DRAFT (03.09.18)

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March 9, 2018

Mr. Randy Kerkman, Department of Public Works
Village of Bristol
19801 83rd Street
Bristol, WI 53104

Re: George Lake Flooding Analysis–March 9, 2018 DRAFT
Village of Bristol, Wisconsin

Dear Mr. Kerkman:

Enclosed is a draft of the George Lake Flooding Analysis. Please review the draft and let us know if you have any comments. Note that recommended improvements are separated into improvements that can be done by the Village of Bristol (Village) and improvements that are responsibilities of other property owners. This is intended to highlight the challenges that the Village faces in performing any actions to improve flooding conditions due to lack of access to private property. It is also intended to highlight the importance of individual property owners' actions and responsibilities to help reduce flooding impacts in the future.

Please call me with questions.

Sincerely,

STRAND ASSOCIATES, INC.®

Ben W. Wood, P.E.

Andrew E. Toay, P.E.

Enclosure: Report

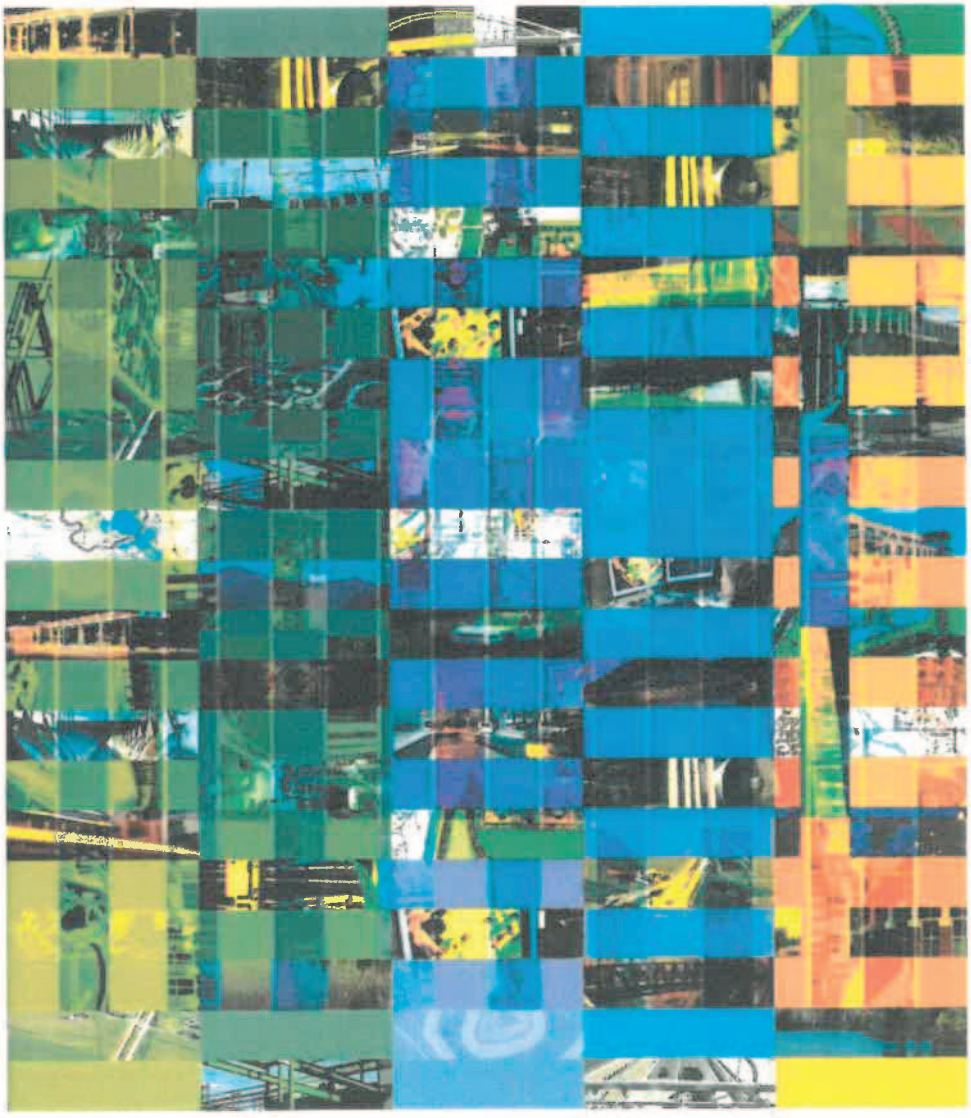
DRAFT-(03.09.18)

Professional

Engineering

Services

George Lake Flooding Analysis



Report

Village of

Bristol, WI

March 2018

STRAND ASSOCIATES

DRAFT-(03.09.18)

Report for
Village of Bristol, Wisconsin

George Lake Flooding Analysis

Prepared by:

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Milwaukee, WI 53202
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February 2018

STRAND ASSOCIATES®

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OPTIONAL

APPENDICES

EXECUTIVE SUMMARY

A. Background

In July 2017, southeast Wisconsin encountered two large rain events that were estimated to have caused a 500-year flood throughout the region. The George Lake Neighborhood in the Village of Bristol (Village) was one neighborhood that was severely affected by the flooding. Many homes had water in the basements, and in some instances, flood levels reached the first floor of the home. Resident survey results indicate that this neighborhood experiences flooding approximately every 4 to 5 years. Figure 2 shows the results of the resident survey. Strand Associates, Inc.® (Strand) was hired by the Village to study the affected area and evaluate recommendations to potentially better control flood waters in the future.

B. Watershed Overview and Function

Figure 3 shows an overview of the George Lake local watershed. George Lake drains to the Dutch Gap Canal (Canal). The neighborhood is situated between north of the Lake and west of the Canal and at an elevation lower than the lake and higher than the Canal. Farm fields to the north and west are at an elevation higher than the neighborhood and are drained through drain tile that discharges to the north of the neighborhood. The 100-year flood plain encroaches into the neighborhood onto several residential properties. Because of the relatively flat elevation between the neighborhood and the Canal, the neighborhood will only drain effectively if the Canal drains effectively. Currently, there is a culvert on the Canal that restricts flow and likely exacerbates the flooding impacts to the neighborhood.

C. Watershed Jurisdiction

The Canal traverses several private properties and lands owned by the Wisconsin Department of Natural Resources (WDNR). The responsibility to maintain the Canal is that of each property owner. While the Village is aware frequent beaver dams, the culvert (owned by WDNR), and downed tree limbs all restrict the flow and therefore the ability for the neighborhood to drain, the Village does not have jurisdiction to maintain the Canal. The Village owns right-of-way along each of the streets and one empty lot on the north and west side of 189th Avenue. Kenosha County owns several empty lots on the north ends of 189th and 190th Avenues including a drainage ditch that drains the neighborhood to the Canal. Most empty lots that carry the neighborhood's stormwater drainage to the Dutch Gap, including most lots that Dutch Gap traverses, are owned privately. This mix of ownership presents a significant challenge for the Village to implement a drainage solution.

D. Conclusions

Implementing the recommendations of this study will likely only minimize and not eliminate the impacts of flooding on the George Lake neighborhood. The Village has already undertaken significant efforts to maintain drainage ways in the neighborhood, but ultimately the responsibility lies with the property owners of the Canal to improve drainage in the local watershed. The Village should consider purchasing properties within the 100-year flood plain as the WDNR has a 50 percent matching grant available. Implementing additional catch basins or crossroad culverts will likely only be effective after the Canal is cleared of restrictions and dredged.

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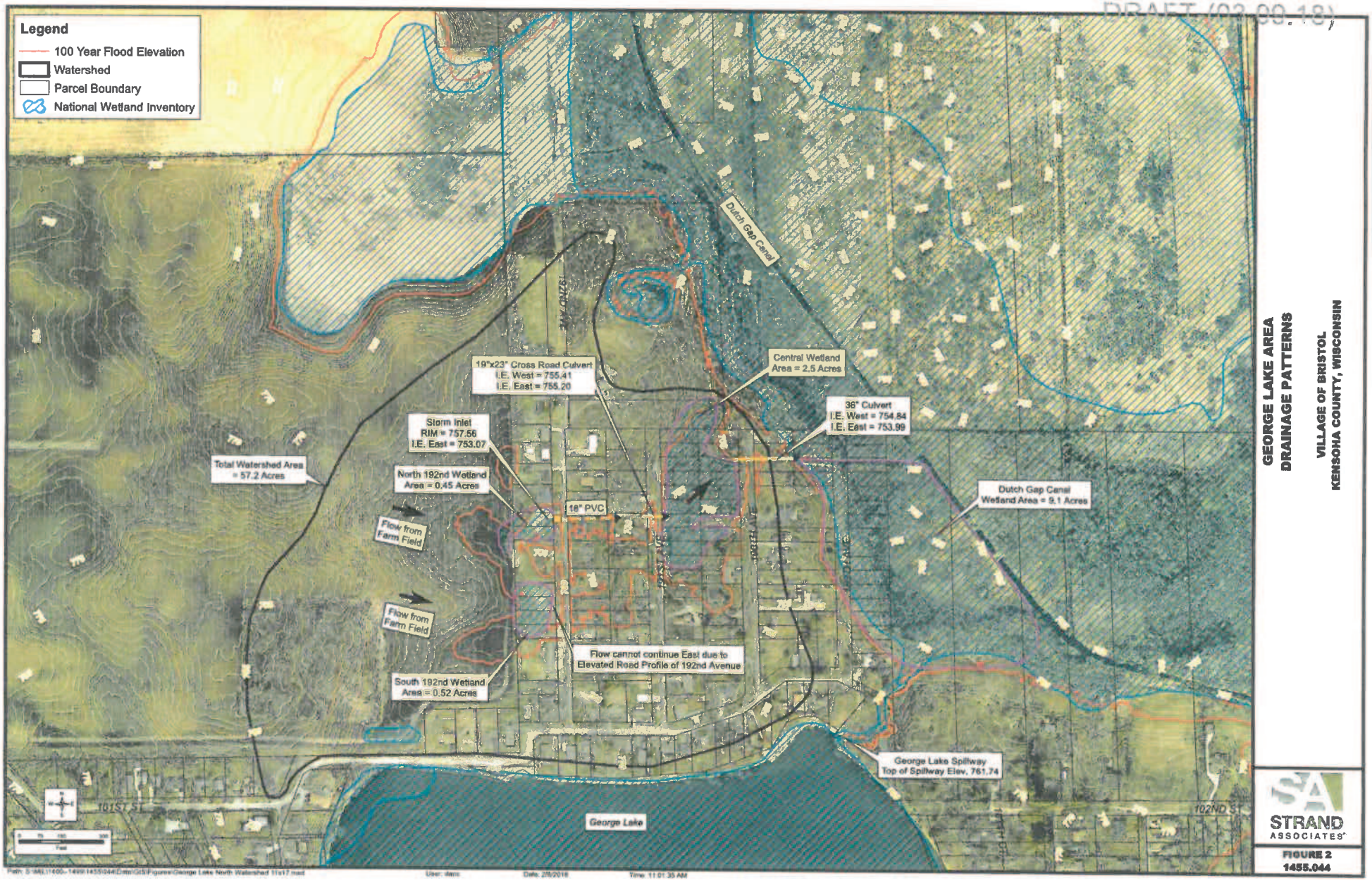

GEORGE LAKE AREA
DRAINAGE PATTERNS

VILLAGE OF BRISTOL
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES

FIGURE 2
1455.044

Past and Present Village Efforts to Reduce Flooding Impacts

The Village has performed a number of actions within the George Lake neighborhood in an attempt to reduce flooding impacts to the residents. The following is a discussion of improvements that have been made by Village staff in the past, and ongoing efforts by Village staff that have improved, or will improve, the drainage conditions in the George Lake neighborhood.

A. Stormwater Conveyance Improvements

1. Installed 36-Inch Culvert beneath 190th Avenue

The Village has installed a 36-inch culvert beneath the north end of 190th Avenue that drains stormwater runoff from the central wetland area between 190th and 191st Avenues. This culvert provides a way for runoff to exit the central wetland area during heavy rain events.

2. Clearing of the Central Wetland Area

In fall 2017, the Village cleared a large area of trees located between 190th Avenue and 191st Avenue. This area is a low spot within the neighborhood, and it is common for water to collect in this wetland area before flowing toward the Canal. Previously this area was heavily wooded with trees and brush, and in many areas, stormwater could not flow because of blockages caused by trees, roots, and brush. The Village has removed a large number of these trees and brush that were impeding the flow of stormwater runoff. While this area is still low, and has generally flat topography, it has been graded to promote drainage from west to east so water can flow out of this central wetland area and toward the Canal.

3. Cleared Ditch North of 190th Avenue

North of 190th Avenue there is a ditch that drains the central wetland area toward the Canal. This ditch is at a higher elevation than the 36-inch culvert the Village installed beneath 190th Avenue, however, this ditch provides an alternate route for stormwater to leave the central wetland area if the water is high enough. Before clearing of the ditch, it was difficult for stormwater to flow because of blockages caused by tree roots, brush, and fallen tree branches.

4. Repairs to Existing Drain Tile System

There is an 18-inch drain tile that runs through the neighborhood that was once installed to drain the farm fields to the west of the neighborhood, and convey stormwater toward the Canal. Recently, the Village has replaced portions of this tile with 18-inch PVC sewer that runs from a newly-installed inlet west of 192nd Avenue to the east of 191st Avenue. As part of these repairs, the Village also installed an inlet on the west side of 191st Avenue.

5. 191st Avenue Culvert Replacement

The Village replaced the 19-inch by 23-inch crossroad culvert at the low point of 191st Avenue before re-paving 191st Avenue.

B. Sanitary Sewer System Improvements

1. Cleaning and Televising Sanitary Sewer Mains

Within the past 5 years, the Village completed a comprehensive cleaning and televising program of the sanitary sewers within the George Lake Neighborhood. The Village cleaned and televised all of the Village-owned sanitary sewer within the neighborhood in an effort to find any defects to the system that needed repair. Frequent cleaning, and televising, help the Village monitor the condition of their infrastructure and allow the Village to make any necessary repairs to the system.

2. Sewer Lateral and Manhole Repairs

The Village is responsible for maintaining manholes and main line sewers. Property owners are responsible for maintaining sewer laterals to the point of connection to the sewer main. The Village has replaced several sanitary sewer laterals that had significant defects in an effort to be proactive about reducing inflow and infiltration (I/I) into the sanitary system. The Village routinely inspects the sanitary sewer manholes, and performs repairs as necessary. Repairing these damaged sanitary sewer laterals is one way to significantly reduce I/I within the sanitary system. Reducing I/I within the sanitary sewer system can reduce the flow in the system during heavy rain events, and reduce the amount of water that could potentially back up into basements.

3. Pumping Station Improvements

The sanitary sewer system in the George Lake neighborhood flows by gravity to a pumping station located on the northeast side of 190th Avenue. Once flow reaches the lift station, it is pumped away toward a wastewater treatment plant. In an effort to increase the capacity of the lift station, the Village has installed larger pumps that increased the pumping capacity by about 30 percent. The Village also installed a backup generator at the pump station so that the pumps will keep running in the event of a power outage. Increasing the capacity of the pump station allows for a larger amount of water to be pumped away before it backs up into a home's basement. Installing a backup generator was another system improvement intended to reduce sewer system backups. Before installing a backup generator, the pump station would not function during a power outage, which could lead to a system backup and sewage in home basements.

C. Roadway Improvements

1. Raising 101st Street Profile

In 2017, the Village re-paved 101st Street, and the profile was raised by approximately 10 inches. By raising the profile of the road, this further restricts flow of water from George Lake into the George Lake Neighborhood by acting as a berm or dam between the lake and the homes.

2. Maintaining Low Points on 190th and 191st Avenues

When the Village re-paved the roads within the George Lake neighborhood in 2017, the low points in the road on 190th and 191st Avenues were maintained so that the roadway would not further impede the flow of stormwater runoff from west to east throughout the neighborhood.

D. Agency Coordination and Public Outreach

1. WDNR Culvert on the Canal

The WDNR owns a culvert on the Canal downstream of the George Lake neighborhood that restricts the flow of the Canal. The Village has been in contact with WDNR about maintaining and possibly removing this culvert in an effort to relieve flooding impacts in the George Lake neighborhood caused by the culvert.

2. Beaver Dam Maintenance

Beaver dams are common along the Canal and create drainage problems that affect the George Lake neighborhood. The Village does not have jurisdiction over the Canal as it flows through state and county-owned land, as well as through private properties. The Village has attempted to raise awareness of the issue by contacting WDNR and private landowners to notify them that they are responsible for the maintenance of beaver dams on the Canal.

METHODOLOGY

The flooding study included the following: a planning level topographic survey of the study area to determine existing drainage patterns, a records study of the Flood Insurance Study (FIS) prepared by the Federal Emergency Management Agency (FEMA), and preparation of a flooding questionnaire that was sent to homeowners in the area. Information gathered through the survey, FEMA documents, and the questionnaire was used to evaluate existing drainage conditions and determine potential ways to reduce the flooding impacts to the George Lake Neighborhood in the future.

FINDINGS

A. FEMA Flood Insurance Study

Included in the FEMA FIS that was done for Kenosha County was a Flood Insurance Rate Map (FIRM) for the George Lake area. Among other things, this map shows the 100-year floodplain elevations for the area. Generally, the 100-year floodplain elevation for George Lake is 763, and the floodplain elevation for the Canal is 759. Figure 1 shows the limits of the 100-year floodplain in the George Lake Neighborhood, and there are a total of 54 parcels that are fully or partially located within the 100-year floodplain. The FEMA FIS for Kenosha County and the FIRM for the George Lake Neighborhood can be found in Appendix A.

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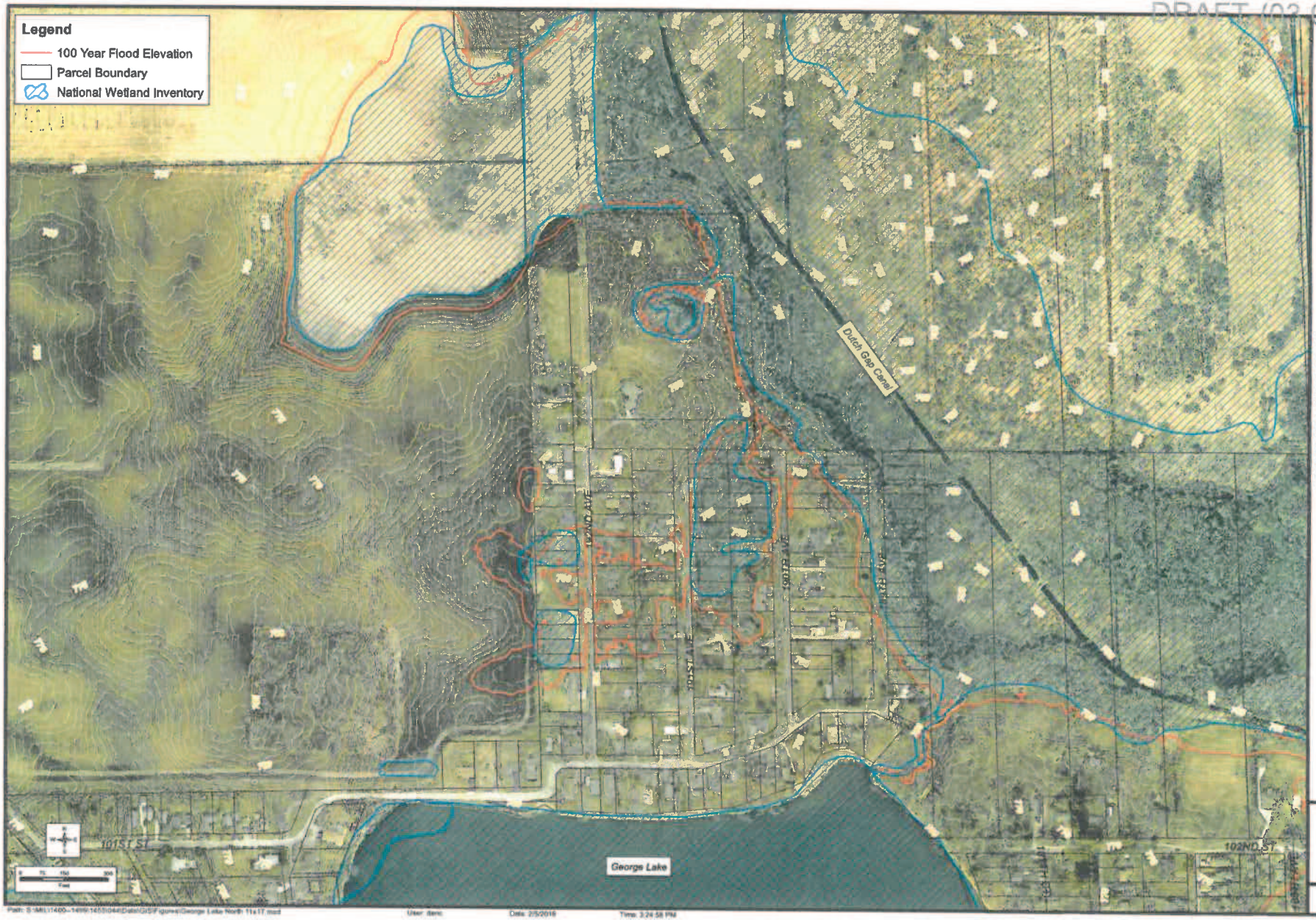

GEORGE LAKE AREA
100-YEAR FLOOD ELEVATION

VILLAGE OF BRISTOL
KENOSHA COUNTY, WISCONSIN

STRAND ASSOCIATES

FIGURE 1
1455.044

B. Flooding Questionnaire

In October 2017, a flooding questionnaire was sent to the homeowners of the George Lake Neighborhood. A sample of the questionnaire and the results are included in Appendix B. There were a total of 28 residents that responded to the survey, and the results are summarized in Table 1 and on Figure 2. Of the 28 respondents, 24 properties had flooding on their property during the July 2017 flooding event. Additionally, 18 of the 28 respondents had flooding inside of their home. The majority of the flooding was limited to basements, garages, and crawlspaces. However, there were two respondents that indicated flood levels reached the first floor of their home. These properties were located at 9843 192nd Avenue and 9808 192nd Avenue.

There were 8 survey respondents that indicated the July 2017 flooding contained sewage, either odor or sewage debris. Strand staff followed up with these residents to ask them more about the sewage in the flood water. Most of the residents indicated that the sewage odor and debris was noticed in the floodwater outside of their homes. However, one resident at 9913 191st Avenue said there was toilet paper and debris in her basement and said that for a period of time there was a sewage "fountain" that sprayed about 1 foot above her floor drain.

Property	Property Flooded (Yes/No)	Flooding on Inside of Home (Yes/No)	Location of Flooding Inside Home	Flooding Contained Sewage
18807 101st Street	Yes	Yes	Basement/Garage	No
18931 101st Street	Yes	No	—	No
19003 101st Street	Yes	No	—	No
19214 101st Street	Yes	Yes	Crawlspace	No
19216 101st Street	No	No	—	No
19218 101st Street	No	No	—	No
19236 101st Street	Yes	No	—	No
19510 101st Street	Yes	Yes	Basement	No
19538 101st Street	Yes	Yes	Basement	Odor
19542 101st Street	Yes	Yes	Basement, Crawlspace	Odor
9837 190th Avenue	Yes	Yes	Crawlspace	No
9901 190th Avenue	Yes	Yes	Basement	No
9913 190th Avenue	Yes	No	—	Odor, Debris
9917 190th Avenue	Yes	No	—	Odor, Debris
9921 190th Avenue	Yes	Yes	Basement	No
9936 190th Avenue	No	No	—	No
9826 191st Avenue	Yes	Yes	Basement	No
9900 191st Avenue	Yes	Yes	Crawlspace	No
9912 191st Avenue	Yes	Yes	Basement	Odor, Debris
9913 191st Avenue	Yes	Yes	Basement	Odor, Debris
9808 192nd Avenue	Yes	Yes	Floor, Walls	No
9818 192nd Avenue	No	No	—	No
9823 192nd Avenue	Yes	Yes	Crawlspace	No
9843 192nd Avenue	Yes	Yes	First Floor, Crawlspace	Odor
9907 192nd Avenue	Yes	Yes	Basement, Crawlspace	No
10012 192nd Avenue	Yes	Yes	Basement	Odor
10022 192nd Avenue	Yes	Yes	Crawlspace	No
10102 196th Avenue	Yes	No	—	No

Table 1 George Lake Neighborhood Flooding Questionnaire Results

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C. Field Drainage Survey

The field survey conducted consisted of a GPS survey of critical elevations and structures in the George Lake Neighborhood that captured and documented the general drainage patterns in the area. Figure 3 outlines the general drainage patterns of the George Lake Neighborhood.

1. Stormwater Runoff

A large portion of stormwater runoff enters the George Lake Neighborhood from farm fields located west of the neighborhood. Once runoff leaves the farm fields, it collects in two places on the west side of 192nd Avenue. There are vacant lots to the north and south of 9902 192nd Avenue where water collects as it runs off the farm fields. In each area, there are classified wetlands present, and drainage cannot continue to flow east because of the elevated road profile of 192nd Avenue (refer to Figure 4). However, in the lots north of 9902 192nd Avenue, there is an inlet that collects stormwater once the water level is high enough.

Figure 4 Wetland Areas on the West Side of 192nd Avenue, Looking East

Water flows into this inlet and through an 18-inch PVC pipe to the east under 192nd Avenue, 191st Avenue, and eventually toward the Canal. There is no inlet to drain the vacant lots south of

9902 192nd Avenue, and once runoff reaches this area it is effectively trapped until it infiltrates or evaporates.

2. George Lake Spillway

The normal water level of George Lake is controlled by a concrete spillway that is located at the northeast side of the lake (refer to Figure 5). The spillway consists of a concrete structure where the water flows over the top and into a creek that eventually runs into the Canal. As the water leaves George Lake over the spillway and into the creek, it flows to the north and east until it reaches the Canal wetlands area where it collects and ponds before making its way into the Canal (refer to Figure 6).

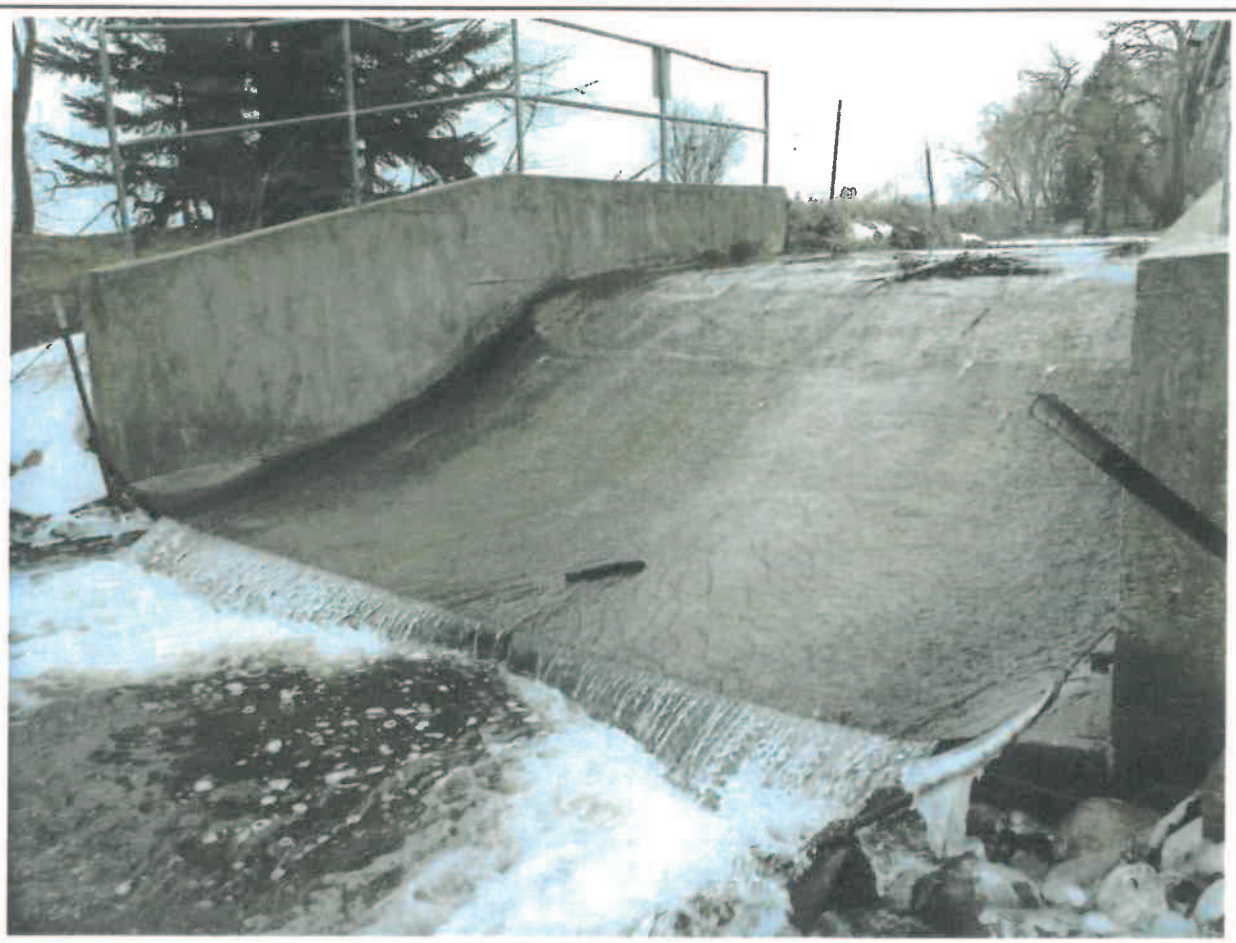

Figure 5 George Lake Spillway

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Figure 6 Creek Downstream of George Lake Spillway Flowing Toward the Dutch Gap Canal

It was suspected that during the July 2017 flooding event, the water levels of George Lake rose to a level that was higher than the road profile of 101st Street on the northwest side of George Lake. Strand staff spoke with several residents that live near the northwest side of the lake, and none were able to confirm whether or not the flood levels of George Lake rose above 101st Street and contributed directly to the flooding in the George Lake Neighborhood. Strand's field survey did, however, confirm that the centerline road profile for 101st Street is approximately 1.4-feet higher than the 100-year flood elevation of George Lake. This confirms that a 100-year storm will not cause George Lake to rise above 101st Street and flow into the George Lake Neighborhood.

3. Central Wetland Area

There is a large, approximately 2.5 acre area (refer to Figure 7) located within the north side of the George Lake Neighborhood between 191st Avenue and 190th Avenue that is located within the 100-year floodplain for the Canal. This area is a natural low point within the George Lake Neighborhood that collects surface runoff from within the neighborhood. There is also a 19-inch by 23-inch culvert underneath 191st Avenue that brings water from the west side of 191st Avenue

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to the east side of the road. The water can exit the wetland area via a 36-inch culvert that is installed underneath the north end of 190th Avenue (refer to Figure 8). Water flows through this culvert and runs into the lowland area west of the Canal before flowing into the Canal. This central wetland area is essentially functioning as a large dry detention basin. The flow route from the 19-inch by 23-inch culvert at 191st Avenue to the 36-inch culvert at 192nd Avenue is approximately 325-feet long, but only has about a 0.1-percent slope. The entire area is extremely flat and likely makes it difficult for water to flow.

Figure 7 Central Wetland Area

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Figure 8 Water Leaves the Central Wetland Area via 36-inch Culvert Under 190th Avenue

4. Dutch Gap Canal Wetlands Area

There is a large, approximately 9.1 acre, wetland area that is located between the lots on the east side of 190th Avenue and the Canal that is extremely flat where water collects before entering the Canal. This entire area is located within the 100-year floodplain of the Canal. Once water reaches this area there is no direct, channelized flow path from the George Lake Spillway or the Central Wetland Area to the Canal. Based on Strand's field observations (refer to Figure 9) and some comments from residents, it is common for the water to pond and stay stagnant in this area. One resident indicated it is common for there to be about 1 foot of standing water and algae is commonly present. The area is heavily wooded, and large trees and fallen branches may be preventing some water to get into the Canal. The elevation of the 36-inch culvert outfall on the northeast side of 190th Avenue is lower than the elevation of the creek leaving the George Lake Spillway. With no direct flow routes to the Canal from the Central wetland area and the George Lake Spillway, it may be possible for water from George Lake to flow from the spillway back into the Central Wetlands area if the water elevations are high enough in the Canal Wetlands area.

During Strand's field investigation, Strand staff saw evidence of beaver dams located along the Canal. Strand discussions with residents of the George Lake Neighborhood also confirmed that beaver dams are common along the Canal. These beaver dams may contribute to flooding that occurs within the George Lake Neighborhood. The Village should continue coordinate with both Kenosha County and the WDNR, as well as private landowners, about further investigation of beaver dams on the Canal, their impacts to flooding in the area, as well as possible ways to minimize or mitigate their effects on the neighborhood.

Figure 9 Looking North as Water from George Lake Spillway Collects and Ponds in Dutch Gap Canal Wetlands with No Direct Route to the Dutch Gap Canal

RECOMMENDED IMPROVEMENTS

Because of the existing low and flat topography in the George Lake Neighborhood and the natural drainage patterns of the area, there is likely no single drainage improvement project that will provide adequate flood protection for the type of severe, 500-year, rainfall events that was experienced in July 2017. The Canal should be dredged so that improvements made within the neighborhood are effective. There are a number of small-scale projects and maintenance-related measures that can be done that will help to minimize the impacts of local flooding (refer to Figure 10) and will improve local drainage after the Canal is drained. The recommendations are organized according to the type of property ownership. The general timing and opinion of probable cost of each recommendation is shown for each item. Opinions of Probable Construction Cost are a concept level budget only. These recommendations should be further evaluated prior to implementation.

A. Dutch Gap Canal Owner Recommendations

The neighborhood drainage is not likely to improve until the flow restrictions on the Canal are removed. Figure 11 presents an overview of the Canal recommendations.

1. The WDNR should remove the culvert located on its property (refer to Figure 11). (Near Term, $5,000)

2. Dredge the Canal from CTH Q to CTH C. (Near Term, $2,000,000)

   The Dutch Gap Canal should be dredged from County Highway Q to the south, upstream to County Highway C on the north. This effort would require coordination between 14 private property owners, the WDNR, Kenosha County, and the Village. This effort would include dredging approximately 10,000 linear feet of mainline channel plus small branches of channel.

3. Form a Local Drainage District (Near Term, no cost identified)

   A drainage district should be organized to include the property owners listed above. This would likely be organized through Kenosha County. Village staff indicated there was a drainage district in place at one time but was dissolved. The purpose of the new drainage district should be to focus on maintenance of the Canal and drain tiles and should include a funding mechanism, such as fees, to cover the cost of those efforts.

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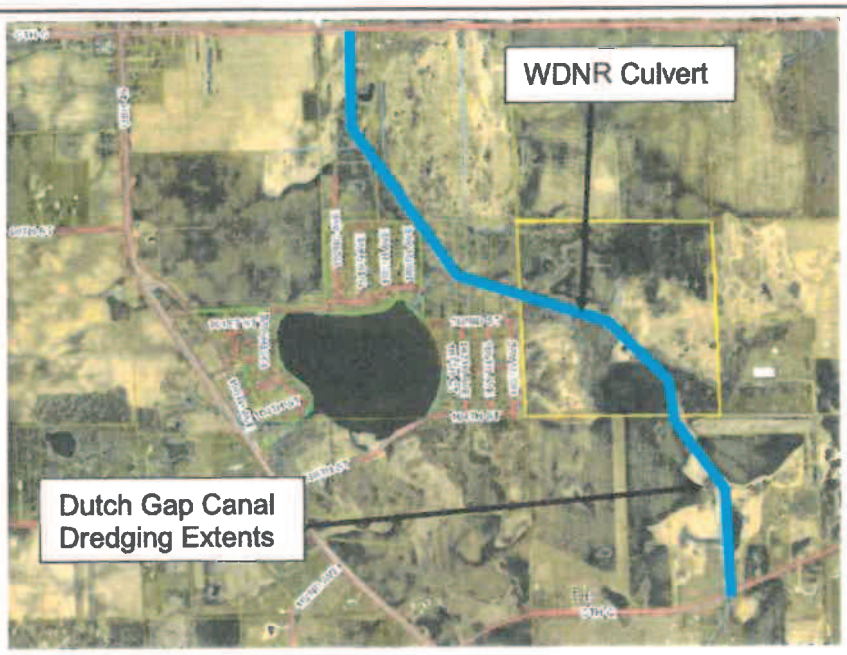

Figure 11 The Dutch Gap Canal should be Dredged and the WDNR should Remove the Restricting Culvert

B. Vacant Lot Owner Recommendations

1. Dredging Central Wetlands Outfall and Bank Stabilization (Near Term, $60,000)

Once stormwater leaves the 36-inch culvert that daylights east of 190th Avenue, there is no clear path or creek for the stormwater to be conveyed to the Canal. Currently, the flow path from the culvert runs through a heavily wooded area that may be full of branches, fallen trees, and other debris, and once water does reach the Canal Wetland Area there is no direct route for the water to reach the Canal. Owners of these vacant lots should dredge the existing flow route to clear it of branches, sediment, and debris, and create a more direct channel for water to flow toward the Canal (refer to Figure 12). Owners of these lands include private property owners and Kenosha County.

Figure 12 Owners of Vacant Lots Must Remove Branches and Maintain a Flow Path to the Dutch Gap Canal.

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C. Neighborhood Homeowner Recommendations

1. Televising and Lining Sanitary Sewer Laterals
(Near Term, $2,000 per lateral)

The Village frequently televises its sewers in the neighborhood. Homeowners own their sanitary lateral to the point of connection to the Village's sewer, which is common throughout Wisconsin. Cracks and leaks in private property laterals can contribute significantly to I/I. This flow of stormwater can overwhelm the sanitary sewer system and contribute to sewer backups in homes. Therefore, homeowners should televise their lateral to evaluate the condition. Deficiencies should be repaired by lining the lateral.

2. Driveway Culvert Replacements and Repairs
(Most effective after the Canal is dredged, $2,000 per property)

Driveway culverts are owned by the individual homeowners. During Strand's field survey, many of the driveway culverts appeared to be damaged or collapsed, and others were blocked with debris or buried (refer to Figure 13). The Village recently resurfaced the roads in this neighborhood and offered to replace driveway culverts for the cost of materials only, which was approximately $750 each. Unfortunately, property owner participation was only approximately 10 percent. Improving the flow through the culverts will help water to drain more readily to the Canal, which will be most effective after the Canal is drained. Until then, water will be able to move more freely in the local drainage system but will still have essentially nowhere to drain to.

Figure 13 Driveway Culvert Blocked on 191st Avenue

D. Village Recommendations

1. Continue Efforts to Organize Property Owners to Implement Recommendations (Near Term, no cost identified)

Multiple property owners will need to implement recommendations in order to improve drainage in the George Lake area. The Village has made several attempts to coordinate with WDNR and property owners to make these improvements in the past. The Village should continue attempts to organize property owners. The Village should work with Kenosha County to initiate the creation of a drainage district that would further help to coordinate and fund improvements.

2. Acquisition of Flood Prone Properties (Near Term, $420,700, refer to Table 2)

There are several properties and homes within the George Lake Neighborhood that are located within the 100-year floodplain of the Canal and are affected by frequent flooding. One such property is located at 9843 192nd Avenue. The residents of 9843 192nd Avenue indicated in their response to the questionnaire that as of mid-November 2017, they were still unable to live in the house because of flooding damage from the July 2017 storm. Strand recommend the Village consider acquiring these properties with assistance through the WDNR's Municipal Flood Control (MFC) Program which provides a 50 percent matching grant. Based on the response from the questionnaire, the structures on these properties are frequently flooded. Projects that involve acquiring flood prone properties are viewed favorably by the WDNR.

Property Information		Assessed Value		
Address/Location	**Parcel No.**	**Land**	**Improvements**	**Total Value**
9843 192nd Avenue	37-4-121-204-0255	$44,500	$88,000	$132,500
9839 192nd Avenue	37-4-121-204-0250	$44,500	$108,900	$153,400
191st Avenue	37-4-121-204-0292	$17,400	$0	$17,400
191st Avenue	37-4-121-204-0294	$17,400	$0	$17,400
9913 191st Avenue	37-4-121-204-0334	$26,400	$31,300	$57,700
191st Avenue	37-4-121-204-0332	$26,400	$0	$26,400
191st Avenue	37-4-121-204-0330	$5,300	$0	$5,300
191st Avenue	37-4-121-204-0328	$5,300	$0	$5,300
191st Avenue	37-4-121-204-0326	$5,300	$0	$5,300
	Total Assessed Value	**$192,500**	**$228,200**	**$420,700**

Table 2 George Lake Neighborhood Flood Prone Properties Recommended for Village Acquisition

3. Install Culvert Backflow Preventer
(Near Term, $14,000)

There is a 36-inch culvert that runs underneath the north end of 190th Avenue (refer to Figure 14) and drains stormwater from the Central Wetland Area toward the Canal Wetlands Area. The culvert daylights on the border of Village-owned property and private property with the downstream ditch being located on private property. We assume the Village has jurisdiction over this pipe, but that should be verified. The invert elevation of this discharge is at a lower elevation than the creek that flows from the George Lake Spillway. Therefore, when water levels get high enough in the Canal Wetland Area, water may flow back into the George Lake Neighborhood through this culvert. A backflow preventer such as a duckbill check valve should be installed to prevent water from flowing into the George Lake Neighborhood from the Canal Wetland Area.

Figure 14 Potential Installation of Backflow Preventer on Culvert Outfall at 190th Avenue

4. Acquisition of Drainage Way Properties and Frequent Maintenance (Near Term, $100,000 Acquisition, $30,000 Annual Maintenance)

Should the owners of vacant lots be negligent in their responsibility to maintain drainage ways, the Village could pursue the acquisition of additional properties to take over maintenance responsibility. The maintenance responsibility would mean stabilizing the banks and dredging as frequent as necessary, and removing debris before and after each storm. This could add a significant burden of time and cost to the Village. This would require the acquisition of two additional lots (parcel nos. 37-4-121-204-0466 and 37-4-121-204-0436) and a drainage easement through parcel no. 37-4-121-204-0153, shown in Figure 15.

Figure 15 Taking on Additional Drainage Ways will Create Significant Maintenance Efforts for Village Staff

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5. 192nd Avenue Storm Sewer Improvements
(Only after Dutch Gap Canal Dredging, $50,000)

Low areas west of 192nd Avenue do provide some benefit for retaining flow and thereby minimizing flooding impacts to the east under certain rainfall events. Overall, stormwater throughout the neighborhood on both sides of 192nd Avenue does not have a direct way of draining out of the neighborhood since flow is restricted on the Canal. Within the local drainage area, stormwater does not have a convenient way of draining from the west side of 192nd Avenue to the east side toward Dutch Gap wetland area (refer to Figure 16). Creating a drainage path, either by installing a culvert or inlet and storm pipe, may not improve overall drainage conditions until drainage improvements are implemented on the Canal and wetland area. After the Dutch Gap improvements are implemented, an inlet could be installed near the roadway in the ditch line of the south wetland area and connect to the existing inlet in the north wetland area with a pipe running parallel to 192nd Avenue. Connecting the two wetland areas would provide a way to drain the south wetland area during large storm events as part of the larger local system. If this improvement is implemented before Dutch Gap improvements are made, this could worsen flooding in other areas of the neighborhood.

Figure 16 South 192nd Avenue Wetland Area

6. Continue Sanitary Sewer System Inspections and Repairs Plus Smoke Testing
(Continuation of existing effort, $15,000 for smoke testing)

During the July 2017 rain events, the Village observed significantly higher flows through the George Lake Lift Station that services this neighborhood. This is a common occurrence in sanitary systems as it is the result of stormwater I/I. The Village routinely televises the local sanitary sewers and manholes to search for and repair leaks. This is an excellent practice that should be continued. As previously noted, private property I/I through sanitary sewer laterals can also be a significant contributing factor. The Village could conduct smoke testing of the neighborhood, which would quickly reveal large leaks in sanitary sewer pipes and large leaks in laterals. While

this will not provide a comprehensive assessment, smoke testing would be cheaper than having homeowners televise individual laterals and would help the Village to further identify the effects of private property I/I on its sanitary system.