TRACE ELEMENT CONCENTRATIONS IN FLUE GAS DESULFURIZATION WASTEWATER FROM THE JIM BRIDGER POWER PLANT, SWEETWATER COUNTY, WYOMING

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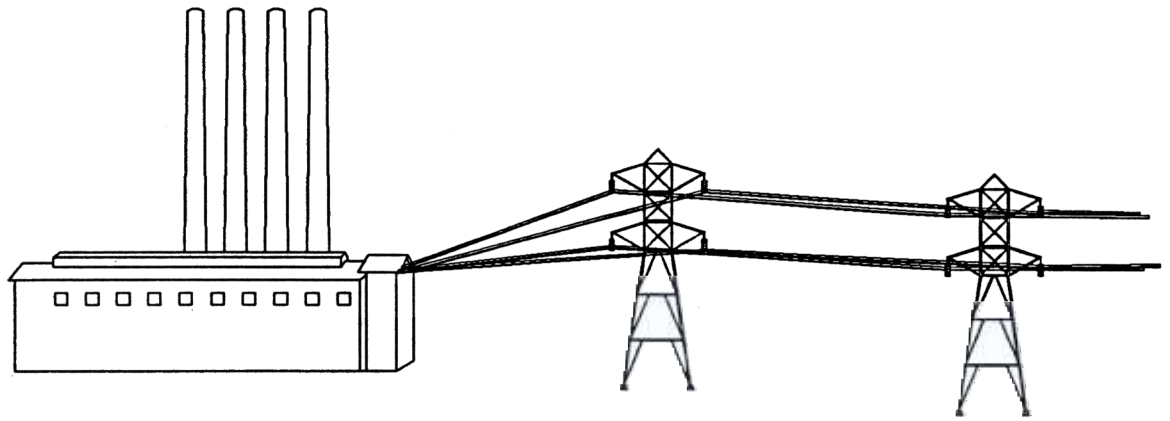
By:
Pedro Ramirez, Jr.
Environmental Contaminants Specialist



Fish & Wildlife Enhancement
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Cheyenne, Wyoming

ABSTRACT

The coal-fired Jim Bridger Power Plant near Rock springs, Wyoming uses soda liquor from nearby trona (soda ash) processing plants to neutralize the acidity of water used in their flue scrubbers. Analyses of this Flue Gas Desulfurization (FGD) liquor by Western Wyoming College Water Quality Laboratory shows high concentrations of sodium, chloride, sulfates, carbonates and bicarbonates. The U.S. Fish and Wildlife Service had samples of the FGD wastewater analyzed for sodium, chloride, sulfates, carbonates and bicarbonates as well as trace metals. Trace metals were not present in concentrations known to pose adverse impacts to wildlife. Sodium concentrations, however, were excessively high. The FGD wastewater is discharged into an evaporation pond which attracts migratory aquatic birds. The FGD wastewater poses a hazard to aquatic migratory birds through exposure to elevated sodium concentrations. The risk to migratory birds could be averted by: (1) eliminating or reducing the sodium concentrations in the FGD pond water; (2) eliminating the FGD pond; and, (3) preventing migratory birds from using the FGD pond.

INTRODUCTION

The coal-fired Jim Bridger Power Plant near Rock springs, Wyoming uses soda liquor from nearby trona (soda ash) processing plants to neutralize the acidity of water used in their flue scrubbers. The water in the scrubbers reduces sulfur dioxide emissions from the power plant. The soda liquor is approximately 25 percent sodium carbonate (Dale Gillespie, Environmental Engineer, Jim Bridger Power Plant, personal communications). Water used in the scrubbers is recycled several times then discharged into a nearby evaporation pond. This Flue Gas Desulfurization (FGD) liquor is high in sodium, chloride, sulfates, carbonates and bicarbonates. The high alkalinity of the FGD liquor keeps the pond ice-free, so it attracts migratory aquatic birds, especially in the late fall, winter and early spring when all other water-bodies are frozen. At temperatures below 70^{0} F, sodium decahydrate crystallizes on any solid object in or on the water. The salt will crystallize on the feathers of any bird on the water and destroy their insulation and buoyancy. This will lead to hypothermia or cause the birds to drown. Birds may also die from sodium toxicity by ingesting the water.

The U.S. Fish and Wildlife Service (Service) has informed Pacific Corp., the operator of the power plant, of their liabilities under the Migratory Bird Treaty Act (MBTA). The MBTA (16 USC 703-711) prohibits the "taking" of migratory birds. Taking can include the following activities resulting in migratory bird mortalities: exposed oil waste pits, hazardous materials spills, hazardous waste pits and oil spills. The maximum criminal penalty for corporations unlawfully taking a protected migratory bird is a $10,000 fine, or six months in jail, or both for each count. There is no "allowable take" under the MBTA, the taking of just one bird is a violation of the Act. Courts have almost uniformly held the MBTA to be a strict liability criminal statute. In *United States v. FMC Corp.* the court affirmed MBTA misdemeanor convictions for bird deaths resulting from FMC's discharge of a pesticide into a wastewater pond that attracted migratory birds and resulted in their deaths. Strict liability has been applied to corporations whose activities have caused migratory bird deaths by exposing birds to oil or other hazardous substances through the operation or maintenance of oil sumps or pits (*United States v. Union Pacific Railroad, U.S. v. Equity Corp., U.S. v. Stuarco Oil Co., U.S. v. Union Texas Petroleum*). The Service is urging

Pacific Power to take immediate corrective actions to prevent migratory bird deaths and avoid violating the MBTA.

FGD wastewater was collected and analyzed to augment the data on sodium concentrations as reported by Western Wyoming College Water Quality Laboratory for Pacific Power and to determine if any trace metals were present at concentrations that could pose adverse impacts to migratory birds.

METHODS

Water samples were collected in May 1991 from the FGD pond and the nearby cooling water evaporation pond at the Jim Bridger Power Plant and submitted to the Patuxent Analytical Control Facility (PACF), Laurel, Maryland for trace element analyses. PACF used cold vapor atomic absorption spectroscopy to analyze for mercury, hydride generation atomic absorption (AA) spectroscopy to analyze for arsenic and selenium, and inductively coupled plasma atomic emission spectrophotometer (ICP) scans to determine concentrations of other trace metals. PACF assured laboratory quality control. Water samples were again collected from the two sites in July 1991 and submitted to the Wyoming Department of Agriculture Analytical Service Laboratory in Laramie for analyses of cations (calcium, magnesium, sodium, and potassium), anions (carbonate, bicarbonate, sulfates, chloride, nitrates), conductance and total alkalinity. Water samples for trace metal analyses were collected in one-liter polyethylene jars and the pH lowered to 2.0 with nitric acid. Water samples for cation/anion analyses were also collected in one-liter polyethylene jars, kept cool and delivered to the Wyoming Department of Agriculture Analytical Service Laboratory on the same day.

RESULTS and DISCUSSION

Trace metal concentrations in water from the FGD and cooling water evaporation ponds is shown in the following table.

Table 1. Trace element concentrations in water (mg/l or ppm) collected from the Jim Bridger Power Plant, Sweetwater County, WY. (< denotes value below analytical detection limit)

Trace Element	Evaporation Pond Sample 1	Evaporation Pond Sample 2	FGD Pond Sample 1	FGD Pond Sample 2
Arsenic	<0.00049	<0.00049	<0.00049	<0.00049
Mercury	<0.00499	<0.00461	<0.00459	<0.00478
Selenium	0.00246	0.00275	0.10298	0.21629
Aluminum	<0.21901	<0.21799	3.20000	9.10000
Barium	0.11000	0.110	0.091	0.190
Beryllium	<0.00497	<0.00495	<0.00495	<0.00496
Boron	2.0	2.0	190.0	230
Cadmium	<0.00497	<0.00495	<0.00495	<0.00496
Chromium	<0.00597	<0.00594	0.05400	0.04400
Copper	0.04500	<0.02873	0.05600	0.07700
Iron	0.11	0.14	2.80	3.20
Lead	<0.00995	<0.00990	<0.01	<0.00992
Magnesium	440	410	220	290
Manganese	0.18	0.16	0.13	0.13
Molybdenum	<0.06968	<0.06936	1.80000	2.10000
Nickel	0.040	0.038	0.024	0.024
Strontium	3.80	3.40	0.46	0.58
	<0.04977	<0.04954	<0.04950	<0.04960
Vanadium	<0.00497	<0.00495	0.80000	1.00000
	<0.04977	<0.04954	0.31000	1.20000

The trace metals reported above were not present in concentrations considered adverse to aquatic birds. Elevated sodium concentrations in the FGD Pond present the greatest risk to aquatic birds. Salt toxicosis in waterfowl has been reported in ponds with sodium concentrations over 17,000 milligrams per liter (mg/l) (Windingstad et al. 1987). Canada geese mortality due to sodium toxicity

and salt crystallization was reported at a hypersaline lake with sodium concentrations ranging from 30,800 to 36,950 mg/l in Saskatchewan, Canada (Wobeser and Howard 1987). Sodium concentrations in the FGD Pond ranged from 52,000 to 66,000 mg/l (Figure 1).

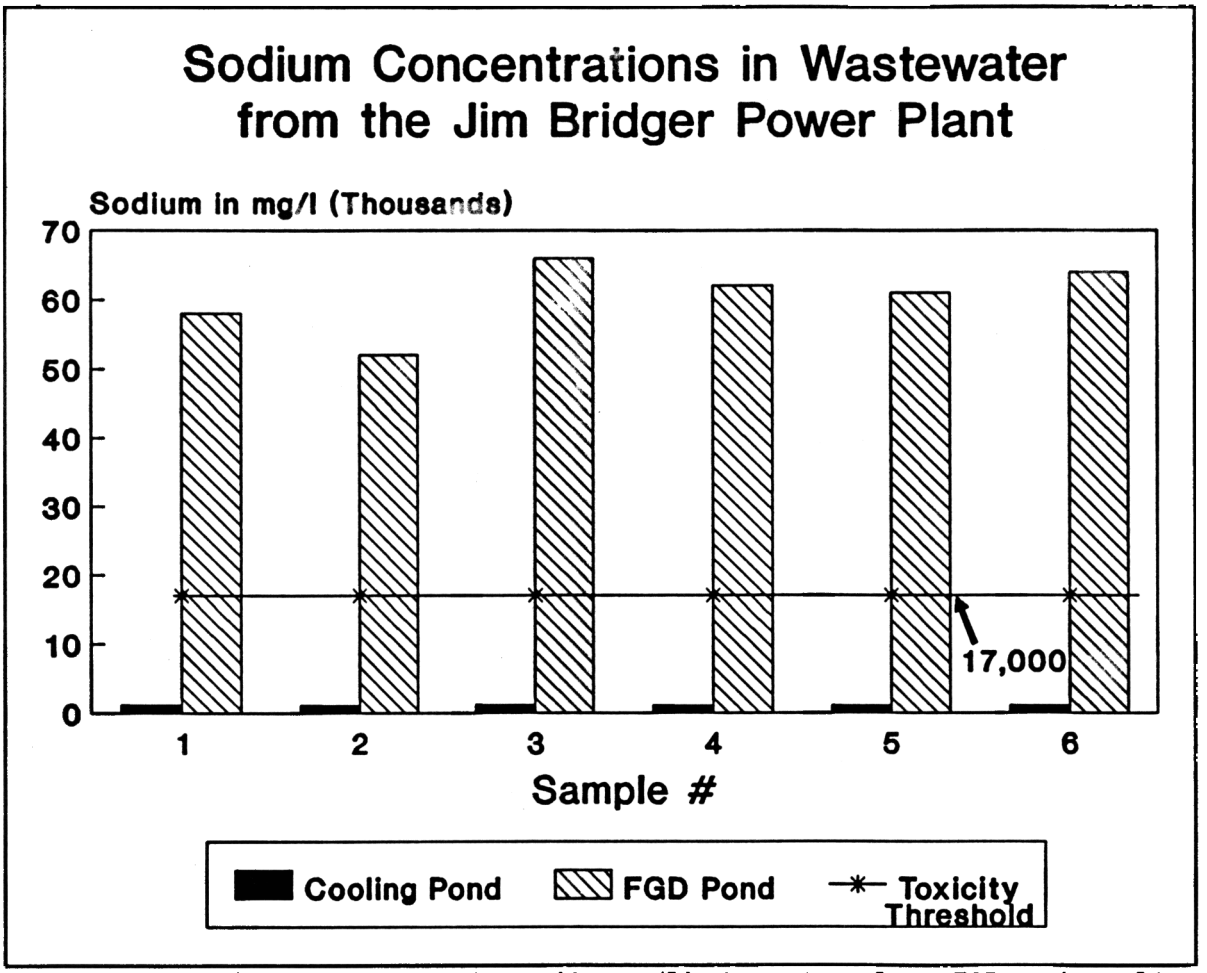

Figure 1. Sodium concentrations (in mg/l) in water from FGD and cooling water ponds at the Jim Bridger Power Plant, Sweetwater County, WY.

FGD wastewater samples collected from 1986 through 1990 by Western Wyoming College Water Quality Laboratory at Rock Springs for the Jim Bridger Power Plant show an increase in sodium concentrations over the four year period (Figure 2). Sodium concentrations during the four year period exceeded the 17,000 mg/l threshold for toxicity to aquatic birds. This data support the conclusion by Dr. Merl F. Raisbeck, veterinary pathologist, University of Wyoming, Laramie, in his December 30, 1991 letter to Monte Garrett, Pacific Power, that "exposure to FGD pond water is potentially toxic to migratory waterfowl."

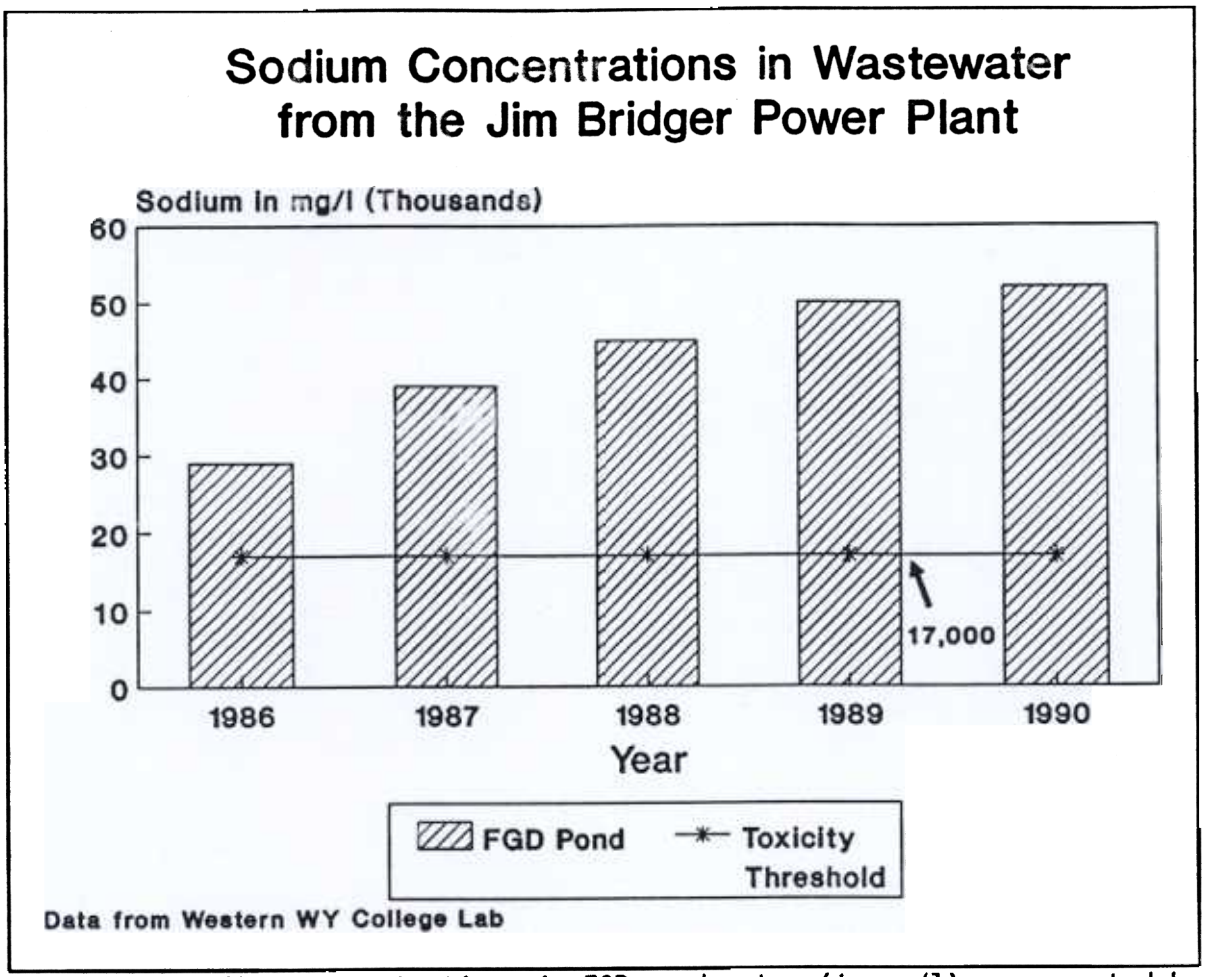

Figure 2. Sodium concentrations in FGD pond water (in mg/l) as reported by Western Wyoming College Water Quality Laboratory, Rock Springs, WY.

Dr. Raisbeck found that brain sodium concentrations in birds spending a minimum of three hours on the FGD pond exceeded the concentration considered toxic (>1,800 μg/g or ppm). The increase in sodium concentrations in the FGD wastewater over a four year period suggest that concentrations may continue to increase. Higher sodium concentrations in the FGD pond in the future may pose a greater risk to aquatic birds because acute levels of sodium could be ingested in less than three hours. Ingestion of water containing high sodium concentrations can also pose chronic effects to aquatic birds. Cooch (1964) found that aquatic birds ingesting water with large amounts of dissolved salts can make the birds more susceptible to avian botulism.

REMEDIATION RECOMMENDATIONS

The FGD wastewater poses a hazard to aquatic migratory birds through exposure to elevated sodium concentrations. The risk to migratory birds could be averted by eliminating or reducing the sodium concentrations in the FGD pond water, by eliminating the FGD pond, or by preventing migratory birds from using the FGD pond.

The first option would consist of using brine concentrators to reduce sodium concentrations in the FGD wastewater. Power plants currently using brine concentrators are listed on Table 2.

Table 2. Power plants using brine concentrators to treat wastewater (Source: Resources Conservation Company, Bellevue, WA).

UTILITY COMPANY	POWER PLANT	STATE
Salt River Project	Navajo	AZ
Utah Power & Light	Huntington	UT
Public Service Co. of NM	San Juan	NM
Colorado Ute Electric Assoc.	Hayden	CO
Montana Power	Colstrip	MT
Colorado Ute Electric Assoc.	Craig	CO
Arizona Public Service	Four Corners	AZ
Public Service Co. of CO	Pawnee	CO
City of Colorado Springs	R.D. Nixon	CO
Otter Tail Power	Big Stone	SD
City of Gainesville	Deerhaven	FL
Texas Utilities	Monticello	TX
Nevada Power	Clark	NV
Texas Utilities	Martin Lake	TX
Southern CA Edison	Mohave	NV
Arizona Nuclear Power Project	Palo Verde	AZ
Texas-New Mexico Power	Calvert	TX

The second option has several possibilities. The wastewater could be injected into deep wells, it could be transported to a trona processing plant for removal of the trona, or the power plant operators could solidify the FGD effluents.

Technology is available to convert the sodium sulfate in the FGD wastewater to calcium sulfate and recycle the sodium salts back to the scrubber for reuse. The calcium sulfate materials can then be pozzolanically stabilized with the resulting end product consisting of a cementitous material (Smith 1987, Smith and Rau 1981, Van Ness et al 1983).

The third option would entail the use of bird deterrents. According to Esmoil (1991), netting is the only proven method of preventing birds from using waste ponds. Flagging, strobe lights, noise makers are not effective at preventing birds from accessing waste ponds (Esmoil 1991).

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