Lake Barney Stormwater & Flood Mitigation – Final Report

Presentation to Fitchburg Committee of the Whole

March 24, 2021

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Presentation Outline

1. Project Review
   - Background and Goals
   - Hydrology analysis and conclusions
   - Conceptual designs
2. Cost-Benefit Analysis
   - Project benefits
   - Project costs
   - CBA results
3. Conclusions and Recommendations
4. Next Steps

Project Review

Area History

Lake Barney is part of a group of glacial kettles (including Swan Pond) and does not have a surface water outflow under “normal” conditions.

Location

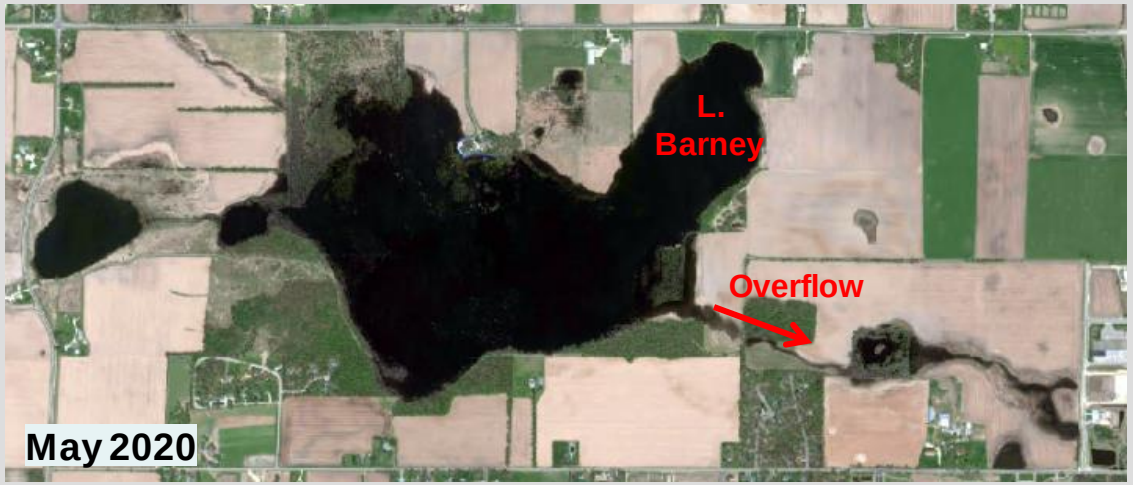
Typically ~42 acres

Recent Conditions

Lake Barney's elevation has typically ranged from 942' to 945', covering ~40-60 acres.

Starting in early 2018, the combination of high annual precipitation, several large runoff-producing storms, and rising groundwater caused the lake to grow to over 300 acres, joining with several wetlands to the west. The lake reached a peak stage of approximately 949' in September 2018 and overflowed continuously from then to July 2020.

Typical conditions, 2017



May 2020

Recent Impacts

Surface water impacts surrounding lake

Groundwater impacts

Downstream surface water impacts

Project Goal

The goal of this project is to determine what can be done to improve the negative impacts that have been seen surrounding Lake Barney.

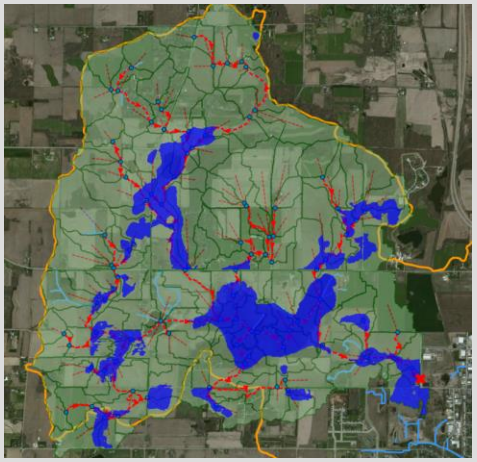
Key Project Outcomes

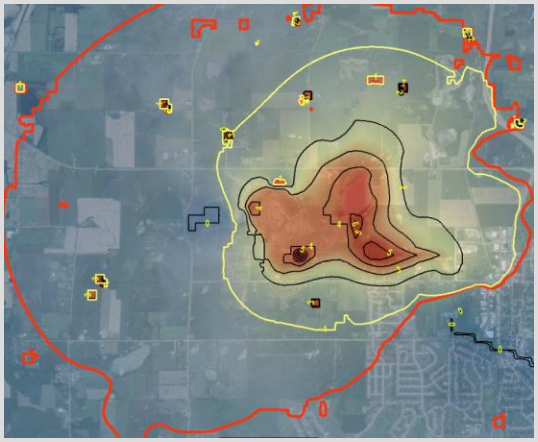
- Conceptual designs of flooding mitigation alternatives
- Estimate “time-to-drain” for alternatives
- Cost-benefit analysis

Hydrology Analysis (Groundwater and Surface Water)

Hydrology methods

- Field data collection (monitoring wells, flow measurements, lake levels)
- Dane County Groundwater model
- Hydrology model
- Proposed outlet models (hydraulics)





Hydrology conclusions

- Recent water levels are unprecedented. We estimate it could take 5 – 10 years to drop down to 942 ft under normal climate conditions, or longer if recent precipitation patterns continue.

- This long timeline is due mostly to the slow nature of groundwater movement. Until the water table drops across the area, the lake will continue to drain slowly and will be susceptible to being filled again during heavy rain events.

Hydrology conclusions (cont.)

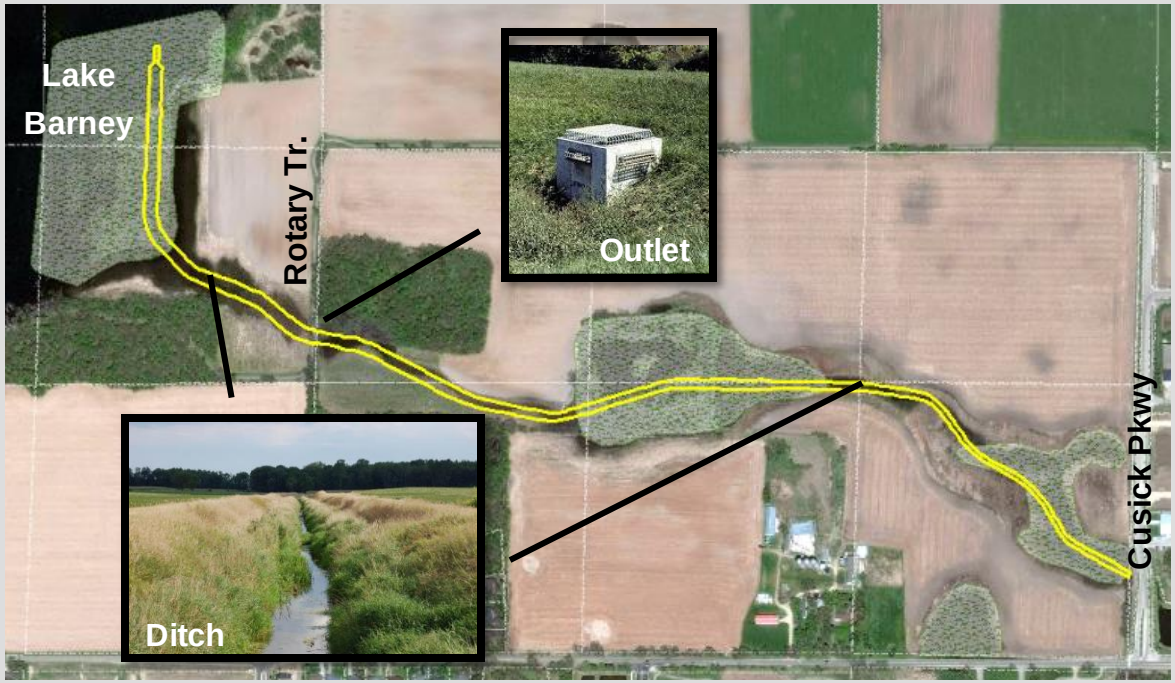
- Installing an outlet would lower the lake level rapidly, but surrounding groundwater would still fall relatively slowly.

- Downstream flood risk increases suddenly when the lake is at 945 ft or higher, as the lake and wetlands no longer have enough storage to prevent the lake from overflowing during large rains.

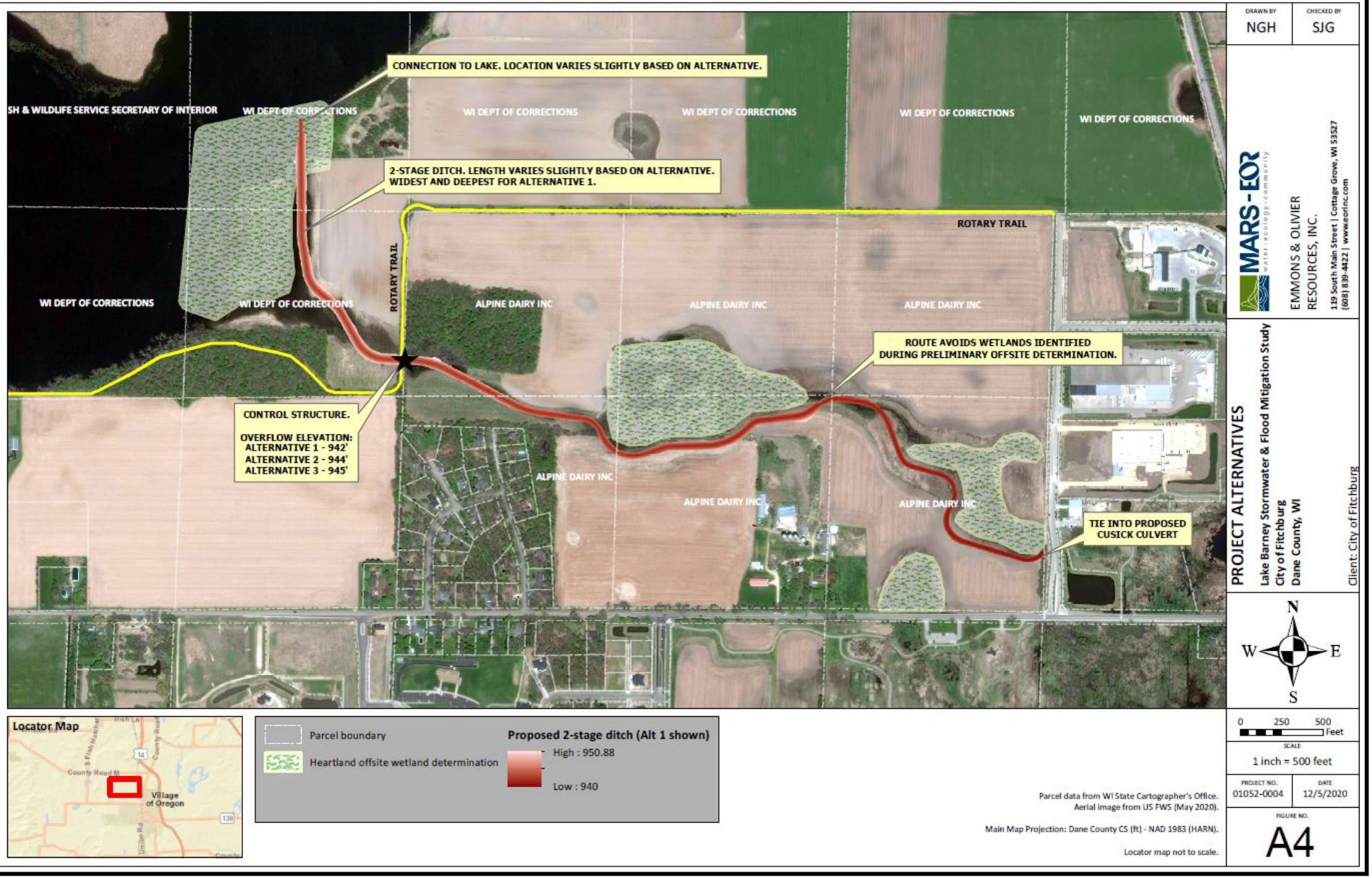
Concept Solutions

Concept designs

We looked at three lake level control options, which each included an outlet structure and drainage ditch / greenway from Lake Barney to the Village of Oregon. The options differ in the target lake stage. Based on the results of hydrology analysis, we looked at overflow elevations of **942** ft, **944** ft, and **945** ft.



Concept designs



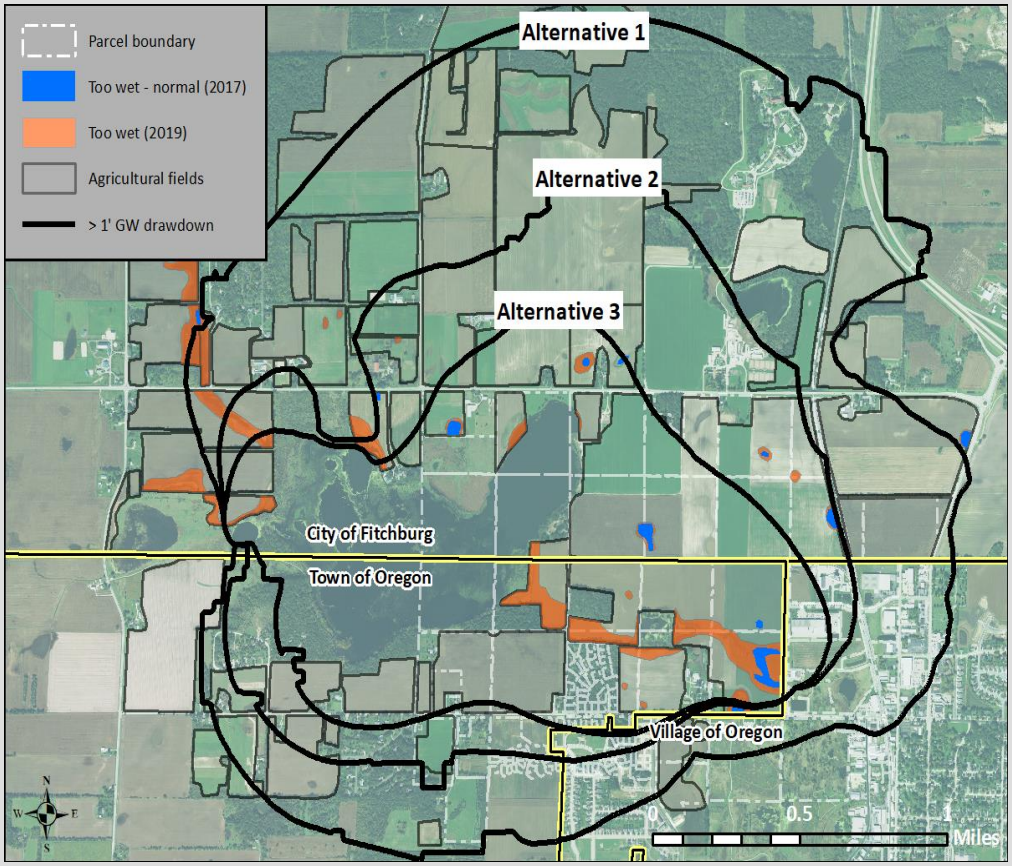
Design conclusions – downstream impacts

For any alternative, the outlet control structure can be configured such that the draft peak flow rates acceptable to the Village of Oregon can be met for storms up to the 100-yr design storm. This assumes that their proposed stormwater conveyance improvements proceed, which is not guaranteed given initial agency denial to establishing drainageways through Lerner Park.

For larger (>100-yr) storms, Alternative 1 demonstrates a clearer flood control benefit than the other alternatives.

Design conclusions – groundwater control

Artificially lowering the lake with an outlet would limit nearby water table from rising during wet periods, such as the present. The extent of the area where groundwater would be lowered by 1 ft or more is predicted by the groundwater model to range from about 1000 acres for a lake outlet at 945 ft to about 3000 acres for a lake outlet at 942 ft.



The areas that would be helped by this groundwater control are much smaller though. This would primarily impact the areas shown in orange, which were dry enough to farm in typical years but were too wet to farm in 2019.

Design conclusions - drawdown

Following construction of an outlet, drawdown of Lake Barney would happen fairly quickly. The estimated time to drain the lake from its current state (947 ft) to the target elevations ranges from 49 to 87 days, compared to 5-10 years with no outlet.

Table 10. Post-construction draw-down time.

Alternative	Approximate drawdown time to control structure elevation*	Mean flow rate during drawdown	Time for lake levels to fall from control structure elevation to 942 ft**
1 (942')	87 days to reach 942 ft	7.1 cfs	0 years
2 (944')	57 days to reach 944 ft	5.2 cfs	2 – 4 years
3 (945')	49 days to reach 945 ft	4.7 cfs	3 – 6 years
No Outlet	Not Applicable	Not Applicable	5 – 10 years

** - Assumes no major rainfall during draw-down, high starting water table, and starting water elevations ranging from 949' (Swan Pond) to 947.3' (Lake Barney).*

*** – Assumes relatively normal or below-normal precipitation patterns and groundwater levels over the time span.*

Design conclusions – construction effort

Of the three proposed solutions there is a considerable amount more earthwork associated with the lowest overflow elevation (Alternative 1 – 942 ft) versus the other options.

Since the earthwork costs are estimated to be the largest portion of the construction cost for any alternative, this leads to Alternative 1 being a much more expensive project.

Table 6. Ditch geometry and earthwork for each alternative.

Alternative	Starting elevation (ft)	Ending elevation (ft)	Length (ft)	Ditch depth (ft)	Average slope	Excavation required (cubic yards)
1	942	940	6,520	3-6	0.04%	30,050
2	944	940	6,300	2.5-4	0.08%	16,200
3	945	940	6,275	2-3	0.10%	10,850

Cost-Benefit Analysis

Benefits to the City

We calculated residents' potential losses due to high lake levels, and then considered the City's benefit to be the avoidance of these losses. For each alternative, there were 2 types of losses considered:

1. Short term agricultural losses (loss of crops and/or loss of rental income)

2. Long-term property devaluation

Benefits to the City - Assumptions

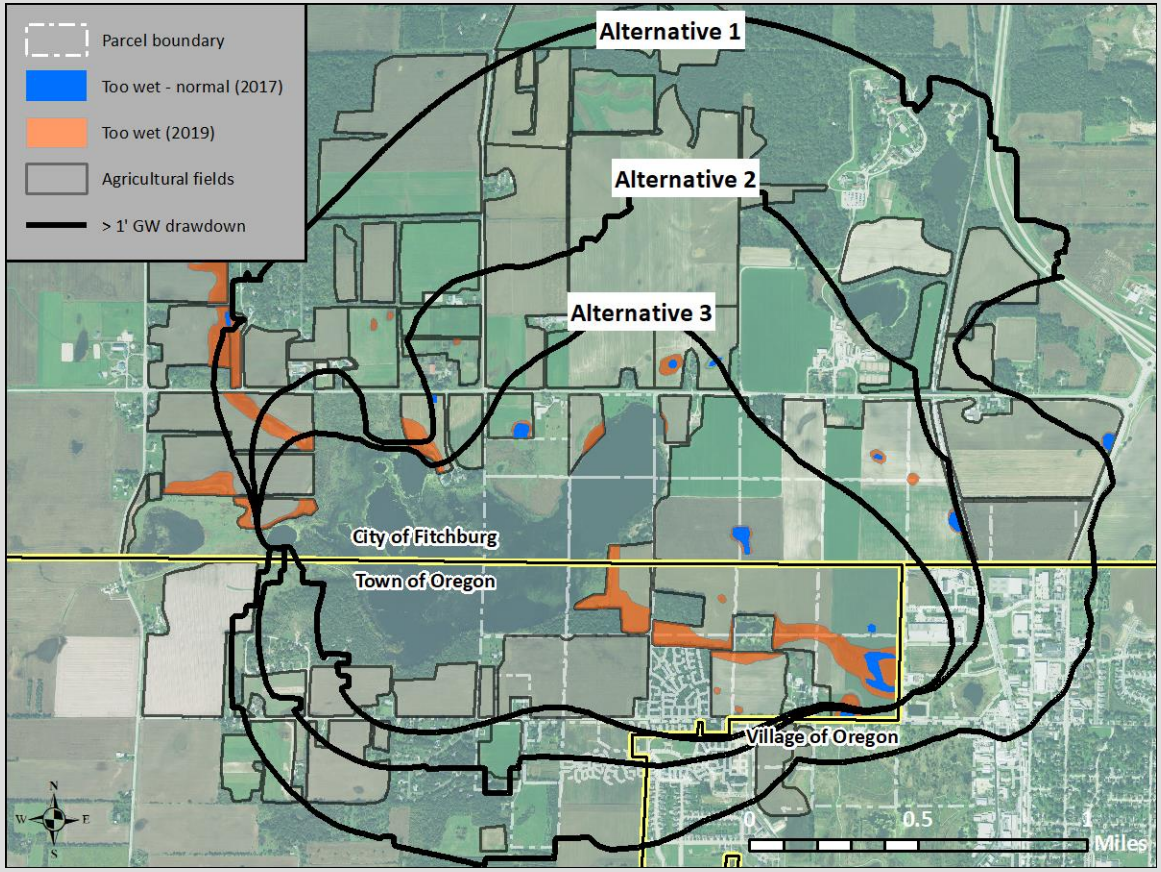
Benefit assumptions:

For the short-term benefits, we are assessing the maximum benefit of an outlet in a very wet year. There would be dry and normal years where the outlet would provide no short-term benefit to landowners.

For the long-term property devaluation, we are assuming that high water conditions seen in 2008 to 2010 and 2018 to the present are likely to occur again, frequently enough that the properties are no longer reliably farmable.

Short-term benefit calculation

1. Determined areas where each outlet would lower surface water and groundwater by at least 1 ft. The lowest alternative (942') "protects" 3x as much land (~3,000 acres) as the 945' alternative.



Short-term benefit calculation

2. Determine the potential revenue lost from farming that acreage of land in one year.

The short-term benefit ranges from $0/yr (in dry to normal years) up to the dollar values shown below.

Option (target)	Land returned to agricultural production during very wet years	Farmable land benefit within City of Fitchburg
1 (942')	71 acres	40 acres
2 (944')	59 acres	18 acres
3 (945')	50 acres	10 acres

Option (target)	Maximum annual benefit to City residents during very wet years
1 (942')	$8,000 - $28,000
2 (944')	$3,600 - $12,500
3 (945')	$2,000 - $7,000

Long-term property devaluation

The long-term property devaluation assumes that without an outlet, certain agricultural lands are no longer consistently farmable and permanently lose value (conversion to wetlands or recreational lands). This loss of value was calculated based on recent, comparable real estate sales.

It also considers that without an outlet, the Thayer residence will need to be further protected with a permanent berm and pump system. This “cost to cure” was assessed for the no outlet condition and for the alternatives, which require smaller protective features.

With no outlet, we estimate these costs to be:

- $185,000 of agricultural land devaluation
- $114,000 cost-to-cure Thayer residence

Long-term property devaluation

The benefit for each alternative is calculated by comparing losses with a particular outlet in place to those with no outlet in place.

The long-term benefit to City residents ranges from $63,500 for Alternative 3 to $180,000 for Alternative 1.

Potential City of Fitchburg resident losses avoided by implementing the Project	Alt. 1 (942 ft)	Alt 2 (944 ft)	Alt 3 (945 ft)
Agricultural land devaluation	$121,000	$59,500	$22,500
Thayer property cost-to-cure	$59,000	$41,000	$41,000
Total	*$180,000*	*$100,500*	*$63,500*

Project costs

Conceptual Cost Estimate
City of Fitchburg - Lake Barney Outlet
Alternative 2 (944')

Item	WisDOT Reference #	Unit	Quantity	Unit Cost	Total
Excavation Common	205.0100	CY	16,190.00	10.00	$ 161,900.00
Topsoil Strip, Stockpile, and Place	-	CY	16,450.00	10.00	$ 164,500.00
Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 24x38-Inch	522.23	LF	60.00	150.00	$ 9,000.00
Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 24x38-Inch	522.26	EACH	1.00	1,400.00	$ 1,400.00
Precast Outlet Structure w/ Weir Plate, Top Grate and Trash Rack	-	EACH	1.00	25,000.00	$ 25,000.00
Riprap Heavy	606.0300	CY	30.00	75.00	$ 2,250.00
Mobilization	619.1000	EACH	1.00	20,000.00	$ 20,000.00
Silt Fence	628.1504	LF	12,000.00	2.30	$ 27,600.00
Erosion Mat Urban Class I Type A	628.2006	SY	33,200.00	1.60	$ 53,120.00
Tracking Pads	628.7560	EACH	1.00	1,600.00	$ 1,600.00
Seeding Mixture No. 40	630.0140	LB	600.00	12.00	$ 7,200.00
Geotextile Type HR	645.0120	SY	50.00	5.00	$ 250.00
			Construction Totals	**Refined Total**	$ 473,820.00

CONSTRUCTION CONTINGENCY	**25%**	**$**	**118,455.00**
PLANNING AND ENGINEERING	**6%**	$	28,429.20
PERMITTING AND APPROVALS	**5%**	$	23,691.00
BIDDING AND CONSTRUCTION ADMIN	**3%**	$	14,214.60
PROFESSIONAL FEES TOTAL		**$**	**66,334.80**
TOTAL PROJECT COST		**$**	**658,609.80**
ESTIMATED ACCURACY RANGE* **	**-20%**	**$**	**526,887.84**
	30%	**$**	**856,192.74**

We developed conceptual cost estimates for each alternative based on anticipated items, estimated quantities and unit costs, and design services.

Project costs

Table 14. Estimated project costs.

Alternative	Earthwork	All other construction items	Construction contingency	Professional fees	**Total Project Cost** (nearest $5k)
1 (942')	$538,000	$163,000	$175,000	$98,000	**$975,000**
2 (944')	$326,000	$148,000	$118,000	$66,000	**$660,000**
3 (945')	$243,000	$141,000	$96,000	$54,000	**$535,000**

- Estimated costs ranged from $535,000 (Alt 3) to $975k (Alt 1).

- The construction cost is driven by earthwork – Alternative 1 requires a much deeper ditch because there would only be 2 feet of drop over the 6,500 ft ditch. The large volume of excavated spoils need to be worked into surrounding lands (with permission) or hauled off-site.

Project wetland mitigation

Table 15. Range of potential wetland mitigation costs.

Alternative	Minimal wetland impacts	Maximum wetland impacts	Assumed Credit ratio and applicable acreage	Potential Mitigation Costs
1 (942')	0.47 acres	8.5 acres	1.7: 1 (0.47 ac), 1.2:1 (8.04 ac)	$60,000 – $780,000
2 (944')	0.18 acres	6.9 acres	1.7: 1 (0.18 ac), 1.2:1 (6.67 ac)	$22,000 – $620,000
3 (945')	0.15 acres	6.1 acres	1.7: 1 (0.15 ac), 1.2:1 (5.96 ac)	$20,000 – $550,000

Wetland mitigation will almost certainly be required for any outlet alternative and has the potential to be very expensive. Impacts near Lake Barney are assumed, as that area has consistently been wetland. But the overflow route may or may not be wetland, depending on the DNR's opinion and weather and land use between now and when a formal wetland delineation would occur.

Unfortunately, without access to Alpine Dairy properties we were unable to observe current wetland characteristics along the overflow route and confirm our off-site wetland analysis. Therefore, the range of potential mitigation costs is very large.

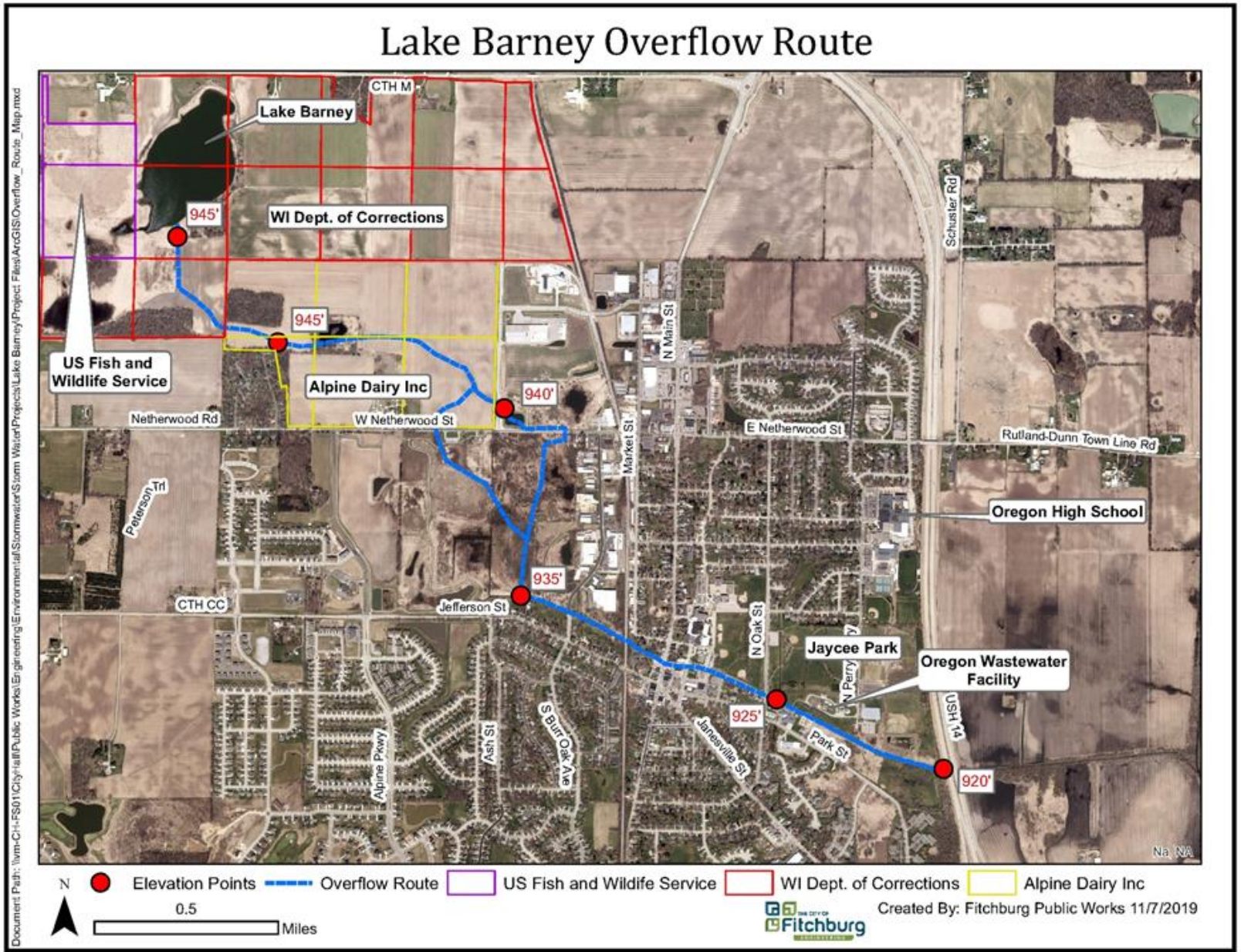
Easement requirements

A permanent easement would need to be obtained from the Department of Corrections and Alpine Dairy to construct the project. Easement costs are unknown at this time, although it's possible that costs could be less than a standard easement as the project would improve the reliability of agricultural lands surrounding the ditch.

Table 16. Easement acreage requirements.

Alternative	Easement required – Department of Corrections	Easement required – Alpine Dairy
1 (942')	2.9 acres	5.7 acres
2 (944')	2.1 acres	4.8 acres
3 (945')	1.8 acres	4.3 acres

Easement requirements



Long-term O&M

Long-term operations and maintenance are expected to include:

- Mowing twice per year
- Annual structure inspection and clean-out
- Ditch dredging every five years

These costs are assumed to be $3,500 per year for any of the alternatives.

20-yr CBA comparison

	Alternative 1 (942 ft)	Alternative 2 (944 ft)	Alternative 3 (945 ft)
Total benefits to City residents*	$360,000	$180,000	$110,000
Total Project Costs + O&M + 50% of max. wetland mitigation estimate	$1,436,000	$1,044,000	$880,000

- * Assumes short-term benefit in half of years and avoidance of property devaluation

Regardless of alternative, project costs are estimated to be much greater than calculated benefits to City residents. But the quantitative CBA analysis does not include other factors which the City may want to consider.

Other quantifiable benefits

There are potential project partners because of downstream benefits.

- Downstream flood reduction in the Village of Oregon. The project would ensure flood storage during very wet years.
- Reduced pumping costs for the Village of Oregon. If uncontrolled releases from Lake Barney are eliminated, the City could save $20,000 to $30,000 in annual operational costs for pumping excess water across Netherwood Drive during very wet years.
- Rotary Trail reconstruction costs. The Village of Oregon has preliminarily identified a cost of $367,000 to raise the trail 5 feet from its current elevation of ~947 ft to 952 ft as a means of avoiding future damages and loss of use.
- The ditch through DOC and Alpine Dairy properties would increase reliability of farming and provide the required greenway and site drainage for any future development.

Additional potential benefits

There are also many benefits that are qualitative, subjective, or exceedingly hard to quantify. These include:

- Increased landowner peace of mind;
- Reduced nuisance high water (yard flooding and wet ditches);
- Reduced landowner costs to farm and/or access lands that are still farmable but are difficult to access due to wet areas; and
- Reduced negative ecological impacts. Large areas of mature oak trees have died due to persistent high water, particularly near the Thayer property. Additionally, much of the original wetland fringe or sedge habitat has been replaced by open water. USFWS has indicated that they would prefer a return to more typical lake levels.

Final Conclusions and Recommendations

Final conclusions

- The costs for all alternatives were considerably higher than the calculated benefits to the City. But the City may place a higher priority on the qualitative benefits than the Cost-Benefit Analysis does.
- We may be able to find downstream municipal partners who are willing to consider downstream benefits and provide financial project support.
- It's possible that downstream landowners (not just municipalities) might also be able to provide support including easements, labor, or financial contributions. It seems to be in their interest to keep their agricultural lands workable or to make the property suitable for future development by having a de facto greenway and stormwater conveyance feature installed.

Final conclusions (cont.)

- Alternative 2 (944 ft) appears to strike the best balance between project cost, benefit, effectiveness, and ability to be approved by permitting agencies.

- The amount of wetland disturbance and required mitigation is unknown but may add significant project costs.

Recommendations

- Council to review the project report and its conclusions, particularly the cost-benefit analysis including likely project costs, calculated benefits, and other non-quantified project benefits to City residents.

Next Steps

Next Steps

- Once the Study Report has been finalized, it will be made available at:

  http://www.fitchburgwi.gov/2688/Lake-Barney-Study

- Downstream infrastructure improvements in the Village of Oregon will likely be completed in 2022 at the earliest.
- It is recommended that design for this project start *after* downstream improvements have been completed (2023 at the earliest).
- The CIP project's timeline will be adjusted in the upcoming iteration of the CIP to show design in 2023 (currently scheduled for 2021).

Next Steps

- Continue discussions with the Village of Oregon to determine potential interest in cost-sharing for this project.
- Continue discussions with the stakeholder group (Village of Oregon, USFWS, USDOC, Alpine Dairy, and other property owners) to keep up-to-date on developments that may impact this project.
- If this project proceeds, we recommend Alternative 2 be the basis for design.

Questions?

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