BMFOU Berkeley Pit and Discharge Pilot Project
Polishing Facility
Butte, Montana 59701

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woodplc.com
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Agenda

- Project Overview
- Basis of Design
- Technical Approach
- Operational Configurations
- Summary
Project Overview

- **Pilot Project Objective**
  - Conduct a full-scale pilot test to evaluate treatment technologies and water management methods for meeting BMFOU Consent Decree requirements at the Berkeley Pit with specific goal of controlling the water elevation in the Pit

- **Pilot Project Includes:**
  - Withdrawing and treating Berkeley Pit water in the existing Horseshoe Bend Water Treatment Plant. Water will be used in the mill and discharged to the Yankee Doodle Tailings Impoundment (YDTI)
  - Constructing a new Polishing Plant to treat YDTI with off-site discharge
  - Polishing Plant discharge must meet discharge standards stated in the BMFOU Consent Decree
  - Polishing Plant will also be used to reduce the volume of water in the YDTI
Major Project Elements
Major Project Elements
Basis of Design

- **Design Feed Flow:**
  - 10 MGD

- **Influent Water Quality**
  - High pH (9.5 to 10.5), consists mostly of calcium sulfate, low metals concentrations, most dissolved metals already meet final CD limits
  - Future water quality estimated to remain similar but with possible increased aluminum concentrations (0.6 and 2.5 mg/L)

- **Effluent Discharge Criteria**
  - Consent Decree requirements for discharge into creek
### Water Quality and Discharge Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Type</th>
<th>Existing YDTI Water Quality</th>
<th>Predicted Future YDTI Water Quality</th>
<th>Final Discharge Limit (30-day average)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Average</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>s.u.</td>
<td>Field</td>
<td>8.4</td>
<td>10.6</td>
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<tr>
<td><strong>Total Alkalinity, as CaCO₃</strong></td>
<td>mg/L</td>
<td>Total</td>
<td>12</td>
<td>44</td>
<td>43</td>
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<td><strong>Major Anions</strong></td>
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<tr>
<td><strong>Chloride</strong></td>
<td>mg/L</td>
<td>Total</td>
<td>11.8</td>
<td>13.3</td>
<td>12.6</td>
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<tr>
<td><strong>Sulfate</strong></td>
<td>mg/L</td>
<td>Total</td>
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<td>2,500</td>
<td>1,382</td>
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<td><strong>Major Cations</strong></td>
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<tr>
<td><strong>Calcium</strong></td>
<td>mg/L</td>
<td>Diss</td>
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<td>715</td>
<td>500</td>
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<td><strong>Magnesium</strong></td>
<td>mg/L</td>
<td>Diss</td>
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<td>1.7</td>
<td>1.4</td>
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<td><strong>Potassium</strong></td>
<td>mg/L</td>
<td>Diss</td>
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<td>46</td>
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<tr>
<td><strong>Sodium</strong></td>
<td>mg/L</td>
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<td>109</td>
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<td><strong>Other</strong></td>
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<td><strong>TSS</strong></td>
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<tr>
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<tr>
<td><strong>Total Hardness, as CaCO₃</strong></td>
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<td>Total</td>
<td>959</td>
<td>1,260</td>
<td>1,090</td>
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</tbody>
</table>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Average</td>
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<td>Aluminum</td>
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<td>µg/L</td>
<td>Diss</td>
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<td>8.6</td>
<td>3.5</td>
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<td>µg/L</td>
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<td>140</td>
<td>13.5</td>
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<td>1.83</td>
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<tr>
<td></td>
<td>µg/L</td>
<td>Diss</td>
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<td>16</td>
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<td>Diss</td>
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<td>1.89</td>
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<td>Acute and Chronic Toxicity</td>
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</table>
Polishing Plant Project Overview

- Accelerated Delivery: <12 months
- Design/Build/Operate
- Collaboration between Wood, Pioneer, and Copper Env
- Completely gravity flow
- Simple, proven technologies
- Designed with flexibility to operate system in various configurations
- Target constituents include: aluminum, metals and dissolved salts, if needed
- Majority of equipment was pre-fabricated for quick installation
- Completely automated with remote monitoring and operator call-out
Conceptual Design of the Polishing Facility

Influent → First Stage Filter (High pH, Metals Removal) → Second Stage Filter (Neutral pH, Aluminum Removal) → RO System → Discharge

- Organosulfide
- Coagulant
- CO2
- Coagulant
- Antiscalant
Multimedia Filters

- Design Flow: 10 MGD
- Design Filtration Rate: 5.1 gpm/ft²
- Integrated, low volume backwash
- 6 Filter Vessels, 3 Cells/Vessel, 150 ft²/cell
- Media:
  - 18” fine sand
  - 18” anthracite
- Effluent turbidity target:
  - Turbidity < 0.2 NTU
  - SDI < 3-4
- Designed for single or two stage operation
Reverse Osmosis

- Design Capacity: 3 MGD permeate
- Recovery: 75%
- Design Flux: 12.2 to 12.8 gfd
- 2 Skids, 3 RO Systems:
  - Skid 1: 2 x 0.75 MGD
  - Skid 2: 1 x 1.5 MGD
- Membranes:
  - Hydranautics: ESNA1-LF2-LD-400
  - Low pressure, low fouling
  - 96% calcium rejection
- Operating Pressure: 100 to 150 psig
Carbon Dioxide System

- Supplier: Praxair
- 54 ton horizontal cylinder with vaporizer
- Three diffuser injection locations
- pH target 6.8 to 7.2 at discharge
- Typical dosage: 20 to 40 ppm
Chemical Feeds

- **Coagulant**
  - Cationic polymer
  - RoQuest 3000 (Avista)
  - Vichem 2001
  - Dosage 0.5 to 1.0 ppm

- **TMT-15**
  - Organosulfide
  - Precipitates heavy metals to low levels
  - Dosage < 3 mg/L

- **Antiscalant**
  - Vitec 7000 (Avista)
  - Nalco 9714
  - Dosage 2 to 3 mg/L
Product Tank

- 7,000 gallon FRB tank
- Blends Filtered Effluent and RO permeate
- 1 min retention time at max flow
- Simple design; internal weirs direct flow to discharge (lower weir) or off-spec/waste vault (upper weir)
- Equipped with pH and conductivity instruments for online measurement and control
Single Stage Operation: High pH filtration. Used when aluminum is low and RO not needed. Limited to 6 MGD.
Two Stage Operation: High pH filtration through first stage. Low pH filtration through second stage. Used when aluminum removal is desired.
Two Stage Operation: Same as previous. Used when RO needed.
Split Stage Operation: High pH filtration through first stage. Low pH filtration through second stage. Used when aluminum is low and RO needed. Advantages: Lower overall filtration rate.
Summary

- Design/Build/Operate Project
- Completed in less than 12 months
- Simple treatment process with flexible operating configurations
- Startup: May
- Discharge Target: June