State of North Dakota Water Quality Report for the Devils Lake Outlet Project

Three-Pronged Approach

Since 1993 the Devils Lake Basin has received above normal precipitation. As a result, Devils Lake has risen nearly 25 feet in elevation. Federal, state and local officials have adopted the three-pronged approach to address the flooding concerns and implement solutions. The three-pronged approach includes, basin water management, infrastructure protection, and an outlet to the Sheyenne River.

Basin water management has been ongoing for the last several decades. Included in this are multiple programs including ASAP/ESAP, State Water Bank, and Wetland Reserve Program, that pay farmers to store water on their land instead of allowing the water to reach Devils Lake. Other basin water management projects include, Sweetwater-Morrison storage structure, Channel "A", and Hurricane Lake. Basin water management is important in alleviating the flooding problems in the Devils Lake Basin, but it cannot adequately address the problem by itself .

Infrastructure protection includes raising roads, dikes, railroads, and property buyouts before inundation. This has proven to be very expensive, with nearly $400 million being spent thus far. If Devils Lake continues to rise to 1459, it is estimated that it could cost an additional $900 million. Infrastructure protection is important within the Devils Lake Basin, but it does not reduce water levels around Devils Lake or provide protection to people living downstream of Devils Lake along the Sheyenne and Red Rivers in the case of a natural overflow.

There are two outlet projects being pursued that would route water from Devils Lake to the Sheyenne River. One is the Corps of Engineers 300-cfs outlet project from Pelican Lake to the Sheyenne River, and the other is the State of North Dakota's 100-cfs outlet project from West Bay to the Sheyenne River. The two projects are different in design and operation, but similar in intent. Both projects are designed to remove water from Devils Lake to reduce damages around the lake and to reduce the risk and possibly prevent a natural overflow. The State's outlet will be the primary focus of this report, and additional information on the project will be provided.

Economics

As stated above, since 1993 Devils Lake has risen nearly 25 feet. This has placed many homes, roads, and other structures in harms way. To combat the rising waters, roads are raised, homes are moved, and dikes are built, to protect the community and livelihood of the people in the Devils Lake region. All of this comes at a tremendous cost. It is estimated that since 1993, nearly $400 million has been spent to keep ahead of the rising lake level. If Devils Lake continues to rise to its natural spill elevation of 1459, it is estimated that an additional $900 million will be needed to raise roads and protect communities. This number does not include protecting communities downstream of Devils Lake. Based on the results from the stochastic

model, the water quality during a natural overflow would vary depending on events prior to and during the spills, with a median TDS of over 3,700 mg/l with maximums up to 6,800 mg/l, compared to a 480 mg/l average in the river, and median sulfate of nearly 1,900 mg/l with maximums near 3,400 mg/l, compared to a 100 mg/l average in the river and 450 mg/l standard for this Class 1A stream. Although a complete analysis of the downstream impacts from an uncontrolled overflow of that size and water quality has not been completed, surface water users, mainly in Valley City, could not tolerate that degree of water quality degradation. Severe water quality impacts would also be experienced by surface water users along the Red River of the North in North Dakota, Minnesota, and Canada. Also, severe erosion might occur because of increased flows in the Sheyenne and Red Rivers.

An outlet, if built and operated, reduces the chance of a natural overflow. This type of benefit could easily outweigh the cost of building and operating an outlet project. Under a wet scenario, if a State 100-cfs outlet project were to operate for 10 years, it will remove approximately 171,000 acre-feet of water. At elevation 1447, that is approximately 17 inches off of Devils Lake. If the State's project has a cost estimate of $20-25 million, that would be enough of a reduction to pay for the project.

Operating Plan

The State of North Dakota's Outlet Project would operate from for seven months (May-November), depending on the water quality of West Bay and the Sheyenne River, and the volume of the base flow in the Sheyenne River. The project will discharge a maximum of 100 cfs, but it is constrained not to exceed the Sheyenne River channel capacity of 600 cfs. Gaging stations that measure streamflow will be constructed upstream and downstream of the insertion point on the Sheyenne River in order to provide continuous monitoring necessary to control discharges. There will also be specific conductance meters located upstream and downstream of the insertion point as well as several other locations along the Sheyenne and Red Rivers to monitor the sulfate level in the water. It is proposed that the sulfate level in the Sheyenne River be constrained to 300 mg/L at the insertion point. The monitoring will be conducted to ensure this constraint is met as well as to gather more information to determine if the constraint should be modified to more closely meet the water quality standards and objectives on the Sheyenne and Red Rivers. The Devils Lake minimum operating level for this project is elevation 1445 ft-msl.

Reduction in Scale

The State Water Commission is moving forward with a 100-cfs outlet out of West Bay. The outlet project is being designed with the possibility of expanding to 200 or 300-cfs. This will only be necessary if Devils Lake remains in a wet cycle, and the Corps is no longer pursuing their project. The purpose behind the 100-cfs outlet project is to remove as much water as soon as possible out of West Bay and still meet downstream water quality standards set by the Health Department. Assuming the wet cycle continues until 2014, a 100-cfs outlet from West Bay

would remove on average 17,123 ac-ft per year. Table 1 is provided below that shows other scenarios and their corresponding volumes. The additional scenarios are Moderate Trace 1455 (MT55) under which the lake would peak at 1455 feet msl without an outlet, and Moderate Trace 1450 (MT50) under which the lake would peak at 1450 feet msl without an outlet. If Devils Lake continues to rise and the water quality in the lake improves, the State's project could be expanded, in order to remove additional water. The State is looking at potential operation to begin in the spring of 2004.

	WET	MT55	MT50	AVERAGE
	TOTALS FOR YEAR	TOTALS FOR YEAR	TOTALS FOR YEAR	TOTALS FOR YEAR
YEAR	SWC100	SWC100	SWC100	SWC100
2005	12,993	4,249	5,163	7,468
2006	8,811	21,223	9,090	13,041
2007	26,174	8,374	5,349	13,299
2008	13,816	4,880	2,204	6,967
2009	20,095	6,380	5,777	10,751
2010	16,016	2,408	3,123	7,182
2011	17,085	2,505	1,630	7,073
2012	18,530	14,332	2,956	11,939
2013	10,667	6,135	3,903	6,901
2014	27,047	17,270	9,699	18,005
TOTALS	171,234	87,754	48,893	102,627
AVERAGE	***17,123***	***8,775***	***4,889***	***10,263***
	NOTE: ALL VALUES ARE ACRE FEET			

The outlet will be operated to meet a sulfate limit on the Sheyenne River that will be specified by the ND Health Department. Considerable analysis has been done to determine what that constraint may be. Graph 1, developed by the Corps, depicts the three scenarios and their peak elevation reduction as a function of the sulfate constraint at the insertion point. Below a constraint of approximately 300 mg/L the effectiveness of the outlet begins to diminish rapidly. It should also be noted that the Corps modeling indicates a 300 mg/L sulfate constraint causes only slight increases in the frequency of exceedances of the Red River water quality standards and objectives. These model results are attached. The 300 mg/L sulfate at the insertion point is the current constraint that the Corps and State are basing their water quality analysis on. This is considerably lower than the 450 mg/L sulfate standard that is enforced by the Health Department on the Sheyenne River.

Basin Water Management (Water Recycle or Reuse)

Unlike an industrial facility there is little opportunity to recycle or reuse the quantities of water that are involved in the Devils Lake basin. However, several efforts are in place or are being investigated to better manage the water in the basin. These efforts may reduce the quantity of water that will be ultimately discharged by an outlet, but will not by themselves eliminate the need for an outlet.

Basin water management is part of the three pronged approach. Water is managed in the basin to find a balance between agriculture and mother nature. Numerous programs are currently storing water in the upper basin as mentioned above. Also, the possibility of utilizing the water in the upper basin for the irrigation of crops is currently being investigated. Both of these management tools may reduce the volume of water that ends up in Devils Lake.

Another example is the Jerusalem Channel clean out work. Six inches of built up sediments/debris along the divide between Devils Lake and Stump Lake was removed to reestablish the divide elevation to an elevation that it was at the time of statehood. This has allowed for easier water movement between the two lakes, which has also accelerated the freshening process of Devils Lake.

Another project that was designed, but never constructed, was the Stump Lake project. This

project would have moved water from East Devils Lake through the Jerusalem Channel to Stump Lake. This would have benefitted the City of Devils Lake as well as residents living around Devils Lake by utilizing the storage in Stump Lake sooner. There is approximately 400,000 ac-ft of storage currently available in Stump Lake. This equates to just over three feet off of Devils Lake. After Stump Lake fills to the elevation of Devils Lake, the two lakes would continue to fill until both lakes spilled into the Tolna Coulee, which empties in to the Sheyenne River. The concerns with this include a National Wildlife Refuge located in Stump Lake, and the water quality issues.

Alternative or Advanced Treatment

Because Devils Lake is a closed basin until it reaches an elevation of 1459 ft-msl, the dissolved solids which naturally occur in the runoff water are concentrated. As a result the TDS levels in Devils Lake are higher that those in the Sheyenne River even though the water entering Devils Lake has similar levels. Because the majority of the water enters the west end of the lake the TDS levels increase in each bay traveling from west to east. If the dissolved solids could be removed from Devils Lake water prior to being discharged to the Sheyenne River, more water could be removed from Devils Lake with a smaller water quality impact on the receiving waters.

Several technologies have been reviewed to treat the outlet water before discharging to the Sheyenne or Red Rivers. One proposal was from A Creative Research & Testing Co., Inc. The contact person from the company was Dr. James Hunt. He claimed his company could design and build a water treatment facility that could decrease the amount of salts in Devils Lake water. His technology included a vacuum-microwave system to remove the dissolved/suspended solids. After several meetings and numerous letters, it was decided that this technology was no longer worth pursuing. Dr. Hunt was reluctant to offer the necessary information including power requirements, percent TDS removal, and construction costs.

Another process that was investigated was electro-coagulation. The company proposing this technology was Ecoloquip. Their process adds small amounts of electricity to a series of metal plates contained inside a cylindrical treatment cell. The plates place an electric charge into the water as it passes through the cell. The electric charge destabilizes the water/dissolved/suspended solids and causes coagulation of the dissolved and suspended solids. Ecoloquip claimed a 95% removal rate of the dissolved solids. Several samples of water taken from the various bays of Devils Lake were run through their system. The results were only a 20% removal rate, which is far below the 95% that they claimed. It was decided that this technology may work, but it could not remove enough salts to justify the cost.

Reverse-osmosis, (R/O) treatment was another process that was researched to treat Devils Lake water. This is a proven technology that is used widely in water treatment processing plants around the world. It was determined that the scale of project necessary for a Devils Lake outlet has never been tested, but it would take nearly all of the membranes that are currently in use in the United States to make it work. The primary drawback of the technology is the overall cost. A 300-cfs treatment plant would cost nearly $80 million to construct and approximately $10

million a year to operate. Another problem with the R/O plant is the disposal of the concentrated effluent. An R/O treatment plant located on East Devils Lake operating at 300-cfs, would generate approximately 5,000 tons of salt per day.

Another process was the freeze-thaw method that was tested by the University of North Dakota's Energy and Environmental Research Center. It works by spraying brackish water onto a freezing pad to create an ice pile. During sub-freezing conditions, runoff from the ice pile will have elevated concentrations of solids compared to the feed water. This runoff water can be diverted to a brine storage facility or back to the feed water for recycle. When temperatures promote thawing, the runoff from the freezing pad can be used for beneficial uses or surface discharge. The EERC conducted a test project using Devils Lake water. The conclusions were similar to the previously mentioned ideas. The volumes that are necessary to be effective for an outlet are too expensive to treat and the disposal of the salts would become a major issue.

Many technologies have been looked at and most of them will work for small scale projects, but a Devils Lake outlet project is not on that small scale. In order to be a beneficial project, a large volume of water has to be removed, at a reasonable cost, every year that the project is needed.

Seasonal or Controlled Discharge Options

The proposed operating plan includes seasonal discharges with a seven month operating season. It is proposed that the outlet will be operated for seven months, May-November to insure the best water quality would be released into the Sheyenne River. The seven month operation would avoid the winter months when the TDS in Devils Lake is at its peak and the flows in the Sheyenne are at its minimums.

The State Water Commission will also monitor the operations in the future and make necessary changes wherever applicable. Monitoring gauges will be placed upstream and downstream of the insertion point to insure necessary precautions are being taken so that the sulfate constraint is not exceeded. As this project is operated, data will be collected that will improve operations in the future.

Finally, another option is weather forecasting. As the weather forecasting technology improves, operators could look at six or twelve month forecasts and determine what present and future discharges should be. This will be monitored and adjusted as more information is gathered.

Alternative Discharge Locations

Many alternative outlet discharge locations have been considered. Discharge locations can be broken down into three different categories, the Sheyenne River, Red River, and James River. The first one is the current preferred location. Several alternatives for discharging water into the Sheyenne River have been investigated. Besides the Peterson Coulee area, which includes the

State of ND's project and the Corps Pelican Lake project, there was the Twin Lake Project. This option would bring water out of the southern portion of West Bay through several lakes before emptying into the Sheyenne River just east of the town of Sheyenne. This option was rejected due to conflicts with tribal land and wildlife easements.

The other options discharging to the Sheyenne River are the East Devils Lake, and Stump Lake outlet projects. These would be the least costly alternatives, but the water in East Devils Lake contains five times more TDS than West Bay or Pelican Lake. Water could be routed directly from East Devils Lake through the Black Slough area and to the Tolna Coulee, which then empties into the Sheyenne River. This is one of the two natural outlet routes. The current divide for this natural outlet is near 1463 ft-msl. A channel could also be constructed from Stump Lake to the Tolna Coulee. This is the other natural outlet route, the current divide elevation for this natural outlet is approximately 1459 ft-msl.

Besides the Sheyenne River, outlet projects that move water directly from Devils Lake to the Red River, bypassing the Sheyenne River altogether, were considered. These projects would use the Goose or Forest River located just across the eastern boundary of the Devils Lake Basin, to move water from Devils Lake to the Red River. The Corps investigated each of these options, and concluded that the water quality issues would not allow for a beneficial volume of water to be removed from Devils Lake for the cost of constructing and operating the project. With these outlet projects, water would be removed from East Devils Lake or East Bay, and the water quality of these bays is too poor.

The last alternative discharge location is the James River. Garrison Diversion facilities could be used to move water from Devils Lake to the James River, and ultimately the Missouri River. This would require construction of a canal from Devils Lake to the New Rockford Canal, and then a feeder canal from the New Rockford Canal to the James River. Moving water over or under the Sheyenne River, downstream mitigation including numerous National Wildlife Refuges, and overall construction costs, combine to make this discharge location undesirable. The estimated project costs are nearly $150 million. The lone positive aspect is the removal of impacts to Canada and Minnesota.

This report does not list all of the alternatives that have been considered by Federal and State agencies. Only brief descriptions of the few that warranted documentation are included. However, additional information on numerous alternatives can be viewed in the State Water Commission's May-1999 report titled, "Devils Lake Emergency Response Alternatives", and the Corps of Engineers, "Devils Lake Integrated Planning Report and Environmental Impact Statement, Volume 1". Copies can be provided if requested.