technical memo

Project Name |	Flood Mapping / Flood Risk Assessment	**Date** |	1/5/2021
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	BCWD Administrator		
From / Contact info |	Ryan Fleming, CFM; Camilla Correll, PE		
Regarding |	Evaluation of Flood Mapping / Flood Risk for Long Lake		

BACKGROUND

The BCWD 2019 rules evaluation process included an evaluation of regional treatment options in the drainage area to Long Lake and the Diversion Structure. During this evaluation, EOR updated the 100-year high water levels (HWL's) on the District's waterbodies to reflect the updated NOAA Atlas 14 Precipitation Frequency Estimates as well as refined the hydraulics based on recent changes and available hydraulic information in the watershed. This evaluation demonstrated that the 100-year HWL on Long Lake (associated with the most recent historical information) increased from 893.00 feet to 894.93 feet. Under these conditions it appears that there may be homes/structures within the updated 100-year Long Lake floodplain.

Since this evaluation, the Long Lake watershed has received a significant amount of rain, on top of what has been the wettest decade on record. As a result, several residents on Long Lake are experiencing sustained high water along their lakeshore due, in part, to the Long Lake outlet capacity and the downstream crossing culverts at County Road 12.

The BCWD and the City of Stillwater are interested in more accurately identifying those homes that are in the updated 100-year floodplain, and the magnitude of the flooding. Therefore, in October of 2020, the BCWD approved a scope for surveying structure elevations and updating the hydrologic and hydraulic modeling to evaluate the degree of flood risk for properties within the larger anticipated 100-year flood footprint.

This information can be used to provide flooding information and potential technical assistance to homeowners who may need to obtain flood insurance in the future or are interested in flood-proofing their homes. The BCWD will also use this information as it considers the development of a Flood Risk Management Grant Program.

UPDATE

In November, EOR surveyed structures on 23 parcels surrounding Long Lake and 62nd Street Pond. Elevation information from a 1997 survey conducted by SEH, Inc. was also checked for consistency. In total, elevation information was collected on 44 structures as shown in Table 1.

The updated hydrologic and hydraulic model was run for synthetic design events between the 1-year 24-hour and the 500-year 24-hour event using the NOAA Atlas 14 NRCS MSE-3 distribution as summarized in Table 2. The current FEMA regulatory flood for which that the 2010 Flood Insurance Study was based is also listed for reference.

Table 1: Structure Elevation Data for Lakeshore Properties on Long Lake

Property Location	Low Opening Elevation [Feet]	Basement Type*	Lowest Floor Elevation** [Feet]
7130 Mid Oaks Avenue North	895.00	Crawl Space	895.00
1200 Nightingale Boulevard	897.58	Full	897.58
3017 Marine Circle	898.46	Full	891.05
3018 Marine Circle	898.51	Full	890.51
2978 Marine Circle	900.13	Full	893.46
2954 Marine Circle	901.60	Full	893.10
2913 Marine Circle	902.70	Full	894.20
3041 Marine Circle	896.93	Lookout	894.10
2916 Marine Circle	897.06	Lookout	893.56
2970 Marine Circle	897.19	Lookout	894.40
2921 Marine Circle	897.24	Lookout	894.41
3033 Marine Circle	897.40	Lookout	894.22
3023 Marine Circle	897.97	Lookout	894.17
220 Northland Avenue	899.20	Lookout	895.20
2929 Marine Circle	899.30	Lookout	895.63
2946 Marine Circle	899.89	Lookout	897.06
2889 Long Lake Drive	907.27	None	907.27
2895 Long Lake Drive	907.33	None	907.33
2869 Long Lake Drive	907.42	None	907.42
2851 Long Lake Drive	907.46	None	907.46
2875 Long Lake Drive	907.48	None	907.48
2863 Long Lake Drive	907.53	None	907.53
2857 Long Lake Drive	907.53	None	907.53
2825 Long Lake Drive	908.23	None	908.23
2803 Interlachen Drive	893.52	Walkout	893.52
2962 Marine Circle	894.46	Walkout	894.46
3009 Marine Circle	894.58	Walkout	894.58
3001 Marine Circle	894.63	Walkout	894.63
3034 Marine Circle	895.52	Walkout	895.52
2922 Marine Circle	895.80	Walkout	895.80
2930 Marine Circle	896.04	Walkout	896.04
3025 Marine Circle	896.23	Walkout	896.23
2938 Marine Circle	896.38	Walkout	896.38
1220 Nightingale Boulevard	896.70	Walkout	896.70
7160 Mid Oaks Avenue North	898.68	Walkout	898.68
7070 Mid Oaks Avenue North	899.00	Walkout	899.00
228 Northland Avenue	899.23	Walkout	899.23
312 Northland Avenue	899.88	Walkout	899.88
304 Northland Avenue	899.89	Walkout	899.89
7100 Mid Oaks Avenue North	899.91	Walkout	899.91
1102 Nightingale Boulevard	901.27	Walkout	901.27
1186 Nightingale Boulevard	901.69	Walkout	901.69
7190 Mid Oaks Avenue North	912.00	Walkout	912.00

* Basement type referenced from observation, interviews with residents, and county records.

** Lowest Floor Elevations estimated assuming 8.5-foot ceiling (full basement) or 3.5 feet below lookout window where survey data not available.

Table 2. Rainfall Event Simulations

24-Hour Design Storm	Rainfall Depth [Inches]
MSE3 1-Year	2.44
MSE3 5-Year	3.49
MSE3 10-Year	4.17
MSE3 25-Year	5.23
SCS Type II 100-Year (Current FEMA regulatory flood)	5.90
MSE3 50-Year	6.17
MSE3 100-Year	7.20
MSE3 200-Year	10.00
MSE3 500-Year	11.40

RESULTS

Early conversations between the BCWD staff and the city of Stillwater prompted modeling two distinct hydraulic scenarios for Long Lake:

A. Current conditions, though including additional impervious for upcoming development south of Long Lake; and
B. Removal of the weir on the control structure for Long Lake, thus controlling the lake and downstream wetland as a connected system at County State Aid Highway 12.

As summarized in Table 3, the model predicts there to currently be four homes where the 100-year high water level in Long Lake will exceed the lowest opening of the structure for the revised 100-year, 24-hour event. This number is reduced to one home if the weir were to be removed from the Long Lake outlet structure. Any measures that reduce the high water level will result in decreasing flood risk for all surrounding structures.

Table 3: Long Lake Model Scenario High Water Level Summary

24-Hour Design Storm [NRCS MSE3 distribution]	Scenario A: Current Conditions		Scenario B: Weir Removed	
	Long Lake HWL [Feet]	Structure Low Openings Exceeded	Long Lake HWL [Feet]	Structure Low Openings Exceeded
10-Year	892.67	0 (1 with less than 1' freeboard)	891.92	0 (lowest with 1.6' of freeboard)
25-Year	893.57	1	892.84	0 (1 with less than 1' freeboard)
50-Year	894.28	1	893.64	1
100-Year	894.93	4	894.36	1
200-Year	895.66	6	895.08	5
500-Year	896.67	10	896.11	8

Note that the model also predicts that the 100-year water level in 62nd Street Pond[1] will exceed the lowest opening for two of the Long Lake Villas and be within 0.25 feet of the other six villas. The 200-year event exceeds the lowest floor of all eight nearby villas. Removal of the weir on Long Lake has no impact to the peak water levels at 62nd Street Pond because the pond is controlled by a separate outlet structure. These parcels are displayed on Figure 4.

Figure 1 through Figure 4 visually convey similar information to that shown in Table 3 for existing conditions (Scenario A). The parcels where survey information was collected are color coded from green to red indicating less to more risk of flooding based on the amount of freeboard the structure has for the 100-year 24-hour event. The square icons within the parcels are color coded to indicate the predicted level of protection that the structure has based on the modeled design storm events. The elevations listed are the low openings determined from the exterior of the building, though lower interior floors may exist at these and other homes. The 100-year flood footprint, based on the 2011 LiDAR elevation data available from MnDNR MnTOPO state dataset, is shown on the figures to depict the anticipated extent of flooding on the parcels. In cases where the lowest floor is below the floodplain, but the low opening is sufficiently high to allow freeboard from flood water entering the house, proximity to the floodplain extent and duration of high water may result in flooding due to seepage through the ground. For reference, Long Lake remains above the outlet weir elevation for approximately 14 days following the 100-year 24-hour event with nearly four days exceeding the lowest opening (893.52 feet) and eight days above the estimated lowest floor elevation adjacent to the lake (estimated at 890.51 feet, though outside of the flood footprint).

Also shown on Figure 1 through Figure 4 is the estimated depth of flooding over the roads that results from Long Lake's 100-year 24-hour event. General guidance is that typical automobiles should not

[1] 62nd Street Pond is not part of the 2010 Washington County Flood Insurance Study and therefore does not have a designated FEMA flood zone associated with it.

attempt to cross when flood water exceeds 0.5 foot. At one foot of depth, the car may begin to float due to the underbody being sealed. Of note, the anticipated flooding across Mid Oaks Avenue North would strand nine properties without access. The flooding across 62nd Street North may leave one property without access. The modeled depths for scenario A and B are summarized in Table 4 below.

Table 4: Long Lake Model Scenario Road Flooding

24-Hour Design Storm [NRCS MSE3 distribution]	Scenario A: Current Conditions			Scenario B: Weir Removed		
	Mid Oaks Depth [Feet]	62nd Street Depth [Feet]	72nd Street Depth [Feet]	Mid Oaks Depth [Feet]	62nd Street Depth [Feet]	72nd Street Depth [Feet]
10-Year	0.37	0	0	0	0	0
25-Year	1.27	0.04	0	0.54	0	0
50-Year	1.98	0.75	0.28	1.34	0.11	0
100-Year	2.63	1.4	0.93	2.06	0.83	0.36
200-Year	3.36	2.13	1.66	2.78	1.55	1.08
500-Year	4.37	3.14	2.67	3.81	2.58	2.11

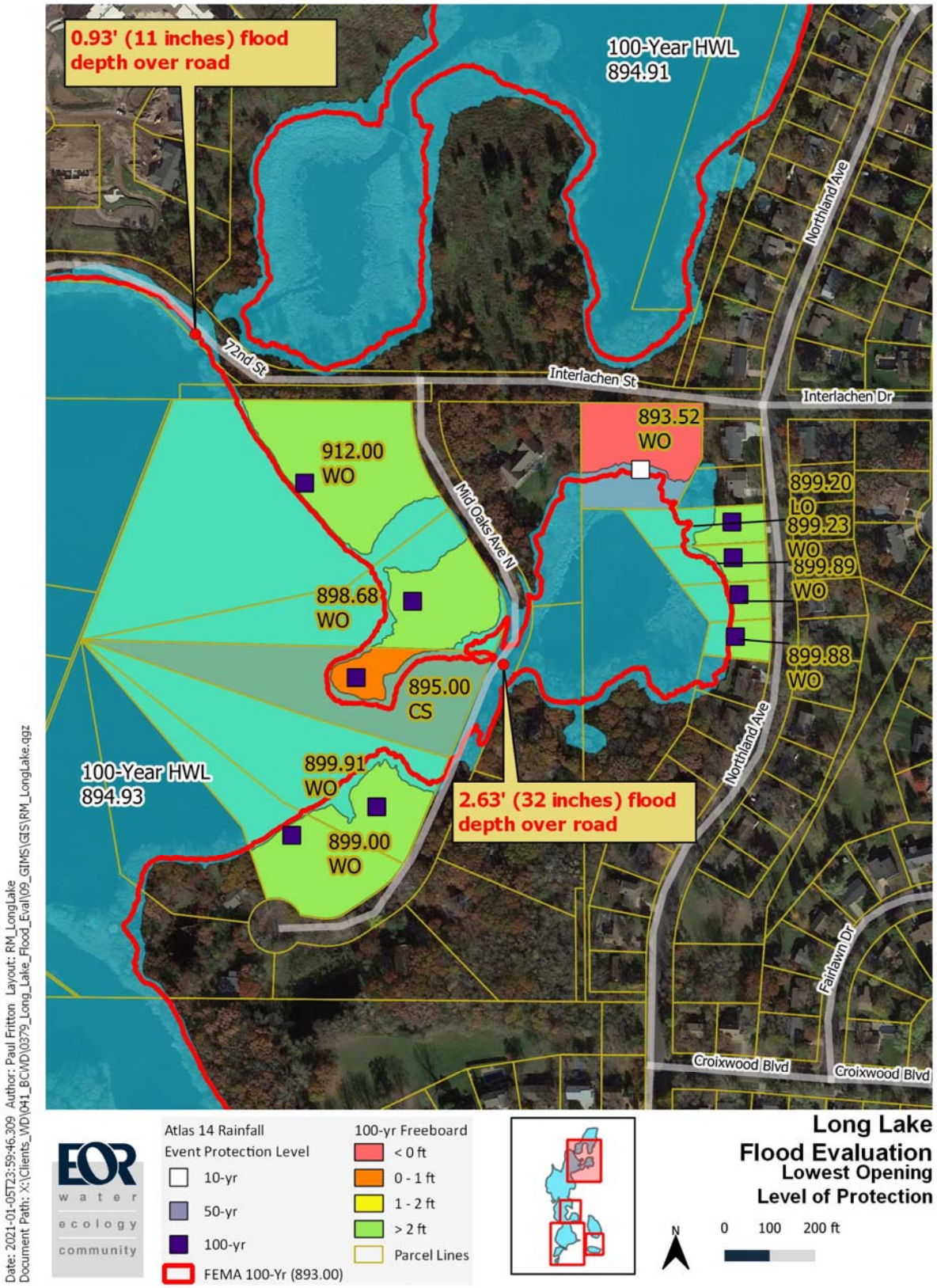

Figure 1: Mid Oaks Ave & Northland Ave

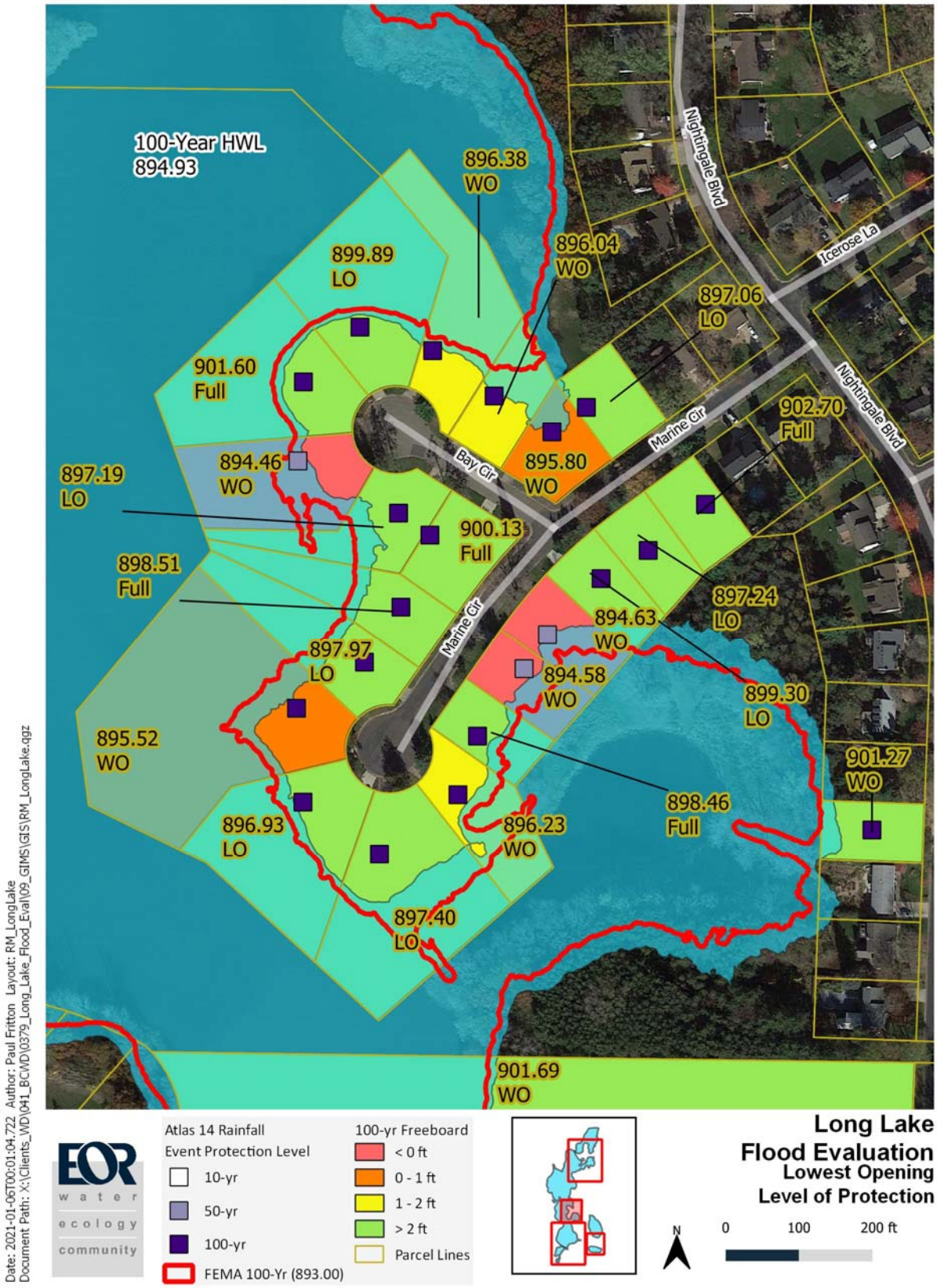

Figure 2: Marine Circle

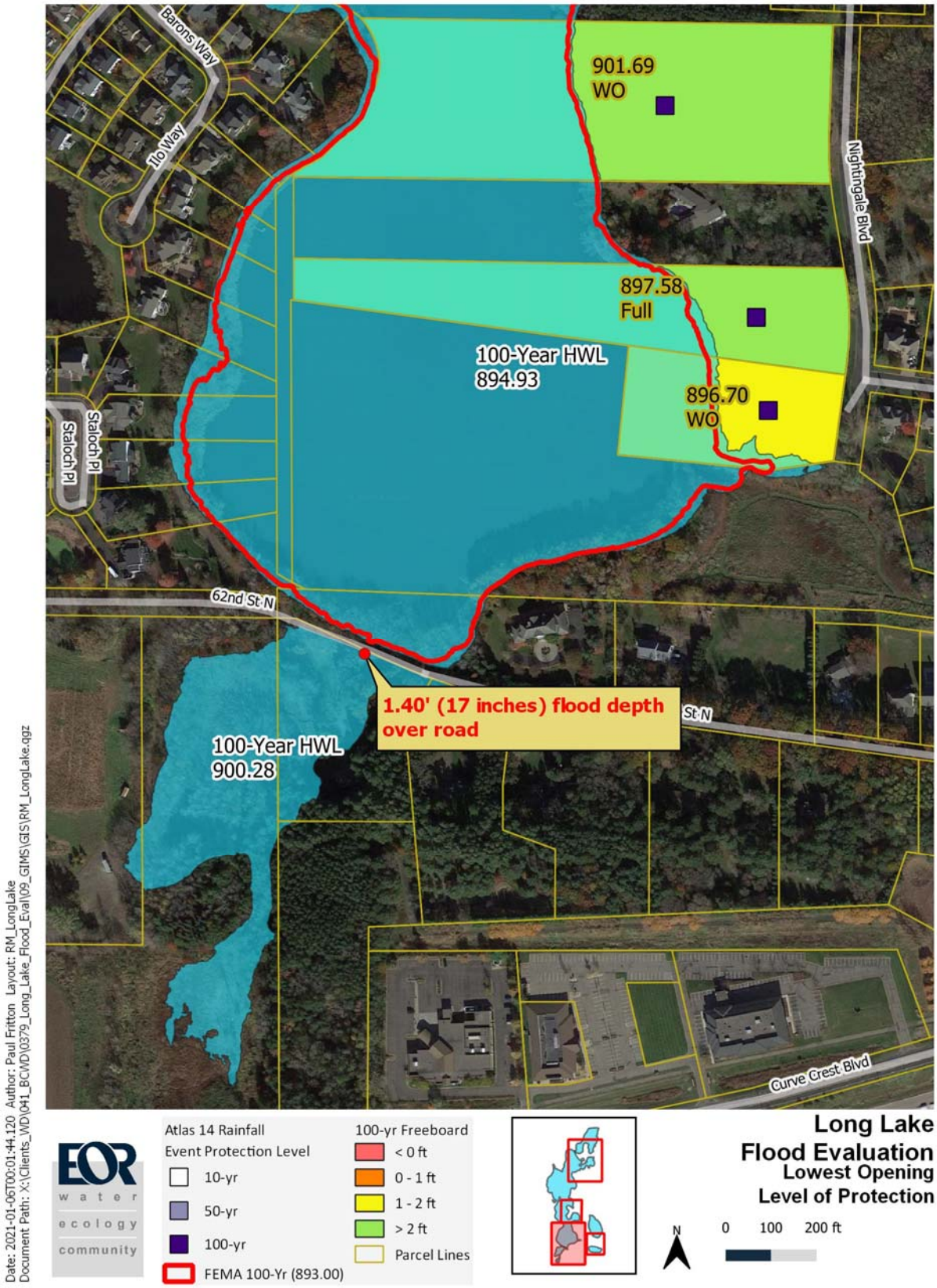

Figure 3: Nightingale Blvd & 62nd Street

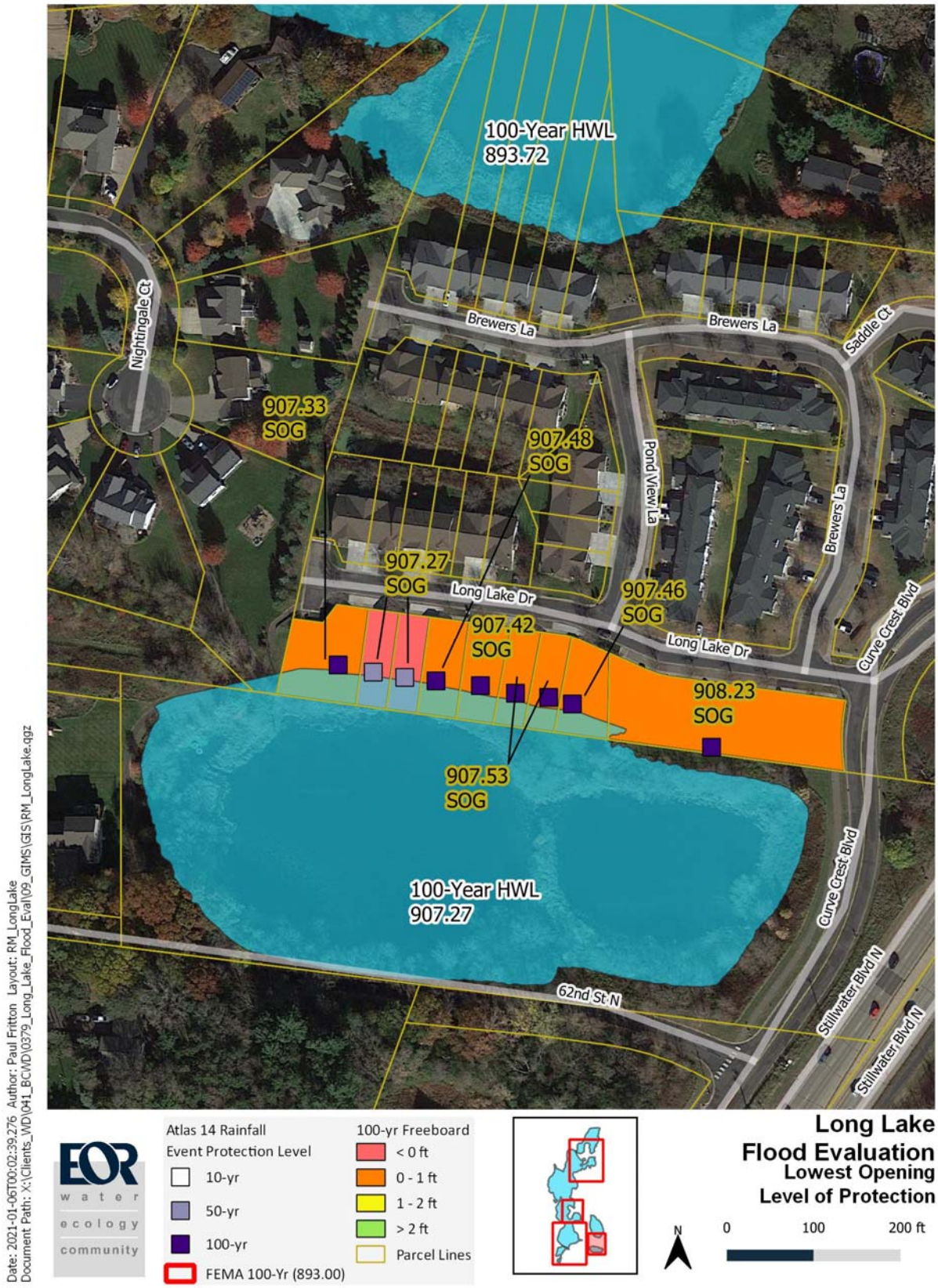

Figure 4: Long Lake Villas

FLOODPLAIN ORDINANCE REVIEW

BCWD, the state of Minnesota through local ordinance, and FEMA regulate land use and development in the floodplains of the state.

The following definitions are for frequently used terms when reviewing floodplain ordinance:

Base Flood Elevation (BFE): Also referred to as the 100-year flood elevation, this is the elevation reached by a flood with a return frequency of 100 years, or an annual chance of occurrence of 1 percent.

Lowest Floor Elevation (LFE): The lowest floor of the lowest enclosed area of the building (including a basement).

Lowest Adjacent Grade (LAG): The elevation of the lowest ground point touching a structure, including attached patios, stairs, window wells, deck supports, or attached garages.

Lowest Lot Elevation (LLE): The lowest elevation of a legally recorded property or the lowest elevation of a portion of a legally recorded property as defined by a metes and bounds description.

Regulatory Flood Protection Elevation (RFPE): MnDNR definition. One foot above the 100-year flood elevation plus the flood stage increase due to filling in the flood fringe.

Special Flood Hazard Area (SFHA): The area where the National Flood Insurance Program's floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies.

Within BCWD, flood zones are regulated federally though FEMA, by the state of Minnesota through local ordinance, and through the BCWD Rules. FEMA has designated SFHA's for all 51 MnDNR inventoried public waters in the BCWD, while the BCWD floodplain standards apply to all waterbodies within the District's jurisdiction, including wetlands and constructed ponds. In addition to regulating permitted and conditionally permitted activities within the floodplain, the floodplain ordinances set minimum standards for separation of structures within the floodplain from the 100-year flood elevation. Table 5 compares the required minimum **Lowest Floor Elevation** within the floodplain, according to the different applicable standards.

Table 5. Minimum Lowest Floor Elevation requirement for new structures, measured from BFE (100-yr HWL)

FEMA	Minnesota RFPE	BCWD (Rule 7.0)	City of Stillwater
BFE	BFE + 1 foot	BFE + 2 feet	BFE + 2 feet

The increased elevation beyond the Base Flood Elevation is referred to as the Freeboard and represents a factor of safety added to compensate for unknowns in the flood model calculations and to provide protection when flood levels exceed the calculated 100-year flood. Note that, while FEMA does not require freeboard, they do advise that state incorporate more stringent requirements, and the most restrictive applicable standards apply.

FLOODPLAIN REMAPPING IMPLICATIONS

Long Lake has a FEMA Zone AE[2] regulatory floodplain. The Zone AE flood zone is shown on the effective Flood Insurance Rate Map (FIRM). At this time, the homes are located outside of the regulatory FEMA floodplain (Washington County Flood Insurance Study, 2010). However, the revised Atlas 14 peak water level footprint for Long Lake indicates the risk of flood waters encroaching on the surrounding homes, and lake residents have reported consistent, unusually high water levels. The MnDNR is in the process of updating the FEMA flood zone maps throughout the state using Atlas 14, among other more recent data. When the FEMA floodplain maps are updated, properties with insurable structures located in the revised floodplain will be required to obtain flood insurance. Flood insurance may also be required of future homeowners for mortgage underwriting given the proximity to the flood source. As homeowners face these potential challenges, it is important to understand the options available to them to eliminate or lower their insurance premium through various means such as elevation verification certificate, obtaining insurance prior to the map revisions, or structural modifications. Currently, FEMA's remapping efforts have prioritized other areas over the St. Croix River watershed and the timeline for remapping in Stillwater is unknown.

The updated BCWD model results for the Long Lake floodplain, indicate that four structures, currently outside of the current, effective Long Lake BFE of 893.00, will likely be included in the re-mapped BFE footprint area at 894.93 feet. Also, the updated model results indicate that two of the townhomes located near the 62nd Street Pond have a LFE that is below the predicted 100-year high water level for the pond (62nd Street Pond does not have a FEMA flood zone designation).

Homeowners located within a newly mapped BFE footprint will be required to purchase flood insurance at the preferred risk rate for the first year. The rate will then increase 15 percent annually until the full rate is reached based on the flood risk of the home. There may be a cost savings on the premium for those that have the insurance in place prior to the new maps becoming effective.

FEMA's new mapping program, Risk MAP (Mapping, Assessment, and Planning), focuses on different levels of risk as opposed to drawing the line where property is either in or out of the floodplain.

The National Flood Insurance Program (NFIP) is redesigning its risk rating with the goal of providing rates that better reflect a property's flood risk. FEMA calls this effort Risk Rating 2.0 (Deferred to October 1, 2021). FEMA Risk Rating 2.0 will combine data sets from multiple agencies to create a probabilistic instead of deterministic approach to flood rating. Characteristics for each property will inform the new risk rating plan such as:

- Distance to the flooding source
- Different types of flood risk with a broader range of flood frequencies (not just the 100-year and 500-year events)
- Hydrologic and hydraulic model parameter confidence and seasonality
- The cost to rebuild a home

[2]FEMA Zone AE - Areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. Base Flood Elevations (BFEs) are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

In addition to fairer and more intuitive insurance rates, Risk Rating 2.0 will offer mitigation credits to help incentivize risk reduction efforts and reduce the cost of future flood events.

OPTIONS FOR HOMEOWNERS

Homeowners within a newly mapped flood risk area generally have three options:

1. Accept the increased flood risk and pay for flood insurance.
2. Submit a request for a Letter of Map Amendment (LOMA) with FEMA.
3. Retrofit their home to comply with elevation regulations.

According to the MnDNR, as of 2016 the average annual premium was $849 and ranged from less than $200 to tens of thousands of dollars. Error! Reference source not found. displays how premiums vary based on the distance between the LFE and BFE as presentation by the MnDNR. Based on the updated BCWD modeling results, this distance ranges from 0 to 1.41 feet for the six structures that are within the SFHA. For every foot that the LFE can be raised, annual premiums drop by around $1,000.

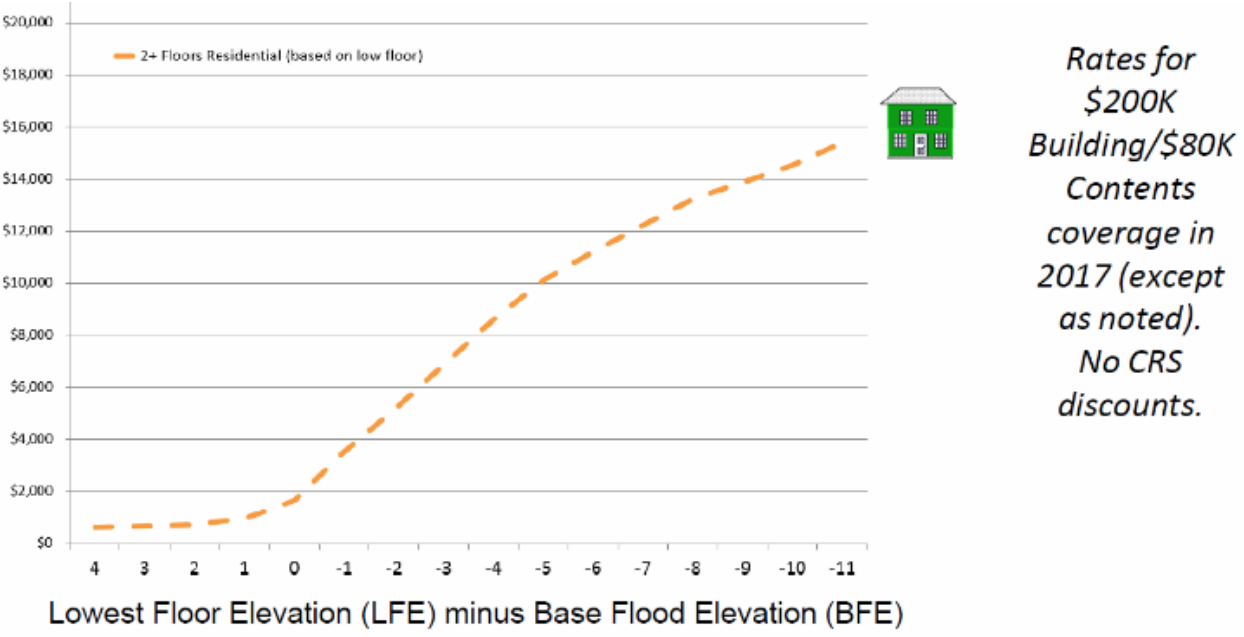

Figure 5. Building Elevation and Flood Insurance Rates[3]

FEMA recognizes that due to limitations of scale or topographic definition of source maps, small areas may be inadvertently shown within a SFHA, even though the property is on natural ground at or above the BFE. It is also possible for small areas to have had earthen fill placed during construction, elevating a small area within the SFHA to an elevation above the BFE. To address these situations, FEMA established procedures to change the designation of these properties on the FIRM, referred to as the Letter of Map Amendment (LOMA) process and the Letter of Map Revision-Based on Fill (LOMR-F) process. Through the amendment process, an individual who owns, rents, or leases

[3] Figure from *Floodplain Updates for Surveyors* presentation by Ceil Strauss, Minnesota DNR State Floodplain Manager on February 16, 2017.

property can submit mapping and survey information to FEMA and request that FEMA issue a document that officially removes the property and/or structure from the SFHA. The survey must be completed by a certified professional and show that the **Lowest Adjacent Grade** (LOMA/LOMR-F for a structure) or the **Lowest Lot Elevation** (LOMA for one or more lots) is above the BFE, thus showing the structure is at a lower risk of flooding. LOMR-F requests for one or more lots must provide both the LAG and LLE, showing all elevations are above the BFE.

If the structure or property is within the SFHA and is not applicable to receive a LOMA/LOMR-F, the homeowner may choose to retrofit the home to increase the **Lowest Floor Elevation**, reducing the flood risk and reducing the flood insurance requirements. The retrofitting process is handled through the community, often in collaboration with the FEMA coordinator at the MnDNR. Retrofitting for flood protection often falls under conditional use permitting, to ensure the flood protection methods are maintained in perpetuity. Retrofitting can include dry floodproofing measures such as watertight shields for doors and windows, wet floodproofing such as flood vents, functional measures such as moving HVAC and electric systems from basement to higher floors, or structural measures such as raising the home elevation e.g., lifting the building and constructing a thicker foundation or crawlspace). To avoid flood insurance requirements, the Lowest Floor Elevation (LFE) of the home needs to be elevated to the Regulatory Flood Protection Elevation (RFPE, 1 foot above the base flood elevation).

Retrofits measures such as levees and adding fill to the property are subject to additional certification and regulation to prevent inadvertent impacts to the floodplain and would require the homeowner to obtain a BCWD permit (BCWD Rule 7.0).

Table 6 presents factors and estimated cost ranges to consider with respect to the above options.

Table 6: Example Flood Proofing Options and Considerations

Option	Pros	Cons	Planning Level Costs and Notes
1: Remove the Structure Entirely	Meets goal of preventing flood losses	Costly, loss of real estate asset	Total Costs: Depends on value of structure Demolition: $5-8k Move Structure: $10k-$20k Costs estimates based on RS Means data and conversation with Andersen Building Movers.
		Potential sentimental loss for owner	
2: Adding an earthen levee or other flood exclusion structure	Meets goal of preventing flood losses	Not typically recommended for a single residential application due to costs and operations and maintenance needs	Certified Levee Total: $65-$85k, Annual O&M: $2,000-$2,500 Non-Certified Levee Total: $25k-40k Annual O&M: $1,000-$1,500 Costs calculated based on data provide in *Engineering Principals and Practices for Retrofitting Flood Prone Residential Structures* (FEMA, 2012) and *Selecting Appropriate Mitigation Measures for Flood Prone Structures* (FEMA, 2007) Assumptions: • Added 15% to 2012 base costs. • Added 26% to 2007 base costs. • Due to topography levee will likely need to encircle home. • Certified levee assumed 4 feet high and 300 feet long. • Non-certified levee assume 2 feet high and 300 feet long • Estimated engineering fees included in total. • Ongoing O&M cost is 5% of construction costs.
	No change to the house itself (though the surroundings would be modified dramatically)	Significant landscaping and residential access impacts (assuming the modeled 100-yr elevation with freeboard).	
		To prevent NFIP requirements ("Flood Insurance") the levee would need: 1. To be FEMA "Certified", which is a burdensome status to obtain and maintain 2. FEMA Freeboard requirements (BFE plus three to four feet), which would significantly alter the existing landscaping and residential access. 3. Annual inspections and periodic re-certification	
		A levee system requires significant design and construction expense to ensure adequate protection (regardless of NFIP status), including: 1. A means of groundwater cutoff 2. Provisions for interior drainage (flood-proof storm outlets) 3. Provisions for interior pumping (for "coincident extreme events")	
		A levee system requires continuous upkeep, maintenance, and skills for operational management.	
		To remove the flood insurance requirement per MN regulations, the basement may need to be filled.	

Option	Pros	Cons	Planning Level Costs and Notes
3: Structural Modification (Raising the house up)	Meets goal of preventing flood losses in a "resilient" manner	Construction project would require temporary housing for residents	Total Costs: $70k-$120k Costs based on conversation with Otting House Movers and Anderson Building Movers. Approximate breakdown of costs: 1/3 lift, 1/3 basement foundation, 1/3 utilities; +landscaping & well abandonment & relocation.
	Upgrades house foundation and utility entrances	Cost may be somewhat more expensive than a simple levee (however if a more advanced levee is needed due to soil type, or certification needs this option may still be less expensive)	
	May involve upgrades to HVAC, plumbing, electrical, depending on the existing conditions and the existing location of the MEP equipment		
	No special ongoing maintenance, certification, or technical operations	In MN, the basement floor elevation cannot be located below the RFPE. Therefore, to be exempted from the NFIP the basement may have to be filled. (assuming the BFE is revised to be near the modeled 100-yr flood elevation)	
	Permanent exemption from NFIP and conventional flood insurance with an "Elevation Certificate" and/or "LOMR-F" process		
Option 4: Water Proofing Basement	Addresses seepage issues if resident is experiencing issues.	Does not remove flood insurance requirements. Or address surface flooding concerns for the regulatory flood event	Total Costs: $9,500-$13,500 Basement waterproofing costs based on conversations with Complete Basement Systems
	Potentially the least disruptive options & can be combined with other flood proofing options.		

CONCLUSIONS AND RECOMMENDATIONS

The current floodplain regulations are based on model data that BCWD developed in 2002. Since then, significant hydrologic and hydraulic changes have occurred in the Long Lake watershed. In addition, more recent precipitation frequency estimates have become available such as Volume 8 of NOAA Atlas 14. This analysis, released in 2013, incorporates precipitation data through 2011 and utilizes more data from more weather stations than previous efforts, e.g., Technical Paper No. 40. As a result, this evaluation of high-water levels on Long Lake is more representative of recent conditions when compared with the 2002 modeling analysis. That said, it does not account for recorded precipitation between 2012 and 2020, nor does it account for future predictions for precipitation patterns.

Given that 2019 was the wettest year on record for central Washington County, that 2015-2019 was the wettest 5 years, and 2010-2019 was the wettest 10 years, it would be prudent to include this precipitation data in floodplain mapping efforts. Research by Daniel Wright, PhD, M. ASCE, Assistant Professor in the Department of Civil and Environmental Engineering, University of Wisconsin – Madison has demonstrated that today's 100-year storm is likely to be equivalent to the 20-year storm by the late 21st century. This has been shown through updating the rainfall statistics to include more recent precipitation data and an expanded data set (NEXRAD radar rainfall data). Since the industry standard rainfall statistics do not include the recent change in precipitation trends, recalculation of the statistical rainfall depths, intensities, and durations on a more frequent basis should be considered in long range floodplain management for the BCWD.

This evaluation found that removal of the weir control structure on Long Lake would result in removing three homes from the revised flood footprint and reduce flood risk for several more structures by providing additional freeboard for the design events presented herein. This modification, or any lowering of the Long Lake flood levels, would lower flood water levels across roads and potentially improve access for those homeowners who may experience access issues under the existing conditions

Another finding is that the structures adjacent the 62nd Street Pond may experience flooding for the 100-year, 24-hour event. While considering scenarios for modification to the outlet structure on 62nd Street Pond was outside the scope of this study, it could be considered to alleviate potential flooding of these homes. The water quality treatment currently provided by this pond will need to be considered with any modification to the outlet.

Based on these findings, it is recommended to continue coordination with the city of Stillwater in vetting options to lower the high water level on Long Lake to reduce the overall flood risk to surrounding homeowners for all extreme rainfall events.

It is also recommended that a workshop be held to present this evaluation to homeowners that are at higher risk of flooding so that they may further consult on flood insurance based on their individual circumstances.

Furthermore, the Board may desire to outline the next steps involved in establishing a Flood Risk Management Grant Program to align with the 2021 and future budget allocations. These may involve the following:

A. The administrator exploring the details of programs in other communities.
B. Legal counsel outlining the legal framework and mechanics to establish a program.
C. The district engineer refining floodproofing cost estimates based on individual at-risk property owners who express interest in participating in an assistance program.