CRBSCP - Paradox Valley Unit - Title II

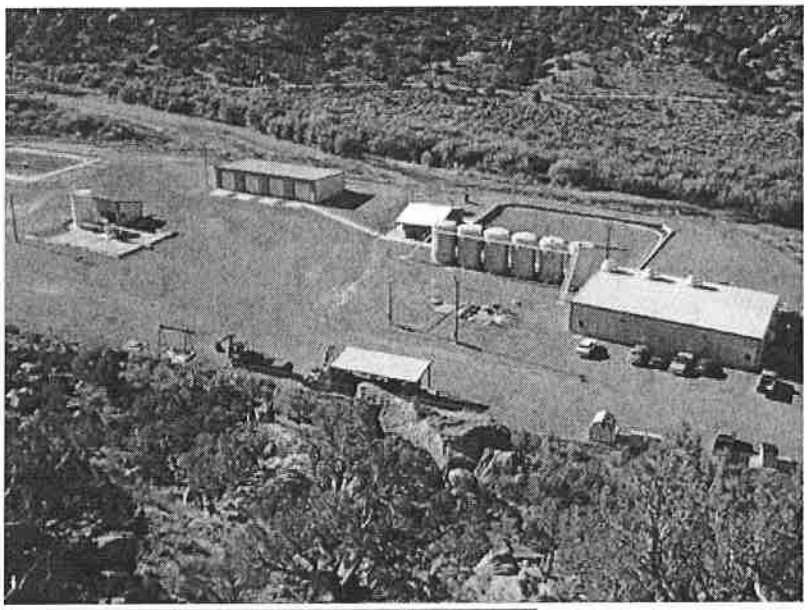

Photo of Brine Injection Facility

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Parent Program/Project

Colorado River Basin Salinity Control Project

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General Description

The Paradox Valley Unit is located near Bedrock, Colorado, about 10 miles east of the Colorado-Utah state line and about half-way between Grand Junction and Cortez, Colorado. The Dolores River picks up an estimated 205,000 tons of salt annually as it crosses the Paradox Valley, primarily from the surfacing of natural brine groundwater.

The Paradox Unit is designed to prevent this natural salt load from entering the river and degrading the water quality of the main stem of the Colorado River. The unit intercepts the brine groundwater before it enters the river and disposes of the brine by deep well injection. Major project facilities include a brine production well field, brine surface treatment facility, injection facility, a 15,932 feet deep injection well, and associated roads, pipelines, and electrical facilities.

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Plan

The Paradox Valley Unit is in southwestern Colorado along the Dolores River. The Paradox Valley is formed by a collapsed salt dome. Groundwater in the valley comes into contact with the top of the salt formation, where it becomes nearly saturated with sodium chloride. Saline concentrations have been measured in excess of 250,000 milligrams per liter, by far the most concentrated source of salt in the Colorado River Basin. Groundwater then surfaces in the Dolores River. Reclamation studies show that the river picks up more than 205,000 tons of salt annually as it passes through the Paradox Valley.

The plan consisted of:

Constructing a series of shallow brine production wells paralleling the Dolores River next to known brine inflow areas

Pumping the wells at a combined rate of 5 cubic feet per second to intercept the brine

Transporting the brine via a 21-mile long pipeline to Dry Creek Basin

Disposing of the brine by evaporation in the 3,700 surface acre Radium Evaporation Reservoir.

Development

History

The Paradox Valley was formed from the collapse of a salt anticline, one of five in the southwestern Colorado - southeastern Utah area. Formation of the anticline began some 250 million years ago when the emergence of mountainous uplifts on each side of the area placed intense lateral pressures on the intervening sedimentary formation, resulting in faulting and fracturing along weak axial zones. Relaxing of the lateral stresses combined with the weight of the overlying strata, allowed a deeply buried layer of salt-rich material to flow upward into the faulted area creating the anticline. As the pressures eased, the crest of the anticline gradually dropped downward in fault blocks.

Throughout this process, the Dolores River stayed in its original course and in combination with other erosional forces, removed the collapsed materials to form the valley. The Dolores River now bisects the valley, thus the name, Paradox Valley. The valley is underlaid by a bed of salt extending from near the surface to a depth of approximately 14,000 feet. Contributing to the collapse of the anticline has been the constant dissolution and removal of the underlying salt bed by groundwater. This process is still active and contributes the approximately 200,000 ton of salt annually to the Dolores River.

Investigations

Reclamation began studies at Paradox Valley in 1971. The Dolores River is relatively fresh as it enters the valley and saline as it leaves, especially during periods of low flow. Investigations have shown that nearly saturated brine apparently underlies the entire valley. The brine has a total dissolved solids content of about 260,000 milligrams per liter (mg/l), nearly 8 times the concentration of sea water. About 93% of the dissolved solids are sodium chloride. A significant fresh water lens overlays the brine in west Paradox Valley while on the east side of the river very little-- if any-- fresh water exists. From near the middle of the Valley to near the river`s exit from the Valley, brine enters the river through seeps and springs and nearly triples its flow-weighted average salinity. Brine inflow rates are estimated to range from 0.2 to 2.1 cubic feet per second.

In its definite plan report (September 1978), Reclamation recommended that a series of wells be drilled on both sides of the Dolores River to intercept the brine before it reached

the river. The brine would then be pumped to an evaporation pond in Dry Creek Basin. A draft environmental statement was prepared for this plan and made public on May 11, 1978; a final statement was filed with EPA on March 20, 1979. Deep well injection was one of the alternative brine disposal methods discussed briefly in the environmental statement but was eliminated because the proposed 5 cubic feet per second brine production rate was considered to be higher than the geologic formations could absorb. The Environmental Protection Agency recommended further evaluation of deep well injection as the brine disposal method.

A private consulting firm completed a feasibility study of deep-well injection and concluded it to be technically, economically, and environmentally feasible. Reclamation then contracted with a second consulting firm to do a more detailed study of injection and to design the disposal system including injection well and surface facilities. A final design for the test injection well was completed in August 1985.

Initial Testing.--Reclamation has completed its initial testing of the well. The tests results were used to determine the capacity of the well to accept brine and develop specifications for the permanent facilities. A full production test of the permanent facilities at 400 gpm started in 1997. At this rate of injection, the facility should be capable of disposing more than 100,000 tons of salt per year. The project has been able to consistently meet this objective. A pilot test of a pretreatment process is underway which may allow higher rates of disposal.

Verification Studies.--The brine collection field has been fully tested. Gauges in the Dolores River above and below the brine inflow area measure salinity levels. When the pumps are turned on, salt gains in the reach drop immediately. Reclamation has contracted with USGS to conduct verification studies beginning in 1999. Like the Meeker Dome Unit (another source of salinity), monitoring should be able to accurately measure the effectiveness of the unit.

Development

A Definite Plan Report (1978) and Final Environmental Statement (1979) were approved recommending a plan to prevent the natural inflow of brine to the Dolores River.

After publication of the planning reports, test facilities were constructed and a verification program was initiated. Facilities constructed included 24 test brine production wells, numerous piezometers and water table observation wells, 4 continuously recording electric conductivity stations, and a temporary brine holding pond. Testing of these facilities proved the plan to be highly effective in controlling the inflow of brine to the Dolores River and that pumping 11 of the brine production wells at a collective rate of 1.5 cubic feet per second would achieve the project`s goal of 90% control. As a result of the lower required pumping rate, the brine disposal plan was re-evaluated.

A consulting firm experienced in deep well disposal was retained to evaluate the feasibility of injection as a disposal method for the produced brine. The consulting firm concluded that injection was a technically viable method of brine disposal and would be more economical than disposal by evaporation. Injection was selected as the preferred

disposal method and Reclamation proceeded to retain a design firm to select the injection well, design the injection system and provide technical guidance during the well drilling and completion phase of construction.

Authorization

The Paradox Unit was authorized for investigation and construction by the Salinity Control Act (Public Law 93-320) of 1974.

Construction

The Paradox Valley Injection Test Well No. 1 was drilled to a total depth of over 16,000 feet and completed at a depth of 15,932 feet during the period from November 1986 through December 1988. Surface treatment and injection facilities were completed in 1990. The brine production well field was previously developed during the verification program. Injection testing began in July 1991 and continued through March 1995. Geochemical studies conducted during the testing program indicated the possibility of calcium sulfate precipitation occurring in the injection zone and as a result, a freshwater treatment plant was constructed to supply water to dilute the brine by 30% before injection. A pilot test program to evaluate the feasibility of using nanofiltration to remove the sulfate from the brine and allow the injection of 100% brine is currently underway.

Due to the extremely corrosive nature of the brine, a multitude of problems were encountered during the testing period. However, in 1995 it was determined that deep well injection was a viable method of disposal and the Unit was converted to a permanently operating facility including the replacement of the test injection pumps with 4 new quintuples pumps.

A seismic monitoring network was installed prior to completion of the injection well to obtain background seismic activity and to monitor activity that would occur as a result of brine injection. The seismic data is processed at Reclamation`s Denver Technical Center.

Facilities have been installed and mechanical tests performed. Numerous mechanical and electrical problems with the facilities have been identified and solved. Several new technologies were developed to overcome the extremely high pressures created by the injection pumps.

Benefits

Salinity Control

Under normal operation, the Paradox Unit averages the injection of about 14 to 14.5 million gallons of brine per month. This results in the disposal of about 10.2 to 10.6 thousand tons of salt per month or up to about 128 thousand tons of salt per year.

The Paradox Unit removes 128,000 tons of salt per year, for a total capital cost of

67,400,000 and an annual O&M cost of $2,800,000--for a cost of $71 per ton.

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