrologic evaluation of surface elevations and are not consistent with defined hydrologic units.

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

SPARROW (Spatially Referenced Regressions on Watershed Attributes)

In 2009, USGS released *Scientific Investigations Report 2009-5007,"Spatially Referenced Statistical Assessment of Dissolved-Solids Load Sources and Transport in Streams of the Upper Colorado River Basin"* (SPARROW91). This report, which includes a user-interfaced GIS model to access and review data, provides opportunity to compare past salt-loading estimates with state-of-the-art, computerized efforts to numerically model salt transport in the river and its tributaries.

As published, SPARROW91 reports the estimated agricultural salt load for one year only, 1991. A study is underway to improve input data and run a new SPARROW model to estimate average loads over longer periods of record. Until that effort is completed, conversion to long-term averages is accomplished by applying correction factors to each catchment in SPARROW91. The latest correction factors are based on comparisons of long term average salt loading at USGS gauge stations and have been given the name "Anning 2.2".

Figure 3 compares salt-loads estimated by NEPA documents with SPARROW 91 output. The consensus total agricultural load from NEPA documents is 328,000 tons/year, compared to 320,000 tons/year from Anning 2.2 adjusted SPARROW91 (pink bars). The Anning adjusted SPARROW91 numbers are for the overall average salt load and have been influenced by thirty years of ongoing irrigation practice improvements.

The blue bars represent salt load remaining at the end of 1991. Recalculated progress reports estimated agricultural salt loading to be about 278,000 tons/year at the end of 1991 (eleven years into the program).

SPARROW91 estimates an agricultural salt load of 227,000 tons/year at the same point in time. SPARROW91 represents only one year and not any type of long term average salt loading.

For the Uintah Basin Unit, adjusted SPARROW91 data seems to reasonably agree with other data sources.

Distribution of salt loading is of special interest, in that the SPARROW model indicates a radically different distribution than does the EIS. (Figures 4 and 5)

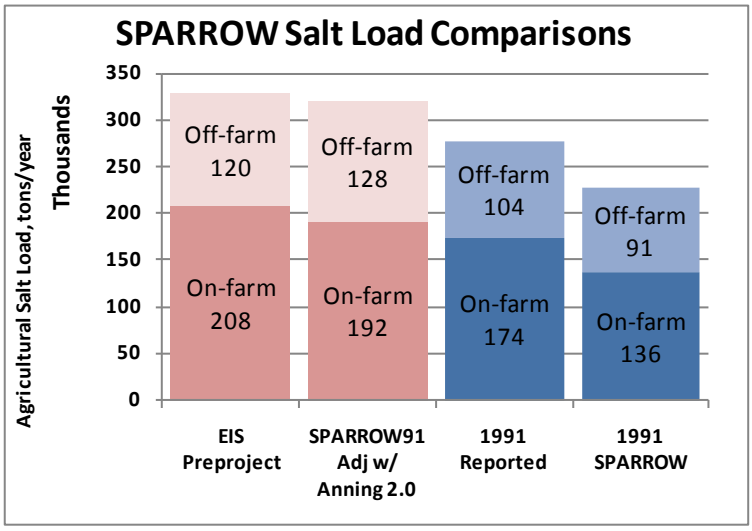


Figure 3. SPARROW91 Salt Load Comparisons

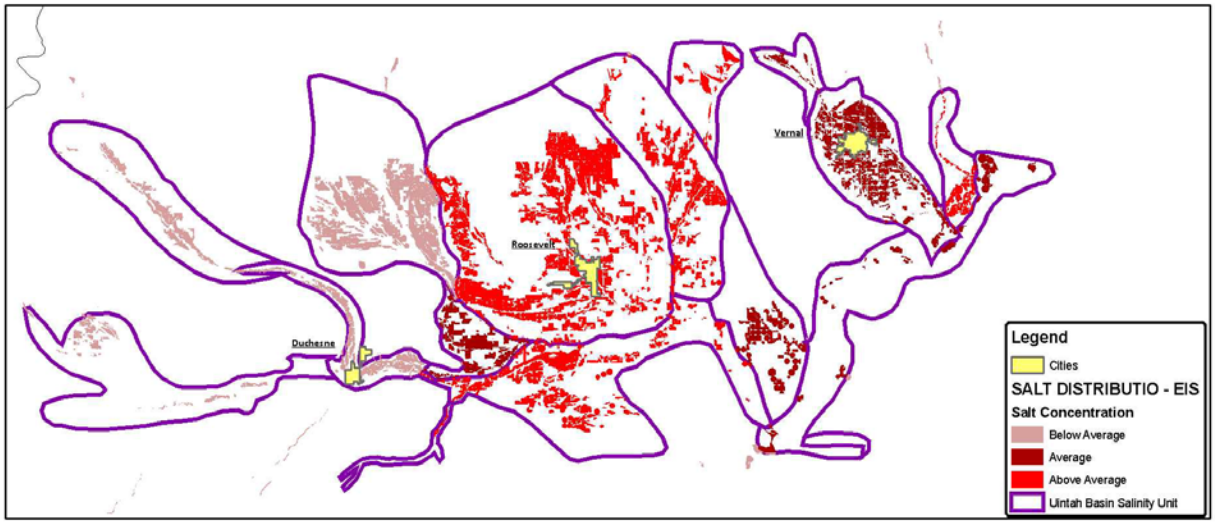


Figure 4. Salt loading distribution estimated by EIS.

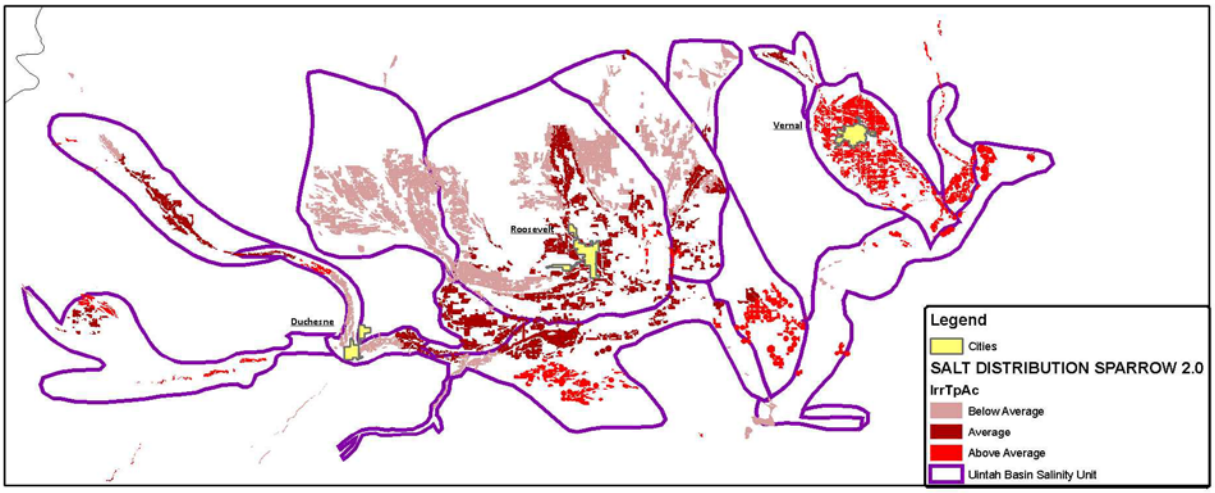


Figure 5. Salt loading distribution estimated by SPARROW91, adjusted to long-term averages (Anning 2.2)

Planned Practices

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

The installation of salinity control practices is voluntary on the part of landowners. An incentive to participate is created by cost-sharing installation using federal grants. In essence, federal cost-share purchases salt load reductions in the Colorado River, while the participants' cost-share buys them reduced operating costs and increased production.

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

FY2014 Obligation

In FY2014, $2.40 million was obligated in 44 contracts to treat 1,297 acres with improved irrigation. Of that amount, $26,000 was for wildlife habitat improvements.

Salt Load Reduction Calculation

The estimated salt load reduction from FY2014 planned practices is 1,205 tons/year on-farm and 0 tons/year off-farm. On-farm salt load reduction is calculated by multiplying the original tons/acre-year for the entire basin, by the acres obligated for treatment 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% = 39.9 tons/year salt load reduction. Salt load reduction in this report is calculated using this method, outlined in "*Calculating Salt Load Reduction*", July 30, 2007. In addition to on-farm salt load reduction, when ditches that cross non-irrigated acres are put in pipe, as part of an irrigation project, off-farm salt loading is also reduced. In FY2014, no off-farm salt load reductions were claimed.

Cost/Ton Calculation

The federal cost/ton for salt load reduction is calculated by amortizing the federal financial assistance (FA) over 25 years at the federal discount rate for water projects (3.500% for FY2014). Two-thirds of the FA is added for technical assistance (TA) (the average federal cost of outreach, ranking, planning, design, construction Inspection, monitoring and evaluation, etc.) and the amortized total cost is divided by tons/year to yield cost/ton-year. Normalization of past obligations and expenditures, to 2014 dollars, is accomplished using the National Agricultural Statistics Service (NASS) Producer Price Index (PPI) for agricultural equipment purchased (1992 series).

For FY2014 the amortized cost of obligated projects is $202/ton (FA+TA).

Obligation Analysis

In 2014 dollars, cumulative obligation thru FY2014 is $188 million, planned on 161,500 acres, with a salt load reduction of 157,000 tons/year (on-farm and off-farm), resulting in an overall average cost of $170/ton. Note that in 2014 dollars, the annual, normalized cost/ton has stayed in a reasonable range throughout the life of the project. Overall average cost/ton is below the cost projected by NEPA documents. (Figure 6, table 5)

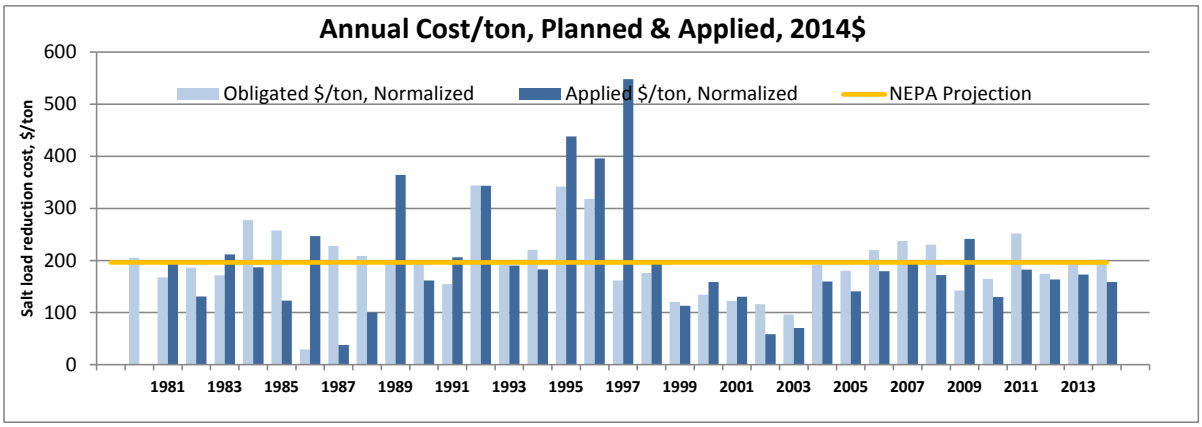


Figure 6. Cumulative obligated and applied cost/ton in 2014 dollars

Table 5. Cost/Ton of annual obligations since 1980, in nominal and 2014 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	2014 PPI Factor	FA Planned 2014 Dollars	Amortized FA+TA 2014 Dollars	$/Ton 2014 Dollars	Cum $/Ton, 2014 Dollars
1980	7.125%	84	$1,848,864	5,000	3,735	$267,404	$72	286%	$5,296,433	$766,032	$205	$205
1981	7.375%	95	$1,899,073	6,000	4,482	$280,839	$63	267%	$5,072,681	$750,158	$167	$185
1982	7.625%	76	$1,782,461	5,000	3,735	$269,438	$72	258%	$4,605,600	$696,186	$186	$185
1983	7.875%	108	$2,641,958	8,282	6,187	$408,097	$66	260%	$6,871,316	$1,061,396	$172	$180
1984	8.125%	36	$1,107,903	2,152	1,608	$174,829	$109	255%	$2,825,710	$445,902	$277	$188
1985	8.375%	70	$1,536,585	3,368	2,516	$247,640	$98	262%	$4,022,881	$648,338	$258	$196
1986	8.625%	39	$1,176,359	2,885	18,055	$193,569	$11	275%	$3,229,498	$531,412	$29	$122
1987	8.875%	63	$797,629	2,121	1,584	$133,971	$85	269%	$2,145,069	$360,289	$227	$126
1988	8.625%	127	$6,153,570	16,362	12,223	$1,012,567	$83	252%	$15,494,768	$2,549,655	$209	$144
1989	8.875%	87	$2,111,397	5,614	4,194	$354,634	$85	237%	$4,998,170	$839,501	$200	$148
1990	8.875%	75	$2,963,581	7,880	5,887	$497,768	$85	229%	$6,801,269	$1,142,352	$194	$152
1991	8.750%	132	$3,358,040	10,968	8,194	$558,282	$68	227%	$7,629,467	$1,268,417	$155	$153
1992	8.500%	284	$3,382,799	4,826	3,605	$550,898	$153	225%	$7,609,623	$1,239,248	$344	$162
1993	8.250%	156	$2,780,712	6,750	5,042	$443,465	$88	218%	$6,074,786	$968,800	$192	$164
1994	8.000%	113	$3,317,415	6,741	5,036	$517,952	$103	214%	$7,110,535	$1,110,177	$220	$167
1995	7.750%	27	$720,561	899	672	$110,109	$164	208%	$1,501,940	$229,513	$342	$168
1996	7.625%	161	$5,840,101	6,816	5,483	$882,794	$161	198%	$11,538,008	$1,744,094	$318	$177
1997	7.375%	24	$610,282	988	1,076	$90,250	$84	193%	$1,175,051	$173,769	$161	$177
1998	7.125%	18	$686,902	1,173	1,115	$99,348	$89	198%	$1,357,079	$196,277	$176	$177
1999	6.875%	22	$770,221	1,950	1,784	$108,918	$61	198%	$1,521,689	$215,183	$121	$176
2000	6.625%	45	$1,674,422	3,456	3,263	$231,438	$71	189%	$3,170,239	$438,190	$134	$175
2001	6.375%	60	$1,604,814	3,461	3,265	$216,745	$66	185%	$2,964,339	$400,362	$123	$173
2002	6.125%	122	$3,601,896	7,784	7,490	$475,200	$63	183%	$6,599,603	$870,689	$116	$169
2003	5.875%	145	$4,695,491	5,782	11,176	$604,936	$54	178%	$8,334,497	$1,073,761	$96	$162
2004	5.625%	140	$5,191,612	5,995	5,824	$652,943	$112	171%	$8,868,679	$1,115,403	$192	$164
2005	5.375%	158	$6,177,762	7,285	6,669	$758,243	$114	159%	$9,815,297	$1,204,705	$181	$165
2006	5.125%	116	$6,212,616	4,366	5,185	$743,898	$143	154%	$9,537,205	$1,141,984	$220	$167
2007	4.875%	62	$3,890,488	2,152	2,749	$454,319	$165	144%	$5,594,423	$653,300	$238	$168
2008	4.875%	77	$4,364,084	3,233	2,839	$509,624	$180	128%	$5,601,807	$654,162	$230	$169
2009	4.625%	62	$2,791,994	2,402	2,770	$317,866	$115	124%	$3,466,344	$394,640	$142	$169
2010	4.375%	65	$4,463,030	2,046	3,583	$495,203	$138	119%	$5,308,903	$589,059	$164	$169
2011	4.125%	89	$3,601,619	3,624	1,713	$389,338	$227	111%	$3,991,648	$431,500	$252	$170
2012	4.000%	59	$2,587,337	1,437	1,654	$276,034	$167	105%	$2,708,954	$289,009	$175	$170
2013	3.750%	35	$2,538,219	1,394	1,419	$263,686	$186	107%	$2,707,433	$281,265	$198	$170
2014	3.500%	44	$2,404,606	1,297	1,205	$243,162	$202	100%	$2,404,606	$243,162	$202	$170
Totals		3,076	$101,286,403	161,490	157,017	$13,835,407	$88		$187,955,549	$26,717,889	$170	

Cost Share Enhancement for Historically Underserved Customers

Typical federal cost share (FA), over the last several years, has been about 75% of total installation cost. A feature of the 2002, 2008, and 2014 Farm Bills is a cost share enhancement of the federal share to about 90% of total cost for limited resource, beginning, or socially disadvantaged farmers or ranchers.

In FY2014, $467,000 (35% of Salinity EQIP obligations), was obligated in 15 enhanced contracts, treating 205 acres to reduce salt loading by 187 tons/year. The average cost for cost-share enhanced contracts is $252/ton, compared to $202/ton for all contracts. About 20% of acres treated in the Uintah Basin Unit, in FY2014, are in enhanced contracts.

For FY2003 through FY2014, $13.6 million FA (2014 dollars) was obligated in 261 enhanced contracts, 27% of total obligation. Enhanced contracts were to treat 7,565 acres, reducing salt load by 7,412 tons/year on-farm and off farm. In 2014 dollars, the cumulative average cost for enhanced contracts is $208/ton compared to $149/ton for all contracts in the same time range.

From FY2003 to FY2014, the incremental cost of enhancement is $2.26 million in 2014 dollars, about 4.1% of total FA for the same period. A preponderance of enhanced obligations are with beginning farmers/ranchers. (Figure 7)

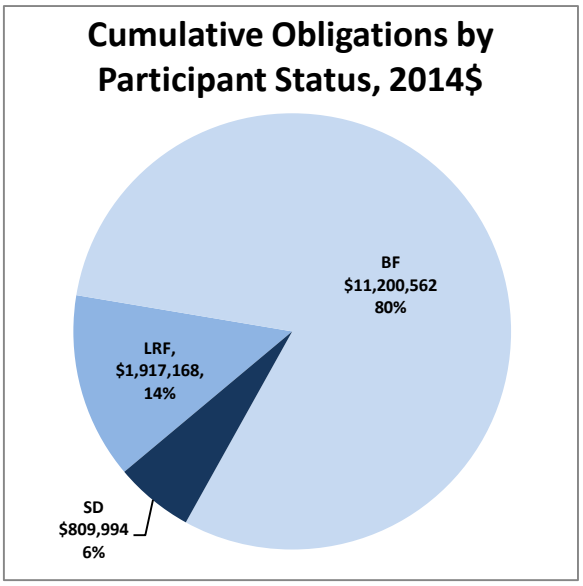


Figure 7. Cumulative obligations by participant status

Irrigation System Replacements

In the Uintah Basin Unit, many salinity funded irrigation systems have reached their expected practice life of fifteen years. Sixty-eight percent of applied systems are fifteen years old or older and forty percent are twenty-five years old or older.

Many of these systems have been well maintained and continue to function well. Some have been abandoned for a variety of reasons. Some are poorly operated and maintained and in need of repair and careful attention.

The following paragraphs describe what has historically taken place with regard to salinity control irrigation practices that have exceeded their prescribed service life.

Replacement of Prior Treated Practices

Some worn-out sprinkler systems, installed prior to federal salinity funding, have never claimed any federal cost-share or salt load reduction. These types of replacements have occasionally been funded with salinity money for many years. Such funding increased dramatically beginning with FY2008.

Starting in FY2008, replacements of worn-out, prior treated systems have been obligated using salinity funds at a federal payment percentage of about 65%. (About half of these contracts were with historically underserved cooperators and the average payment percentage was increased to 90 %.)

Since no salt load reduction or federal funds have ever been used on these fields, cost per ton was calculated on the basis of practice improvement from wild flood to the improved practice.

No prior-treated contracts have been obligated since FY2011.

From FY2009 – FY2011, 26 contracts obligated $1.59 million FA (2014 dollars) to reduce salt loading by 1,686 tons/year, on 1,791 acres, resulting in a cumulative cost of $105/ton (2014 dollars).

System Upgrades (Improved flood to Sprinkler)

From FY2008 – FY2011, 26 improved flood practices that had exceeded their useful life, were obligated for upgrade to more efficient wheel line or center pivot systems. These practices had previously had salinity grants and salt load reduction was claimed for their installation. It was assumed that the average application efficiency of these improved flood systems had declined from 55% to 45% over the prescribed life of the system and that the average salt loading of these systems was 48% of original salt loading (0.50 tons/acre-year). Systems upgraded to wheel lines would therefore reduce salt loading by 36% of the original loading (0.37 tons/acre-year), and center pivots by 45% of the original load (0.47 tons/acre-year).

Federal payment percentage has been about 65% for normal contracts and 90% for contracts with historically underserved participants.

No upgrade contracts have been obligated since FY2011.

Cumulatively, 26 contracts have obligated $1.37 million (2014 dollars) FA, to reduce salt loading by 448 tons/year, on 974 acres, at an amortized cost of $355/ton FA+TA (2014 dollars). Cumulative cost for all salinity obligations is $170/ton.

System Upgrades (Periodic Move to Continuous Move)

In FY2011, 36 contracts were obligated to upgrade worn-out periodic move sprinklers to continuous move systems (center pivots). Salt load reduction was based on increasing application efficiency from 55% to 75%, reducing salt loading by 19% of original salt load or 0.2 tons/acre-year.

Federal payment percentage has been about 65% for normal contracts and 90% for contracts with historically underserved participants.

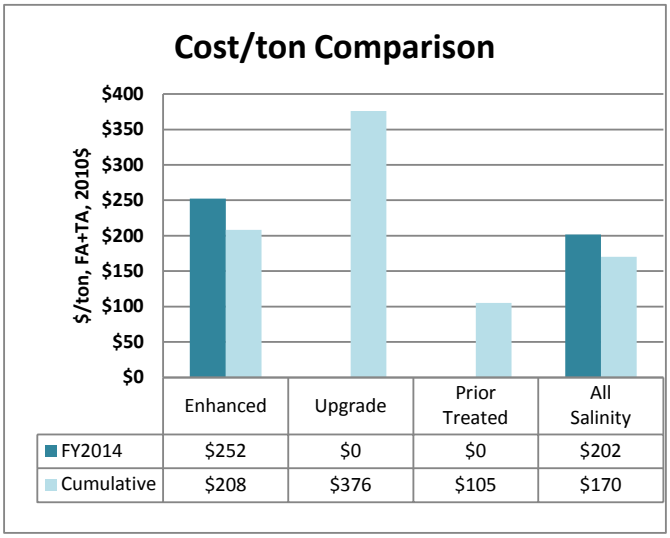
The cumulative cost for all salinity wheel-line to pivot upgrades is $1.73 million (2014 dollars) obligated on 2,256 acres, reducing salt loading by 475 tons/year at a cost of $394/ton.

Figure 8 compares the relative cumulative cost/ton for Enhanced, Upgrade, Prior Treated, and all salinity contracts in 2014 dollars.

Replacement of worn out like-for-like systems

By statute, only practices assuring significant environmental improvement may be funded with EQIP. Utah NRCS policy requires that any sprinkler proposed for replacement must achieve a 15% potential water savings as determined by the Farm Irrigation Rating Index (FIRI). This policy has effectively eliminated like for like replacements and irrigators faced with replacing worn-out equipment would be well advised to not wait on Federal funding.

Through FY2014, no systems of this nature have been obligated with salinity funds.



	Enhanced	Upgrade	Prior Treated	All Salinity
FY2014	$252	$0	$0	$202
Cumulative	$208	$376	$105	$170

Figure 8. Cumulative cost/ton by contract type, 2014 dollars

Effect of not Replacing Worn-out Systems

The preponderance of data suggests that salt loading levels are not likely to increase appreciably if replacements are not federally funded. Existing modifications to delivery systems would make returning to wild-flood difficult, in most cases. Sprinkler installations have decreased operating and maintenance costs, increased production, and improved useable irrigation season length, making it financially prudent to replace worn out systems when needed.

Multiple surveys with participants have indicated that the majority would replace their systems without additional federal participation. ***(See the "Hydro salinity" Section below for more detail.)***

Applied Practices

FY2014 Expenditures

In FY2014, $2.66 million FA was expended applying 1,640 acres of irrigation improvements. The estimated salt load reduction is 1,695 tons/year, on-farm and off-farm, at an amortized cost of $159/ton FA+TA (includes WLO). This calculation is somewhat 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. They 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, practices in contracts are assumed to be applied in proportion to dollars paid out, on a contract by contract basis.

Cumulative expenditure FY1980-FY2014 is $170 million FA (2014 dollars), applied to 157,200 acres (143,500 sprinkler acres, 13,600 improved flood acres, and 96 acres of drip irrigation), reducing salt loading by 155,200 tons/year (128,000 tons/year on-farm and 27,700 tons/year off-farm) at an average cost of $156/ton (2014 dollars).

There is a time lag between obligating and installing salinity control practices. Between planning and application, a few contracts are modified for various reasons such as design modification, change in ownership or cancellation. (Figure 9)

For NRCS funded projects, off-farm expenditures are a minor fraction of on-farm spending. (Figure 10)

Table 6 summarizes annual expenditures and cost/ton calculations for applied practices, nominal and 2014 dollars. Table 7 is a detailed summary of applied practices since project inception.

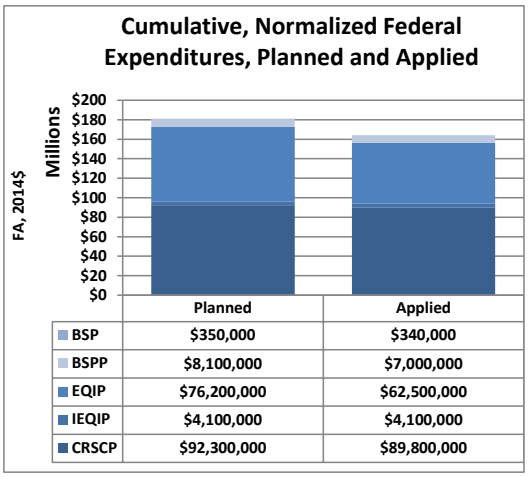


Figure 9. Comparison of Obligated and Expended funds by Program, 2014 dollars

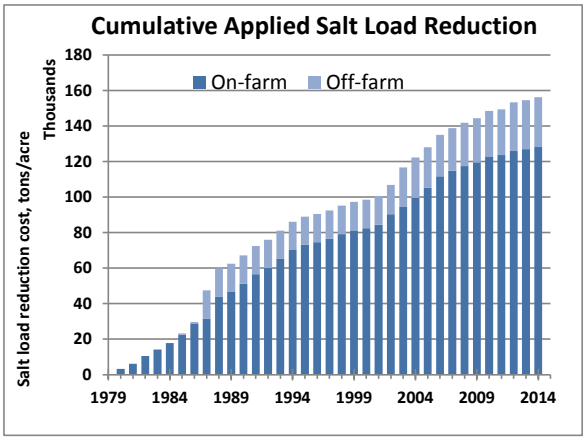


Figure 10. Cumulative applied salt load reduction

Table 6. Annual applied cost/ton, nominal and 2014 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	2014 PPI Factor	FA Applied 2014 Dollars	Amortized FA+TA 2014 Dollars	$/Ton 2014 Dollars	Cum $/Ton, 2014 Dollars
1980	7.125%	$0	4,349	3,234	$0	$0	286%	$0	$0	$0	$0
1981	7.375%	$1,450,506	3,919	2,928	$214,504	$73	267%	$3,874,498	$572,968	$196	$93
1982	7.625%	$1,450,506	5,801	4,333	$219,260	$51	258%	$3,747,880	$566,532	$131	$109
1983	7.875%	$1,899,239	4,823	3,603	$293,371	$81	260%	$4,939,621	$763,011	$212	$135
1984	8.125%	$1,746,366	5,040	3,765	$275,580	$73	255%	$4,454,112	$702,867	$187	$146
1985	8.375%	$1,578,710	6,131	5,405	$254,429	$47	262%	$4,133,167	$666,112	$123	$141
1986	8.625%	$3,491,444	8,285	6,395	$574,515	$90	275%	$9,585,179	$1,577,236	$247	$163
1987	8.875%	$1,500,879	3,691	17,847	$252,090	$14	269%	$4,036,323	$677,948	$38	$116
1988	8.625%	$3,011,008	16,675	12,457	$495,460	$40	252%	$7,581,757	$1,247,574	$100	$113
1989	8.875%	$2,327,840	3,400	2,540	$390,988	$154	237%	$5,510,541	$925,560	$364	$123
1990	8.875%	$1,978,927	6,432	4,716	$332,384	$70	229%	$4,541,538	$762,804	$162	$126
1991	8.750%	$2,823,067	7,078	5,171	$469,342	$91	227%	$6,414,008	$1,066,344	$206	$132
1992	8.500%	$3,382,799	4,834	3,611	$550,898	$153	225%	$7,609,623	$1,239,248	$343	$142
1993	8.250%	$2,752,919	6,750	5,042	$439,032	$87	218%	$6,014,068	$959,117	$190	$145
1994	8.000%	$2,749,248	6,741	5,036	$429,244	$85	214%	$5,892,728	$920,039	$183	$147
1995	7.750%	$4,071,491	3,965	2,962	$622,167	$210	208%	$8,486,631	$1,296,848	$438	$157
1996	7.625%	$1,882,617	1,902	1,421	$284,578	$200	198%	$3,719,396	$562,227	$396	$160
1997	7.375%	$3,277,813	1,991	1,703	$484,729	$285	193%	$6,311,179	$933,309	$548	$168
1998	7.125%	$1,391,042	2,193	2,030	$201,189	$99	198%	$2,748,216	$397,479	$196	$168
1999	6.875%	$852,084	2,488	2,105	$120,494	$57	198%	$1,683,422	$238,054	$113	$167
2000	6.625%	$750,166	1,275	1,239	$103,688	$84	189%	$1,420,314	$196,316	$158	$167
2001	6.375%	$1,104,669	2,357	2,112	$149,196	$71	185%	$2,040,494	$275,588	$130	$166
2002	6.125%	$1,499,522	6,458	6,160	$197,833	$32	183%	$2,747,511	$362,480	$59	$160
2003	5.875%	$3,040,199	4,404	9,884	$391,679	$40	178%	$5,396,353	$695,230	$70	$152
2004	5.625%	$4,096,866	5,517	5,512	$515,258	$93	171%	$6,998,556	$880,200	$160	$153
2005	5.375%	$4,149,302	6,521	5,754	$509,275	$89	159%	$6,592,457	$809,141	$141	$152
2006	5.125%	$6,918,799	6,896	7,080	$828,457	$117	154%	$10,621,291	$1,271,793	$180	$153
2007	4.875%	$4,412,156	3,044	3,706	$515,238	$139	144%	$6,344,569	$740,899	$200	$155
2008	4.875%	$3,424,172	2,900	2,985	$399,864	$134	128%	$4,395,321	$513,272	$172	$155
2009	4.625%	$4,474,513	2,058	2,619	$509,419	$195	124%	$5,555,242	$632,459	$241	$157
2010	4.375%	$4,100,607	3,724	4,160	$454,990	$109	119%	$4,877,790	$541,224	$130	$156
2011	4.125%	$1,394,280	730	916	$150,723	$165	111%	$1,545,270	$167,045	$182	$156
2012	4.000%	$5,647,470	2,054	3,861	$602,509	$156	105%	$5,912,927	$630,830	$163	$156
2013	3.750%	$1,954,235	1,102	1,252	$203,018	$162	107%	$2,084,517	$216,552	$173	$156
2014	3.500%	$2,661,334	1,640	1,695	$269,123	$159	100%	$2,661,334	$269,123	$159	$156
Totals		$93,246,795	157,169	155,240	$12,704,522	$82		$170,477,835	$24,277,431	$156	

Table 7. Summary of Applied Irrigation Practices by Year

Applied Practices										
FY	Nominal FA Applied	2014$ 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	$0	$0	3,651	698	-	4,349	-	-	3,234	-
1981	$1,450,506	$3,874,498	3,371	548	-	3,919	-	-	2,928	-
1982	$1,450,506	$3,747,880	4,452	1,349	-	5,801	-	-	4,333	-
1983	$1,899,239	$4,939,621	2,905	1,918	-	4,823	-	-	3,603	-
1984	$1,746,366	$4,454,112	3,122	1,918	-	5,040	-	-	3,765	-
1985	$1,578,710	$4,133,167	4,155	1,976	-	6,131	-	-	4,580	825
1986	$3,491,444	$9,585,179	6,642	1,643	-	8,285	-	-	6,395	-
1987	$1,500,879	$4,036,323	3,162	529	-	3,691	119	1,013	2,772	15,075
1988	$3,011,008	$7,581,757	15,201	1,474	-	16,675	15	1,638	12,457	-
1989	$2,327,840	$5,510,541	3,027	372	1	3,400	478	1,814	2,540	-
1990	$1,978,927	$4,541,538	6,060	372	-	6,432	280	625	4,716	-
1991	$2,823,067	$6,414,008	6,984	93	1	7,078	109	230	5,171	-
1992	$3,382,799	$7,609,623	4,666	160	8	4,834	154	3,004	3,611	-
1993	$2,752,919	$6,014,068	6,597	145	8	6,750	375	2,400	5,042	-
1994	$2,749,248	$5,892,728	6,581	150	10	6,741	213	868	5,036	-
1995	$4,071,491	$8,486,631	3,934	17	14	3,965	95	755	2,962	-
1996	$1,882,617	$3,719,396	1,856	42	4	1,902	655	404	1,421	-
1997	$3,277,813	$6,311,179	1,990	-	1	1,991	100	40	1,703	-
1998	$1,391,042	$2,748,216	1,946	236	11	2,193	24	17	1,836	194
1999	$852,084	$1,683,422	2,349	136	3	2,488	-	8	2,080	25
2000	$750,166	$1,420,314	1,200	75	-	1,275	1	17	1,180	59
2001	$1,104,669	$2,040,494	2,114	243	-	2,357	8	26	2,024	88
2002	$1,499,522	$2,747,511	6,322	136	-	6,458	-	15	5,980	180
2003	$3,040,199	$5,396,353	4,400	1	3	4,404	14	9	4,057	5,827
2004	$4,096,866	$6,998,556	5,513	3	1	5,517	24	103	5,168	344
2005	$4,149,302	$6,592,457	6,277	244	-	6,521	56	154	5,746	8
2006	$6,918,799	$10,621,291	6,863	29	4	6,896	78	247	6,274	806
2007	$4,412,156	$6,344,569	3,141	(99)	2	3,044	178	125	3,181	525
2008	$3,424,172	$4,395,321	2,993	(99)	6	2,900	451	2,217	2,682	303
2009	$4,474,513	$5,555,242	2,621	(569)	6	2,058	617	142	2,100	519
2010	$4,100,607	$4,877,790	3,810	(89)	3	3,724	341	256	3,344	816
2011	$1,394,280	$1,545,270	810	(80)	-	730	28	272	737	179
2012	$5,647,470	$5,912,927	2,068	(15)	1	2,054	12	100	2,278	1,583
2013	$1,954,235	$2,084,517	1,102	(5)	5	1,102	41	182	1,027	225
2014	$2,661,334	$2,661,334	1,637	(1)	4	1,640	164	38	1,551	144
Totals	93,246,795	170,477,835	143,523	13,550	96	157,169	4,630	16,719	127,515	27,725

Evaluation by Program

Since 1980, over 3,000 contracts have been obligated with landowners, through multiple funding programs, to upgrade irrigation practices on approximately 161,500 acres. (Table 8) As of the end of FY2014, practices are applied on about 157,200 acres. Less than 10% of applied systems are improved flood systems, 91% being higher-efficiency sprinkler systems.

EQIP and BSP, current funding programs, represent about 34% of obligated acres. (Figure 11)

Thirty percent of irrigated acres remain unplanned for treatment. (Figure 12) Of 14,800 acres initially treated with improved flood, about 1,200 acres have since been upgraded to sprinkler systems.

Table 8. Contracts Planned and Applied by Program

FY2014	Planned				Applied			
Program	Contracts	FA, 2014 $	Irrigated Acres	Salt Load Reduction, Tons	FA, 2014 $	Irrigated Acres	$/Acre	Salt Load Reduction, Tons
ACP & CRSCP	1,671	92,300,000	99,200	90,000	89,800,000	101,900	900	92,000
IEQIP	62	4,120,000	2,500	2,200	4,070,000	2,600	1,600	3,400
EQIP	1,249	76,200,000	55,200	57,500	62,500,000	48,600	1,300	54,300
BSPP	88	8,050,000	4,500	7,000	7,010,000	4,100	1,700	6,400
BSP	6	353,000	116	221	340,000	109	3,100	218
Totals	3,076	181,023,000	161,516	156,921	163,720,000	157,309	1,000	156,318

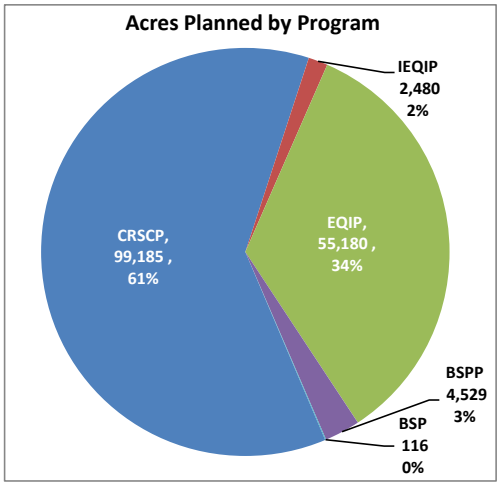


Figure 11. Acres planned by program

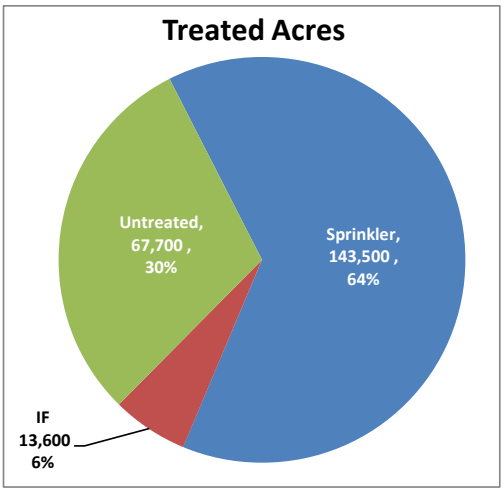


Figure 12. Treated acres

Hydro Salinity Monitoring

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

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

1. 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.
2. 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).
3. 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 to reduce deep percolation. 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%.

NRCS salinity control programs focus on helping participants improve irrigation systems and better manage water use to sharply reduce deep percolation and associated 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 now account for approximately two-thirds of acres obligated each year.

Salinity Monitoring Methods

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

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

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

Due to budget restraints, field intensive M&E efforts were curtailed in the late 1990s and a new "Framework Plan for Monitoring and Evaluating (M&E) the Colorado River Salinity Control Program"

was adopted in 2002. Having established that properly installed and operated practices yield predictable and favorable results, the 2002 Framework Plan addresses hydro-salinity by:

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

Cooperator questionnaires

From 2002 to 2005, 538 Cooperators were interviewed to determine perceptions and attitudes about salinity control practices installed on their property. In general, those surveyed are pleased with their involvement in salinity control programs. Most respondents claim to be operating within original design parameters and operating procedures. Detailed results of these surveys were reported in past M&E Reports.

While no direct questions were asked regarding potential like-for-like replacements, a large majority of participants expressed positive economic consequences from irrigation practice improvements. Ninety percent felt that their share of installation cost had been offset with improved production. Ninety-eight percent said that their initial investment resulted in substantial economic gain. Ninety-nine percent thought that there was a positive economic effect on the area and region from the salinity program.

With individual benefits described, it seems that few cooperators would willingly revert to flood systems even if they needed to replace equipment at their own expense.

USU Study, FY2007

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

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

Of interest concerning the present replacement discussion is this quote from the study: ***"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."***

UACD Study, FY2008

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 issued a final report for this study, "*Irrigation System Evaluation and Replacement Study*".

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

Of interest concerning the present replacement discussion is this quote from the study: ***"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."***

Irrigation Water Management (IWM)

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

In general, sprinkler systems designed by NRCS are capable of irrigating the most water-consumptive potential crop in the warmest months of the year. When growing crops with lower water needs, or at other times in the growing season, these systems are capable of limited over-irrigation.

Crops generally use water before irrigation begins in spring and after irrigation ends in autumn, leaving the soil moisture profile partially depleted. Filling the soil with water may require additional water in spring. (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 are trained and mentored in the proper use and maintenance of irrigation systems.

Cooperator interest is enhanced by creating financial incentives for IWM. In FY2014, three practice options were available for IWM,

1. Basic IWM, which requires the cooperator to
    a. Attend a two hour IWM training session, an approved water conference, or receive one-on-one training on their farm
    b. Keep detailed irrigation records using the IWM Self-Certification Spreadsheet or another irrigation water accounting system (check book method)
    c. Review the records with an NRCS employee or contractor trained to evaluate and explain IWM principals

2. Intermediate IWM, which requires everything in Basic IWM and the installation and use of simple electronic soil moisture monitoring equipment.
3. Advanced IWM, which requires everything in Basic and Intermediate IWM and real-time estimating evapotranspiration, monitoring soil moisture, or monitoring crop temperature stress using telemetered data. Irrigation water volumes are recorded from a flow meter near the field.

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 long-term averages. 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 incorporates input forms to enter system design information and irrigation records (figure 13) and creates two graphs (figure 14).

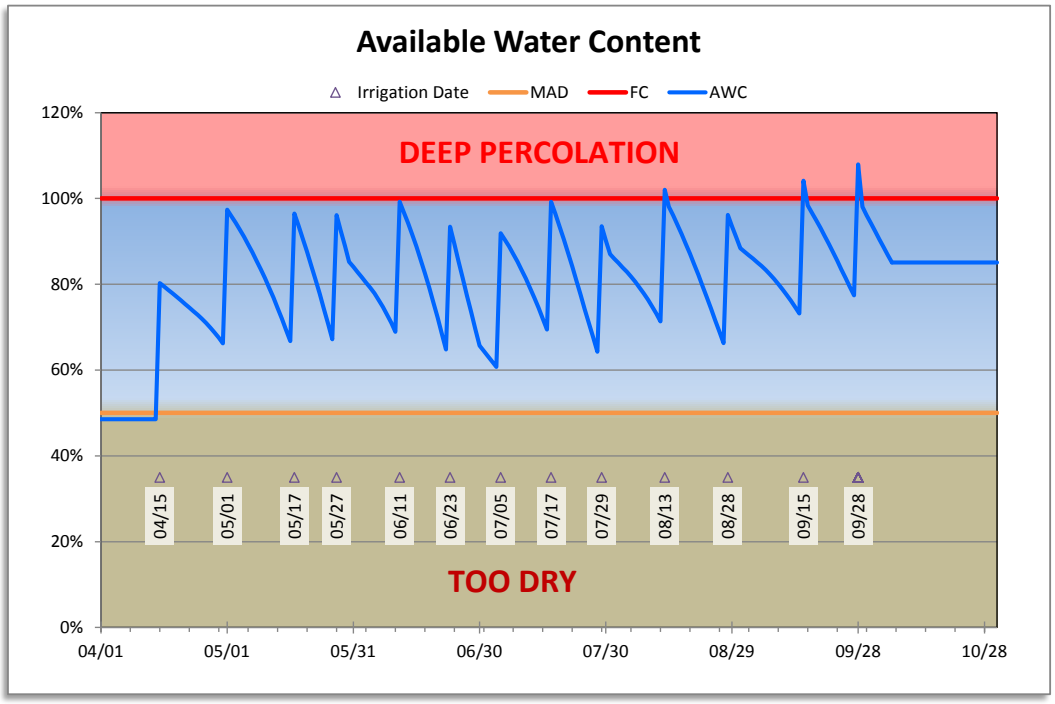
Irrigation Water Use Record - Farmer Self Certification

Cooperator:	Uinta Basin Rancher	**Crop:**	Alfalfa	**Year:**	2014
Tract/Field:		**Root Depth, ft:**	5.00		
Date:	10/15/2014	**Station:**	Duchesne	**CU:**	33.46 inches
		Contract Eligible Acres:			125.00
Soil Texture:	Clay Loam	**Irrigation method:**	Pivot		
AWC, In/Ft:	1.80	**Efficiency:**	75%		
AWC Max, in:	9.00	**Evaluated Acres:**	125.66		
MAD, in:	4.50	**Evaporation %:**	10%		
Pre-season AWC, In.	4.50	**Cycle Hours:**	168		
		Flow rate, gpm:	1,100		

Start date of irrigation cycle	End date of irrigation cycle	Total Cycle Hours	Alternate Cycle Hours	Flow, gpm	Gross Inches Cycle	Net Inches Season	CU Season	AWC Deficit	AWC	Deep Perc
04/15/14	04/22/14	168		1100.0	3.25	2.92	0.07	1.77	7.23	0.00
05/01/14	05/08/14	168		1100.0	3.25	5.85	1.45	0.24	8.76	0.00
05/17/14	05/24/14	168		1100.0	3.25	8.77	4.46	0.32	8.68	0.00
05/27/14	06/03/14	168		1100.0	3.25	11.70	7.42	0.35	8.65	0.00
06/11/14	06/18/14	168		1100.0	3.25	14.62	10.06	0.07	8.93	0.00
06/23/14	06/30/14	168		1100.0	3.25	17.55	13.51	0.59	8.41	0.00
07/05/14	07/12/14	168		1100.0	3.25	20.47	16.57	0.73	8.27	0.00
07/17/14	07/24/14	168		1100.0	3.25	23.40	18.83	0.07	8.93	0.00
07/29/14	08/05/14	168		1100.0	3.25	26.32	22.27	0.58	8.42	0.00
08/13/14	08/20/14	168		1100.0	3.25	29.25	24.43	0.00	9.00	0.18
08/28/14	09/04/14	168		1100.0	3.25	32.17	27.70	0.35	8.65	0.00
09/15/14	09/22/14	168		1100.0	3.25	35.10	29.91	0.00	9.00	0.37
09/28/14	10/05/14	168		1100.0	3.25	38.02	32.12	0.00	9.00	0.72
Totals	**13**	**2,184**	**0**	**1100.0**	**42.25**	**38.02**	**32.12**		**8.61**	**1.27**
Acre Feet					**442.39**	**398.15**	**336.33**		**94.25**	**13.32**
Deep Percolation					**Needed:**	**1.11**	**Designed:**	**6.34**	**Actual:**	**1.27**
Seasonal Application Efficiency (CU / water applied):							**Designed:**	**75%**	**Actual:**	**84%**

Figure 13. Sample IWM Self Certification Spreadsheet – Data entry page

System design, climate, crop, and soil data are entered into this sheet. Then all that is required is the start date of each irrigation cycle. The spreadsheet makes the calculations and tracks AWC and deep percolation. For maximum crop growth, AWC must be maintained in the upper 50% of its range. Some deep percolation is designed into each system as a leaching fraction to avoid buildup of salts in the soil.



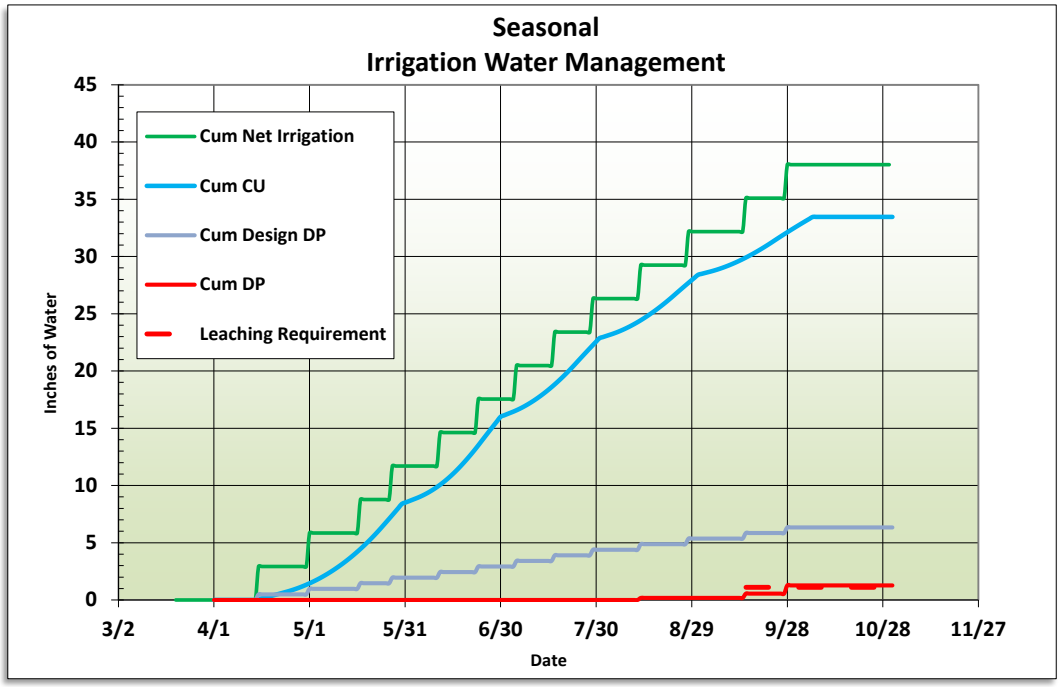


Figure 14. Sample graphs from the IWM Self Certification Spreadsheet.

In the top graph, the blue line is AWC. Spikes above the red 100% line are deep percolation. In the bottom graph, the blue line is the long-term average water requirement, based on location and crop. The green line is the actual water applied. The gray line is designed deep percolation. The dashed red line is the leaching requirement. The solid red line is actual deep percolation.

This spreadsheet is used by participants to self-certify a participant's irrigation records when presented to and discussed with NRCS employees or contractors.

Washington State University AgWeatherNet

Washington State University (WSU) also provides a web-based irrigation timing application that can be used with a connected computer or smart phone. Real-time ET data is accessed from the USBR AgriMet network and the Utah Climate Center (UCC) network. More stations are being added to the system all the time. This system can be accessed at http://weather.wsu.edu/awn.php. Registration is required but there is no charge for the service.

IWM incentive payments have created opportunities 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 quality records. NRCS personnel anticipate that nearly all new sprinkler owners will improve their IWM in future years, based on IWM training and user acceptance of irrigation water management principles.

Since FY2006, 1,212 completed IWM Self Certification Spreadsheets have been delivered to the M&E team, representing 35,000 acres. On an acreage basis 64% had no deep percolation, 19% were within design limits of deep percolation for the irrigation system, and 17% exceeded design limits of deep percolation. (Figure 15)

Eight years of IWM Self-certification data indicates that the average actual volume of deep percolation is about 65% of the expected volume.

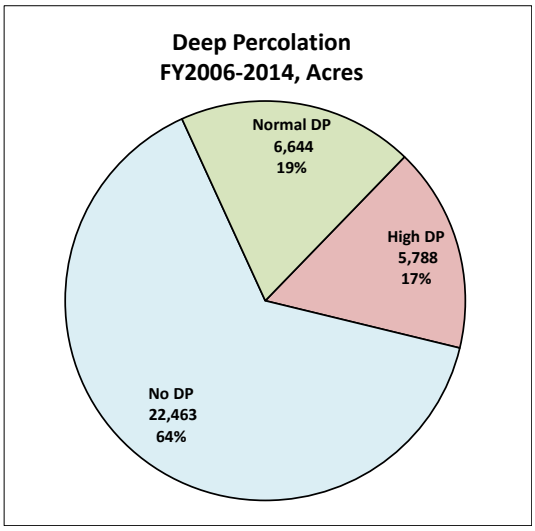


Figure 15. Acres with deep percolation from 1,212 IWM Certification Spreadsheets

ET Weather Stations

As part of M&E, NRCS has operated ten weather stations since the late 1980s. Data from these stations is used to calculate ET and produce a weekly ET report for public use.

With the advent of the WSU real-time system, NRCS has started to upgrade these stations and make data available to AgriMet and/or UCC. In FY2014, a weather station was installed at Manila, UT, in conjunction with UCC. New AgriMet stations have been installed at Duchesne, Pleasant Valley, and Pelican Lake. These four stations should be online and data available for use with the WSU application by the beginning of the 2015 irrigation season.

Soil Moisture Monitoring

A historically proven method for timing irrigation involves augering a hole and determining the water content of the soil to help decide when the next irrigation should be applied. This may well be the best

method available for irrigation timing, both simple and inexpensive. However, few operators take time to do it.

NRCS is demonstrating and guiding operators in the use of another tool for timing irrigation - modern soil moisture monitoring systems, utilizing electronic concentric granular matrix sensors to measure soil water tension. Soil water tension can be read with a portable electronic reader or automatically recorded with a data recorder. The intermediate IWM incentive payment is higher for participants that elect to install soil moisture monitors. Such systems can be installed for as little as $700, giving the operator information, at a glance, about the water content of their soil at multiple depths and locations.

Figure 16. Soil Moisture data recorder with graphing

In a typical case, water tension sensors are installed at three or more different depths, such as 12”, 24” and 48”, along with a single temperature sensor. Using a simple data recorder, indicated soil pore pressure (implied soil moisture content) is sampled and recorded multiple times per day. With some recorders, soil pore pressure is presented graphically on an LCD display in the field, making it a simple matter to estimate when the next irrigation will be required. (Figure 16) Newer, cellphone based systems will instantly deliver data to a computer to smart phone.

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 below -10 centibars. In the Uintah Basin, two 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 accurately estimate AWC. The lower limit of the Readily Available Water Content (RAW) may fall in the range of -80 to -120 centibars. Assuming a linear relationship from 0 to -200 centibars, and knowing the AWC/foot of soil, the soil profile can be divided into layers and total AWC estimated for each layer, knowing soil pore pressure (and derived saturation), layer thickness, and capacity. Summing AWC for all layers yields total AWC for the soil profile.

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

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

In a graph of AWC, based on recorded soil moisture data, each irrigation cycle is apparent. (Figure 17)

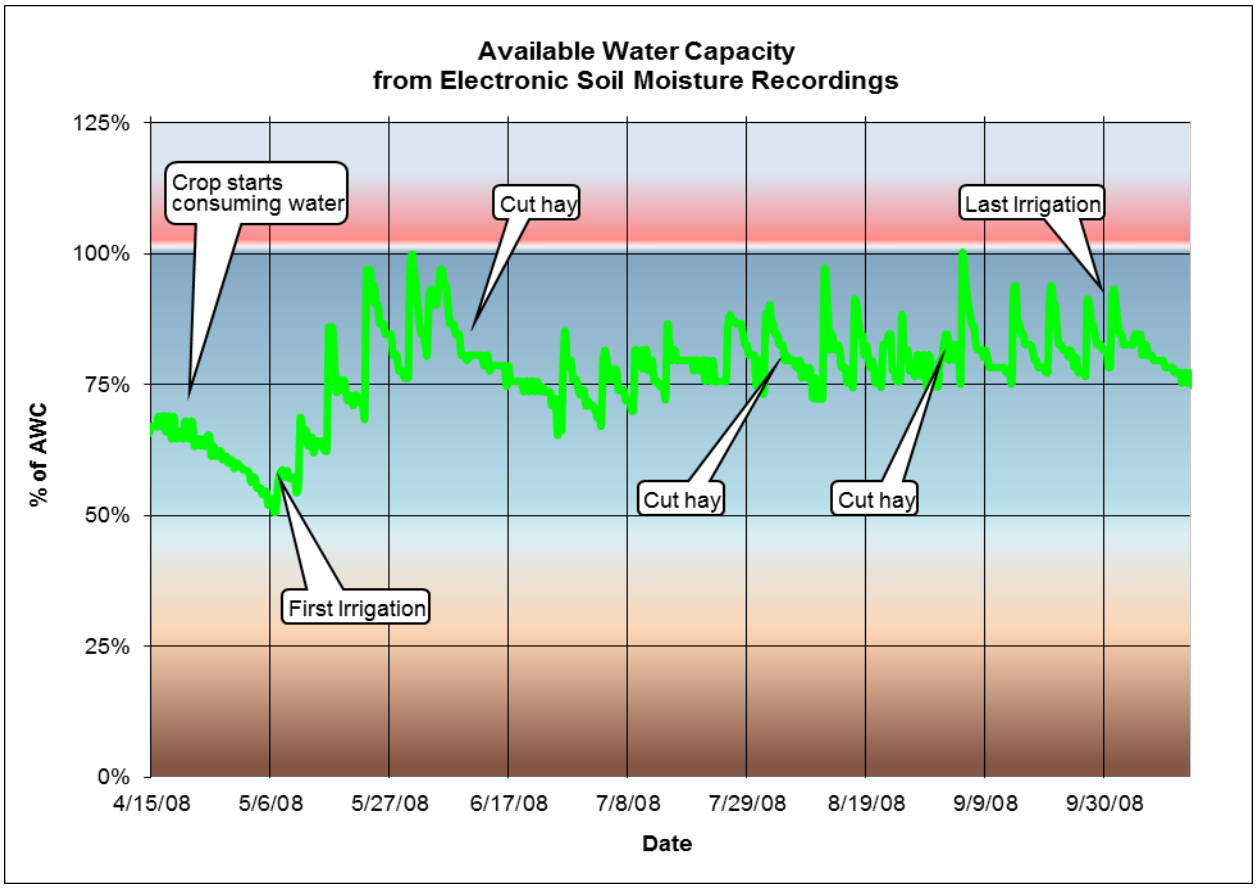


Figure 17. AWC from Soil Moisture Data graphed in Microsoft Excel

This rich loam soil absorbs moisture readily and has good water storage characteristics. In early spring, alfalfa starts to grow, pulling stored moisture from the soil. Irrigation begins, adding water to the soil profile. Each pass of the pivot is a peak on 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. Soil moisture was kept in the MAD zone from 50% to 100% of AWC, through the entire irrigation season, yielding a satisfying crop.

Equipment Spot Checks and Uniformity Evaluation

Catch-can Testing

Since FY2005, catch-can tests have only been ran on request. As reported in the FY2005 M&E Report, for wheel lines, catch-can testing is most useful to evaluate design, but is not particularly useful in determining system condition. The typical procedure chooses three adjacent sprinkler heads, appearing to be the best functioning, to run the test, assuring an optimum outcome.

Operating Sprinkler Condition Inventory

After a three-year hiatus, a field inventory of sprinklers was resumed in FY2012. In contrast to inventories in FY2006-FY2008, all sprinklers and gated pipe are being inventoried as opposed to just systems in operation. Mapping all irrigation systems will aid in updating the treated-acres layer and provide another indication of how systems are being operated.

Sprinklers are mapped and 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 is sketched into a shapefile and attributes recorded. The following rules are used for data attribution:

Age is estimated visually and rated: 1 = 0-3 years, 2 = 4-10 years, 3 = >10 years.

Condition is rated visually: 1 = no repairs needed, 2 = minor repairs needed, 3 = not useable without major repairs and 9 = not operating.

Leaks from hoses, drains, heads, and other sources are evaluated visually and the total gallons per minute (GPM) leakage estimated for the system.

Sprinkler length is calculated from the shapefile.

Acres are estimated assuming a 660' long field for wheel-lines (approximately 11 sets/irrigation cycle). Net irrigation requirement is assumed to be 8 GPM/acre. The leak % represents the GPM from leaks ÷ GPM for the system and all leakage is assumed to deep percolate (a conservative assumption).

Only wheel lines in operation are evaluated for potential deep percolation.

As would be expected, age is a major factor in system condition and overall leakage rates. (Figure 18) However, even with the oldest systems, average leakage amounts to only 1.31% of water applied, much smaller than evaporation, and somewhat minor in the overall scheme of things. Most leaks could be avoided with consistent, quality maintenance. There are more than a few 25-year-old systems operating with no leaks.

Over six years, 3,212 systems have been visually evaluated for age, leaks, and general condition. Of those evaluated, 2,612 are operating wheel lines, pod-lines, or hand-lines.

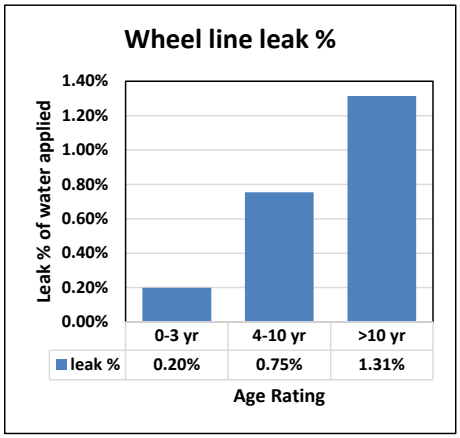


Figure 18. Average wheel-line leakage versus age, 2006-2014.

For FY2012-FY2014, all irrigation systems were inventoried, whether operating or not. Of 908 periodic-move systems, 326, or 36% were operating. Operated as designed, one would expect that well over 70% would be in operation during the heat of summer. The implication is that a large number of participants are likely under-irrigating, reducing deep percolation well below estimated levels. (Figure 19)

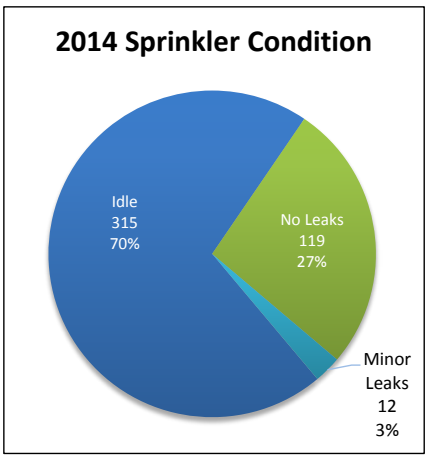


Figure 19. FY2014 Irrigation system condition.

Long-term Sprinkler Water Budgets

Long term monitoring of water budgets on fields has ended. The effectiveness of salinity control gains from irrigation improvements is well established.

Wildlife Habitat and Wetlands

Background

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

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

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

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

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

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

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

accomplished with the help of current year, high resolution, aerial photograph interpretation and on-site visits.

A photographic history is also 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 measurement of actual habitat extents by incorporating detailed mapping, establishment of permanent photo points, and smaller-scale case studies. This methodology is still in effect as of the current date, or until other more effective methods become available.

Habitat Replacement Goals

On November 27, 2012 NRCS received a response to a letter sent to Ms. Patricia S. Gelatt, Western Colorado Supervisor for the USFWS regarding proposed changes in the assessment method of wildlife replacement needed to offset incidental fish and wildlife values foregone resulting from salinity control projects in the State of Utah. The Service supported the proposal for minimum habitat improvement to be greater than 2 percent of irrigation acres treated for salinity control, and that wildlife habitat losses resulting from irrigation improvements will be replaced on a 1:1 acreage basis. The Service also stated that they agree that permanent easements would be preferred, but if not possible the habitat practice lifespan will be as long as, if not longer, than the lifespan of irrigation improvement practices (see Appendix).

The Uinta Basin Salinity unit has far surpassed this proportion and as of this report the unit is considered concurrent and proportional with salinity irrigation improvements. Efforts to plan and apply additional acres of habitat replacement will not relax by virtue of this change in assessment method. NRCS will continue to plan and apply real habitat improvements to offset losses incurred by the Colorado River Salinity Control Program.

Through FY2014, 157,700 acres have been treated with improved irrigation practices and 21,349 acres of habitat replacement has been completed, for a replacement ratio of 13.5%.

Basin Wide Wildlife Habitat Monitoring

Permanent photo points, representative of locations throughout the Uinta Basin of wetlands, wildlife habitat, agricultural areas, and areas where pipelines had recently been built were selected. Future photographs could be taken near the same date, and compared.

Wildlife Habitat Contract Monitoring

In FY2014 two Environmental Quality Incentive Program (EQIP) wildlife habitat improvement projects were planned and funded in the Uinta Basin for a total of 22.5 acres. No Wildlife Habitat Incentives Program (WHIP), Basin States Parallel Program (BSPP), or Basin States Program (BSP) projects were planned or funded in FY2014 in the UB Salinity Area. (Table 9)

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

Tables 11 and 12 provide more insight as to the amount of money spent on the ground for wildlife habitat replacement using EQIP, BSPP, BSP, and WHIP funding.

When is a contract completed or Conservation Practices applied? As stated above in the Hydro-salinity portion of this document, the cooperator may receive several partial payments in the course of construction. They may complete construction, commence operation, be reimbursed for 99% of FA and still have two years of Upland Wildlife Habitat Management left in the contract before it is officially completed. For this document, all practices in contracts are assumed to be applied in proportion to dollars paid out, on a contract by contract basis.

Voluntary Habitat Replacement

NRCS continues to encourage replacement of disturbed 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 (http://www.ut.nrcs.usda.gov) also has information and deadlines relating to Farm Bill programs.

Table 9. FY2014 Wildlife habitat acres planned and applied

Acres of Wildlife Habitat Creation or Enhancement by Program				
FY2014 Annual practices				
Program	Acres Planned		Acres Applied	
	Wetland*	Upland	Wetland*	Upland
EQIP	-	23	164	38
BSPP	-	-	-	-
BSP	-	-	-	-
WHIP	-	-	-	-
Total	**-**	**23**	**164**	**38**

*Wetland habitat type includes riparian areas

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

Acres of Wildlife Habitat Creation or Enhancement by Program				
FY2014 Cumulative practices				
Program	Acres Planned		Acres Applied	
	Wetland*	Upland	Wetland*	Upland
CRSCP	2,600	12,799	2,600	12,799
IEQIP	-	-	-	-
EQIP	2,182	4,790	2,010	3,469
BSPP	128	395	19	326
BSP	-	-	-	-
WHIP	2	164	1	125
Total	**4,912**	**18,147**	**4,630**	**16,719**

*Wetland habitat type includes riparian areas

Table 11. Annual Habitat Obligated, nominal and 2014 dollars.

FY	Contracts	Obligation	Wetland Planned	Upland Planned	PPI Factor	Normalized Obligation
	Number	$	Acres	Acres		2014$
1997	1	$1,350	12	10	193%	$2,599
1998	2	$8,500	30	100	198%	$16,793
1999	0	$0	0	0	198%	$0
2000	1	$2,566	1	17	189%	$4,858
2001	0	$0	8	27	185%	$0
2002	1	$2,566	0	15	183%	$4,702
2003	8	$35,113	75	257	178%	$62,326
2004	4	$96,528	95	2,597	171%	$164,896
2005	7	$131,476	68	199	159%	$208,891
2006	7	$227,360	87	395	154%	$349,028
2007	8	$590,663	1,794	219	144%	$849,358
2008	3	$119,977	44	67	128%	$154,004
2009	3	$122,744	53	101	124%	$152,390
2010	10	$396,068	36	1,263	119%	$471,134
2011	4	$139,334	0	39	111%	$154,423
2012	2	$25,424	0	16	105%	$26,619
2013	2	$194,337	10	7	107%	$207,293
2014	2	$26,063	0	23	100%	$26,063
Totals	65	$2,120,069	2,312	5,351		$2,855,378

Table 12. Annual Habitat Applied, Nominal and 2014 Dollars

FY	Payments	Wetland Applied	Upland Applied	PPI Factor	Normalized Payments
	$	Acres	Acres		2014$
1997	$0	100	40	193%	$0
1998	$4,545	24	17	198%	$8,979
1999	$12,512	0	8	198%	$24,719
2000	$8,619	1	17	189%	$16,318
2001	$16,280	8	26	185%	$30,072
2002	$7,182	0	15	183%	$13,160
2003	$8,098	14	9	178%	$14,374
2004	$60,811	24	103	171%	$103,881
2005	$66,237	56	154	159%	$105,238
2006	$99,971	78	247	154%	$153,469
2007	$119,477	178	125	144%	$171,805
2008	$269,661	451	2,217	128%	$346,141
2009	$243,614	617	142	124%	$302,454
2010	$128,652	341	256	119%	$153,035
2011	$192,540	28	272	111%	$213,391
2012	$92,946	12	100	105%	$97,315
2013	$99,663	41	182	107%	$106,307
2014	$25,701	164	38	100%	$25,701
Totals	$1,456,509	2,137	3,968		$1,886,360

Case Study: Farm Creek Fire Restoration Project (FCFRP)

Background

On July 1st 2007 a massive wildfire started by fireworks tore its way across the foothills and mountains of the South Slope of the Uinta Mountains. Two people lost their lives in the blaze including a fellow co-worker who worked as a loan officer for the Farm Service Agency (FSA), Tracy Houston. The fire started in the foothills and traveled north (up the mountains) and east (along the farmland in the foothills). This fire burned fences, hay fields, homes, and other structures. It also took its toll on wildlife habitat areas. One such area was a small drainage, Farm Creek, near the Whiterocks River. Farm Creek was already in poor shape due to de-watering (for irrigation purposes), overgrazing by livestock, and noxious weed invasions (mostly cheat grass and nodding thistle).

Seven years later (2014) one of the landowners along Farm Creek signed up his property for a Salinity Wildlife Only project. The project is located about 1.5 miles from the Ashley National Forest boundary, north of the town of Whiterocks, in Uintah County, Utah. The total size of the property is about 15 acres, most of which is in a grass alfalfa pasture. The northwestern corner of the property is bisected by Farm Creek. The woody vegetation along the creek was burnt in the 2007 fire and the three acres on the NW side of the creek has started to heal but is now infested with cheatgrass and thistles.

Figure 20. FCFRP Location Map

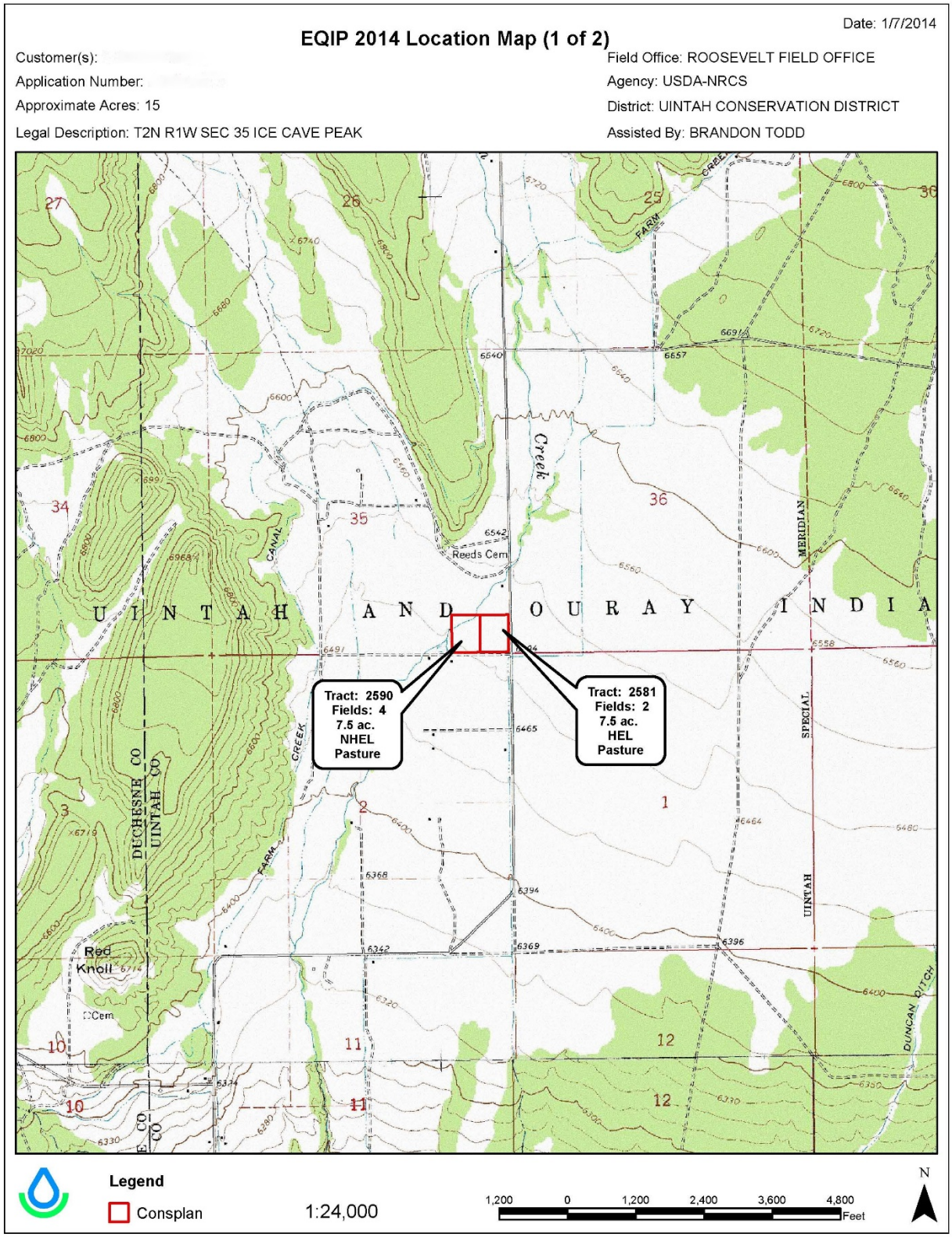


Figure 21. FCFRP Location Map

Date: 1/7/2014

EQIP 2014 Location Map (2 of 2)

Customer(s):

Application Number:

Approximate Acres: 15

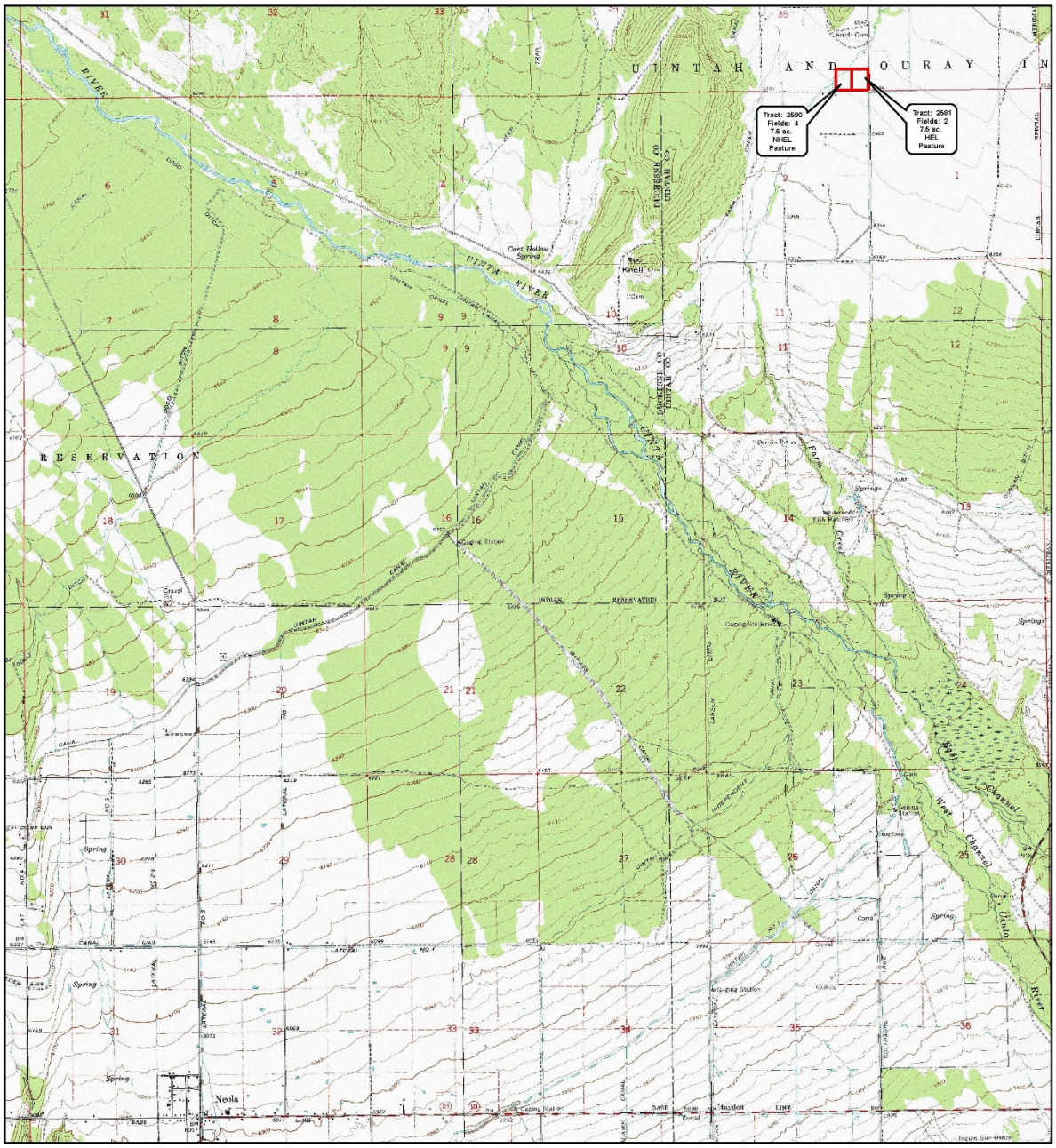
Legal Description: T2N R1W SEC 35 ICE CAVE PEAK

Field Office: ROOSEVELT FIELD OFFICE

Agency: USDA-NRCS

District: UINTAH CONSERVATION DISTRICT

Assisted By: BRANDON TODD



Legend

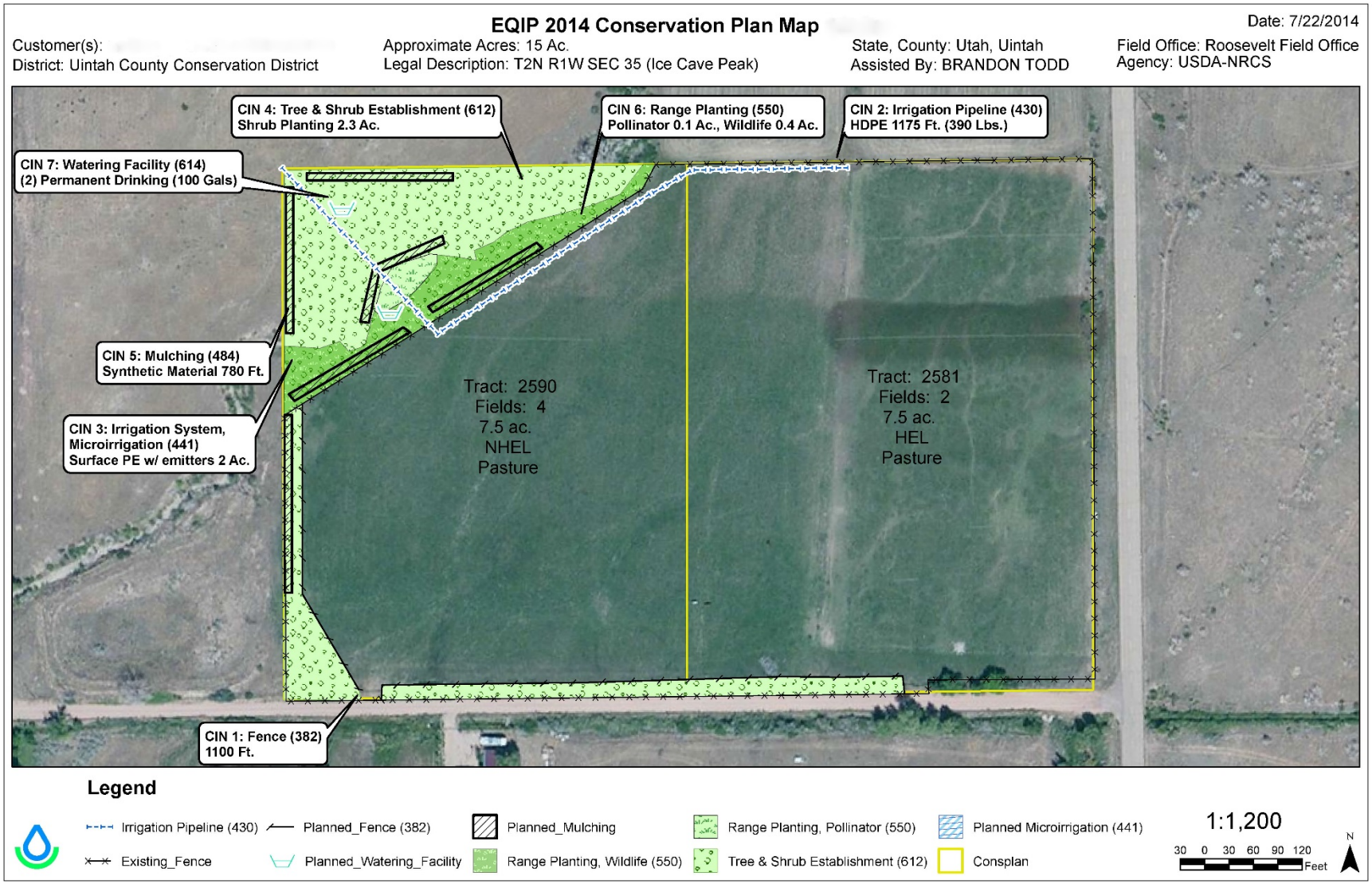
Consplan

1:48,000

2,400 0 2,400 4,800 7,200 9,600 Feet

N

Figure 22. FCFRP Wildlife Habitat Conservation Plan Map



Objectives

FCFRP, just as many other wildlife salinity replacement projects, is a comprehensive Conservation Plan with multiple objectives. Aspects of this project that facilitated funding were: wildlife water, habitat loss due to fire, poor pollinator foraging habitat, upland game species, lack of woody vegetation, and family recreation. Most objectives revolve around these circumstances and are listed below, in no particular order:

- Control woody vegetation degradation by livestock.
- Eliminate or greatly reduce noxious weeds throughout the property cheat grass (*Bromus tectorum*) and nodding thistle (*Carduus nutans*), exist on the property to the detriment of the land and the exclusion of native species.
- Wildlife food, shelter, and cover such as woody and herbaceous vegetation were lacking or of poor quality. Poor recruitment of woody vegetation was present before project inception because of livestock herbivory and fire. Herbaceous vegetation was dominated by pasture grasses, and noxious weeds (cheatgrass and nodding thistle).
- Lack of flowering plants pollinated/visited by native bees, wasps, and flies was also a resource concern the landowner wanted to address.
- Beautifying area for a more aesthetic experience for landowner family while recreating. Benefits would be more green vegetation on landscape due to controlled grazing. Cooler temperatures in summer due to the growth of trees, shrubs and other vegetation, and edible fruit.
- Lack of wildlife watering places during summer/fall when Farm Creek runs dry.

Results

On-the-ground meetings took place April-July, 2014 with the landowner to assess resource concerns/objectives. From these meetings consensus was achieved and the following practices were included in the Wildlife Habitat Conservation Plan:

- 1,100 feet of wildlife friendly fence
- 300+ trees and shrubs (2.2 ac) w/ weed barrier (mulch)
- 0.5 acre range seeding, including flowering forb species for pollinators
- Two wildlife watering facilities
- 1,175 feet irrigation pipeline for micro-irrigation system
- 2.0 acres of micro-irrigation system for wildlife area
- Weed barrier mulch under trees and shrubs to promote better survival rate

During the first growing season the landowner planted over 200 trees and shrubs, installed weed barrier, and built fence to exclude plantings from grazing. The landowner also applied herbicide to help control noxious weeds at his own expense as this item is not in the contract. Landowner intends to install other practices in the 2015 growing season. Photographs of the FCFRP property and practices installed can be seen below on the Photo Gallery.

Farm Creek Fire Restoration Project Photo Gallery

Figure 23. July 1st 2007; looking north from Roosevelt toward Neola Fire

Figure 24. July 1st 2007; looking south from Whiterocks Canyon toward Neola Fire and FCFRP

Figure 25. July 22, 2014; looking west, from northeast corner of the property at fire scar on hillside

Figure 26. July 22, 2014; looking northwest at burnt cottonwoods along Farm Creek

Figure 27. July 22, 2014; looking west along south edge of property at fence under construction

Figure 28. July 22, 2014; looking west along south edge of property at fence under construction

Figure 29. July 22, 2014; looking south at newly planted trees and shrubs and micro-irrigation system

Figure 30. July 22, 2014; looking north at newly planted trees and shrubs and micro-irrigation system

Figure 31. July 22, 2014; Looking northeast along Farm Creek and future pollinator seeding area

Figure 32. July 22, 2014; Looking northwest at Farm Creek and future pollinator seeding area

Figure 33. July 22, 2014; looking north along boundary between Fields 2 & 4 at new (2014) replacement wheel-line irrigation system purchased by landowner to replace Salinity purchased hand-lines.

Figure 34. July 22, 2014; looking northwest across property at new (2014) replacement wheel-line irrigation system purchased by landowner to replace Salinity purchased hand-lines

Discussion

The FCFRP project is only one year old and has had only one growing season for implementation of practices. In that growing season the landowner has planted over 200 trees and shrubs, and built the fence to protect the nursery stock (approx. 1/3 of practices in project are complete). Project will continue to be monitored to assure contract is fulfilled and wildlife benefits are achieved.

This is another small, simple habitat replacement project where NRCS was able to meet both the needs of the program and the needs of a small acreage landowner. In this example water resources are being used more efficiently, wildlife areas are created and protected from being degraded by livestock, woody vegetation planted, pollinator foraging habitat created, and noxious weeds controlled. This property is also an example of a tract of land where the landowner wanted both an improved irrigation system *and* wildlife habitat. NRCS has found over the years to include both habitat work and irrigation improvements in the same contract is not an ideal situation. All the improvements, however, are included in the same Conservation Plan provided to the landowner. Subsequently, two contracts were written for FCFRP using the same Conservation Plan as reference; one for the irrigation and another for wildlife habitat replacement.

These areas are the types of habitat being lost with the implementation of the CRSCP; as fields are squared off for sprinkler installation. Smaller projects tend to get lost in the big picture of wildlife habitat replacement; though not directly benefiting threatened or endangered species, they help maintain plant and animal species diversity in rapidly urbanizing landscapes.

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

NRCS will continue to monitor the progress of planned practices and those already applied and supply the landowner with technical assistance and guidance for future improvements and additional resource concerns.

Economics

Cooperator Economics

Production Information

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

Alfalfa production data downloaded from the National Agricultural Statistics Service (NASS) indicates that alfalfa yields from the entire Uintah Basin Unit have increased from about 3.3 tons/acre to about 4.1 tons/acre since 1980, based on a linear regression of the data set.

With 157,000 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 about 58% since 1980. From 1980 to 2013, average production increased from 170,000 tons/year to 270,000 tons/year, while alfalfa acreage increased from 50,000 acres to 70,000 acres (Utah Division of Water Resource's Water Related Land Use data indicates an acreage change from 41,000 to 90,000 acres for all hay land), implying a yield on the order of 4.5 tons/acre for acreage upgraded to alfalfa production from another crop, most often grass pasture (based on linear regression of the data). (Figure 35)

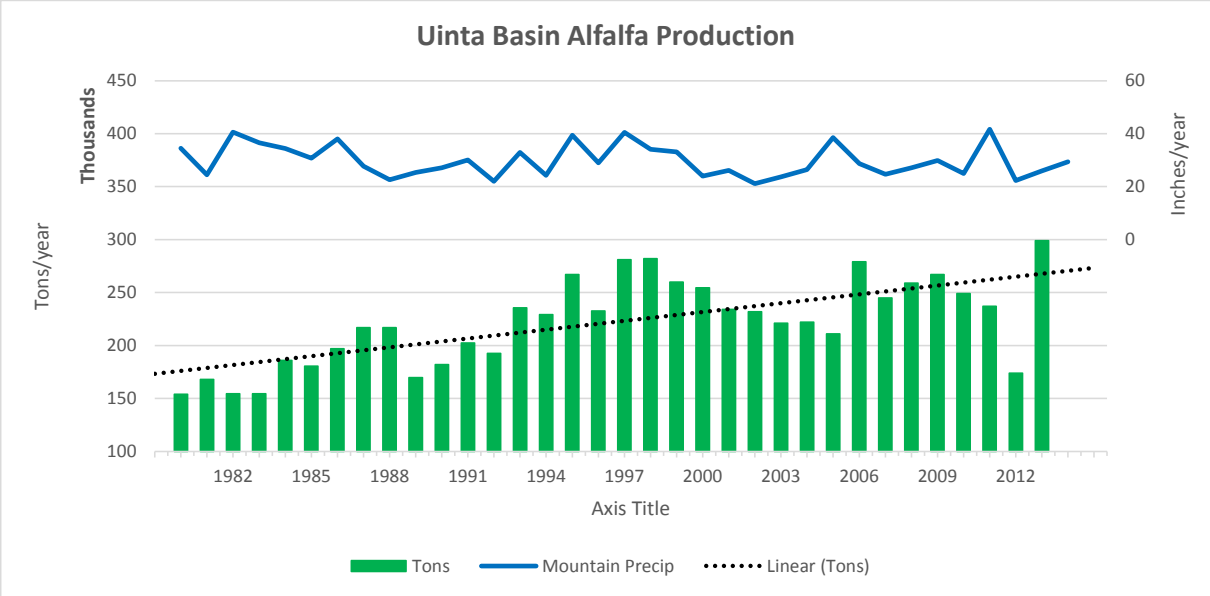


Figure 35. Alfalfa Production and Annual average mountain precipitation

Improved Irrigation Water Management has enabled UB farmers and ranchers to help compensate for drought related crop losses in West Texas and California. Resulting market conditions have driven alfalfa and beef prices to all-time highs.

Labor Information

From the 2012 Census of Agriculture (Census) the cost of hired farm labor in UB doubled in five years. (Figure 36) Eight percent of farm operations hired outside labor in 2012. Fifty-six percent of principal operators have full-time occupations other than farming.

While numerical data is inconclusive, anecdotal information indicates that participants are satisfied with labor savings associated sprinkler systems.

In 2012, 28% of principal operators were 65 or more years old. (Figure 37) Sprinkler systems may be easier to operate for aging farmers and ranchers. A distinct preference for Center Pivot Systems has developed.

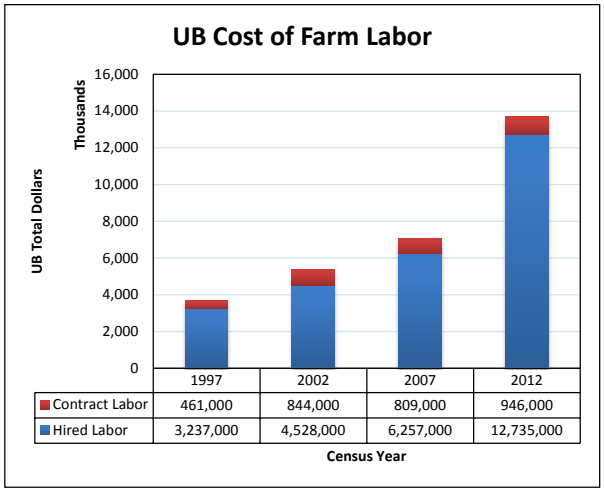


Figure 36. Census Cost of Hired Labor

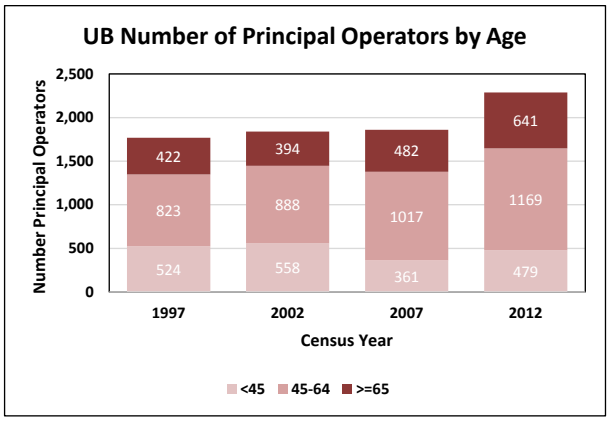


Figure 37. Census Principal Operator by Age

Public Economics

Ninety-nine percent of survey respondents believe that salinity control programs have a positive economic effect 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 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. However, the FY2014 average cost of $202/ton for planned practices is not the highest over the life of the program (in 2014 dollars). The cost of downstream damages from excess salt is an elusive target and not well defined. Colorado River Basin Salinity Control Programs are successful and cost effective in reducing salt load in the Colorado River.

Positive public perceptions of the Salinity Control Program include:

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

Negative public perceptions of the Salinity Control Program include:

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

Summary

Local landowners are willing and able to participate in salinity control programs. At present funding levels, there are ample applications for funding, 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 plastic pipe, transportation, labor, and equipment. The local economy is thriving, and upward pressure on labor and equipment prices is substantial.

Glossary and Acronyms

ACP – Agricultural Conservation Program.

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.

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

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

Application efficiency – The portion of the irrigation water delivered to the field that is stored in the soil, expressed as a percentage of the total delivery volume.

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

BSPP – Basin States Parallel Program – managing LCRB matching funds from FY1997 to FY2012.

BSP – Basin States Program - managing LCRB matching funds starting in FY2012.

Bureau of Reclamation (Reclamation or USBR) – 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 the uniformity of water application.

CFS – Cubic feet per second or second-feet.

Christiansen Coefficient of Uniformity (CCU) – a sprinkler uniformity rating. In a catch-can test, CU is the sum of the squares of the ratio of each catch to the average catch.

Continuous Move Sprinkler – a sprinkler system designed to move continuously, such as a center pivot, lateral move, or a big-gun on a reel.

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

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

CRBSCP – Colorado River Basin Salinity Control Program, 1974 to present. National program created by the 1974 Salinity Control Act.

CRSCP – Colorado River Salinity Control Program, a USDA funding program from FY1984 to FY1995.

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

Deep Percolation (DP) – 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 irrigation water is applied to a field. If DU is poor, more water is needed to assure that the entire crop has an adequate supply. Using a catch can test, DU is the ratio of the low quarter average catch to the total average catch.

EQIP – Environmental Quality Incentives Program, FY1997 to present.

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 (FC) – The total volume of water contained in the soil after gravimetric drainage has occurred. The soil pore pressure is 0 to -33 centibars, depending on soil texture.

Financial Assistance (FA) – The Federal cost share of conservation practices. For USDA funding, FA is normally assumed to be 60% of the total federal cost of conservation practices.

Gated Pipe – Water delivery pipe with individual, evenly spaced, adjustable gates designed to put the same amount of water into each of many furrows.

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

Hand line – A periodic-move 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.

IEQIP – Interim Environmental Quality Incentives Program, FY1996 only.

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

LCRB – Lower Colorado River Basin.

Leaching Requirement – amount of deep percolation required to sweep salt delivered with irrigation water below the root zone.

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

Management Allowable Depletion (MAD) – The fraction of AWC that allows for maximum production. Typically 50% for forage crops. Only the top 50% of AWC should be used for crop growth.

National Agricultural Statistics Service (NASS) - A branch of the U.S. Department of Agriculture (USDA) charged with keeping agricultural statistical data. NASS provides the Producer Price Index for farm equipment purchased (PPI) used to normalize costs in this report.

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 – 1970 National Environmental Policy Act which sets out requirements for Federal Agencies to evaluate impacts of Federal actions 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 periodically moved to a new position by hand or on wheels repeatedly until the field is covered. (Includes sprinkler systems such as hand-line, wheel-line (side-roll), pod, big-gun, etc.)

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

Pivot or Center Pivot – A continuous-move 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.

Pod – A periodic-move sprinkler system consisting of several plastic pods at fixed spacing along a small-diameter (1.25-2.00”), flexible HDPE supply line. Each pod has a sprinkler and the operating lateral is typically moved by dragging it with a four-wheeler.

Producer Price Index for farm equipment purchased (PPI) –An economic index compiled by NASS and used to normalize costs in this report. It is available at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/econ/prices/

Ranking – A process by which applications for federal funds are competitively prioritized based on their effectiveness in achieving federal goals. Applications may be screened into high, medium, or low priority prior to ranking.

Readily Available Water (RAW) – water that a plant can easily extract from the soil. A synonym for Managed Allowable Depletion.

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

Root Zone – The typical depth of the roots of a specific crop type.

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 – 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 advertise, design, monitor, and evaluate practice installation and operation, and to train and consult with cooperators. For USDA, TA is generally assumed to be 40% of the total federal cost of conservation practices in the salinity control program.

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

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

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

Wheel line, Wheeline, Side-roll– A periodic-move sprinkler system designed to be moved periodically by rolling the sprinkler lateral on large wheels.

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

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

Appendix

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
764 Horizon Drive, Building B
Grand Junction, Colorado 81506-3946

IN REPLY REFER TO:
ES/CO:NRCS Salinity Program Habitat Replacement
TAILS 06E24100-2013-CPA-0003

November 27, 2012

David C. Brown, Utah State Conservationist
Natural Resources Conservation Service
125 South State Street, Room 4010
Salt Lake City, Utah 84138-1100

Dear Mr. Brown:

This responds to your July 16, 2012, letter regarding the proposed changes in the assessment method of wildlife replacement needed to offset incidental fish and wildlife values foregone resulting from salinity control projects in the State of Utah. The Fish and Wildlife Service (Service) supports the proposal for minimum habitat improvement to be greater than 2 percent of irrigation acres treated for salinity control, and that wildlife habitat losses resulting from irrigation improvements will be replaced on a 1:1 acreage basis. We agree that permanent easements are preferred, but if not possible, that habitat practice lifespan will be as long or longer than the practice lifespan of irrigation improvements. This change is in line with Colorado Natural Resource Conservation Service (NRCS), and we trust that it will help the salinity program offset real habitat losses with real habitat improvements. We hope this change will allow NRCS biologists to focus their efforts on implementing quality habitat replacement projects with willing landowners.

The Service commends NRCS for the habitat replacements/improvements in both the Uintah Basin and Price San Rafael River Salinity Units, that are proportional and concurrent with salinity irrigation improvements, and exceed 2 percent of the irrigation improvements. We appreciate continuing efforts by NRCS field staff to pursue and implement new projects, as well as to monitor and evaluate ongoing and completed projects. Please let us know if there is any way we can assist NRCS in reaching the replacement needs associated with the Muddy Creek, Green River, and Manila-Washam Salinity Units.

For further assistance, please contact Barb Osmundson by phone at (970) 243-2778, extension 21, or by email at Barb_Osmundson@fws.gov.

Sincerely,

Patricia S. Gelatt
Western Colorado Supervisor

cc: NRCS-SLC Utah (Travis James, Pedro Ramos)
NRCS-Roosevelt Utah (Ed Whicker, Jim Spencer)

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