

# Agencies:

California Department of Water Resources  
 California State University, Fresno  
 Catholic University of Santiago del Estero, Argentina  
 University of California, Davis

U.S. Bureau of Reclamation  
 U.S. Department of Agriculture  
 Westside Resource Conservation District

## Solar Evaporator

### Solar Evaporator—UC Davis Pilot Plant

Agencies: Department of Geology, Department of Biological and Agricultural Engineering, University of California, Davis; California Department of Water Resources; U.S. Environmental Protection Agency

Salt management is essential for achieving the sustainability of agriculture and the environment on irrigated farmland. No long-term strategies to dispose of salts from agricultural drainage water have been developed.

The UC Davis pilot plant solar evaporator addressed the tasks of salt recovery, purification, and utilization. Project phases and tasks included the following:

#### Phase I

1. Investigate recovery and purification processes.
2. Design and build salt recovery and purification pilot plant.
3. Test plant performance.
4. Perform technical and economic modeling.
5. Use the produced salt in various industrial applications.
6. Design a farm scale salt recovery and purification plant.
7. Technology transfer.

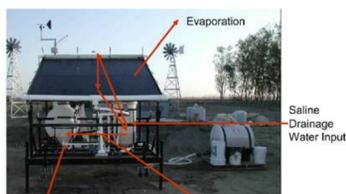
#### Phase II

1. Build a farm-scale plant.
2. Test plant in the field.
3. Report technical, economic, and environmental results.
4. Promote marketing of farm-based salt and salt products.
5. Technology transfer.

Work is continuing to advance the research and investigations of the separation and mineral recovery process. The groundwork will be used to build a production facility to separate agricultural salts into sellable commodities.



Solar Evaporator - UC Davis Pilot Plant



Pilot Plant System Operation



Oven-dried sodium sulfate, crystallized from reconstituted Andrews Ag Inc. water.



Comparison of scale removal techniques (wiping, sweeping and flexing): The wiping technique, applied on the wetted surface gave the best result. When the surface was dried, these techniques could not remove scale as well, conceivably due to strong bonds between the scale and plastic.



Scale formed on the absorber film from Red Rock Ranch water.

## HydroGeoSphere

### IFDM Case Study—Application of HydroGeoSphere, a three-dimensional numerical model

Agencies: U.S. Bureau of Reclamation; University of Waterloo; Universite' Laval; Hydrogeologic, Inc.; California Department of Water Resources; Red Rock Ranch, Inc.

Hydrologists are investigating interaction of surface and subsurface water systems. The model being applied, HydroGeoSphere, is a robust fully-coupled surface/subsurface numerical flow and transport model. In its current form it accounts for flow, solute and thermal transport in variably-saturated three-dimensional subsurface and flow and transport in two-dimensional surface water systems.

The conceptual model was developed to include a geological conceptual model, well locations, surface and subsurface hydrologic and hydraulic features, flow domain extent, boundary and initial conditions. GIS and visualization tools were applied to facilitate construction of this model. The conceptual model is complete and modeling tasks advanced to preparing in-put data files. Model input includes data files and GIS based databases corresponding to the conceptual model and other site specific data. Topographic survey data of Red Rock Ranch and vicinity was collected to determine elevation points and to locate fixed works such as sumps, pumps, and wells. Water quality samples and groundwater levels are currently being collected on a regular basis to develop input data files for the model. Extensive and detailed historical site characterization data is available to calibrate this model.

The model results from this case study will be useful for the formulation of optimal design and management of IFDM systems, aimed at salinity and agricultural drainage control.



3D Fence diagram illustrating the geologic conceptual model looking north. Lithologic layers represent Clay and Silt layers which will have intermittent sand lens' added using various visualization tools.



Aerial photo showing total model boundary extent and location of Red Rock Ranch (green) location.



USGS topographic map illustrating model extent, location of California Aqueduct to the west and Tile drains located within Red Rock Ranch.

## Prosopis alba

### Plantation trials of Prosopis alba in the San Joaquin Valley

Agencies: D'Arrigo Bros. Co.; Forestry Research Station, Catholic University of Santiago del Estero, Argentina; Westside Resource Conservation District; California Department of Water Resources

In the western San Joaquin, growing *Prosopis alba* would be multipurpose. *Prosopis alba* may help to improve subsurface drainage problems and generate economic return for the agroforestry component of the IFDM system.

The Forestry Research Station at Catholic University of Santiago del Estero (CUSE) in Argentina provided 2,000 scarified *Prosopis alba* seeds to initiate plantation trials in the San Joaquin Valley. The seedlings were planted on five farms; all affected by soil salinity and shallow groundwater tables. The objectives are to evaluate salinity tolerances and various growth characteristics and to identify individual plants that could grow at higher salinities to use as clonal propagules.

In Argentina, *Prosopis alba* frequently grows on the edges of high pH, highly saline salt flats. *Prosopis alba* was evaluated in a greenhouse study where the salinity was controlled and found that the growth of *Prosopis* did not become affected until the salinity exceeded approximately 12 dS m-1. Many *Prosopis* grew moderately well up to 24 dS m-1 and some continued to grow at 45 dS m-1. *Prosopis* has one of the world's most dimensional stable lumbers. Over 100,000 tons of *Prosopis alba* logs are being harvested annually in the Chaco Province, Argentina for fine furniture, doors, windows and flooring.

Under favorable conditions with year round water availability or groundwater within 10 ft of the surface, *Prosopis alba* will grow approximately 0.80 inch in diameter per year. For the minimum tree size for lumber of 16 inches, this would require about 20 years. Research and development are needed in growing *Prosopis alba* to perfect the process for the reliability of massive production of elite *Prosopis alba* for large-scale reforestation. In the summer the young trees are quite flexible and they can be bent or molded. More work is needed to develop definitive techniques to enhance the form of the trunk for lumber.



Prosopis alba trees have been cut to produce logs for furniture in Argentina. (P. Felker)



Mature *Prosopis alba* with a broad canopy in a saline area of Argentina. (P. Felker)



*Prosopis alba* with a long straight trunk growing in a closed bottom land site in the Chaco. (P. Felker)

## Boiler

### Demonstration of Brine Boiler and Solar Thermal Concentration System

Agencies: Central Coast Inventions, Inc.; California Department of Water Resources; Westside Resources Conservation District; Red Rock Ranch, Inc.

This project investigated the use of a boiler to evaporate water from drain water to produce concentrated salt solids as a by-product. Central Coast Inventions (CCI) designed and constructed the brine boiler and solar thermal concentration system. A total of four trials were completed to test the system.

The first trial was performed from May 4 to May 8, 2006 to evaluate the operation of the propane fuel fired boiler. The initial results were unsatisfactory and it was necessary to make a number of modifications to better assess the operations.

For the second trial, water and mass balances were performed to track where the water and salts eventually end up after boiling. Two additional trials were performed subsequently. Only fuel trials were performed as technical problems (due to winter season) prevented the use of parabolic solar collectors. The demonstration of brine boiler trials determined the following:

- 1) The majority of the calcium was found in the boiler unit and the soluble salt in the blow-by.
- 2) An improved boiler design would need to be developed with tubes resistant to corrosion and that are easily replaceable.
- 3) The quantity of propane used for the 48 hour second trial was 3888 cubic feet. This converts over to 110 gallons of propane. At the current cost of \$1.369 per gallon, the cost of propane for the 48 hour trial was \$150.80. For the 830 gallons of brine water used, the fuel cost to treat 1 gallon of brine water is \$0.18, which projects out to \$58,653 per acre-foot.
- 4) The steam engine operated a 10 kilowatt generator for the duration of the test, 48 hours. The quantity of electricity generated during the trial was 480 kilowatt-hours (kWh). At the present electricity rate of \$0.19240 per kWh, the worth of the electricity generated was \$92.16.
- 5) During the fourth trial the boiler failed due to severe calcium scaling and steam corrosion.



Steamboy Boiler



Solar Array