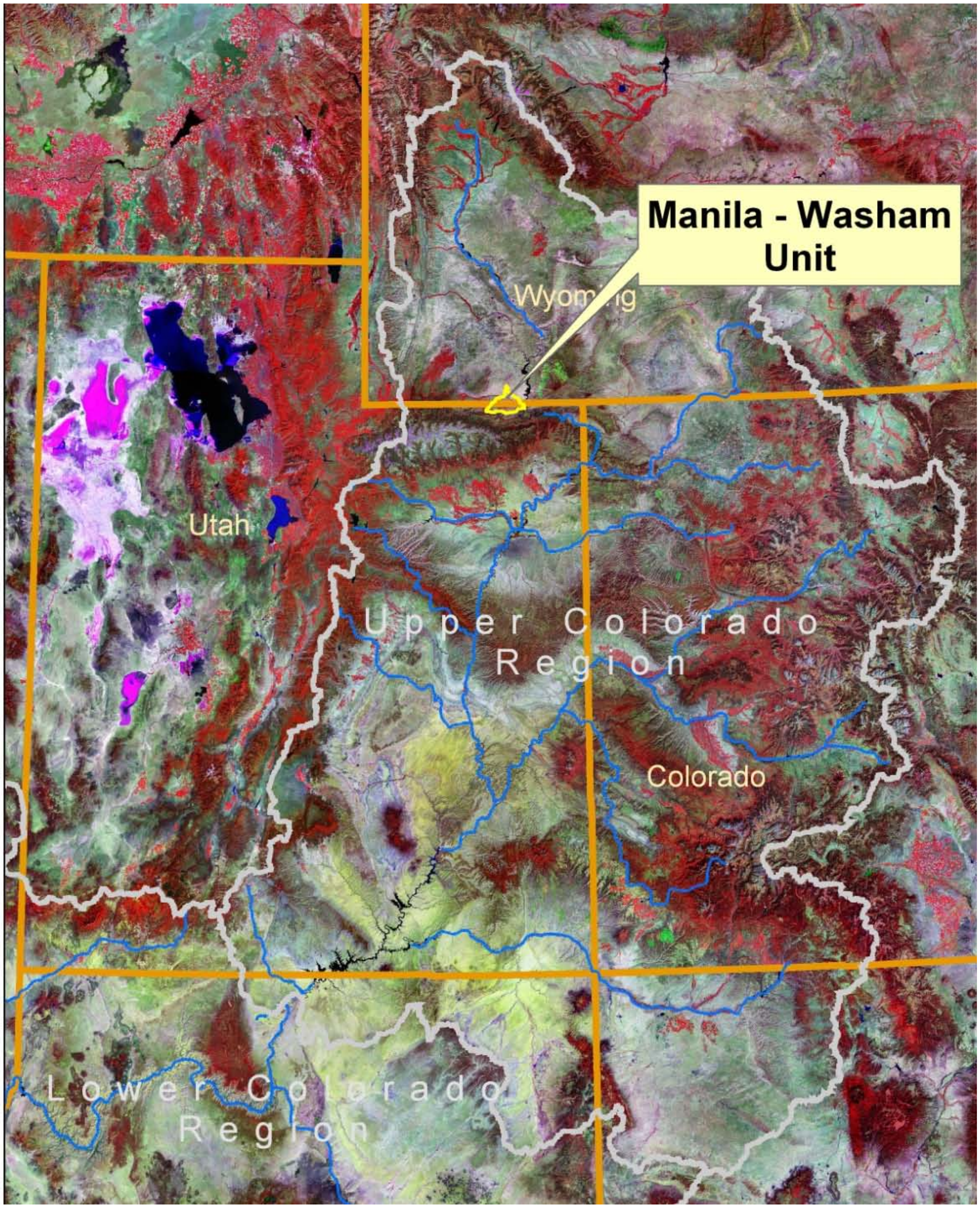
Colorado River Basin Salinity Control Program

Manila - Washam Unit

Monitoring and Evaluation Report, FY2009



U.S. Department of Agriculture

Natural Resources Conservation Service

Executive Summary

Project Status

- NRCS and Reclamation have reviewed and concurred on an initial agricultural salt loading of 27,000 tons on-farm and 13,000 tons off-farm pre-project salt loading.
- For FY2009, $1.11 million FA was obligated planning 829 acres to reduce salt loading by 2,000 tons at an amortized cost of $63/ton.
- Cumulative federal obligation planned for through FY2009 is $4.80 million FA (2009 dollars), planned on 3,372 acres, reducing salt loading by 7,313 tons at an average cost of $76/ton FA+TA.
- In FY2009, $1.83 million FA was applied treating 1,474 acres, reducing salt loading by 3,548 tons/year at an amortized cost of $59/ton FA+TA.
- Cumulative funds applied are $3.02 million FA (2009 dollars), on 2,394 acres, reducing salt loading by 5,731 tons/year at an average cost of $61/ton.
- Of 11,100 water-rights acres, 7,500 acres are projected to be improved, reducing salt loading by 20,000 tons/year.
- USGS salt load monitoring indicates a 50% decrease in salt loading since 2005, which is probably more related to climate variations than irrigation treatments.
- Passage of the 2008 Farm Bill has extended EQIP through 2012.

Hydro-salinity

- Cooperators will need to complete installation before IWM record keeping, soil moisture monitoring, and sprinkler condition surveys can be initiated.

Wildlife Habitat and Wetlands

- Habitat monitoring methodology will be land cover maps created by examining aerial photographs and quantified using GIS software as new NAIP images become available.
- There were no applications or applied acres for wildlife habitat replacement in FY2009.
- US Bureau of Reclamation has funded a project to pipe the Peoples Canal by October, 2010. Impacts to USFS Wetland Complexes are to be monitored.

Economics

- Alfalfa production is in a slight upward trend.
- Interest in salinity control projects is moderate.

Table 1, Project Progress Summary

Manila - Washam Unit FY2009 Program Summary				
Practices Planned	**Units**	**FY2009**	**Cumulative**	**Target**
Contracts (Planned)	Number	10	36	
	2009 $, FA	1,107,501	4,797,713	
	Acres	829	3,372	7,500
	Tons	2,004	7,313	19,000
	2009 $/Ton	63	76	
Applied Irrigation Practices	**Units**	**FY2009**	**Cumulative**	**Target**
Expenditures	2009 $, FA	1,826,775	3,017,059	
Sprinkler Systems	Acres	1,474	2,390	7,500
Improved Surface Systems	Acres	-	-	
Drip Irrigation Systems	Acres	-	4	
Salt Load Reduction, on-farm	Tons/Year	3,548	5,731	19,000
Salt Load Reduction, off-farm	Tons/Year	-	-	
Federal cost	2009 $/ton	59	61	

NRCS Salinity Control Programs			
Program Name	**Acronym**	**Start Year**	**End Year**
Environmental Quality Incentive Program	EQIP	2007	Current
Basin States Parallel Program	BSPP	2007	Current

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Monitoring and Evaluation History and Background

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

- The Water Quality Act of 1965 (Public Law 89-234) as amended by the Federal Water Pollution Control Act of 1972, mandated efforts to maintain water quality standards in the United States.
- Congress enacted the Colorado River Basin Salinity Control Act (PL 93-320) in June, 1974. Title I of the Act addresses the United States' commitment to Mexico and provided the means for the U.S. to comply with the provisions of Minute 242. Title II of the Act created a water quality program for salinity control in the United States. Primary responsibility was assigned to the Secretary of Interior and the Bureau of Reclamation (Reclamation). USDA was instructed to support Reclamation's program with its existing authorities.
- The Environmental Protection Agency (EPA) promulgated a regulation in December, 1974, which established a basin wide salinity control policy for the Colorado River Basin and also established a water quality standards procedure requiring basin states to adopt and submit for approval to the EPA, standards for salinity, including numeric criteria and a plan of implementation.
- In 1984, PL 98-569 amended the Salinity Control Act, authorizing the USDA Colorado River Salinity Control Program. Congress appropriated funds to provide financial assistance through Long Term Agreements administered by Agricultural Stabilization and Conservation Service (ASCS) with technical support from Soil Conservation Service (SCS). PL 98-569 also requires continuing technical assistance along with monitoring and evaluation to determine effectiveness of measures applied.
- In 1995, PL 103-354 reorganized several agencies of USDA, transforming SCS into Natural Resources Conservation Service (NRCS) and ASCS into Farm Service Agency (FSA).
- In 1996, the Federal Agricultural Improvement and Reform Act (PL 104-127) combined four existing programs, including the Colorado River Basin Salinity Control Program, into the Environmental Quality Incentives Program (EQIP).

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

M&E is conducted as outlined in "The Framework Plan for Monitoring and Evaluating (M&E) the Colorado River Salinity Control Program", last revised in 2001.

Project Status

FY2009 Project Results

FY2009 project results for the Manila-Washam Unit (MW) are summarized in table 2.

Cumulative Project Results

Cumulative results through FY2009 are tabulated in Table 3, along with EA projections. Dollar amounts are expressed in 2009 dollars.

Table 2, FY2009 results

FY2009	Planned	Applied
Irrigation improvements, acres	829	1,474
Federal cost share, FA, 2009 dollars	1,107,501	1,826,775
Amortized federal cost share, FA+TA, 2009 dollars/year	126,088	207,977
Salt load reduction, tons/year	2,004	3,548
Federal cost, FA+TA, 2009 dollars/ton	63	59

Detailed Analysis of Status

Pre-Project Salt Loading

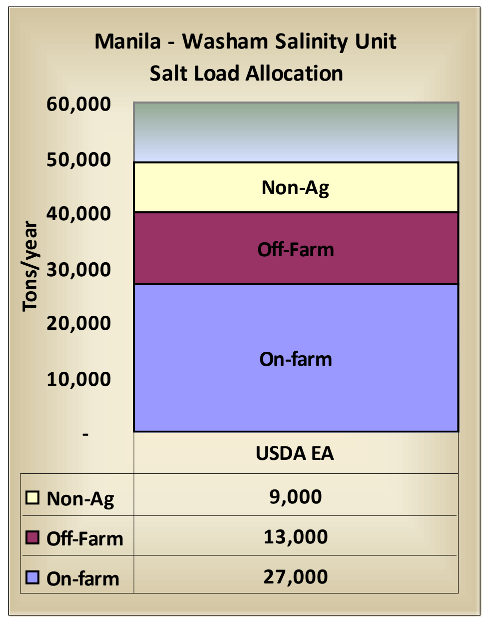
Agricultural irrigation is a major source of salt loading into the Colorado River and is completely human induced. Irrigation improvements have great potential to control salt loading.

In 2007 NRCS and Reclamation reviewed available literature and came to a consensus agreement on the most reasonable pre-project salt contribution from agriculture prior to implementing federal salinity control measures in the Manila – Washam Unit (MW). The result of this effort is depicted in figure 1.

Table 3, Project goals and cumulative status

FY2009 Cumulative Improvements	EA	Planned	Applied
Irrigation improvements, acres	7,500	3,372	2,394
Federal cost share, FA, 2009 dollars	10,703,000	4,798,000	3,017,000
Amortized federal cost share, FA+TA, 2009 dollars/year	1,220,000	557,000	347,000
Salt load reduction, tons/year	25,000	7,313	5,731
Federal cost/ton, FA+TA, 2009 dollars	49	76	61

Figure 1, Consensus Initial Salt Load Allocation.



Salinity Control Practices

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

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

Planning Documents

For the Manila-Washam Salinity Area (MW), in 2006, NRCS developed an Environmental Assessment (EA) for which a Finding of No Significant Impact (FONSI) was issued by the Utah State Conservationist. Development of salinity control contracts started in FY2007.

The EA and NRCS plans address only on-farm practices in MW. In FY2009, Peoples Canal Company received a Reclamation grant to pipe the entire canal using American Recovery and Reinvestment Act (ARRA) funds. It is anticipated that the remaining canal company, Sheep Creek Canal Company, will continue to seek funding for off-farm improvements.

Planned Practices (Obligations)

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

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

Federal cost-share is obligated when a contract is signed with the participant, assuring timely installation to federal standards, of salt load reducing irrigation practices.

Table 4 lists annual planned obligations and costs in nominal and 2009 dollars.

Table 4, Planned practices, cost/ton, nominal and 2009 dollars

FY	Federal Water Project Discount Rate	Contracts Planned	FA Planned Nominal	Acres Planned	Salt Load Reduction Planned	Amortized FA+TA Nominal	$/ton FA+TA Nominal	2009 PPI Factor	FA Planned 2009 $	Amortized FA+TA 2009 $	$/ton 2009 $	Cum $/ton 2000 $
2007	4.875%	17	2,596,059	1,835	3,609	303,160	84	111%	2,891,807	337,696	94	94
2008	4.875%	9	802,932	708	1,700	93,764	55	99%	798,405	93,235	55	81
2009	4.625%	10	1,107,501	829	2,004	126,088	63	100%	1,107,501	126,088	63	76
Totals		36	4,506,492	3,372	7,313	523,012	72		4,797,713	557,020	76	

FY2009 Obligation

In FY2009, $1.11 million was obligated in 10 contracts to treat 829 acres with improved irrigation. Two of the contracts included fourteen acres of windbreak/shelterbelt and Upland Habitat Management practices.

Salt Load Reduction Calculation

The estimated salt load reduction from FY2009 planned practices is 2,000 tons/year, calculated by multiplying the original tons/acre for the entire basin, by the acres to be treated and a percentage reduction based on change in irrigation practice. For MW, the initial estimate of on-farm irrigation salt loading is 2.67 tons/acre-year. As an example, if 135 acres are converted from wild flood to center pivot sprinkler, an estimated 91% of the original salt load will be eliminated. Hence, 135 acres x 2.67 tons/acre-year x 91% = 328 tons/year salt load reduction.

Cost/Ton Calculation

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

Obligation Analysis

In FY2009, $1.11 million was obligated to treat 829 acres, reducing salt loading by 2,000 tons. The resulting cost is $63/ton.

In 2009 dollars, cumulative obligation thru FY2009 is $4.80 million, planned on 3,372 acres, with a salt load reduction of 7,300 tons, resulting in an overall cost of $76/ton. See table 4.

Cost-Share Enhancement

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

In MW, 15 contracts on 650 acres for $1.108 million (2009 dollars) are cost-share enhanced. Estimated salt load reduction is 1,523 tons. The average salt load reduction cost is $85/ton FA+TA (2009 dollars), compared to $76/ton for all contracts and $74/ton for unenhanced contracts. The incremental cost of enhancements is $185,000 FA, about 4% of total FA. All 15 enhanced contracts are beginning farmers.

Figure 2 depicts the cost of enhanced and non-enhanced contracts in 2009 dollars/ton.

Figure 3 depicts acreage of enhanced contracts.

Figure 2, Cost of Contract Enhancement

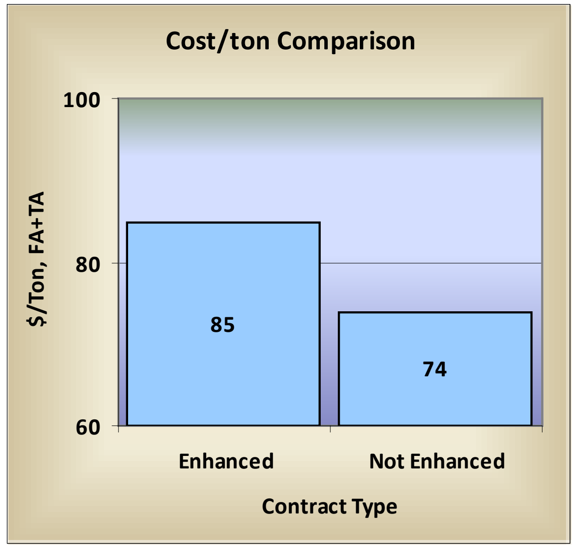
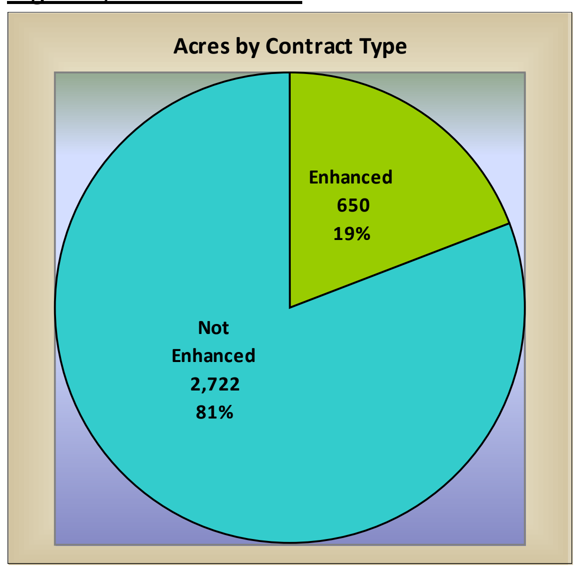


Figure 3, Enhanced Acres



Applied Practices

FY2009 Expenditures

In FY2009, $1.83 million FA was expended applying practices to 1,474 irrigated acres. The estimated salt load reduction is 3,548 tons/year, at an amortized cost of $59/ton FA+TA.

Cumulative expenditure FY2007-FY2009 is $3.02 million FA (2009 dollars), applied to 2,394 irrigated acres, reducing salt loading by 5,731 tons/year at a cost of $61/ton FA+TA (2009 dollars).

Table 5 details cumulative applied practices.

Table 5, Applied practices, cost/ton, nominal and 2009 dollars

FY	Federal Water Project Discount Rate	FA Applied Nominal	Acres Applied	Salt Load Reduction Applied	Amortized FA+TA Nominal	$/ton FA+TA Nominal	2009 PPI Factor	FA Applied 2009 $	Amortized FA+TA 2009 $	$/ton 2009 $	Cum $/ton 2009 $
2007	4.875%	114,454	514	1,006	13,366	13	111%	127,493	14,888	15	15
2008	4.875%	1,068,817	406	1,177	124,813	106	99%	1,062,791	124,110	105	64
2009	4.625%	1,826,775	1,474	3,548	207,977	59	100%	1,826,775	207,977	59	61
Totals		3,010,046	2,394	5,731	346,155	60		3,017,059	346,974	61	

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

For tracking, acres treated and salt load reductions are assumed to be proportional to dollars paid out.

Salt load reduction in this report is calculated using "*Calculating Salt Load Reduction*", July 30, 2007, found in appendix I.

Figure 4 compares cumulative planned and applied acres. The blue dashed line at 7,500 acres depicts the treatment goal for MW.

Figure 5 compares planned and unplanned acres.

Figure 6 compares calculated cost/ton, planned and applied, with the projected cost/ton from the EA, in 2009 dollars.

Figure 7 is a map displaying planned and applied acres.

Figure 4, Planned and applied acres

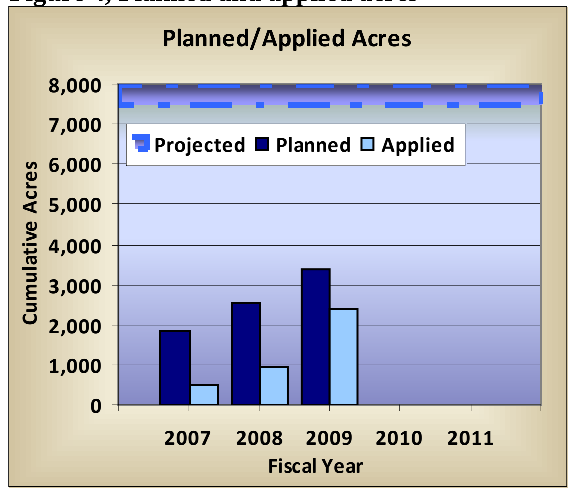


Figure 5, Planned and unplanned acres

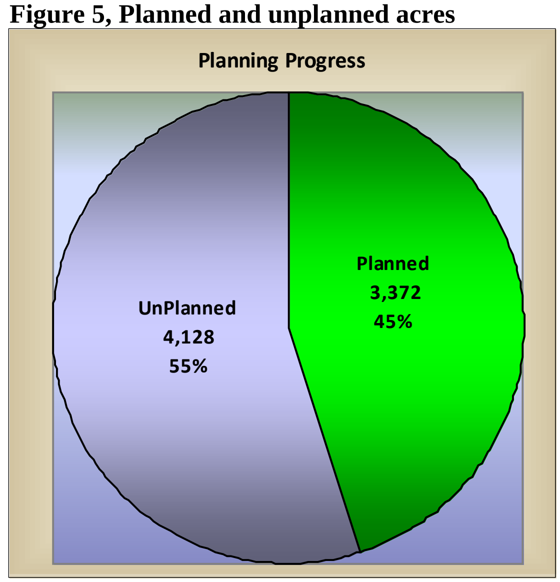


Figure 6, Cost/ton, planned, applied, projected

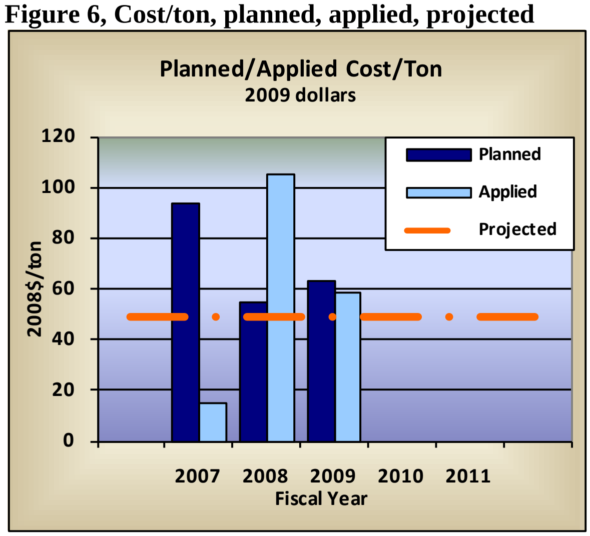
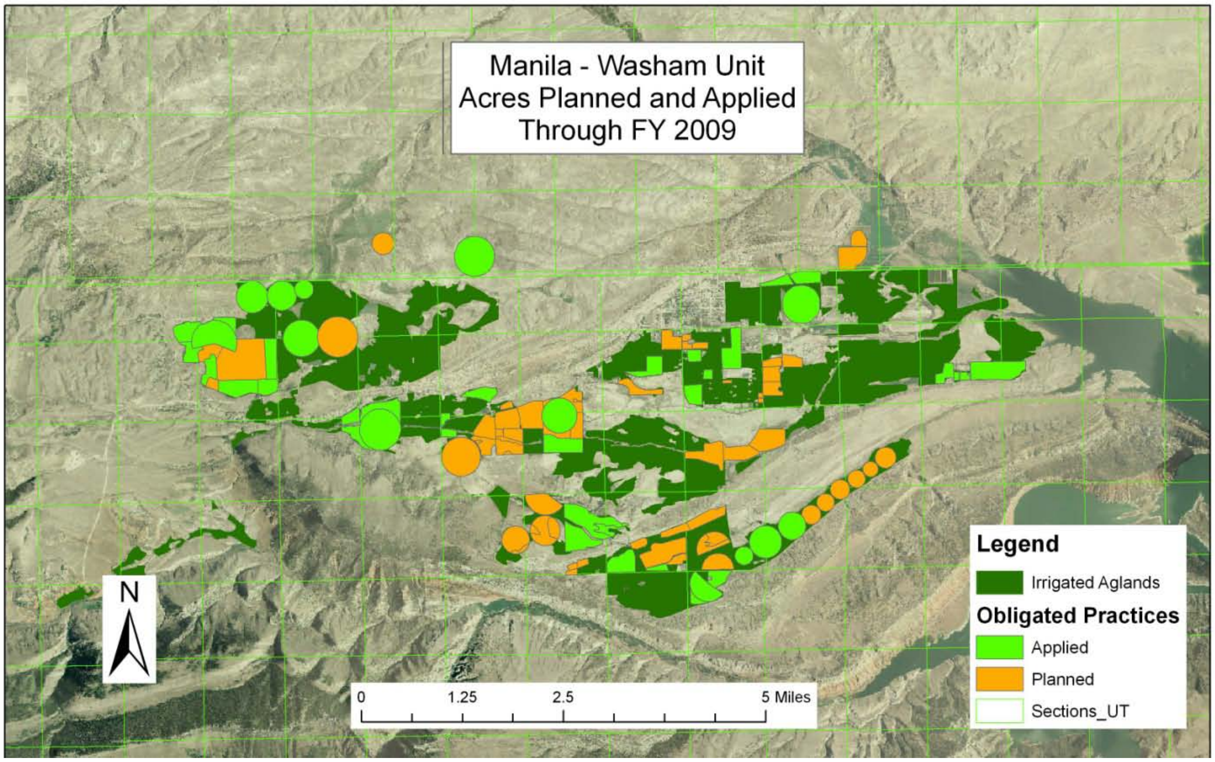


Figure 7, Planned and applied acres.



Hydro Salinity Monitoring

Before implementation of salinity control measures, Manila - Washam Unit agricultural operations contributed an estimated 40,000 tons of salt per year to the Colorado River (on-farm and off-farm), from an average of 10,100 acres of annually irrigated land. Salt loading of 27,000 Tons/year was allocated to on-farm activities and 13,000 tons to off-farm canals and large laterals.

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

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

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

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

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

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

Salinity Monitoring Methods

The 1991, "*…Framework Plan for Monitoring and Evaluating (M&E) the Colorado River Salinity Control Program*" as utilized in the Uintah Basin and adopted by the EIS for the Price – San Rafael Rivers Unit, focused on:

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

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

A new "*Framework Plan for Monitoring and Evaluating (M&E) the Colorado River Salinity Control Program*" was adopted in 2001. Having established that properly installed and operated practices yield predictable and favorable results, the 2001 Framework Plan addresses hydro-salinity by:

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

In MW, virtually all salinity program irrigation improvements are sprinkler systems. Center Pivot systems are preferred by three to one over wheel lines, on an acreage basis, presumably due to large average field size. The average contract size is 94 acres.

Cooperator questionnaires, interviews, and training sessions

No cooperator questionnaires have been done in the Manila – Washam Unit. It is anticipated that it will take two or three years for cooperators to become familiar with system operations before interviews would become practical.

Irrigation Water Management (IWM)

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

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

Over-irrigating in early spring and late fall is mitigated by water storage aspects of the soil. Crops generally use water before irrigation begins and after irrigation ends, leaving the soil moisture profile partially depleted. Filling the soil with water requires additional irrigation, over and above crop needs, in the spring.

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

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

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

Additional, personal guidance is available to cooperators, on request, at local NRCS field offices.

Intensive and continuous IWM training is essential to successful long term salt load reduction.

To help cooperators with irrigation timing, a major part of IWM, NRCS demonstrates two simple, low-cost approaches:

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

2. Soil moisture monitoring, wherein the cooperator determines when to irrigate, based on measured available water content (AWC) of the soil

Irrigation Record Keeping

To help with irrigation timing, NRCS has developed and provided the, "IWM Self Certification Spreadsheet" which allows cooperators to graphically evaluate available water content (AWC) of the soil and compare actual irrigation with projected average crop water requirements and/or with modeled crop evapotranspiration. Evapotranspiration 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 final output of the spreadsheet is a graph comparing water applied, with water required, on a seasonal basis. See figures 8 and 9.

Figure 8 is the input form, on which the irrigator enters data into the blue shaded cells. The spreadsheet then calculates the remaining data.

Figure 9 consists of two graphs created by the spreadsheet. In the first graph of figure 9, available water content (AWC) of the soil is plotted. If AWC reaches 100% (the soil/water profile is full), any additional irrigation water applied becomes deep percolation, expressed as red bars descending below the normal AWC bars. A modest amount of deep percolation is designed into all irrigation systems to compensate for distribution anomalies and to leach accumulated salt from the root zone.

In the second plot in figure 9, if the red actual application line is below and to the right of the blue consumptive use line, the crop is under irrigated. The purple line is from near-real-time ET calculations.

In order to receive incentive payment for IWM, each irrigator must

1. attend a two hour IWM training session or a water conference

2. with help, augur a hole and determine the soil moisture by the feel method, and

3. bring his irrigation records to the local field office, where data is entered into the spreadsheet and results are calculated, graphed, and discussed. The graphs are printed for the farmer's reference.

In general, cooperators respond positively to this training and work hard to irrigate more efficiently.

In FY2008 – FY2009, 10 IWM Self Certification Spreadsheets were submitted for payment. None of the ten irrigators had excessive deep percolation. Nine had no deep percolation.

Figure 8, Data entry page from IWM self certification spreadsheet

Irrigation Water Use Record - Farmer Self Certification

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

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

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

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

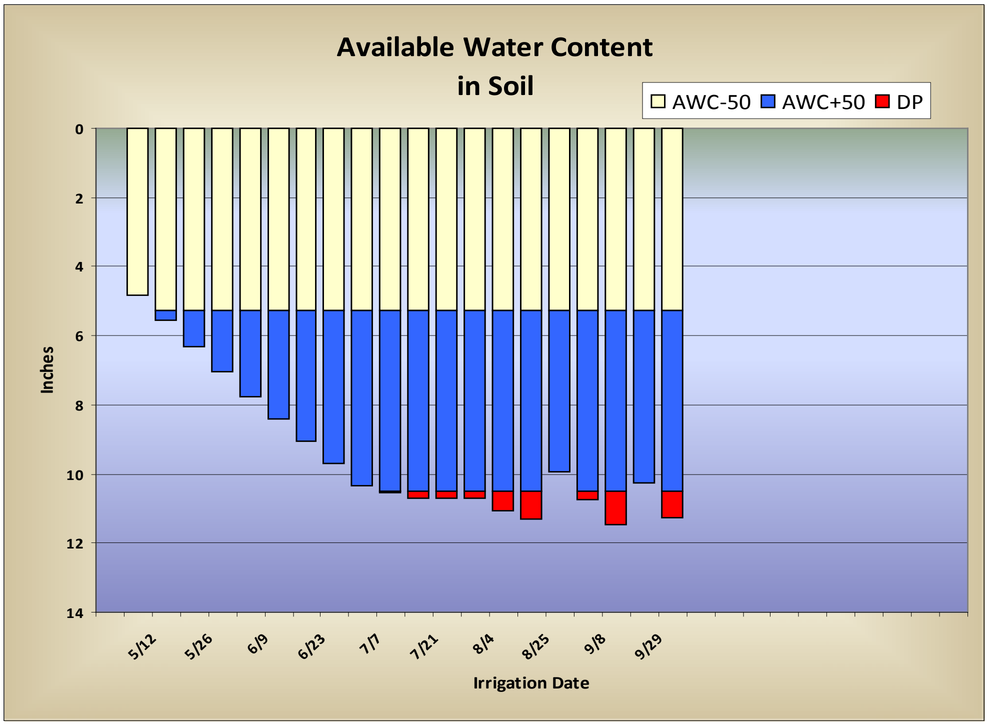
Soil Type: Clay Silt **AWC, In/Ft** 2.00 **Root Depth:** 5.00 **AWC, Max AWC, In.** 10.00

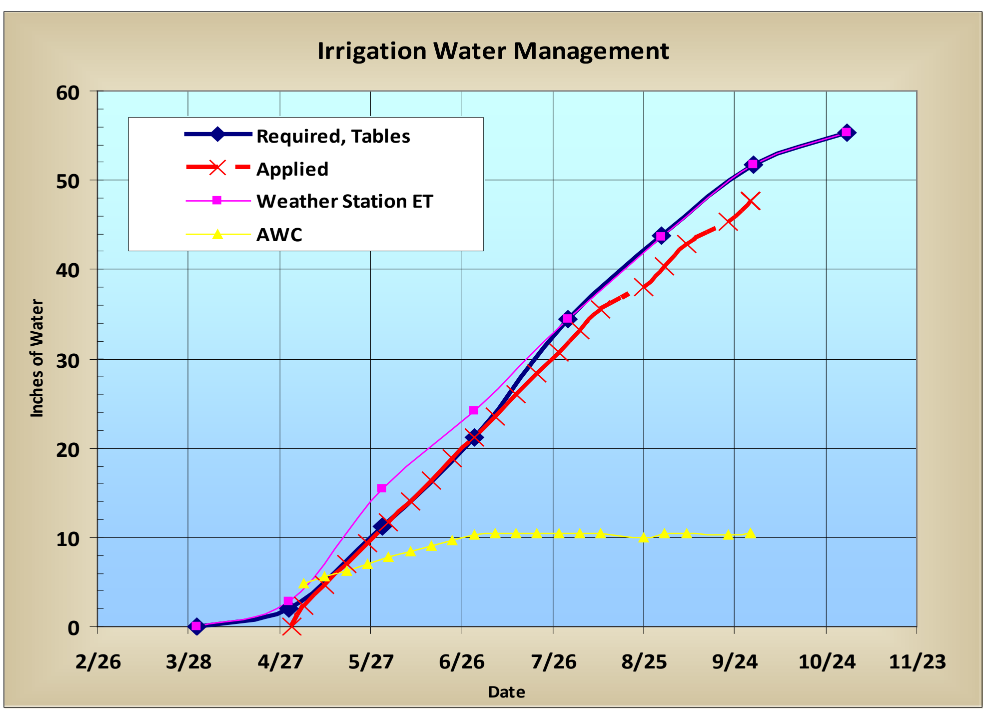
Application Evaporation % 10%

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

Figure 9, Sample graphs from the IWM Self Certification Spreadsheet.

The blue bars indicate the Managed Allowable Depletion (MAD). For maximum crop growth, soil moisture should be kept in this interval at all times. Red bars indicate deep percolation. In the second graph, the blue line is a long-term average water requirement, based on location and crop. The red line is the actual water applied. Where data is available, the purple line is modeled from current local data collected at a nearby weather station, using the FAO-56 Penman—Montieth evapotranspiration model.





Soil Moisture Monitoring

A time-tested method for timing irrigation involves augering a hole and determining the water content of the soil to decide when to apply the next irrigation. This may well be the best method available for irrigation timing, both simple and inexpensive. However, few irrigators take time to do it.

NRCS is demonstrating and guiding cooperators in the use of modern soil moisture monitoring systems, utilizing electronic probes and data recorders. Such systems can now be installed for about $600, giving the cooperator information on the water content of his soil at several different depths, without time-consuming augering.

In a typical case, electrical resistance based probes are installed at various depths, such as 12", 24" and 48". Using a simple data recorder, indicated soil pore pressure (implied soil moisture content) is read and recorded multiple times per day. With some recorders, soil pore pressure is presented graphically on an LCD display in the field, making it a simple matter to estimate when the next irrigation will be required (figure 10).

Figure 10, Sample Soil Moisture Data Logger.

Since gravimetric drainage generally does not occur unless the soil horizon is nearly saturated (above field capacity), it is assumed that deep percolation is not occurring if the deepest probe reading is greater than -10 centibars. In MW, one installed data recorder indicates that deep percolation occurs less than 3% of the time on the monitored field.

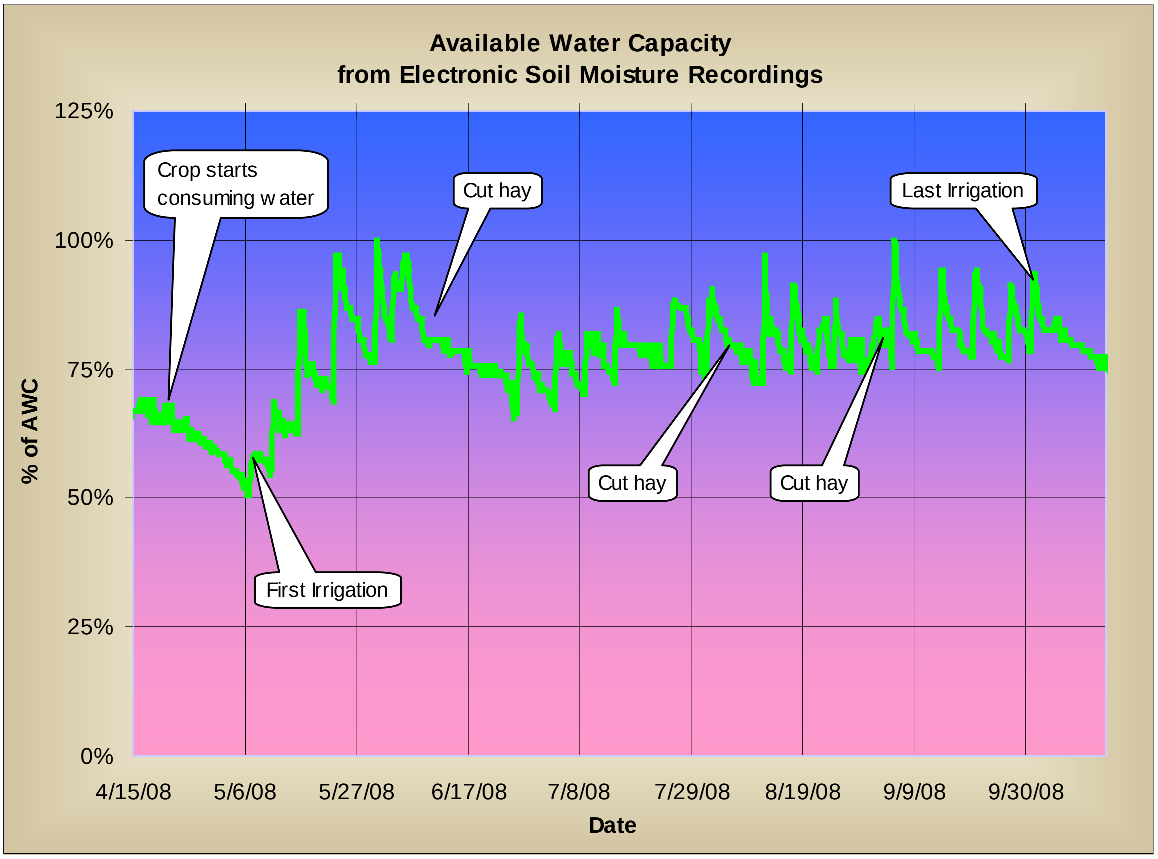
Soil moisture data recorders typically store 10 months of data or more in nonvolatile memory and can be downloaded using a laptop computer or PDA. Battery life is over a year, using AA or 9 volt batteries. When carefully installed, maintenance requirements are minimal.

Available water content (AWC), the soil moisture available to the plant, can be roughly estimated, using multiple probes. The AWC calculation is dependant on many soil and environmental parameters and is tedious to model accurately, but when an operator becomes familiar with the system, he will be able to use it well for irrigation timing. (See figure 11).

In the Manila – Washam Unit, four data recorders have been purchased and installed by Daggett Soil Conservation District members. The M&E team has access to download data from one of these recorders.

In the FY2009 payment schedule, an additional IWM Intense (449) practice was included that increased the IWM payment for participants who agree to install soil moisture monitoring equipment in addition to taking classes, attending workshops, and keeping records. It is hoped that future contracts will capitalize on this opportunity to enhance instrumentation and IWM interest at the field level.

Figure 11, AWC estimated from downloaded soil moisture data.



USGS Water Quality Monitoring

US Geological Survey (USGS) studied salt loading from the Manila-Washam Salinity Area (MW) from July 1, 2004 to June 30, 2005. From this data they prepared Scientific Investigations Report 2004-05, entitled "Characterization of Dissolved Solids in Water Resources of Agricultural Lands near Manila, Utah, 2004-2005". The amended final report estimated the total agricultural salt loading to be 31,200 tons/year. Of the 31,200 tons/year, NRCS estimates that 5,700 tons/year has been eliminated due to the installation of highly efficient sprinkler systems.

Because MW is small in size, isolated, and with well defined water sources and drains, USGS continues to monitor the discharge of dissolved salts into Flaming Gorge Reservoir as a result of agricultural activities. In 2008, USGS issued a report titled "Results of Water-Quality Monitoring during May 2007—May 2008 in Selected Sub-basins near Manila, Utah to Evaluate the Effect of Irrigation Improvements on Dissolved Solids Loads Discharged to Flaming Gorge Reservoir", which examines changes in salt loading since the 2004-2005 report. This report estimated the salt loading from May 2007 to May 2008 to be 19,900 tons.

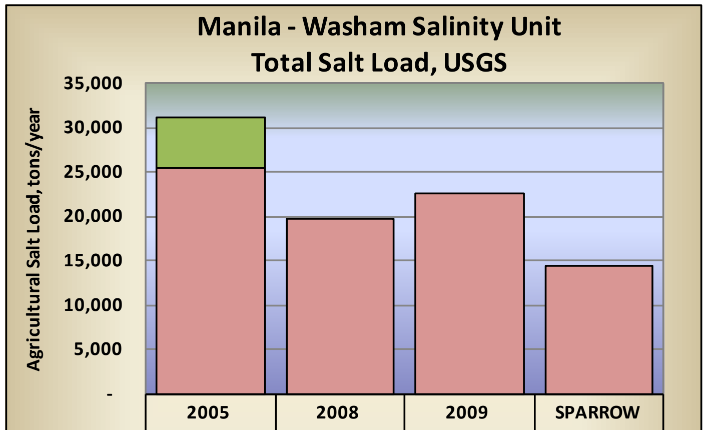
Monitoring continued through 2009. A final report for 2009 has not been issued, but initial indications are that the salt loading for May 2008 to May 2009 is about 22,700 tons.

In 2009, USGS issued Scientific Investigations Report 2009-5007, Spatially Referenced Statistical Assessment of Dissolved-Solids Load Sources and Transport in Streams of the Upper Colorado River Basin (SPARROW), which models salt loading throughout the Upper Colorado River Basin. This model is based on water and weather data from 1991. The SPARROW model estimates the total agricultural salt load in MW to be 14,500 tons/year with a potential margin of error of 51%.

Since many factors affect salt loading, the actual amount can be expected to vary widely from year to year.

Figure 12 is a comparison of different estimates of total agricultural salt loading for the Manila – Washam Unit.

Figure 12, Comparison of Salt Loading Estimates



	2005	2008	2009	SPARROW
Applied	5,731			
Measured	25,500	19,900	22,700	14,500

Wildlife Habitat and Wetlands

Background

In February, 2007, the Manila-Washam project was recognized as a Colorado River Basin Salinity Control Program (CRBSCP) Salinity Area. Salinity irrigation and wildlife habitat development plans are now eligible to compete for funds allocated to the CRBSCP. Impacts from this project to wildlife habitat and wetlands will be monitored and evaluated and subsequently compensated. Compensation is accomplished on a voluntary basis from private landowners through applications for funding from the Environmental Quality Incentives Program (EQIP). Impacts may include loss of wildlife habitat and wetlands, conversion of wetland habitats to upland areas such as agricultural fields, or other vegetation changes brought about by the more efficient use of irrigation water.

In the upper Colorado River Basins there are several Salinity Areas, each with its own unique methodology for monitoring and evaluating impacts and replacement of wildlife habitat and wetlands. The Manila-Washam Salinity Area is a relatively small project, and impacts from the project can be observed from project inception. The Monitoring and Evaluation Team (M&E) will create a series of land cover maps utilizing aerial photography from the National Agricultural Image Program (NAIP). The NAIP images are one meter resolution true color or color-infrared aerial photos, projected to be re-flown biannually. With these high resolution photos, M&E has the ability to zoom in close and create a reasonably accurate land cover map which can be verified with minimal ground truthing. These images can be compared through time to monitor any land cover changes. By the use of Geographical Information System (GIS) software, estimates of gains or losses in wildlife habitat or wetlands can be quantified.

Representative photographic points will also be established, to be compared throughout the years, to assist with land cover mapping efforts, defining vegetation composition of the land cover elements and what impacts, if any, are occurring.

The U.S. Forest Service (USFS) has created two wetland complexes west of Flaming Gorge reservoir. The Henry's Fork complex, located north of the Utah-Wyoming border, has a secure water right which may need to be more carefully managed in the event that irrigation improvements reduce the amount of excess run-off now being collected and channeled through this USFS property. The Linwood Pond complex, located south of the Utah-Wyoming border has no secure water right and could be impacted by reduced tailwater availability associated with irrigation improvements.

USFS has been encouraged to obtain more secure water rights for this wetland complex. As irrigation improvements are planned, NRCS cooperators will be encouraged to work with USFS to assure an adequate water supply for the complex.

These wetland complexes represent an important aspect of wildlife habitat found in the Manila-Washam Salinity Area. Many species of plants and animals are found in these areas and they are also used by many members of the public for recreation such as wildlife viewing. These wetlands are located on federal, public land and provide access to all people wishing to enjoy their natural resources. M&E intends to work with USFS personnel and NRCS customers to help monitor the health of these systems, and provide input for solutions to the uncertain outcome of potential tailwater reduction.

Area-wide Wildlife Habitat Monitoring

As mentioned above, M&E will create a series of land cover maps utilizing aerial photography from the National Agricultural Image Program (NAIP). As new images become available the land cover maps will be presented in future versions of this document. The initial years will be baseline data as there will be no comparison photos. Photographs will be taken near the same date annually, and compared approximately every five years in a visual display in M&E Reports.

Reclamation funded a project to pipe the Peoples Canal near the town of Manila in FY2009. This project is at its midpoint and is anticipated to be complete in October 2010. Piping of this canal could impact USFS constructed wetland complexes and other wetlands downstream from the canal. Photographs will be taken of the areas below the canal in Spring/Summer 2010, to attempt to capture any changes (if any) in subsequent years. Changes will also be monitored using current and updated NAIP aerial photos.

Wildlife Habitat Contract Monitoring

In this third year of eligibility (FY2009) for salinity projects, there have been no applications for salinity wildlife only habitat improvement project funds. Table 6 represents total cumulative acres of wildlife habitat improvement applied within irrigation projects in the MW Salinity Unit.

Voluntary Habitat Replacement

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

Table 6, Wildlife Habitat Replacement

Acres of Wildlife Habitat Creation or Cumulative practices planned and applied				
Program	Acres Planned		Acres Applied	
	Wetland (*644)	Upland (645)	Wetland (*644)	Upland (645)
CRSCP	-	-	-	-
IEQIP	-	-	-	-
BSPP	-	-	-	-
EQIP	-	14	-	13
WHIP	-	-	-	-
Total	**-**	**14**	**-**	**13**

*Wetland acres includes Riparian habitat.

Economics

Cooperator Economics

It is logical to expect that upgrading from flood to sprinkler irrigation improves profitability by increasing production while decreasing costs for water, fertilizer, labor, and field maintenance. Irrigation system maintenance may increase somewhat, but should be less variable on an annual basis.

Production Information

Farming in the Manila area is principally related to livestock production. Crops are generally forage related and alfalfa production is a reasonable indicator of output. In the Manila – Washam Unit, alfalfa yields have been cyclical over the past twenty years. A linear regression on production indicates a slight uptrend. The yield, in tons/acre is also up-trending, but recent values are well below the linear long-term average. Figure 13 reflects total alfalfa production and yield over a 24 year period. Yield may be more closely related to climate variations than anything else. Figure 14 depicts historical mountain precipitation.

Expense Information

Reliable expense information is difficult to obtain. Many of the farms are family operations and the cost of family labor is rarely evaluated or reported. From National Agricultural Statistics Service (NASS) data, labor benefits are elusive as both *Hired Farm Labor* and *Total Farm Production Expenses* have increased steadily over the 1987, 1992, 1997, 2002, and 2007 Agricultural Censuses.

From the 2007 Census of Agriculture, 85% of farmers hire no outside labor and 62% have full-time occupations other than farming, it is assumed that most cooperators are satisfied with their personal labor savings.

Figure 13, Manila - Washam Unit alfalfa production and yield

Source data is tabulated in Appendix III

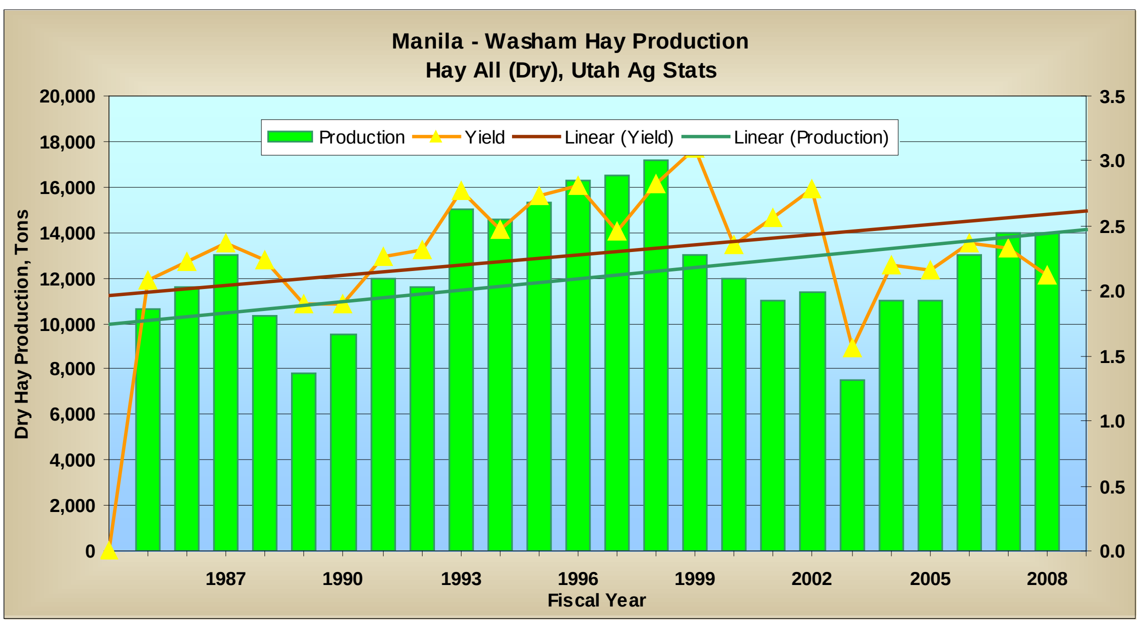
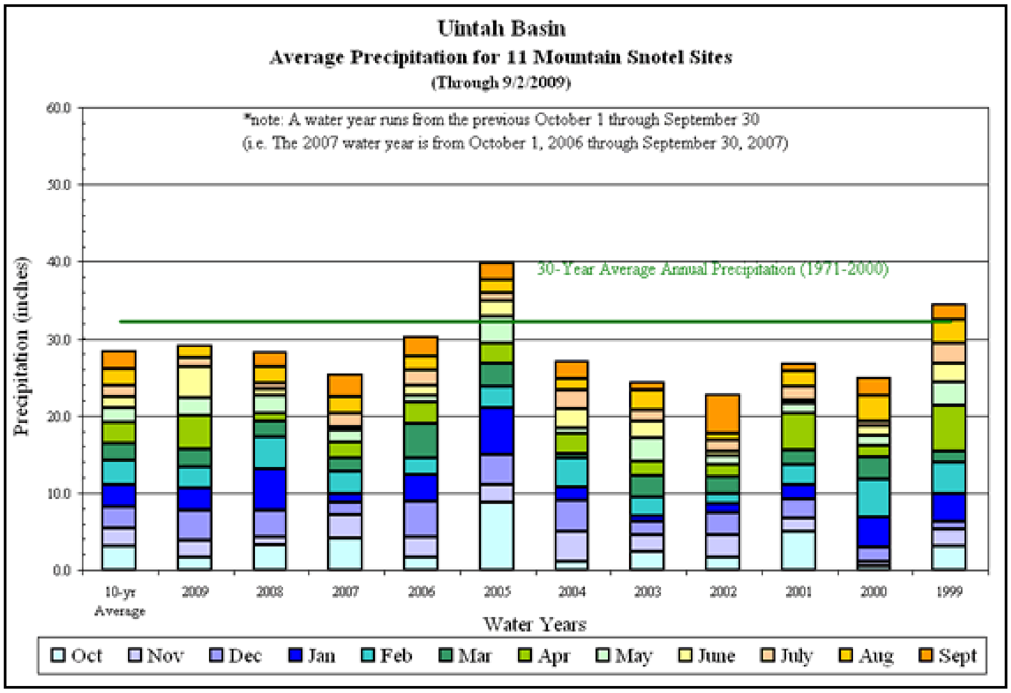


Figure 14, Manila - Washam Unit Mountain Precipitation from Utah Division of Water Resource



Public Economics

Ninety-five percent of survey respondents, from other salinity areas, believe that salinity control programs have a positive economic affect on the area and region.

Positive public perceptions of the Salinity Control Program include:

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

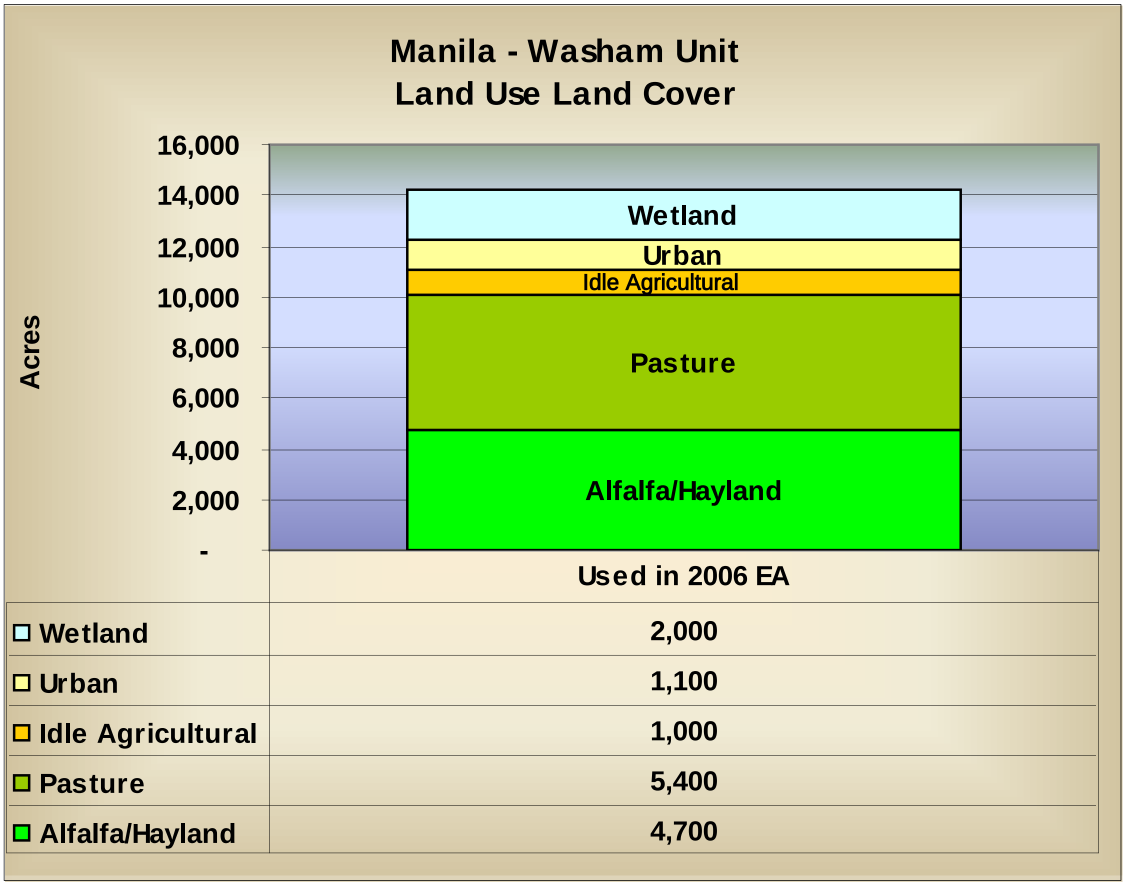
Negative public perceptions of the Salinity Control Program include:

- Conversion of artificial wetlands to upland habitat and other shifts in wildlife habitat
- Changes in Water Related Land Use (WRLU)

Land Use Land Cover

Figure 15 is a graphical presentation of pre-project land use in the Manila-Washam Unit. This data was derived by comparing the Utah Division of Water Resources Water Related Land Use layer (for the Utah portion) with a cover map created by overlaying orthoimagery. Changes to land cover will be tracked in future reports.

Figure 15, Pre-project land use land cover, used in preparing 2006 EA



Summary

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

Irrigation installation costs are escalating. Increased world energy prices have resulted in much higher costs for pipe, transportation, labor, and equipment. It can be assumed that the value of downstream damages will also be escalating due to energy impacts.

With labor, material, and equipment prices rising, it is expected that the cost/ton of salinity control measures will also increase. However, the FY2009 average planned cost of $63/ton does not approach the cost of downstream damages from excess salt. Colorado River Basin Salinity Control Programs are successful and cost effective in reducing salt load in the Colorado River.

APPENDICES

Appendix I – Revised salt load reduction calculation

COLORADO RIVER BASIN
SALINITY CONTROL PROGRAM

CALCULATING SALT LOAD REDUCTION

MODIFICATION OF PROCEDURE
JULY 30, 2007

Prepared by
Natural Resources Conservation Service

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NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Executive Summary

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

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

SALT LOAD CALCULATION

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

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

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

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

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

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

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

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

Where

SL_0 = The Salt Load before any treatment

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

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

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

Where

SLe = the salt load at a given efficiency

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

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

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

Where

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

eff = Irrigation efficiency at the time of evaluation

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

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

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

Where

A = Area in acres

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

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

Where

SL_1 = the beginning salt load

SL_2 = the final salt load

SLF_1 = the beginning salt load factor

SLF_2 = the final salt load factor

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

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

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

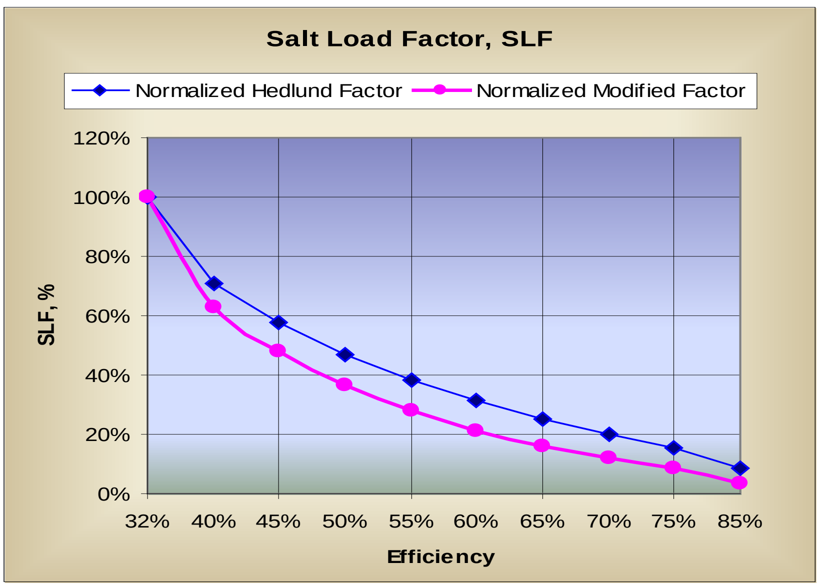

Figure 2 Graph of salt load factor, SLF. The upper line was used in the Ranking Worksheet FY2004 – FY2007. The lower line is used in new Salinity Worksheets for Ranking, beginning with FY2008 contracts and is mathematically defined above.

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

1. Assure that salt load reduction claims will not exceed EIS/EA expectations

2. Calculations from Colorado and Utah will use the same procedure and results will be comparable

3. Worksheet user inputs have been minimized, also minimizing opportunity for error

Appendix II - Salt Load Reduction Worksheet

COLORADO RIVER BASIN SALINITY CONTROL PROGRAM

Utah NRCS

WATER AND SALT SAVING WORKSHEET for Ranking

Version 090311

Client:		Date:	29-May
Salinity Area:	Manila	Planner:	RSW

Irrigation System Changes

System Before	Eff	System After	Eff	Acres	EIS Salt Load Tons/Ac	Effective Salt Load Reduction	Salt Load Reduction Tons
UF	32%	Center Pivot	75%	284	2.67	91%	693.8
		System Totals		284.0			693.8

Ditch Losses, Off-farm

	Feet Replaced		Tons /Mile	Tons Salt
	-		0.0	-

Contracts - On-farm

Contract Number	Date	Amount	Treatment Description	Treated Area	FY	Interest Rate	Amortized FA
		$		Acres		%	$
BSPP	03/11/09	353,742	Sprinkler System	284.0	2009	4.625%	24,164
						4.625%	-
						4.625%	-
						4.625%	-
						4.625%	-
						4.625%	-
Totals		353,742		284		FA	$ 24,164
						TA	16,109
						FA+TA	40,273

$/Acre	1,246
Tons/Ac	2.44

Amortized $/Ton, FA+TA	**$58**

Appendix III Daggett County, Utah Hay Production

Daggett County **All Dry Hay**						
Crop	Year	State	County	Harvested Acres	Yield Tons/Ac	Production Tons
Hay All (Dry)	1985	Utah	Daggett	5,100	2.08	10,600
Hay All (Dry)	1986	Utah	Daggett	5,200	2.23	11,600
Hay All (Dry)	1987	Utah	Daggett	5,500	2.36	13,000
Hay All (Dry)	1988	Utah	Daggett	4,600	2.24	10,300
Hay All (Dry)	1989	Utah	Daggett	4,100	1.90	7,800
Hay All (Dry)	1990	Utah	Daggett	5,000	1.90	9,500
Hay All (Dry)	1991	Utah	Daggett	5,300	2.26	12,000
Hay All (Dry)	1992	Utah	Daggett	5,000	2.32	11,600
Hay All (Dry)	1993	Utah	Daggett	5,400	2.78	15,000
Hay All (Dry)	1994	Utah	Daggett	5,900	2.47	14,600
Hay All (Dry)	1995	Utah	Daggett	5,600	2.73	15,300
Hay All (Dry)	1996	Utah	Daggett	5,800	2.81	16,300
Hay All (Dry)	1997	Utah	Daggett	6,700	2.46	16,500
Hay All (Dry)	1998	Utah	Daggett	6,100	2.82	17,200
Hay All (Dry)	1999	Utah	Daggett	4,200	3.10	13,000
Hay All (Dry)	2000	Utah	Daggett	5,100	2.35	12,000
Hay All (Dry)	2001	Utah	Daggett	4,300	2.56	11,000
Hay All (Dry)	2002	Utah	Daggett	4,100	2.78	11,400
Hay All (Dry)	2003	Utah	Daggett	4,800	1.56	7,500
Hay All (Dry)	2004	Utah	Daggett	5,000	2.20	11,000
Hay All (Dry)	2005	Utah	Daggett	5,100	2.16	11,000
Hay All (Dry)	2006	Utah	Daggett	5,500	2.36	13,000
Hay All (Dry)	2007	Utah	Daggett	6,000	2.33	14,000
Hay All (Dry)	2008	Utah	Daggett	6,600	2.12	14,000

Glossary and Acronyms

Average salt pickup – The increase in the amount of salt carried by a stream as it flows as a result of inflows containing 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 soil that is captured, stored, and available to the crop, expressed as a percentage of the total delivery volume.

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

BSPP – Basin States Parallel Program

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

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

cfs – Cubic feet per second or second-feet.

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

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

CRBSCP – Colorado River Basin Salinity Control Program

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

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

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

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

EQIP – Environmental Quality Improvement Program

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Soil Conservation Service – The predecessor agency to NRCS.

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

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

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

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

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

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

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

References

1. U.S. Department of the Interior, Bureau of Land Management, The Effects of Surface Disturbance on the Salinity of Public Lands in the Upper Colorado River Basin, 1977 Status Report, February, 1978.
2. U.S. Department of Agriculture, Natural Resources Conservation Service, Plan and Environmental Assessment, Manila – Washam Project Area of the Colorado River Salinity Control Program, July, 2006.
3. "Salt Primer – Water and Salt Budgets", John C. Hedlund, Soil Conservation Service, 1992.
4. "FRAMEWORK PLAN FOR MONITORING AND EVALUATING THE COLORADO RIVER SALINITY CONTROLL PROGRAMS of the U.S. Department of Agriculture (USDA)-Natural Resources Conservation Service (NRCS)", May, 2002.
5. "QUALITY OF WATER COLORADO RIVER BASIN – Progress Report #20", U.S. Department of the Interior, 2001.
6. "Colorado River Salinity Control Program, Uintah Basin Unit, Monitoring and Evaluation, 2001 Report", Draper, Brent W., Goins, Donald J., Lundstrom, D. Nick.
7. "Colorado River Salinity Control Program, Uintah Basin Unit, Monitoring and Evaluation, 2005 Report", USDA-NRCS.
8. 1987, 1992, 1997, 2002, 2007 "Census of Agriculture", United Stated Department of Agriculture, National Agricultural Statistics Service.
9. U.S. Department of the Interior, US Geological Survey, Scientific Investigations Report 2006-5211, entitled "Characterization of Dissolved Solids in Water Resources of Agricultural Lands near Manila, Utah, 2004-2005", Gerner, Steve etal., http://pubs.usgs.gov/sir/2006/5211/.
10. U.S. Department of the Interior, US Geological Survey, Results of Water-Quality Monitoring during May 2007—May 2008 in Selected Sub-basins near Manila, Utah to Evaluate the Effect of Irrigation Improvements on Dissolved Solids Loads Discharged to Flaming Gorge Reservoir, Gerner, Steve etal.
11. U.S. Department of the Interior, US Geological Survey, Spatially Referenced Statistical Assessment of Dissolved-Solids Load Sources and Transport in Streams of the Upper Colorado River Basin, Scientific Investigations Report 2009-5007, http://pubs.usgs.gov/sir/2009/5007/.
12. Allen, Richard G. etal., FAO Irrigation and Drainage Paper No. 56, Crop Evapotranspiration, http://www.fao.org/docrep/X0490E/X0490E00.htm.