**State:** Montana

**Borrower Name and Case No.:** Town Of Froid

**Engineering Firm:** Kadrmas, Lee & Jackson

**Rural Development Contact:** Karen Bucklin Sanchez, State Engineer 406/585-2520

**Congressional Information:** Senators Max Baccus and Conrad Burns
Representative Rick Hill

**County:** Roosevelt

**Keywords:** Disinfection, Reverse Osmosis

# Reverse Osmosis Water Treatment Plant and Water System Improvements

## Description of Problem / Issue:

The Town of Froid has a population of approximately 230 and provides water to about 138 users (147 EDU's). (Not including bulk water sales.) The Town's water source is groundwater. The raw water quality is poor, exhibiting elevated levels of iron, manganese and total hardness.

Raw Water Analysis
Date of Analysis : 4-15-96

Conductivity @ 77F = 2300.5 pMHOS/cm
Residual Sodium Carbonate = 0.40 MEQ/L
Sodium Absorption Ratio = 5.92
Total Dissolved Solids (Calculated) = 2072 mg/L
Sodium Chloride (Calculated) = 15 mg/L
pH = 8.07
Hardness = 39.1 Grains/gal
Hardness = 670 mg/l

| CATION | MEQ/L | mg/L | ANION | MEQ/L | mg/L |
|---|---|---|---|---|---|
| Calcium | 8.8 | 175 | Chloride | 0.3 | 9 |
| Magnesium | 4.6 | 51 | Carbonate | 0.0 | 0 |
| Sodium | 15.3 | 352 | Bicarbonate | 13.8 | 842 |
| Iron | 0.1 | 1.6 | Sulfate | 13.1 | 630 |
| Potassium | 0.3 | 11 | Nitrate-N | 0.0 | 0.1 |

Total Iron = 7.70 mg/L
Total Manganese = 0.28 mg/L

Treatment of the Town's water is necessary. In addition, other improvements to the water supply and distribution system were necessary.

A backup water supply well was needed since one of the two existing water supply wells was exhibiting elevated nitrate levels. The water distribution system was constructed in the 1950's and consisted of one 50,000 gallon storage tank, 4 and 6 inch AC pipe, and only one operational gate valve, no water meters and minimally operational fire hydrants.

Design parameters for the water treatment plant included:

- Remove iron, manganese and hardness.
- Minimize project capital costs
- Minimize operation & maintenance costs.
- Construct a treatment plant which could be easily modified to meet future regulations.

**Solution:**

Froid's consulting engineer assisted the community to prepare a Preliminary Engineering Report and applications for funding. In 1994, funds were provided by Rural Development (Farmer's Home Administration), Montana Treasure State Endowment program and the Town of Froid.

The project was divided into two phases. The first was development of an additional water supply well. Once the new well was developed, a pilot plant study was conducted on the water source.

Based on the engineer's preliminary report and the pilot plant study, it was determined that the most effective treatment for this water source was a combination of iron and manganese removal using ozone for oxidation followed by reverse osmosis (RO) membrane treatment. Ozone was the oxidant chosen due to the organics present in the raw water as well as the chemical cost.

Froid's 100 gpm ( 0.144MGD) RO water treatment plant was constructed in 1995. Following is a brief summary of the water treatment plant process:

- Raw water is pumped from the wells to the water treatment plant.

- Ozone is injected into the raw water utilizing a deep tube injection system.

- Water passes through a pressure filter to remove iron and manganese.

- After the iron and manganese filter, the water flow is split. A portion is directed to the membrane treatment system (reverse osmosis membranes) and the remainder is directed to the blending tank.

- Water pressure is increased before entering the membrane filters. The RO membranes process the water and a portion is rejected as concentrate ("brine"). The treated water (permeate) is directed to the blending tank.

- From time to time the RO membranes are cleaned with a solution of citric acid, sulfuric acid or sodium hydroxide. Sodium bisulfide is periodically injected into the membranes to inhibit biological growth. Membranes must be replaced periodically, every 5 to 7 years. The cleaning solution, iron manganese filter backwash water and the brine produced from the RO process are all flushed to the sanitary sewer system, and treated by the municipal wastewater facultative lagoon.

- The final water blend of RO permeate to Fe/Mn-treated water can be adjusted. The Town has been operating generally at a 50/50 blend. Winter production has been at 80 gpm, and summer at 100 gpm, due to water demand and water temperature.

- At the blending tank, sodium hypochlorite is injected for disinfection and orthophosphates are injected for corrosion control before being pumped to the water distribution system.

The plant is unique in that it is essentially "chemical free". Operation & maintenance costs for the system are approximately $1.04 to $1.40 per 1000 gallons of finished water.

Since nearby rural non-residents' well water quality is also poor quality, bulk water sales to area residents is brisk. Non-residential water use includes using the water as "spray mix" for agricultural fertilizer and pesticide application purposes. The treatment facility has been operating at capacity since it was put on line.

In addition to constructing the water treatment plant, the distribution system was upgraded by replacing all gate valves and adding some additional valves, replacing leaking fire hydrants, looping dead ends and installing water meters.

Also, with the increase in sewage flow due to backwash water from the water treatment plant, a portion of the sanitary sewer system was also upgraded. The existing one-cell facultative lagoon was leaking. One lift station was rehabilitated and a second new lift station was constructed. A new wastewater lagoon with three lined treatment cells was constructed.