LAKE NOKOMIS AREA GROUNDWATER & SURFACE WATER EVALUATION

At A Glance Overview | April 2022

Minneapolis
City of Lakes

Minneapolis
Park & Recreation Board

MINNEHAHA CREEK
WATERSHED DISTRICT

Hennepin

DEPARTMENT OF
NATURAL RESOURCES

USGS
science for a changing world

AT A GLANCE OVERVIEW

This "At A Glance" synthesizes information from the Lake Nokomis Area Groundwater and Surface Water Evaluation, which was completed in April 2022.

It is organized into the following sections:

Wirth reflecting on the dredging of Lake Nokomis:

"The transformation of that 400-acre tract—formerly shallow water surrounded by a peat bog and swampland, which had prevented earlier development of that large southeast section of residential properties—into a clear-water lake and an attractive, useful park and recreation area had its desired effect on the growth of the city in that direction."

Theodore Wirth, 1945, Minneapolis Park System 1883–1944

WHO WAS THEODORE WIRTH?

Superintendent of Minneapolis parks from 1906–1935, Theodore Wirth was instrumental in designing the Minneapolis parks system. Through massive dredging and filling projects, Wirth redefined the shorelines of nearly every lake in the city. At the time, his work at Lake Nokomis was billed as the City's largest lake shaping effort to date.

Questions?

Visit the City of Minneapolis website:
www.minneapolismn.gov/nokomis-groundwater

View the full report:
tinyurl.com/29aret94

Email: nokomisgroundwater@minneapolismn.gov

INTRODUCTION

RESIDENTIAL WATER ISSUES ARISE IN MINNEAPOLIS

During the wettest seven years on record in the Twin Cities, 2013-2019, property owners southwest of Lake Nokomis reported water-related concerns to the City of Minneapolis. Concerns included wet basements, wet backyards, sinkholes, impacts to private sewer lines, and extended periods of saturated soils in previously dry areas. Between 2014-2018, the City of Minneapolis received water concern reports from 21 property owners in three areas, shown on Figure 1.

MULTI-AGENCY TEAM CONVENED TO EVALUATE

In response, the City of Minneapolis assembled a multi-agency team ("Team," see list at bottom right) to evaluate what could be contributing to the issues and help identify mitigation measures for homeowners and community leaders. The expertise of each agency was needed because surface water and groundwater crosses several jurisdictions. Understanding that the water issues being reported paralleled those occurring more broadly across the region and state, this work offers an important case study on the local effects of climate change.

EXTENSIVE DATA REVIEWED TO DETERMINE CAUSES

From 2017–2021, the Team invested over $200,000 to install six new groundwater wells, gathered data about precipitation, geology, hydrology, lake and creek water levels, and reviewed historic records, including newspaper and MPRB reports. This information was analyzed to arrive at key findings and conclusions.

While completing this work, the Team also actively engaged the community and affected residents, through participation in five public meetings with residents and policy makers, holding a public open house, responding to emails, and creating a City of Minneapolis email list and webpage.

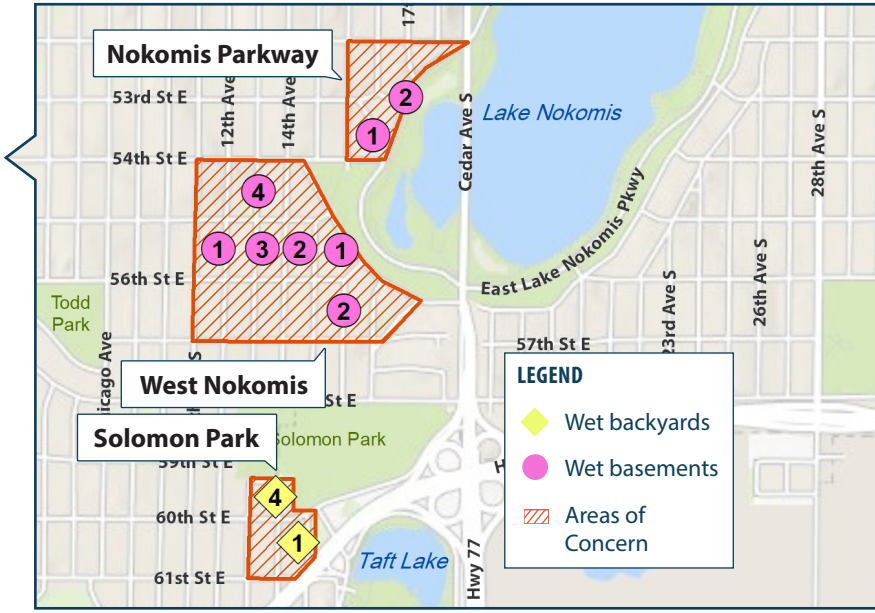


Figure 1: Mapped Water Concerns. City of Minneapolis data showing the number of reported wet basement and wet backyard reports per city block during 2014-2018. Three separate "Areas of Concern" (Nokomis Parkway, West Nokomis, and Solomon Park) were identified. (Credit: MCWD; Data Source: City of Minneapolis)

MULTI-AGENCY TEAM MEMBERS:

- U.S. Geological Survey (USGS)
- Minnesota Department of Natural Resources (DNR)
- Hennepin County
- Minnehaha Creek Watershed District (MCWD)
- Minneapolis Park and Recreation Board (MPRB)
- City of Minneapolis

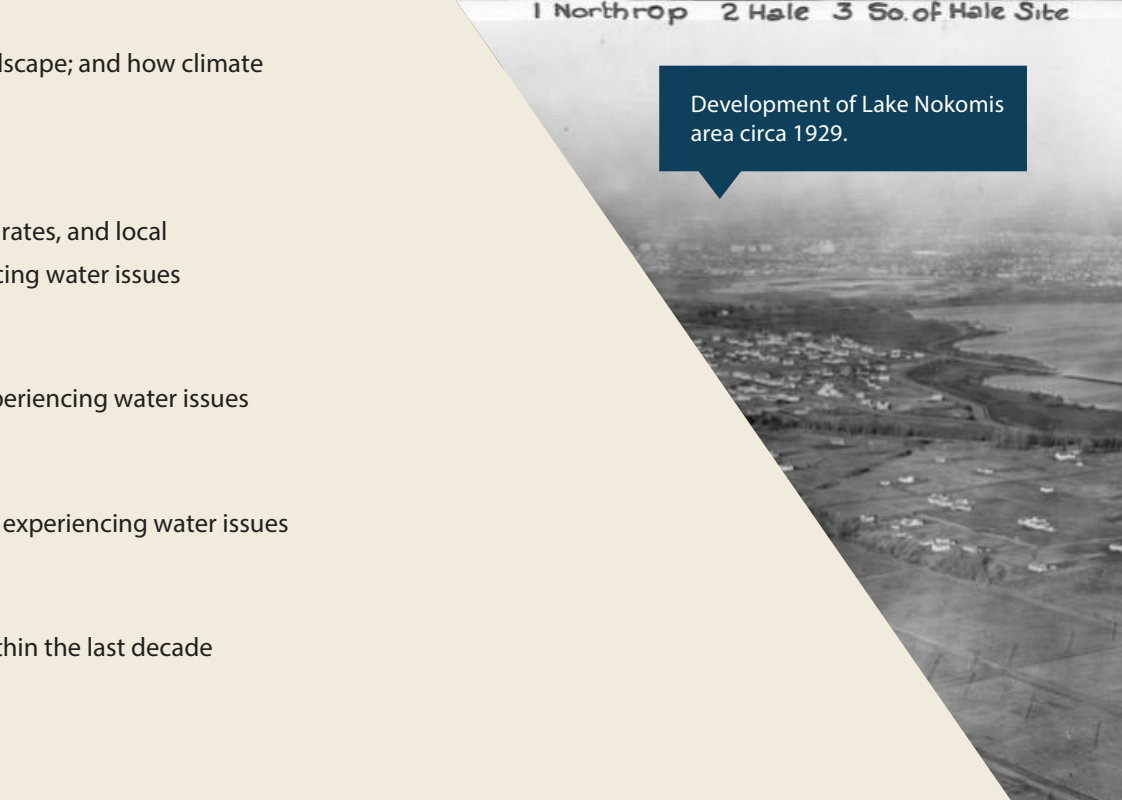
COORDINATION WITH ADDITIONAL AGENCIES:

- University of Minnesota (U of M)
- Metropolitan Council
- Minnesota Department of Transportation (MnDOT)
- Metropolitan Airports Commission (MAC)
- City of Richfield

EVALUATION APPROACH

The Team cataloged over 30 proposed hypotheses, put forth by community members, policymakers, and agency staff, that might be contributing to the Nokomis area water issues. These were distilled and cataloged into seven possible factors, which were evaluated against the data to determine their possible contribution to the reported concerns:

Wild Rice growing in the South Section of Lake Nokomis in 1915.



Development of Lake Nokomis area circa 1929.

GEOLOGY AND HYDROLOGY HISTORY:

How the landscape around Lake Nokomis naturally formed to hold and store water

RESIDENTIAL DEVELOPMENT:

How people reshaped the landscape between the 1910s–1950s for housing and parks

PRECIPITATION RECORDS & CLIMATE CHANGE:

The influence of record drought on the development of the landscape; and how climate change influenced the wettest decade on record in the 2010s

GROUNDWATER RECHARGE & LEVELS:

The relationship between record rainfall, groundwater recharge rates, and local groundwater levels, relative to the elevation of homes experiencing water issues

LAKE NOKOMIS WATER LEVELS:

The level of Lake Nokomis relative to the elevation of homes experiencing water issues

MINNEHAHA CREEK WATER LEVELS:

The level of Minnehaha Creek relative to the elevation of homes experiencing water issues

REDEVELOPMENT AND STORMWATER MANAGEMENT:

How land use change and stormwater management systems within the last decade influenced hydrology in the area

EVALUATION FINDINGS

1 Glaciers shaped the landscape to hold and store water

The landscape around Lake Nokomis was formed by natural forces, to be a place that absorbed and stored water. Over 11,000 years ago, glaciers carved through the land, and then retreated and melted. As the ice blocks that were left behind melted, they formed an expansive system of interconnected wetlands and lakes. Under these saturated conditions organic material from dead plants was unable to completely decompose, forming extensive peat deposits — a wetland soil. Because peat readily absorbs moisture and can hold up to 10 times its weight in water, it can act as a barrier and prevent rainfall from draining into deeper layers of the soil. This can cause water to accumulate, or perch, above the peat.

2 Once abundant wetlands in South Minneapolis were filled for development

In 1853, the U.S. Surveyor General's Office conducted the first government land survey of the landscape around Lake Nokomis, then called Lake Amelia (Figure 2). The area contained over 1,500 acres of lakes and wetlands. At that time, the natural lakes were larger and shallower than today (shown in blue on Figure 2). Since then, nearly 60% of the area's wetlands have been filled. In their place is today's built landscape.

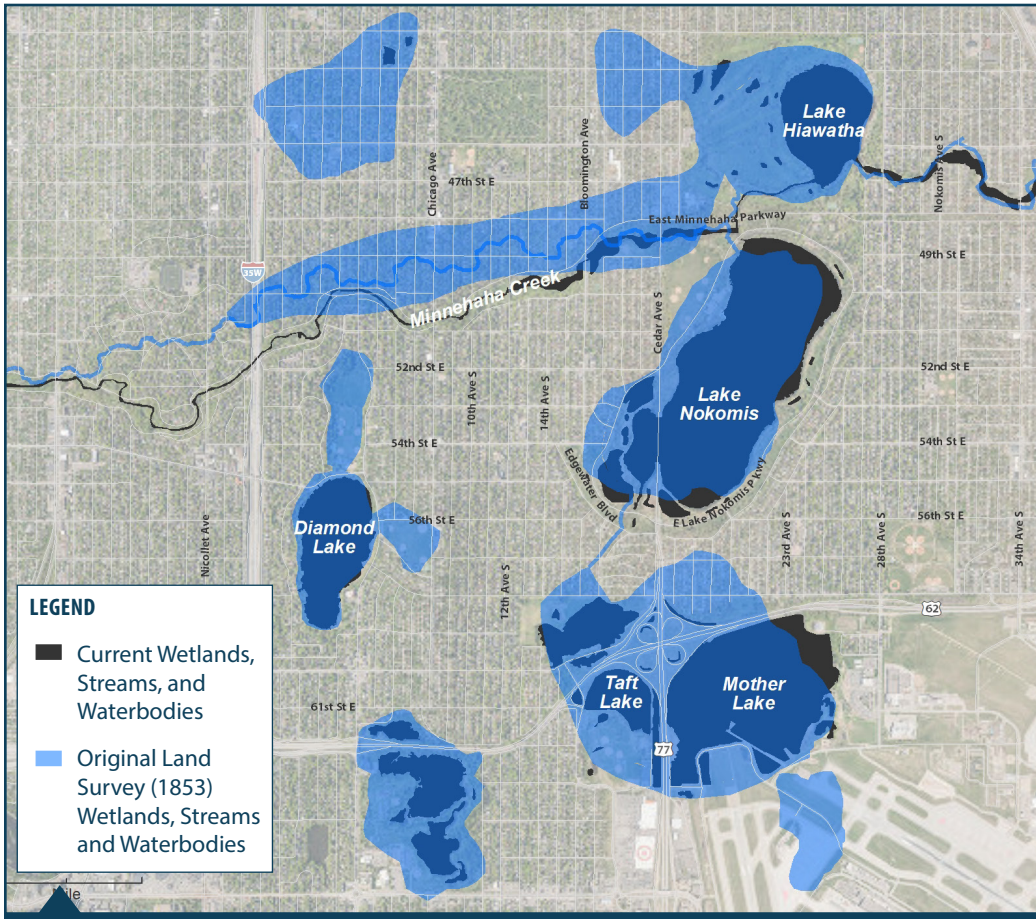


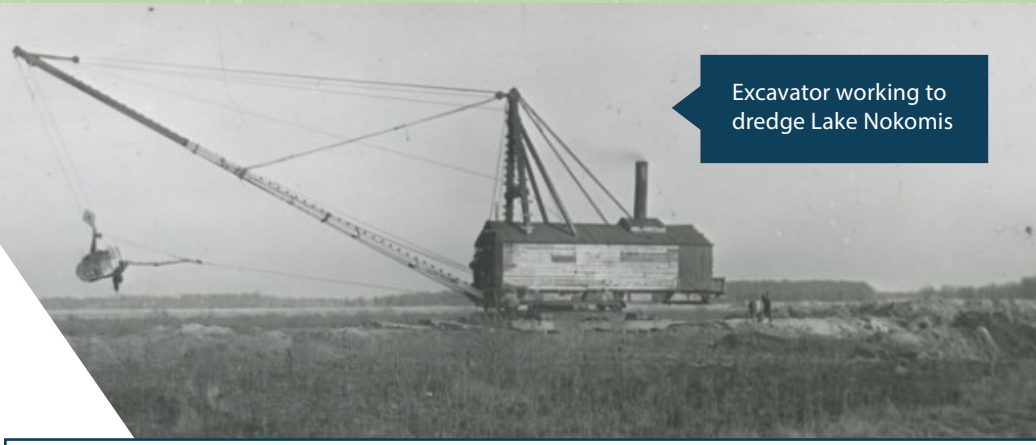
Figure 2. 1853 land survey boundaries for wetlands, streams, and waterbodies are shown in blue. Present-day boundaries for wetlands, streams, and waterbodies are shown in black. (Credit: MCWD; Data Source: National Wetland Inventory and GLO Historic Plat Maps)

3 The most "ambitious lake shaping plan in the history of Minneapolis parks" turns "useless swampland" into modern day Lake Nokomis area

Over 110 years ago, Lake Nokomis and its surrounding wetlands were excavated to convert what was a shallow wetland into an open-water lake. At that time, Wirth considered the wetlands in the Lake Nokomis area to be "useless, unsanitary, and an impediment" for development. A 1914 Minneapolis Sunday Tribune article anticipated that the excavation would "change a weedy slough into a beautiful place". Over the course of four years (1914–1918), MPRB led a massive dredging project that removed 2.5 million cubic yards of wetland and peat soils from Lake Nokomis. This amount is equivalent to around 250,000 dump truck loads. This excavated and dredged material was used to fill adjacent low-lying wetlands, which increased the total land area by 100-acres and deepened the lake. Wirth noted that, "the transformation of formerly unsanitary and unsightly sections" led to the residential development and park creation that anchors the area we know today.

4 During the driest period ever recorded, Wirth's transformation of "shallow water surrounded by a peatbog and swampland . . . had its desired effect on the growth of the city in that direction"

The dredging and subsequent development of Lake Nokomis coincided with the driest period ever recorded for the Twin Cities, 1920–1959, during which the average annual precipitation was approximately 25-inches. This drought saw Lake Nokomis at its lowest recorded level of 809.67-feet, in 1932, which is 5.7-feet below the current DNR established ordinary high-water level of 815.4-feet. These dry conditions created a long-term precipitation deficit, leading residents, and development officials to perceive that water was relatively easy to manage in this area. As a result, homes were built over former filled wetlands, peat soil, and the former footprint of Lake Nokomis.



Excavator working to dredge Lake Nokomis

LAKE NOKOMIS AND MINNEHAHA FALLS

Nearly 410 acres in area of which, in normal seasons, about 300 acres are water, Lake Nokomis will be one of the largest parks in the system. I regret that more of the wooded land along the east shore could not be acquired, but this defect, as far as land area is concerned, can be remedied when plans for the improvement of the tract are prepared and carried out. The lake is shallow with a mud and sand bottom. Under normal conditions the maximum depth is not more than 12 feet, and the average depth about 5 feet. For the improvement of the lake alone, considering only its relation to the park as a clean sheet of water of a minimum depth of not less than 8 feet during low water stages, it will be necessary to dredge the lake and change its shore lines. This transformation would most likely result in reducing the water area to about 200 acres, making the land area about 210 acres. A plan, which will also treat the proper development of the entire park, will be worked out during the year.

Figure 3: Excerpt from the MPRB's 28th Annual Report in 1910, which discusses the need to dredge Lake Nokomis to reduce the footprint of water.

"The last period of subnormal precipitation was an unusually long one, for during the twenty-five years from 1915 through 1940, only eight years had normal or abnormal precipitation, the other seventeen having been subnormal, with a total deficiency of 62.04 inches — in consequence of which our spring-fed lakes have been low at times and Minnehaha Creek practically dry during most of that period."

(Theodore Wirth, 1945, Minneapolis Park System 1883-1944)

5 Peat and wetland soils caused infrastructure and parkland issues soon after development

During the development of the area around Lake Nokomis (1920s-1950s), underlying wetland and peat soils caused problems for underground infrastructure, roads, and parkland. City sewer lines constructed in the 1930s needed almost immediate and ongoing repair due to poor soil conditions. In 1941 when West 58th Street was extended towards 15th Avenue South, peat bogs up to 16-feet in depth significantly disrupted road construction and created public safety issues (see bottom picture on Figure 4).

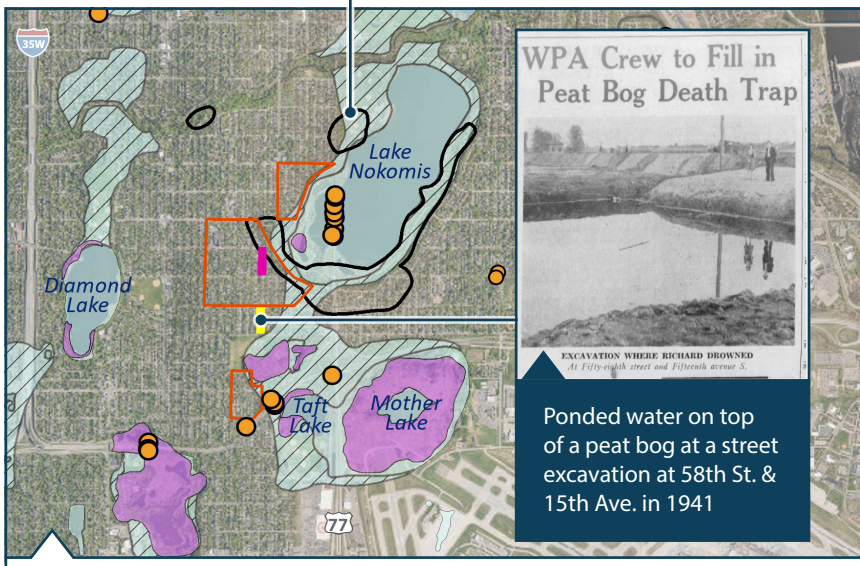
20 years after the excavation of Lake Nokomis, the wetlands and peat soils settled—requiring extensive repair work to parkland, shoreline, curbs, and pavement. Among the many repairs between 1936–1939, Works Progress Administration (WPA) workers excavated peat up to 15-feet deep and regraded over 52 acres of peat ground around the lake after it settled and cracked (see top picture on Figure 4). WPA records also show that 33,875 cubic yards of peat (equivalent to over 3,300 dump truck loads) was excavated from under settled walks, curbs, and pavements.

6 Peat soils continue to be discovered and mapped today

Our current understanding on the location of natural peat deposits and historic relocation of peat is incomplete, but continues to be refined with new data. Historic WPA records note that peat soils were removed from Lake Nokomis and used to fill depressions by Minnehaha Creek and peat soils from Mother Lake were used to fill depression on the south side of Lake Nokomis (see black outlines on Figure 4). Maps from the Minnesota Geological Survey (MGS) in 2007 and 2018 show areas of peat in the Lake Nokomis area (shown in purple on Figure 4). Yet recently, peat has been found at the surface and up to 50-feet deep outside of these areas as well (shown as yellow dots in Figure 4). Given the movement of peat in and around Lake Nokomis for development, and the discovery of peat soils outside of mapped areas, we know that peat soils exist in small pockets that are not completely documented in geologic atlases—including under homes in the evaluation's Areas of Concern. Given peat's ability to trap water, further mapping is needed to refine our understanding of peat locations.

The University of Minnesota, Minnesota Geological Survey, and USGS, with support from the City of Minneapolis, will conduct additional soil drillings to map the small pockets of peat and wetland soils in the Areas of Concern. **Read more on page 9.**

WPA workers turned over peat soils on the northwest side of Lake Nokomis in 1937 to eliminate cracks and settling



Ponded water on top of a peat bog at a street excavation at 58th St. & 15th Ave. in 1941

Figure 4: Known peat areas based on the 2018 MGS Surficial Geology Atlas, WPA reports on excavated and filled peat areas, documented infrastructure issues, and soil boring data. (Credit: MCWD)

LEGEND

Geology Data:

- Areas of concern
- Former lake sediment that has been drained, excavated, and filled
- Peat and muck
- Soil borings with peat

Historical Infrastructure Issues:

- 1937–1939: City sewer line repairs
- 1936–1939: Excavated and filled peat areas based on WPA reports
- 1941: Peat up to 16-feet deep disrupted road construction and created public safety issues

7 Nokomis residents experienced water issues during the wettest decade on record

From 2010–2019, the Twin Cities experienced the wettest decade ever recorded. The DNR Climatology Office notes that during this period the average annual precipitation was 34.31-inches.

This means the Twin Cities received nearly 100-inches, or 8-feet more precipitation in the 2010s, than when most of the homes near Lake Nokomis were built (shown on Figure 5). The 2010s also included the wettest seven years on record, from 2013–2019, resulting in a surplus of 32-inches of rain during those seven years. The equivalent of receiving an entire extra years' worth of rain during that time period.

8 Record rainfall combined with peat soils caused water to be trapped and perched

Record rainfall, combined with peat soils that were excavated and buried during one of the largest lake shaping efforts in the city's history, are driving water issues in the area.

Buried peat soils restrict the downward movement of precipitation into the ground. The presence of these peat soils within the areas of concern could serve to trap the surplus precipitation from 2013–2019, forming what's called perched groundwater. Since peat soils act like a sponge, once wet, they can hold onto water for extended periods of time. This may be why property owners near Lake Nokomis continued to experience water issues during drought conditions in 2020 and 2021, even though water levels were lower than normal.

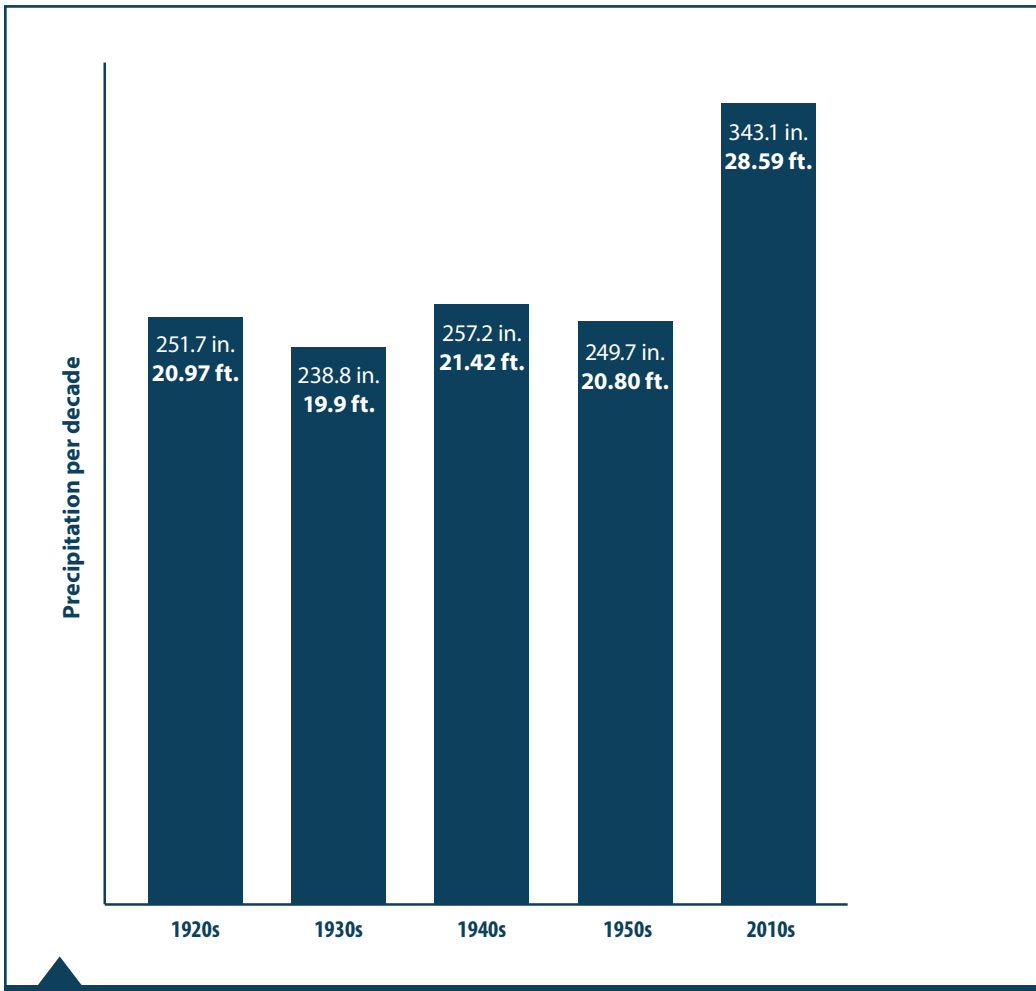


Figure 5: Precipitation per Decade. The Lake Nokomis area received nearly 100 inches (8-feet) more precipitation in the past decade (2010s), than during any decade when the homes were being built (1920s-1950s).

9 Groundwater levels are driven by precipitation

Comparing precipitation data with groundwater well data confirmed that rainfall amounts are directly driving regional shallow water tables connected to lakes, like Lake Nokomis. Groundwater wells across the Twin Cities, including those installed for this evaluation, showed that groundwater levels responded in the same way to rainfall despite being in different geographies. This demonstrates that precipitation is driving groundwater levels and not other potential local factors like infrastructure, development, or Minnehaha Creek.

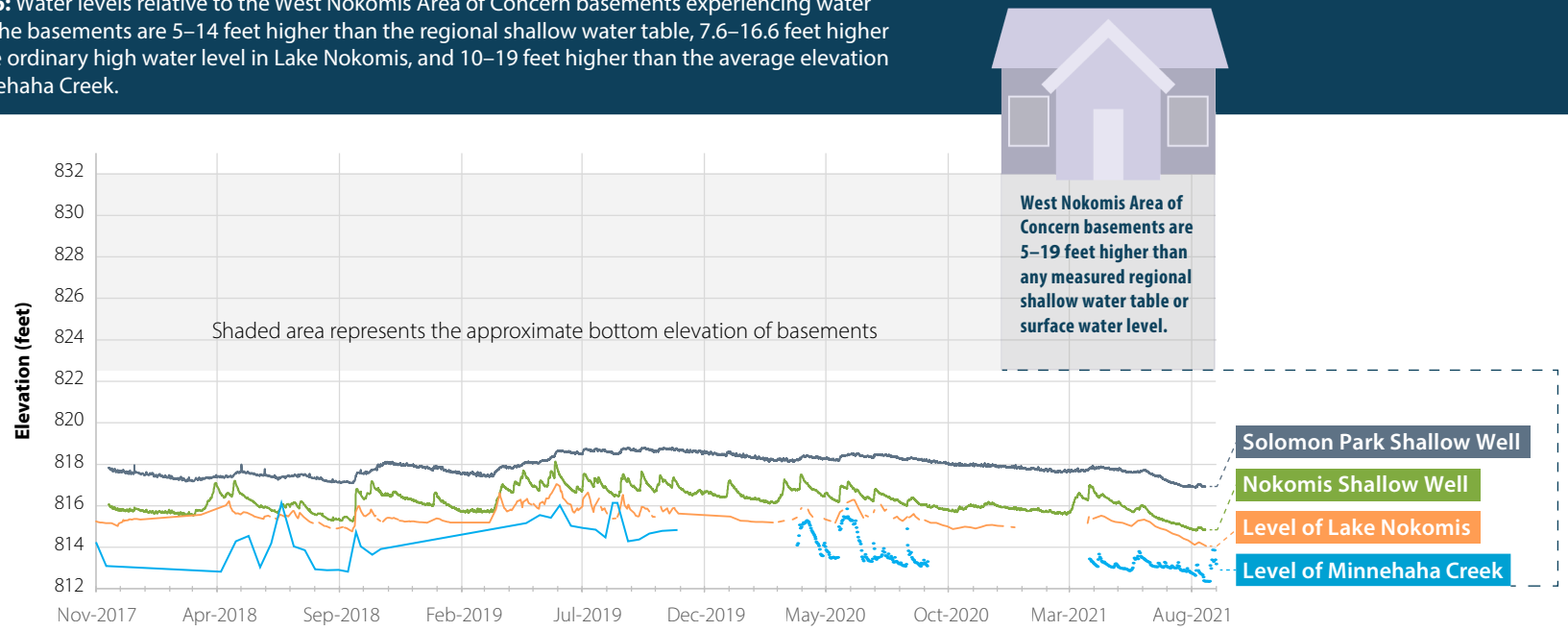
10 Basements with water issues are elevated well above shallow groundwater and surface water

Most basements with reported water concerns are elevated at least 5-feet, and up to 19-feet, higher than the regional shallow water table and surface water (Figure 6). Basements are similarly elevated above the surface water level of Lake Nokomis and Minnehaha Creek. This shows that the shallow regional water table, Lake Nokomis, and Minnehaha Creek do not contribute to the water issues for most reported basements; and that perched groundwater near those homes could be contributing to the issues.

11 Redevelopment over the past decade is not a contributing factor

Land use change and redevelopment over the past decade (2010s), and their associated stormwater management activities, are not contributing to the water concerns. The total amount of water infiltrated by stormwater management practices is modeled to be approximately 1% of the total regional groundwater recharge.

Figure 6: Water levels relative to the West Nokomis Area of Concern basements experiencing water issues. The basements are 5–14 feet higher than the regional shallow water table, 7.6–16.6 feet higher than the ordinary high water level in Lake Nokomis, and 10–19 feet higher than the average elevation of Minnehaha Creek.



EVALUATION CONCLUSIONS

UNDERSTANDING CONCLUSIONS FOR LAKE NOKOMIS AREAS OF CONCERN:

In the Lake Nokomis Areas of Concern (see page 1 for locations), property owners experienced water issues for slightly different reasons. This is due to the characteristics of each location, and how each is responding to record-breaking precipitation, based on the geologic history of the area, the movement of peat soils in the area, the subsequent residential development of the land, and the respective elevations of each area.

▲ SOLOMON PARK:

Issues experienced: Wet backyards

Conclusion: Homes were built on or adjacent to former or existing mapped wetlands with peat soils. Peat soils have prevented record-breaking precipitation from soaking into the ground and resulted in standing water.

▲ WEST NOKOMIS:

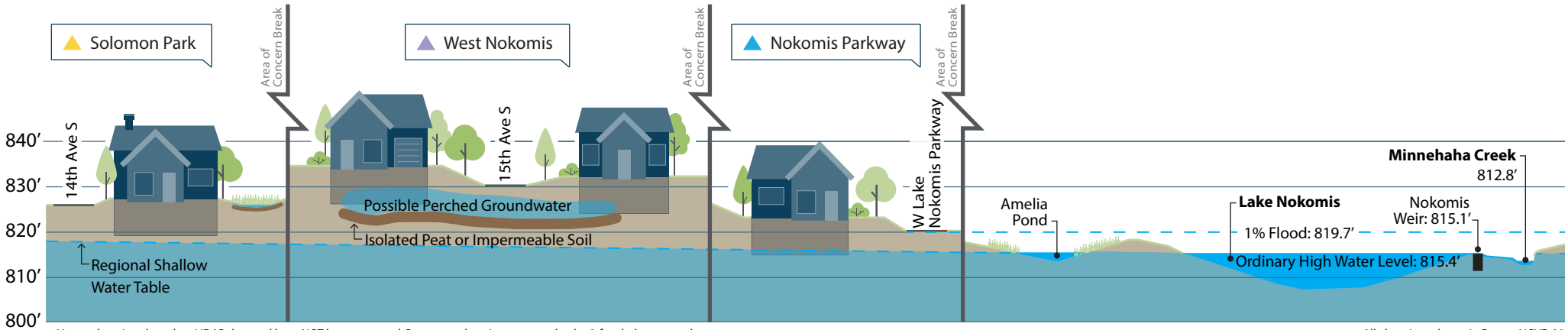
Issues experienced: Wet basements

Conclusion: Homes were built adjacent to historically filled wetlands, in areas where peat was deposited, in areas of naturally occurring peat soils, and in some instances, over the former stream channel between Mother Lake and Lake Nokomis. Lake Nokomis, Minnehaha Creek, and the regional shallow water table are not contributing to the water issues as they are 5-feet to 19-feet lower than the affected basements. This indicates the issues resulted from record-breaking precipitation being trapped by peat soils, which caused localized perched groundwater systems.

▲ NOKOMIS PARKWAY:

Issues experienced: Wet basements

Conclusion: Homes were built over former wetlands, within the former Lake Nokomis basin, and below the current normal water level of Lake Nokomis. Record-breaking precipitation and groundwater recharge are likely exacerbating existing water issues due to area's geologic history.



House elevations based on LiDAR data and have NOT been surveyed. Basement elevations assumed to be 8-feet below ground elevation from LiDAR data. Street elevations based on survey data.

All elevations shown in Datum NGVD 29

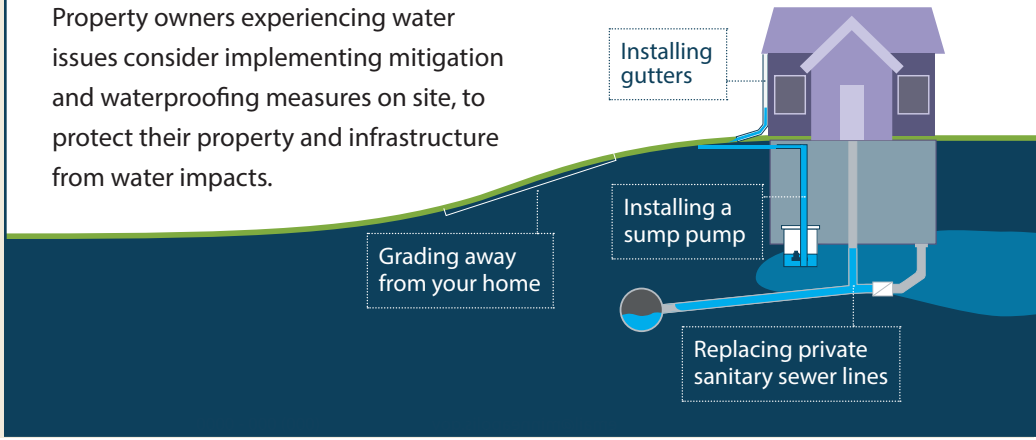
*Horizontal axis not to scale

MOVING FORWARD: **LAKE NOKOMIS AREA RECOMMENDATION AND NEXT STEPS**

The Lake Nokomis area water issues have been found to be localized and driven by geologic history, past land-use decisions, and climate change in the form of record rainfall. As a result, it is recommended that property owners experiencing water issues consider implementing mitigation measures on site, to protect their property and infrastructure from water impacts. Next steps for local governments and the Multi-Agency Team for the Lake Nokomis area will include leveraging state funding to map local geology and perched groundwater, continuing to collect and monitor surface and groundwater data from the area, while also identifying and sharing resources to support property owners in implementing individual mitigation measures.

RECOMMENDATION

Property owners experiencing water issues consider implementing mitigation and waterproofing measures on site, to protect their property and infrastructure from water impacts.



NEXT STEPS

Quantify

» **U of M, USGS, & MGS:** Leverage allocated state funds to quantify and more precisely delineate the local geological and hydrogeological features in the Lake Nokomis area. Conduct soil borings to specifically map peat and wetland soils that are causing perched groundwater conditions and affiliated issues and assess the potential impact to properties around Lake Nokomis. Develop guidelines to predict areas across the region which may experience similar issues.

» **City of Minneapolis:** Provide project support to the U of M, USGS, and MGS effort to map the extent of peat and wetland soils (geologic features) in the Lake Nokomis Areas of Concern.

Assist

» **City of Minneapolis:** Leverage data and guidelines from the U of M to continue identifying areas potentially impacted by climate driven shifts in surface and groundwater patterns across the city. Continue to evaluate and respond to emerging water issues, including those at Lake Nokomis, using established prioritization frameworks.

» **City of Minneapolis:** Continue evaluating existing laws, policy frameworks, and resources that are available to assist all affected property owners within the city with water mitigation measures; identify potential gaps and continue advocating for appropriate legislative support for local climate adaptation.

» **City of Minneapolis:** Continue identifying and sharing resources on the city's website to support actions property owners might consider implementing to mitigate localized water related impacts.

Monitor

» **Hennepin County:** Continue to collect, monitor, and analyze groundwater data from the wells on the southwest side of Lake Nokomis and near Solomon Park.

» **Minneapolis Park and Recreation Board:** Continue to collect, monitor, and analyze Lake Nokomis water levels; and operate the Lake Nokomis outlet structure according to the Lake Nokomis Outlet Operating Plan.

» **Minnehaha Creek Watershed District:** Continue to implement and expand the watershed wide real-time sensor network (RESNET) to collect, monitor, and analyze water level information across the watershed, including at Lake Nokomis.

MOVING FORWARD: **REGIONAL AND STATE-WIDE COORDINATION FOR CLIMATE ACTION**

LOCAL BUT WIDESPREAD IMPACTS OF CLIMATE CHANGE UNDERSCORES THE NEED FOR COORDINATED ACTION

The Lake Nokomis Area Groundwater and Surface Water Evaluation offers a case study on how climate change is already impacting people and communities at a local scale. It also reinforces the need for a coordinated partnership approach across various levels of government, to efficiently collect and evaluate data at multiple scales and to convene partners at appropriate levels to develop effective climate adaptation strategies.

Mobilizing a team of federal, state, county, watershed, and city partners to address local and specific impacts of climate change is not a repeatably sustainable approach to successfully planning or responding to the level of climate adaptation needed at a regional and state scale. The partnership surrounding the Lake Nokomis area issues has revealed many insights which the partners on the Team are carrying forward to advance in synchrony on the issue of climate action across all of Minnesota. Partners on the Team are actively working on climate action planning — offering a strong foundation for new coordination to build upon (see sidebar).

CLIMATE ACTION PLANNING COMPLETE OR UNDERWAY

- 2022 State of Minnesota Draft Climate Action Framework
- Hennepin County 2021 Climate Action Plan
- MCWD Climate Action Framework (to be released mid-2022)
- MPRB 2020 Ecological System Plan
- City of Minneapolis 2013 Climate Action Plan

NEXT STEPS FOR PUBLIC PARTNERS WORKING TOGETHER FOR CLIMATE ACTION

To help Minnesota communities adapt, the Team has identified that new governance models are needed to:

UNDERSTAND & PREDICT

Utilize and expand technical capabilities in data collection, analysis, and tools to understand and predict the impacts of climate change at a systems scale.

CONVENE & PLAN

Agencies convene to build consensus around the issues, align goals, form partnerships, leverage resources, and develop a coordinated response plan.

IMPLEMENT, MEASURE, & ADAPT

Coordinate implementation actions with partners to make measurable progress towards goals. Implementation actions may include funding, policy changes, projects and programs.

To review the full list of next steps and recommendations from the Multi-Agency team, see Appendix A in the Lake Nokomis Area Groundwater and Surface Water Evaluation here: **tinyurl.com/29aret94**

REFERENCES

Front Cover

Top left image: Meeting of the Multi-Agency Team, Credit: MCWD

Bottom left image: 1920s or 1930s aerial photo looking northeast towards Lake Nokomis. Hennepin County Library, https://digitalcollections.hclib.org/digital/collection/p17208coll14/id/2326

Bottom center image: 1853 Original Land Survey. GLO Historic Plat Map https://www.mngeo.state.mn.us/glo/index.html

Right image: Lake Nokomis South West Swamp Looking from 26 Line at Cedar Avenue (Baths Before Improvement). Minneapolis Park & Recreation Board, http://collection.mndigital.org/catalog/p16022coll55:2154

At A Glance Overview

Wirth, T. (1945). Minneapolis Park System 1883-1944: Retrospective Glimpses into the History of the Board of Park Commissioners of Minneapolis, Minnesota and the City's Park, Parkway, and Playground System.

Page 2: Evaluation Approach

South Section of Lake Nokomis Park, Minneapolis, Minnesota. Minneapolis Park & Recreation Board, https://collection.mndigital.org/catalog/p16022coll55:2198

Lake Nokomis and Hale Neighborhood on November 5, 1929. Hennepin County Library, https://digitalcollections.hclib.org/digital/collection/p17208coll14/id/2401

Page 3: Evaluation Findings (1&2)

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Page 5: Evaluation Findings (5&6)

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