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Technical Memorandum

To: Golden Valley County Water Resource Board
From: Matt Peterson, PE and Ron Koth
Subject: Sediment Removal in the Odland Dam Reservoir
Date: February 8, 2018
Project: 34171001.00

This memorandum provides high-level descriptions and costs for two options to remove accumulated sediment in the Odland Dam reservoir: mechanical excavation and hydraulic dredging.

Background and Introduction

Sediment and organic material have accumulated in the Odland Dam since its construction in 1936. Over the years, there have been ongoing discussions about possibilities of removing sediment or raising the dam to provide a deeper reservoir. Motivations for sediment removal include improved recreation, fish habitat, and water quality.

In April 1987, the North Dakota State Water Commission (NDSWC) issued a Preliminary Engineering Report, which presented four alternatives for excavating the accumulated sediment from the reservoir. All of the alternatives assumed the dam would be breached, the reservoir drained, and the sediment would be excavated in dry conditions. The alternatives assumed sediment would be excavated from portions of the reservoir such that any area with water depths greater than four feet deep would be at least eight feet deep following excavation. . Each alternative considered excavation in different portions of the reservoir. Volumes of removed sediment ranged from 18,000 cubic yards to 124,900 cubic yards, and costs ranged from $46,000 to $203,500 (1987 dollars).

The North Dakota Game and Fish Department (NDGF) conducted a bathymetric survey of the Odland Dam reservoir in 2003. Results of the survey are shown in attached **Figure 1**. This is the most recent bathymetric survey data we are aware of, and it is likely that additional sediment has accumulated in the reservoir in the 15 years since this survey. However, the rate of sedimentation in recent years (2009-current vs mid-1990's) is presumed to have decreased due to changes in watershed management, as evidenced by a downward trend of nitrogen and phosphorus concentrations in reservoir water (Wax and Ell 2011).

Both options evaluated in this memorandum assume 27,000 cubic yards of sediment would be removed from the reservoir. We assumed sediment would be removed from portions of reservoir shown as greater than 12 feet deep in **Figure 1**. The sediment removal concentrates on making the deepest parts of the reservoir deeper, which provides the greatest benefit to fish habitat by providing deeper portions of the reservoir to reduce the potential for winterkill, especially during years when the reservoir freezes with lowered water surface elevations due to precipitation patterns. We have assumed that two feet of sediment would be removed from portions of the reservoir currently 12-15 feet deep and four feet of sediment would be removed from areas currently greater than 15 feet deep. The assumed sediment removal extents are shown in attached **Figure 2**.

Alternatively, if the primary emphasis were to provide deeper water areas to support recreational boating and boat access, the sediment removal could be adjusted to create deeper water areas in the areas of the reservoir currently between 3 and 9 feet deep. Areas for sediment removal and associated quantities should be further refined as the project moves forward, balancing costs while meeting the project objectives.

Option 1 – Mechanical Excavation

Option 1 involves removing accumulated sediment with mechanical excavation in a drained reservoir. Because the sediment removal is planned for the deepest parts of the reservoir, the reservoir would need to be completely or nearly completely dewatered. The reservoir would need to be drained in a controlled manner over time to prevent flooding downstream of the dam and prevent bank caving upstream of the dam. This option and associated costs have been developed as an independent action from Alternative 2 for spillway replacement (Barr 2017). A complete reservoir drawdown is unnecessary to replace the existing spillway since the spillway sits on natural ground at a higher elevation than the reservoir bottom. Some overall cost savings would likely be achieved by doing both projects in concurrently due to economy of scale and shared costs for contractor mobilization.

The reservoir could be dewatered using a variety of methods, but for the basis of our cost estimate, we have assumed draining the reservoir would involve the following steps:

- Lower the water surface elevation in the reservoir as low as possible using pumps and/or siphons.
- Install a temporary cofferdam upstream of the portion of the embankment that will be breached.
- Breach the dam by excavating the portion of the embankment to be removed down to the base elevation of the reservoir.
- Install a temporary pipe at the bottom of the excavation. Equip the pipe with a gate or similar device to control the flow rate through the pipe.
- Backfill and compact the pipe and temporarily restore the embankment.
- Excavate drainage channels upstream and downstream of the pipe.
- Remove the temporary cofferdam and allow flow to pass through the pipe. Control flow rates using the gate to lower the reservoir elevation in a controlled fashion.

After the reservoir is mostly dewatered, the sediment would be removed using excavators and front-end loaders. Some water control during excavation of the material would likely be necessary, as it is unlikely the reservoir would be completely drained due to localized low spots, and there would still be inflow into the reservoir. Performing the work in winter and/or allowing the sediment to dewater for a lengthened amount of time are options to minimize the amount of water control necessary. The temporary pipe would continue to pass flows through the dam during construction.

The excavated material would be placed into off-road haul trucks and hauled to a nearby disposal site. The material would be graded out and seeded to restore the disposal site.

Following excavation of the sediment, the temporary pipe passing through the embankment would be removed, and the embankment would be restored. The natural inflows to the reservoir would refill the reservoir over time.

Draining the reservoir is a significant downside of mechanical excavation, as most fish and other aquatic biota will be killed. Reservoir drawdown should ideally be scheduled immediately following a naturally occurring winterkill to avoid disruption of viable recreational fishing opportunity. Coordination with NDGF will be important to reduce adverse impacts on recreational fishing and to plan for re-stocking following sediment removal. There is also risk involved with breaching the embankment – if not executed carefully, it could lead to an uncontrolled release of the remaining water in the reservoir.

Option 2 – Hydraulic Dredging

The second option considered is removal of the accumulated sediment via hydraulic dredging using a barge. The reservoir would not be dewatered for hydraulic dredging. Hydraulic dredging includes the use of pumps and piping for removing (pumping) a mixture of dredged material and water from the reservoir bottom. A typical pipeline hydraulic dredge sucks the mixture (slurry) of sediment and water through one end and pumps the material through the discharge pipeline (approximately 8 to 12 inch diameter) directly to a sediment dewatering area. A mechanical cutting head, consisting of rotating blades, is often included at the intake pipe to agitate and loosen bottom sediments so they can be pumped through the dredge pipeline system. Hydraulic dredging typically requires a larger dewatering area than mechanical excavation because of the significant volume of water that must be managed. Typically, hydraulically dredged material consists of a sediment/water slurry that ranges from 5% to 20% solids (by volume).

We have assumed that the slurry would be pumped directly to its disposal site in the immediate vicinity of the reservoir. Ring dykes would be constructed in the disposal site to create a dewatering area. The water in the sediment slurry would be allowed to drain out by gravity over time. The amount of dewatering time varies depending on the makeup of the sediment – sands and gravels dewater more quickly than silts and clays. Alternatively, other dewatering methods could be used, such as pumping the material into geotextile dewatering bags or using a dewatering polymer, but these options would likely be more expensive than the gravity draining method described above. After the material has dewatered, material would be graded out and seeded to restore the disposal site.

The major benefit of hydraulic dredging over mechanical excavation is that the reservoir would not need to be drained. Locally generated turbidity from dredging activities would not likely be detrimental to fisheries.

Key Assumptions

The following key assumptions have been made in preparation of this memorandum and the associated cost estimates:

- We have assumed the sediment in the reservoir is not contaminated. We have no reason to believe the sediment is contaminated, however, this assumption should be confirmed through testing of the sediment if the project is pursued. If the sediment is contaminated, the cost to remove and dispose of the sediment would increase.
- We have assumed that the removed sediment could be placed in an upland area adjacent to the reservoir. Specific disposal sites have not been identified. Costs associated with obtaining land for the sediment disposal have not been included.

Costs

Cost estimates by task for the two options are included in the attached cost estimate tables. The concept level five percent design mid-range cost estimates are $492,000 for mechanical excavation and $805,000 for hydraulic dredging including a ten percent construction contingency, engineering, and permitting.

Conclusions and Next Steps

Hydraulic dredging is a more expensive option for removal of sediment in the Odland Dam Reservoir than mechanical excavation; however, a significant advantage to hydraulic dredging is that the reservoir would not need to be drained to remove the sediment. Costs presented in this memorandum depend heavily on the volume of sediment assumed to be removed. Sediment removal quantities should be further refined as the project moves forward, balancing costs while meeting the project objectives.

If the sediment removal project is pursued, updated bathymetric mapping of the reservoir bottom should be performed and sediment core samples should be obtained. Updated reservoir bathymetry will allow scheduling of sediment removal to derive the most project benefits and future use priorities as identified by reservoir users. The sediment samples should be tested both for contaminants and for physical characteristics, including particle size distribution and soil classification. Coordination with permitting and funding agencies/partners is also a key next step.

References

1. North Dakota State Water Commission, 1987. Preliminary Engineering Report - Odland Dam Restoration, Golden Valley Co., North Dakota, April 1987.
2. Wax, Peter N. and Michael J. Ell, 2011. 2008-2011 North Dakota Lake Water Quality Assessment Reports, Division of Water Quality, North Dakota Department of Health, June 2011.

3. Barr Engineering, 2017. Odland Dam Spillway Repair/Replacement Evaluation, November 2017.

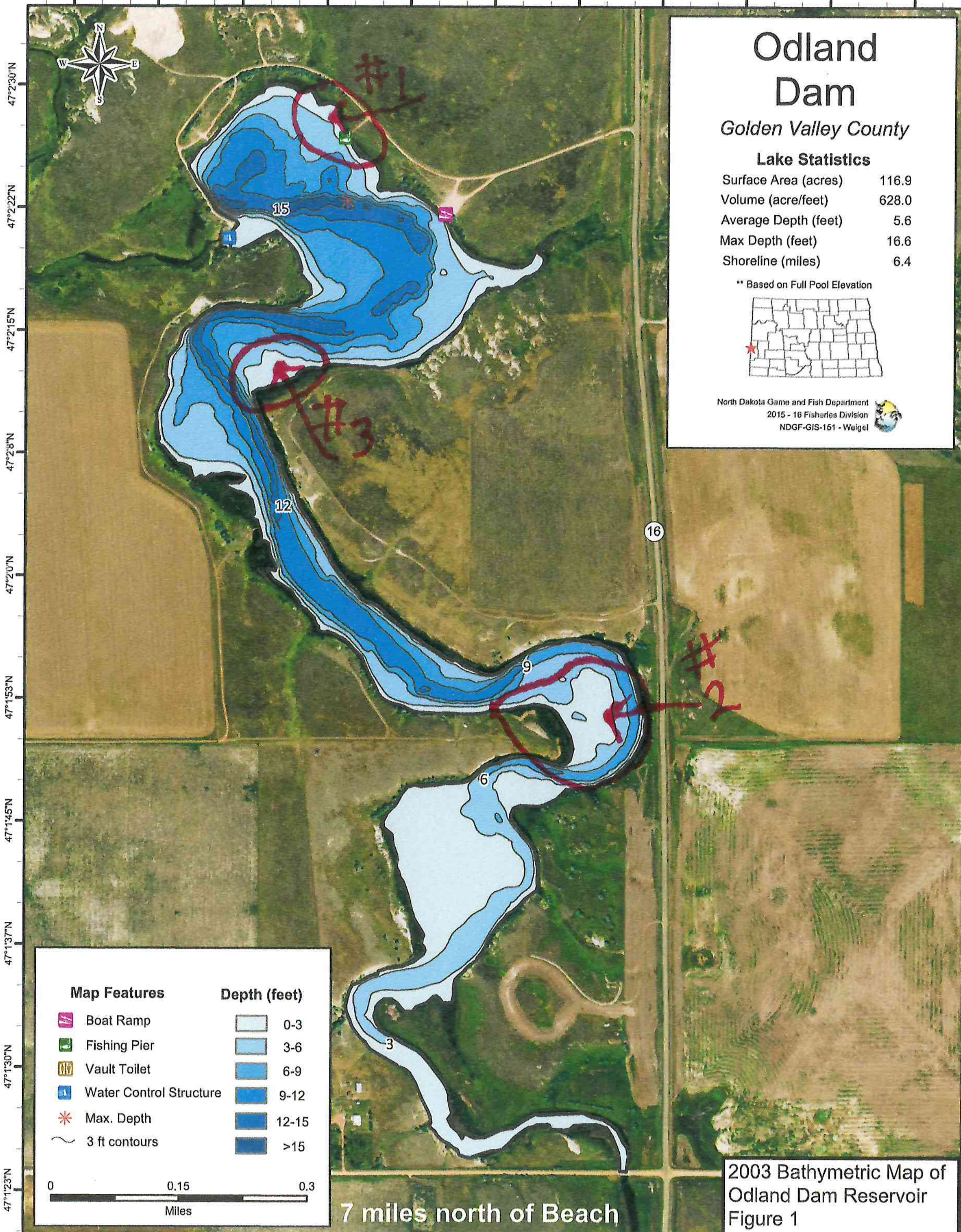
Attachments

- Figure 1 – 2003 Bathymetric Map of Odland Dam Reservoir by North Dakota Game and Fish Department
- Figure 2 – Assumed Sediment Removal Extents
- Cost Estimate Table: Option 1 – Mechanical Excavation
- Cost Estimate Table: Option 2 – Hydraulic Dredging

ODLAND DAM
ASSUMED SEDIMENT
REMOVAL EXTENTS
Golden Valley, ND

FIGURE 2

Barr Footer: ArcGIS 10.4.1, 2018-01-30 13:17 File: I:\Projects\34\17\1001\Maps\Reports\Figure 2 - Odland Dam Assumed Sediment Removal Extents.mxd User: rcs2



2003 Bathymetric Map of
Odland Dam Reservoir
Figure 1

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Option 1 - Mechanical Excavation

Concept Design Level

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: Odland Dam Spillway Repair/Replacement Evaluation

LOCATION: Golden Valley County, North Dakota

PROJECT #: 34171001.00

February 2018

ESTIMATED COSTS

Item No:	Item Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization	1	LS	$40,000	$40,000
2	Breach embankment and install temporary dewatering pipe and gate	1	LS	$35,000	$35,000
3	Water Control During Excavation	1	LS	$15,000	$15,000
4	Mechanical Excavation	27,000	CY	$9	$243,000
5	Temporary Erosion Control at Disposal Site	1	LS	$5,000	$5,000
6	Disposal Site Restoration	1	LS	$15,000	$15,000
7	Remove temporary dewatering pipe and restore embankment	1	LS	$20,000	$20,000
	Construction Cost Subtotal				$373,000
	10% Construction Cost Contingency				$37,000
	Engineering and Permitting (assumed 20% of construction cost)				$82,000
	TOTAL PROJECT COST (Mid Range Estimate)				$492,000
	Low Range Estimate (-25%)				$370,000
	High Range Estimate (+50%)				$740,000

Notes:

[1] Limited Design Work Completed (5% concept level).

[2] This concept-level (Class 4, 5% design completion per ASTM E 2516-11) cost estimate is based on concept-level designs, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of the completion of design, but are not included at this level of project definition. The estimated accuracy range for the Total Project Cost as the project is defined is -25% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance and Construction Administration costs are not included.

[3] Engineering and Permitting are assumed to be 20% of the combined sum of the Construction Cost Subtotal and Construction Cost Contingency.

[4] Cost estimate assumes sediment is not contaminated and can be disposed of in an upland area adjacent to reservoir.

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Option 2 - Hydraulic Dredging

Concept Design Level

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: Odland Dam Spillway Repair/Replacement Evaluation

LOCATION: Golden Valley County, North Dakota

PROJECT #: 34171001.00

February 2018

ESTIMATED COSTS

Item No:	Item Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization - Dredge	1	LS	$100,000	$100,000
2	Hydraulic Dredging	27,000	CY	$15	$405,000
3	Construct Dewatering Berms at Disposal Site	1	LS	$75,000	$75,000
4	Disposal Site Restoration	1	LS	$30,000	$30,000
	Construction Cost Subtotal				$610,000
	10% Construction Cost Contingency				$61,000
	Engineering and Permitting (assumed 20% of construction cost)				$134,000
	TOTAL PROJECT COST (Mid Range Estimate)				$805,000
	Low Range Estimate (-25%)				$600,000
	High Range Estimate (+50%)				$1,210,000

Notes:

[1] Limited Design Work Completed (5% concept level).

[2] This concept-level (Class 4, 5% design completion per ASTM E 2516-11) cost estimate is based on concept-level designs, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. Contingency is an allowance for the net sum of costs that will be in the Final Total Project Cost at the time of the completion of design, but are not included at this level of project definition. The estimated accuracy range for the Total Project Cost as the project is defined is -25% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance and Construction Administration costs are not included.

[3] Engineering and Permitting are assumed to be 20% of the combined sum of the Construction Cost Subtotal and Construction Cost Contingency.

[4] Cost estimate assumes sediment is not contaminated and can be disposed of in an upland area adjacent to reservoir.

Updated #'s 12/2/21

1 $50,000.00 MOBILIZATION
2 $40,000.00 BREACH EMBANKMENT & INSTALL DEWATERING ~~[illegible]~~ PIPE & GATE
3 $20,000.00 WATER CONTROL DURING EXCAVATION
4 $810,000.00 MECHANICAL EXCAVATION 81,000 YDS @ 10.00/YD
5 $6,000.00 TEMPORARY EROSION CONTROL AT DISP. SITE
6 $20,000.00 DISPOSAL SITE RESTORATION
7 $25,000.00 REMOVE TEMPORARY DEWATERING PIPE & RESTORE EMBANKMENT

$971,000.00 CONSTRUCTION COST SUBTOTAL
97,100.00 10% CONSTRUCTION COST CONTINGENCY
213,620.00 ENGINEERING & PERMITTING 20%

1281720.00

APPROX $15,000.00 — THERE IS THE POSSIBILITY OF A FUEL SURCHARGE BECAUSE OF RISEING FUEL PRICE AND WILL BE SOME MINIMAL ROAD RESTORATION WHEN PROJECT IS COMPLETED

$1,296,720.00