



Land Application of Treated Produced Water in the Western U.S.

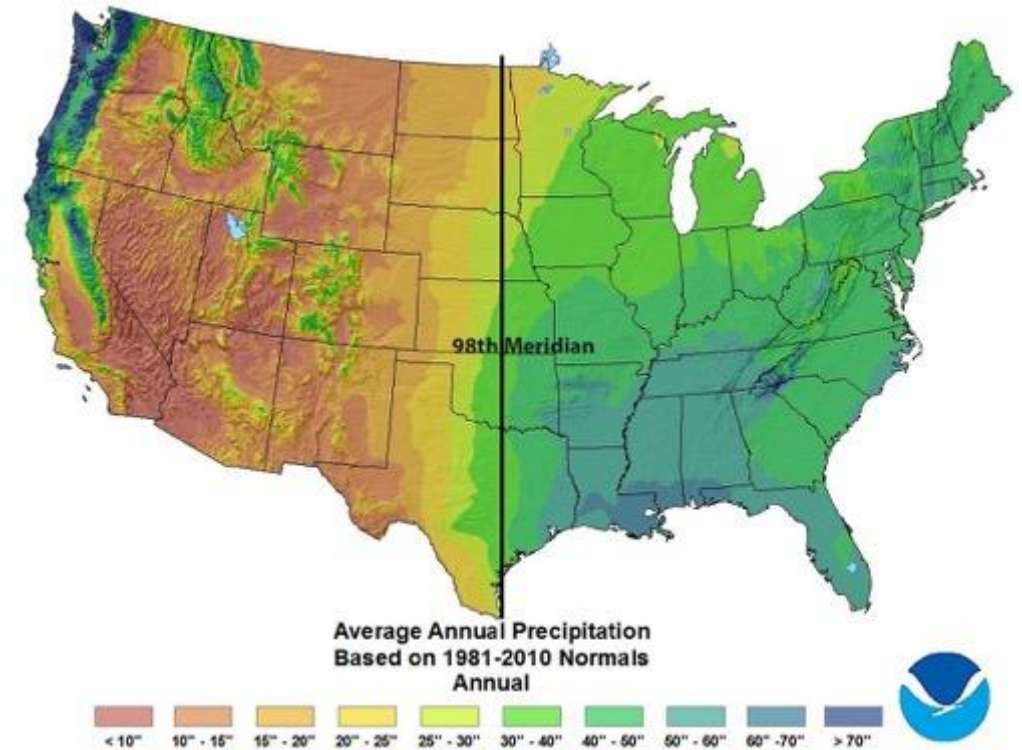
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ANNUAL MEETING

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New Mexico Produced Water Research Consortium



Federal Guidelines on Produced Water Reuse

- 40 CFR 435 – Oil and Gas Extraction Point Source Category
 - Defines produced water as “the water brought up from the hydrocarbon-bearing strata during the extraction of oil and gas, and can include formation water, injection water, and any chemicals added downhole or during oil/water separation process”
 - Produced water cannot be disposed at a POTW
 - Zero discharge of produced water unless sent to a centralized water treatment (CWT) facility, **with one exception, west of the 98th Meridian can be used directly for agriculture**

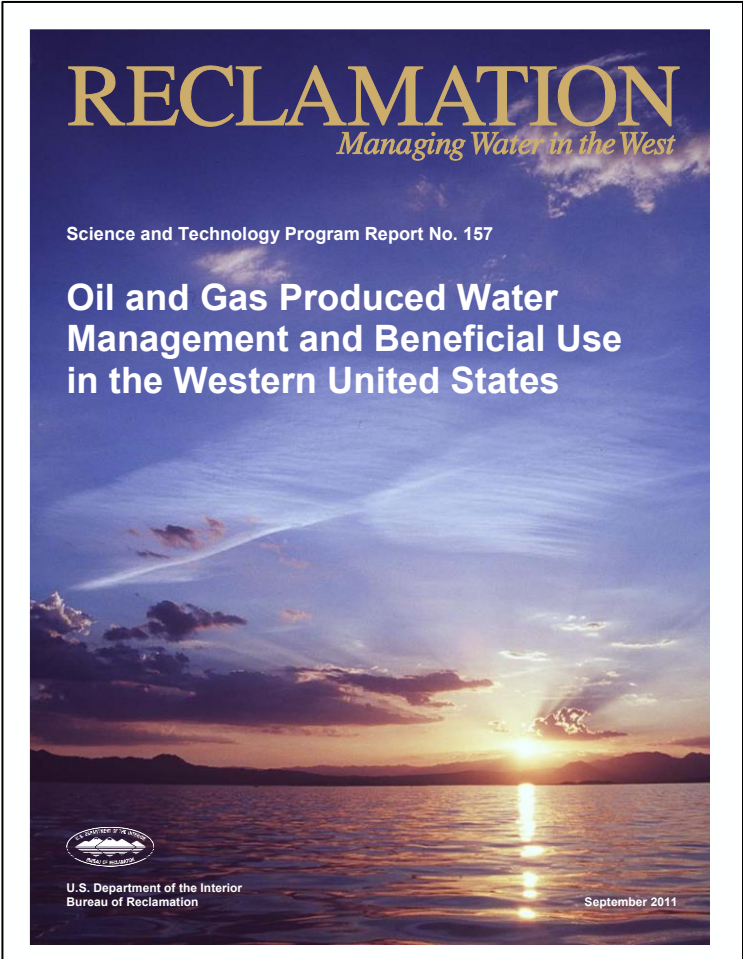


General Produced Water Reuse Regulations from a CWT

- 40 CFR 437 Centralized Water Treatment Point Source Category
 - Generally, produced water for reuse must be sent to a centralized water treatment (CWT) facility.
 - Minimum discharge quality requirements identified by waste stream type, but states may add additional requirements.
- 40 CFR 437 Subpart B – Oily Waste Water Treatment and Reuse
 - Minimum requirements in table at left, pH 6-9, all others mg/L

Regulated parameter	Maximum daily ¹	Maximum monthly avg. ¹
Conventional Parameters		
O&G	127	38.0
pH	(²)	(²)
TSS	74.1	30.6
Metal Parameters		
Arsenic	2.95	1.33
Cadmium	0.0172	0.0102
Chromium	0.746	0.323
Cobalt	56.4	18.8
Copper	0.500	0.242
Lead	0.350	0.160
Mercury	0.0172	0.00647
Tin	0.335	0.165
Zinc	8.26	4.50
Organic Parameters		
Bis(2-ethylhexyl) phthalate	0.215	0.101
Butylbenzyl phthalate	0.188	0.0887
Carbazole	0.598	0.276
n-Decane	0.948	0.437
Fluoranthene	0.0537	0.0268
n-Octadecane	0.589	0.302

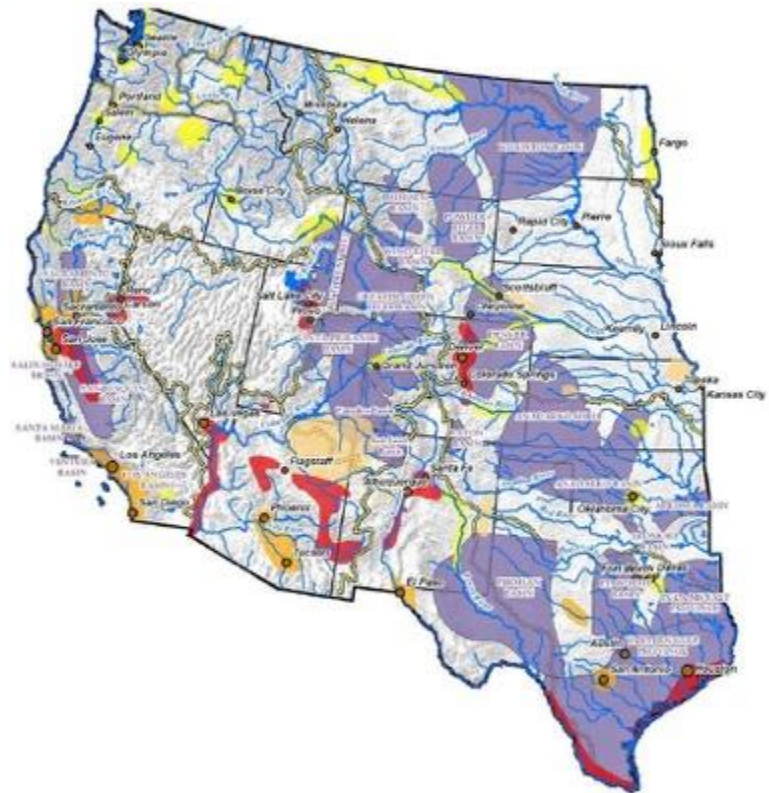
Bureau of Reclamation - Ag, Energy, and Desalination



BOR Report 157, 2011



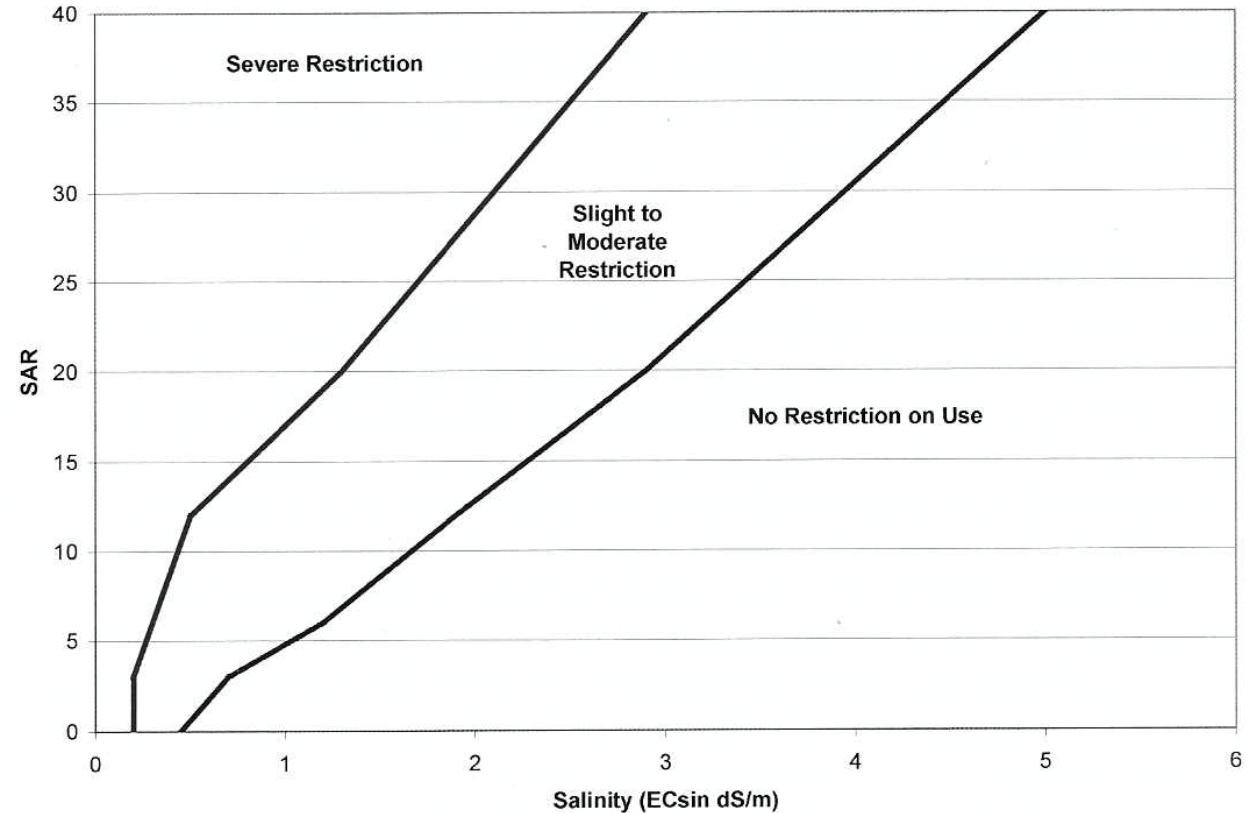
**Brackish Groundwater National Desalination Research Facility
Alamogordo, NM**



Bureau of Reclamation States

Produced Water Reuse In Western Agriculture

- 40 CFR 435 (Subpart E) – Produced water reuse exception west of the 98th Meridian, produced water can be discharged if good enough for agricultural uses and used as such
 - Max oil and grease – 48 mg/l
 - TDS requirements – consistent with agricultural use
- Agricultural use considerations -
 - TDS/Electrical conductivity (Ec)
 - Sodium Adsorption Ratio (SAR)
 - Select constituents – Boron, selenium, ammonia, metals, chlorides, pH, etc.



Agricultural Limitations on Treated Produced Water Quality

Table 8. Crop tolerance to boron in irrigation water

Tolerance Level	Range of Boron Concentration	Crops
Very Sensitive	< 0.5 mg/L	Lemon, blackberry
Sensitive	0.5–0.75 mg/L	Avocado, grapefruit, orange, apricot, peach, cherry, plum, persimmon, fig, grape, walnut, pecan, cowpea, onion
Sensitive	0.75–1.0 mg/L	Garlic, sweet potato, wheat barley, sunflower, mung bean, sesame, lupine, strawberry, jerusalem artichoke, kidney bean, lima bean, peanut
Sensitive	1.0–2.0 mg/L	Red pepper, pea, carrot, radish, potato, cucumber
Moderately tolerant	2.0–4.0 mg/L	Lettuce, cabbage, celery, turnip, kentucky bluegrass, oats, maize, artichoke, tobacco, mustard, sweet clover, squash, muskmelon
Tolerant	4.0–6.0 mg/L	Sorghum, tomato, alfalfa, purple vetch, parsley, red beet, sugarbeet
Very tolerant	60–15.0 mg/L	Cotton, asparagus

pH -6.5-8.4

Chlorides < 70 mg/L

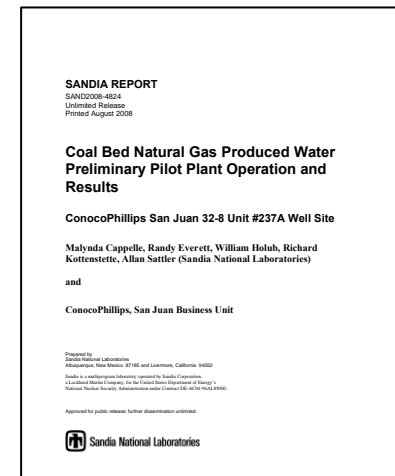
Nitrates – 10 to 45 mg/L

Table 9. Constituent limits for irrigation water (adapted from Rowe and Abdel-Magid, 1995)

Constituent	Long-term Use (mg/L)	Short-term Use (mg/L)
Aluminum (Al)	5	20
Arsenic (As)	0.1	2
Beryllium (Be)	0.1	0.5
Boron (B)	0.75	2
Cadmium (Cd)	0.01	0.05
Chromium (Cr)	0.1	1
Cobalt (Co)	0.05	5
Copper (Cu)	0.2	5
Fluoride (F)	1	15
Iron (Fe)	5	20
Lead (Pb)	5	10
Lithium (Li)	2.5	2.5
Manganese (Mn)	0.2	10
Molybdenum (Mo)	0.01	0.05
Nickel (Ni)	0.2	2
Selenium (Se)	0.02	0.02
Vanadium (V)	0.1	1
Zinc (Zn)	2	10

Example of RDD Permit for Produced Water Reuse for Rangeland Restoration in NM 2004-2008

- Permian Produced Water Reuse Workshop at NMJC with NM WRRRI - 2003 (140 attendees, eight projects - Reed & Stevens, Yates, Devon, Chevron, Conoco, Sandia, LANL)
- Conoco/Sandia/NM Department of Agriculture/NMSU SJ Ag Research Center project for rangeland restoration in San Juan Basin
 - 2004 – 2008 RDD permit with NMED, EPA, and BLM
 - Treated 25,000 ppm TDS produced water with pre-treatment and RO to 4,000, 8,000, and 12,000 ppm TDS to measure grass growth
 - Traditional range grass mix, standard pipe and water canon irrigation from standard tank battery water storage over 10 acres
 - Added 3-4 acre-inches per year on seeded rangeland to supplement annual rainfall during critical growing times



Field Testing of Produced Water – and RD&D Permits

- 40 CFR 264 and 40 CFR 268 – Land disposal of treated waste waters
- 40 CFR 270.63 – Permits for land treatment using field, lab, and pilot-scale data
 - Field, lab, and pilot-scale data can be used to support permits for land application or treatment
- 40 CFR 270.65 – Research, Development, and Demonstration Permits
 - Allows permits to be developed with EPA to enable construction and operation of pilot projects of defined size for one-year.
 - Allows permit to be extended for an additional year up to three times.

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