Remediation Alternatives for Milltown Reservoir

MISSOULA WATER QUALITY ADVISORY COUNCIL

The Missoula Water Quality Advisory Council is a group of citizens appointed by the Water Board to advise the Board and Water District on protecting, maintaining, and restoring the waters of Missoula County. Its members have technical expertise in areas related to water quality, such as hydrology, soils, chemistry, engineering, and environmental law, and include representatives from local government, large water users, public interest groups, and a citizen-at-large.

INTRODUCTION

Milltown Reservoir is located at the confluence of the Clark Fork and Blackfoot Rivers, approximately seven miles upstream of the city of Missoula. It was created by the construction of Milltown Dam in 1907 and has collected contaminated sediments over the years from mining, milling, and smelting activities upstream in Butte and Anaconda.

Approximately 6.6 million cubic yards of sediment has accumulated in the reservoir, containing thousands of tons of arsenic, copper, zinc, iron, and manganese. Periodic scouring events mobilize metal-contaminated sediments, causing water quality standards to be exceeded in the Clark Fork River below the dam. A plume of contaminated groundwater covering approximately 110 acres has developed below and downgradient of the reservoir, with arsenic concentrations exceeding 20 times the drinking water standard. The dam itself presents a barrier to fish migration, including that of the endangered Bull Trout.

Milltown Reservoir was placed on the National Priorities List in 1982, and the Environmental Protection Agency is currently evaluating several alternatives for remedial action at the site.

1. Facts

Sediment Contamination

A. The reservoir currently holds approximately 6.6 million cubic yards of metals-contaminated sediment, with sediment depths up to 29 feet near the dam (1,3).

B. Sediment volume and arsenic contamination by area (1):

<table>
<thead>
<tr>
<th>Area</th>
<th>Volume (cubic yards)</th>
<th>Arsenic (mg/kg)</th>
<th>Copper (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2,600,000</td>
<td>0 - 1,590</td>
<td>131 - 10,800</td>
</tr>
<tr>
<td>II</td>
<td>760,000</td>
<td>0 - 513</td>
<td>387 - 534</td>
</tr>
<tr>
<td>III</td>
<td>480,000</td>
<td>6 - 80</td>
<td>39 - 378</td>
</tr>
<tr>
<td>IV</td>
<td>1,200,000</td>
<td>0 - 1,420</td>
<td>303 - 7,985</td>
</tr>
<tr>
<td>V</td>
<td>1,520,000</td>
<td>0 - 442</td>
<td>340 - 405</td>
</tr>
</tbody>
</table>

C. Reservoir sediments contain (1):
arsenic 2,100 tons  iron 143,900 tons
copper 13,100 tons  manganese 9,200 tons
zinc 19,000 tons

Groundwater Contamination

A. A plume of arsenic-contaminated groundwater, violating groundwater quality standards, has developed over approximately 110 acres below and downgradient of the reservoir (3).

B. This plume is fed by geochemical leaching of metals in the reservoir sediments at an estimated rate of 105 lbs/day arsenic, 3,550 lbs/day iron, and 6,860 lbs/day manganese. Without source removal, groundwater contamination will persist for hundreds of years (1).

Sediment Transport

A. Periodic scouring events mobilize metals-contaminated sediments, causing water quality standards to be exceeded in the Clark Fork River below the dam (4).

B. During much of the year, there is net deposition of a portion of the incoming suspended sediment/metals load in the reservoir. During all but the lowest spring flows, however, some sediment is eroded from the reservoir riverbeds, at a rate that increases with the magnitude of the flow (4).

C. On a long-term basis, essentially all of the load entering the reservoir moves through to downstream reaches. Although net deposition or loss of material may occur in individual years, Milltown Reservoir appears to be in long-term equilibrium and probably is not accumulating or losing substantial amounts of material (5).

1996 Ice Jam

A. An emergency situation occurred in February, 1996 when a ten-foot thick, ten-mile long ice jam broke loose on the Blackfoot River upstream of Milltown Dam. Montana Power Co. officials ordered an emergency drawdown of the reservoir in order to protect the dam.

B. As a result of the emergency release, copper concentrations rose to 770 ppb in the Clark Fork River downstream of the reservoir. The state water quality standard is 18 ppb. Zinc concentrations rose as high as 1,310 ppb; the water quality standard is 120 ppb (7).

C. These water quality violations are thought to have caused a substantial fish kill in the Clark Fork River downstream. 1996 fish population surveys found a 62% decline in catchable rainbow trout and a 56% decline in catchable brown trout from 1995 downstream of Milltown Dam. Declines were also found in the number of juvenile trout and in the overall health and condition of the fish (6).

Fish Migration

A. Milltown Dam acts as a barrier to fish migration in the Clark Fork River, preventing fish in the lower Clark Fork from migrating to their spawning tributaries in the Blackfoot, Rock Creek, Flint Creek, and other tributaries to the Clark Fork.
B. A number of different trout species have been observed at the dam, including rainbow, brown, cutthroat, and the threatened bull trout.

2. Desired Outcomes

The Water Quality Advisory Council has adopted a set of desired remediation outcomes for the Milltown site. These outcomes are essential to the success of any remedial action program for Milltown Reservoir.

A remediation program that meets these outcomes will protect and improve the water resources of Missoula County and enhance the overall health of the Clark Fork River.

If these outcomes are not met, Missoula County residents will continue to live with on-going degradation of our water resources and declining health of the Clark Fork River fisheries.

Adopted by the Missoula Water Quality Advisory Council on Nov. 9, 1999

1. Surface and ground water standards should be met downgradient of the site. Surface water should meet Montana WQB-7 standards for metals based on total recoverable concentrations.

2. Scouring incidents that mobilize metal-contaminated sediments should be prevented.

3. There should be a pathway for fish migration for all species during their required times of the year.

3. Remediation Alternatives

The U.S. EPA is evaluating several alternatives for remediation of the Milltown site. They are presented in four broad categories below. Each alternative is examined for its potential to meet Water Quality Advisory Council outcomes. Concerns with each alternative are presented.

EPA ALTERNATIVES

1. No Further Action

This alternative would leave the dam and sediments in place, would continue the Milltown Water Users Association replacement water supply, and would rely on institutional controls already in place, such as public land use controls, boating restrictions, water quality monitoring, and long-term operational, maintenance, and safety requirements.

Outcomes met:

Does not meet any of the Water Quality Advisory Council’s desired outcomes.

Concerns:

With the sediments in place, there will be a continuous source of groundwater contamination, as well as on-going surface water violations from spring runoff and scour events. Without modification, the dam will continue to be a barrier to fish migration.
2. Dam Modification

Under this alternative, modifications would be made to the dam to help mitigate sediment discharge. Modifications would entail either removal of the flashboards on the dam or replacement of the flashboards with a pneumatic crest gate to improve control of reservoir pool level. New operational practices would be implemented to mitigate the rate or timing of sediment release downstream. A fish ladder could be installed to allow passage for fish migration.

Outcomes met:

Would allow fish passage.

May reduce impacts of catastrophic events, such as the 1996 ice jam.

Needs a much stronger analysis of whether operational controls can address the problem of annual scour.

Concerns:

This is a short-term, high-maintenance solution. At best, contaminated sediment will be released gradually downstream in late spring, rather than at once during peak runoff. The success of this approach depends heavily on daily operational practices, dam maintenance, and land use controls in perpetuity. It does not remove the problem of a large contaminant source deposited in a dynamic river system. These sediments will also continue to leach contaminants into the groundwater for hundreds of years.

3. Dam Modification and Partial Sediment Removal

In addition to dam modification and operational controls, this alternative would provide increased storage capacity through partial removal of sediments from the reservoir. This could be accomplished either by 1) creation of a sedimentation pool immediately upstream of the dam, maintained by periodic dredging, or 2) channelization of the Clark Fork River upstream to Duck Bridge and the Blackfoot River to the I-90 Bridge Embankment.

Outcomes met:

Would allow fish passage.

Needs analysis, as above, of the likely success of operational controls to reduce annual scour, and the need for annual maintenance.

May improve groundwater quality by partial removal of the contaminant source.

Concerns:

Once again, this option will still release sediment downstream during high flow and depends on proper operation and maintenance in perpetuity. Periodic dredging would require sediment dewatering, transportation, and disposal facilities on an on-going basis. As long as the reservoir remains, there will
be continued leaching of any contaminated sediments into the groundwater.

4. Dam and Sediment Removal

This alternative would remove the Milltown Dam and either some or all of the contaminated sediments behind the dam. Engineering controls and/or geomorphologic design would be necessary to protect any contaminated sediments left in place, prevent excessive upstream erosion, and minimize contaminant leaching from sediments left in place.

Outcomes met:

This alternative would likely meet all of the water quality advisory council's desired outcomes for the Milltown site. Groundwater quality downgradient of the site would be improved by removal of the contamination source; although removal of the plume would require a groundwater remediation program. Scouring incidents that mobilize metal-contaminated sediments would be reduced or eliminated by removing contaminated sediments from the river. Dam removal would provide a clear passageway for fish migration.

Concerns:

This remediation option is by no means simple or straight-forward. It will have both short-term and long-term impacts on the river, it will be costly and time-consuming, and it will require careful evaluation of the overall hydrogeologic system. Primary concerns are:

- Impact on the river profile upstream
- Need for a thorough analysis of the fluvial system, impacts of dam removal, and extent to which a natural river channel can be reconstructed
- Need for analysis of downstream sedimentation and impacts of dam removal
- Sediment disposal, transportation, and maintenance
- Need for more detailed analysis of the hydrogeologic system, behavior of the plume, and how reservoir removal might affect the system
- Lack of plans for groundwater remediation once the source has been removed.

Conclusions

- Remove dam and sediments

The remediation alternative of removing both Milltown Dam and the reservoir sediments is the only one that will meet the Water Quality Advisory Council outcomes of acceptable surface and groundwater quality, elimination of harmful sediment scouring events, and fish passage.

- More hydrogeologic analysis

The hydrogeologic system must be analyzed and evaluated in greater detail prior to remediation design.

- Design remediation program carefully
Remediation must be carefully designed and implemented to minimize short- and long-term impacts on the river.

- Focus on long-term impacts

While the short-term impacts of dam and sediment removal may be dramatic, this is the only remediation option which has the long-term benefit of removing the contamination source from the river.

REFERENCES


7. Missoula City/County Health Dept., personal communication, 1996.