North Scheuneman Road Surface Water Management Plan

Surface Water Management Plan

GEMLK 159049

City of Gem Lake | July 19, 2021

Building a Better World
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July 19, 2021

RE: North Scheuneman Road Surface Water Management Plan
City of Gem Lake
SEH No. GEMLK 159049 4.00

Mayor Artig-Swomley
City of Gem Lake
4200 Otter Lake Road
St. Paul, Minnesota 55110

Dear Mayor Artig-Swomley:

Attached is the North Scheuneman Road Surface Water Management Plan. This plan is intended to provide a summary of the analysis completed to alleviate flooding and inundation in the north Scheunemann Road area. Three primary areas were investigated throughout the study area, with a total of six scenarios for the flooding and inundation and two scenarios for water quality options. Opinions of probable cost were developed for each.

Please feel free to contact me if you have any questions or require additional information.

Sincerely,

Emily Jennings

Emily Jennings, PE
Water Resources Engineer
(Lic. MN)

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North Scheuneman Road Surface Water Management Plan

Surface Water Management Plan
City of Gem Lake

SEH No. GEMLK 159049

July 19, 2021

I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Emily Jennings, PE

Date: July 19, 2021 License No.: 56622

Reviewed By: Riley Mondloch Date: July 19, 2021

Short Elliott Hendrickson Inc.
3535 Vadnais Center Drive
St. Paul, Minnesota 55110

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North Scheuneman Road Surface Water Management Plan

Surface Water Management Plan

Prepared for the City of Gem Lake

1 Background

In spring 2019, an unusually large amount of late winter snow, rain, and an expedited melt caused flooding throughout portions of Scheuneman Road and adjacent areas. SEH inspected these areas in spring 2019 and noted various flow paths throughout the corridor, including some low areas with no obvious outlet location. To gain a better understanding of the drainage infrastructure within the City of Gem Lake, SEH was hired by the City of Gem Lake to inspect culvert crossings within the City, including both City owned culverts and privately owned driveway/entrance culverts. SEH inspected culverts in spring 2020 for structural condition, erosion, sedimentation, and whether or not inundation was present. Generally speaking, culverts throughout the City of Gem Lake and within the Scheuneman Road appeared to be in overall good shape. The past studies and documentation are included in Appendix A.

The City has asked SEH to evaluate the drainage in the area and corresponding hydraulics and investigate potential options to alleviate drainage issues throughout North Scheuneman Road through the development of a North Scheuneman Road Surface Water Management Plan (SWMP).

2 Study Area

The study area included the drainage to North Scheuneman Road between Highway 61 to Otter Lake Road with the primary areas of interest located at:

- The cross culvert and ditch system discharging to 3999 Scheuneman Road (“Culvert Area”)
- The low areas at 3809 and 3824 Scheuneman Road (“South Area”)
- The low area 4076 Scheuneman Road

The North Scheunemann Road area is bound by the Otter Lake Road/Scheuneman Road intersection to the north, the railroad to the east, Highway 61 to the south, and Gem Lake and the Gem Lake Hills Golf Course to the west. The study area, and the areas of interest noted above, are shown in Figure 1.

2.1 Cross Culvert and Ditch System

The cross culvert and ditch system, herein and on Figure 1 referred to as 'culvert area', is located just east of the Gem Lake Hills Golf Course. The crossing is a plastic, approximately 12" - 15" diameter pipe and is in good shape structurally. The upstream end of the crossing includes a flared end section surrounded by mature shrub vegetation. The downstream end of the crossing discharges to a riprap swale that extends approximately 80 feet downstream of the crossing towards the Gem Lake Hills Golf Course, ultimately reaching Golf Course Pond.

The topography immediately upstream of the crossing is mostly flat in the front, side, and back yards of the homes adjacent to the crossing. Additionally, the first-floor elevations of the homes are similar to the roadway and ground elevations of this area. Due to this, the homes and surrounding yard areas at risk for inundation and flooding.

2.2 3809 and 3824 Scheuneman Road

3809 and 3824 Scheuneman Road are located in the southern half of the study area, approximately 400 feet north of Highway 61, herein and on Figure 1 referred to as the 'south area'. The drainage in this southern part of the study area generally drains north, with the exception of a very small area in the southernmost part of the study area that discharges towards Gem Lake. The topography of this area is quite flat with several localized low areas that have no clear drainage outlet. These low areas result in water ponding in yards and near several homes, especially during times when the ground is frozen and thus infiltration is reduced. These localized low areas are located at more properties than just 3809 and 3824 Scheuneman Road, however these are the two major locations.

2.3 4076 Scheuneman Road

4076 Scheuneman Road is located in the northern half of the study area, east of Scheuneman Road and approximately 575 feet south of the Otter Lake Road/Scheuneman Road intersection. The drainage in this northern part of the study area generally drains from north to south, splitting along the crown of Scheuneman Road with the east half discharging towards wetlands east of Scheuneman Road and the west half discharging towards Golf Course Pond. The driveways of 4086 and 4076 Scheuneman Road are approximately 30 feet apart and water gets captured between the two driveways, creating nuisance inundation.

2.4 Receiving Waters

As described above, in terms of ultimate discharge, the majority of the study area discharges towards Golf Course Pond with the exception of a very small portion in the south part of the study area that discharges towards Gem Lake and portions to the east discharging towards wetlands or the railroad.

Gem Lake, the Golf Course Pond, and the wetlands located in the northeastern portion of the study area are all landlocked, with no outlet structures or diversions. Other receiving waters in the study area include the wetland located north of Hillary Farm Lane, the pond located south of Hillary Farm Lane, and other low areas located in the backyards east of Scheuneman Road.

2.4.1 Golf Course Pond

Golf Course Pond is located in the northwest corner of the City of Gem Lake. The drainage area to Golf Course Pond is comprised of medium density residential and golf course areas. Golf Course Pond is landlocked. Although the name indicates a 'pond', Golf Course Pond is considered a Public Waters Wetland.

2.4.2 Gem Lake

Gem Lake is located in the center of the City of Gem Lake. The drainage area to Gem Lake is mostly low density residential with some commercial or industrial properties. Gem Lake is a landlocked lake, completely surrounded by private property. The lake was previously listed as impaired for excess nutrients, however, was delisted in 2018.

2.4.3 Other Receiving Waters

Throughout the Scheuneman Road North area, there are a few other wetlands and ponds where water flows naturally, including:

- Wetlands located northeast of study area – These wetlands are landlocked, and the area is considered 'light management' by the Minnesota Routine Assessment Method (MnRAM) for evaluating wetland function.
- Wetland located north of Hillary Farm Lane – This wetland discharges north towards Golf Course Pond and is considered 'moderate management' by the Minnesota Routine Assessment Method (MnRAM) for evaluating wetland function.
- Pond located south of Hillary Farm Lane – The purpose and origin of this pond is unknown; however, it appears to have been constructed as part of the Hillary Farm development based on historical imagery. This pond discharges to the wetland located north of Hillary Farm Lane.
- Low areas located in the backyards east of Scheuneman Road – It is unclear if these low areas are considered wetlands. They appear to be natural low areas based on the topography, that are landlocked.

3 Water Quality Considerations

Most of the City of Gem Lake is part of the Vadnais Lake Watershed, as managed by the Vadnais Lake Area Water Management Organization (VLAWMO). VLAWMO's mission is to protect and enhance the water resources within the watershed. The City of Gem Lake also recognizes that stormwater runoff is a major source of pollution as it transports debris and pollutants into the area lakes and wetlands. Although the overall purpose of this study is to investigate solutions to alleviate drainage issues throughout North Scheuneman Road due to more severe rainfall events, the City is open to investigating options that may also benefit water quality through the installation of Best Management Practices (BMPs).

The study area has some restrictions that limit the water quality treatment options, including:

- Vertical elevation constraints
- Low infiltrating soils

- Areas of perceived high groundwater
- Lack of land ownership, easements, or other drainage permissions

These restrictions provide challenges for the construction of stormwater treatment and may also lead to infiltration and filtration practices to be considered infeasible. It is important to note that water quality improvements can be incorporated in other ways, such as stormwater detention, retention, in-line stormwater treatment, residential rain gardens, or water reuse. It is recommended that the City continue to partner with VLAWMO in the future to collaborate or partner on water quality studies, analysis, or design.

4 Approach

To better understand the drainage patterns and concerns, SEH created an existing conditions hydraulic model using XPSWMM 2D modelling software. Utilizing this 2D software allowed for SEH to numerically and graphically identify where, and estimate to what depth, inundation may occur during a given design storm event.

SEH then modified the existing conditions model to develop planning level proposed scenarios to identify possible solutions to the drainage concerns within the study area. The scope of work included one scenario for the culvert area, one scenario for 4076 Scheuneman Road, and up to three scenarios for 3809 and 3824 Scheuneman Road, as these possible solutions were more exploratory.

The study also included time for one additional area as identified by the existing conditions modelling and analysis. During modelling and analysis, it was determined that this additional area was best used to include an additional scenario for the culvert area.

5 Data Collection

Surface data was obtained from MnTOPO LiDAR. Additionally, in April of 2021, SEH completed a topographic survey of the study area. The survey consisted of collecting elevation data of low areas, ditches, culverts, roads and select first-floor elevations. Residents were notified via letter if the first-floor elevation was to be collected at their property. All first-floor elevations surveyed are tabulated in Appendix B. The first-floor elevation survey included the lowest egress point (walkout basement and egress window) or the point where water may enter a structure in the event of a flood event. Please note that if a basement is considered unfinished, the first-floor elevation may actually be higher (next level up). See Appendix B for additional detail.

The surveyed elevation data was used to modify the larger LiDAR surface. The LiDAR surface used may not accurately represent the Hillary Farm area as the LiDAR data may pre-date some of the area development.

Soil data was obtained from the USDA Web Soil Survey (WSS) website. The soil data report is included as Figure 2. Soil data was used in conjunction with aerial photography to estimate runoff curve numbers for each drainage area within the model.

6 Existing Conditions Model

The existing conditions XPSWMM model was built using collected data and assessed using rain-on-grid methodology to jointly model hydrology and hydraulics. This methodology applies a

uniform rainfall depth over the entire study area which is represented with a two-dimensional ground surface projected as a grid of cells. This allows water to freely move in any horizontal direction simulating a natural rainfall event, which concentrates and flows towards low-lying areas. Output data includes inundation mapping and depths for a given rainfall event.

Using MSE3 rainfall distribution with NOAA Atlas 14 rainfall depths, three storm events were modeled to understand the existing conditions and analyze the benefits of the proposed scenarios investigated. These design events were chosen to represent the study area issues observed in the past, including:

- A 2-year, 24-hour storm with frozen ground conditions. This event is representative of a fast and deep snow melt, or a snow melt with rain on top.
- A 10-year, 24-hour rainfall event, with frozen ground conditions. A 10-year design storm during frozen ground conditions is relatively conservative, therefore a reduction in flooding during this condition would also reduce inundation and flooding experienced during frequent storm events and most snow melt conditions.
- A 100-year, 24-hour storm with non-frozen ground conditions. A 100-year storm would be unlikely to occur on top of frozen ground, and frozen ground is not typically analyzed for major events, so the 100-year was run with normal infiltration consistent with summer conditions and sandy loam soils as indicated in the Web Soil Survey.

Figures 3, 4, and 5 show the existing conditions peak inundation and depth results throughout the project area for the aforementioned design events, respectively. It should be noted that the figures only depict those areas where the depth of inundation is greater than 0.2 feet. The results as shown in Figures 3, 4 and 5 show ponded water in those primary study areas observed in the past and as reported by the City. Most notably, the figures confirm ineffective drainage conveyance in the northern study area (culvert area) and lack of any conveyance in the southern study area (3809 and 3824 Scheuneman Road).

The figures also show ponded water in several low-lying areas or natural areas of conveyance, as expected. Many of the inundation areas as shown in Figures 3, 4 and 5 are not considered problematic as they are located away from permanent structures. Although not considered problematic, these areas may however be a nuisance to the area residents.

Table 1 shows the first-floor elevations and existing peak water surface elevations for the homes in the primary study areas. A map showing the elevation point number location is shown later in this report, in Image 1 and Image 2. **Orange** peak water surface elevation values are within 1 foot of the first-floor elevations (i.e. defined as flood risk by this report), while **red** peak water surface elevation values have exceeded the first-floor elevation.

Table 1 – Existing Peak Water Surface Elevation Results

Elevation Point Number	Study Area	Scheuneman Road Address	Surveyed First-floor Elevation (FFE) (ft)[1]	Existing Peak Water Surface Elevation (WSEL) (ft)		
				2-year	10-year	100-year
1	Culvert Area	3984 (north side)	938.18	**937.76**	**937.99**	**938.23**
2	Culvert Area	3984 (south side)	939.24	937.79	938.02	**938.26**
3	Culvert Area	3970	936.26	**937.86**	**938.06**	**938.29**
4	Culvert Area	3960	935.32	**937.88**	**938.07**	**938.30**
1	South Area	3809	956.52	955.28	**955.72**	**955.65**
2	South Area	3836	958.91	955.44	955.61	955.62
3	South Area	3824	958.86	956.07	956.13	956.16
		3812	961.92			

[1] The first-floor surveyed include the lowest egress point (walkout basement and egress window)

The existing conditions analysis was used in the following sections to compare potential improved drainage scenarios to the existing condition at both the peak of the storm events and 6 hours after the peak of the storm events. A comparison of the storm peak shows the improvement in the most severe conditions while the comparison 6 hours after the peak helps to demonstrate the proposed scenarios effect on longer standing inundation and flooding.

6.1 Flood Risk

For the purposes of this study, flood risk is defined as properties that are within 1 foot of the peak water surface elevations. As shown in Table 1, all the properties are at flood risk in the culvert area in the existing condition while just one property is at risk in the southern part of the study area. The study area is not part of a flood zone mapped by FEMA.

According to the Minnesota Department of Natural Resources (MnDNR), approximately 50% of flood damage occurs outside mapped flood zones, often due to stormwater flooding. Even with the scenarios that are to be presented, flood risk will likely remain, especially for the homes just upstream from the Scheuneman Road cross-culvert. This is due to the first-floor elevations of the homes, which are lower than the roadway and not significantly higher than any downstream discharge points.

As such, these properties (3970, 3960, and (to a lesser extent) 3984 Scheuneman Road) may want to consider purchasing flood insurance. Normal hazard insurance policies do not cover

flooding in most cases for homes. Anyone in a community that participates in the National Flooding Insurance Program (NFIP) can purchase flood insurance, and Gem Lake is on the list of participating communities. It is not necessary for a property to be mapped in a high flood risk area (100-year floodplain) to be eligible to purchase flood insurance. Flood insurance can be purchased through private insurance companies and agents if in an eligible community. It's important to note that in most cases the NFIP does not include coverage of groundwater seepage related damage.

7 Proposed Scenarios

The following proposed scenarios were analyzed:

- One scenario for the culvert area
- One scenario for 4076 Scheuneman Road
- Up to three scenarios for 3809 and 3824 Scheuneman Road
- One additional scenario as identified by the existing conditions modelling and analysis. During modelling and analysis, it was determined that this additional area was best used to include an additional scenario for the culvert area, there two total scenarios were investigated for the culvert area.

Scenarios included improvements or modifications to the existing system or drainage patterns including new and improved ditches, culverts, and/or storm sewer conveyance. The following subsections describe the scenarios investigated in the primary study areas.

Additionally, the following water quality components were also analyzed:

- One scenario incorporating a BMP into the culvert area
- One scenario investigating a BMP in the 3809 and 3824 Scheuneman Road
- Other potential BMP options are summarized in the recommendations section, to be analyzed in the future

The scenarios presented are intended to be a high-level design. Additional design and preparation of construction plans would be needed for construction given that the solutions are more complex than just adding a larger culvert.

7.1 Cross Culvert and Ditch System

Two scenarios were investigated in the cross-culvert area. Initially, just one was planned to be investigated, however after the initial analysis it was determined that additional investigation may be beneficial. An additional water quality option was also investigated.

As previously described, the topography within the immediate upstream of the culvert area is mostly flat with low floor elevations of the homes similar to the roadway and ground elevations of this area. Due to this, the homes and surrounding yard areas are at risk for inundation and flooding which may necessitate utilizing a higher design storm for the culvert crossing, however the relatively flat topography limits the size of conveyance that can feasibly be constructed in this area.

The proposed solutions in the culvert area are intended to reduce peak flood elevations and minimize the flood risk to structures. This simultaneously may reduce the standing water that occurs adjacent to and behind the homes just upstream of the culvert crossing area.

7.1.1 Culvert Area – Scenario 1

Scenario 1 for the culvert area includes the following changes, also as shown in Figure 6:

- Replace the 15" CMP culvert with two 30" RCP culverts
- Lower the culvert inverts approximately 2 feet below the existing pipe, in order to maintain cover without raising the roadway. The proposed inverts were modeled at 933.4 feet NAVD (upstream) and 933.0 feet (downstream).
- Modify and extend the ditch system/swale upstream and downstream to have a 'V' shape with 3:1 side slopes and inverts as shown in Figure 6.

It should be noted that increasing the culvert size beyond two 30" RCP culverts does not provide any additional benefit for the 10-year, 24-hour (frozen ground) event modeled as the crossing is sized for the contributing area that effectively reaches the crossing. Conversely, decreasing the size of the culverts to two, 24" RCP culverts would also be acceptable. Although the two, 30" RCP culverts is an optimal option, the results achieved from two, 24" RCP culverts yield similar benefit to the area.

The swale grading upstream of the cross culvert is needed as there is a high point of ground located near the 3970 and 3960 Scheuneman Road property line. Without this swale, surface drainage in this area ponds deeper until it can flow towards the roadway between the 3970 and 3960 property line and through the 15-inch driveway culvert under the 3970 property driveway. This culvert is not adequately sized for this expanded contributing area during these conditions and contributes to the inundation experienced in this area. Driveway culverts are not typically sized for these conditions. Modification of this driveway culvert was investigated as part of Scenario 2. This was not included in Scenario 1 as it is not the most efficient way to discharge flow.

The downstream swale grading is necessary due to the lowered culverts and would need to extend around 240 feet at an approximate 0.63% slope to tie in with existing ground. The proposed swale downstream can be armored with riprap like it is in the existing condition, however, any riprap should be placed such that the top elevation is at the grade/elevation shown rather than above it (no 'mounding').

7.1.1.1 Culvert Area – Scenario 1 Results

Figures 7, 8, and 9 show the 2-year, 24 hour (frozen ground), 10-year, 24-hour (frozen ground), and 100-year, 24-hour (non-frozen ground) proposed model results in the culvert area with the Scenario 1 changes, as described above.

Table 2 shows the first-floor elevations, existing, and Scenario 1 proposed peak water surface elevations for the homes near the culvert area. A map showing the elevation point number location is shown in Image 1. Scenario 1 results in peak water surface elevations that are between 0.5 and 1.0 feet lower than existing condition. **Orange** peak water surface elevation values are within 1 foot of the first-floor elevations (i.e. defined as flood risk by this report), while **red** peak water surface elevation values have exceeded the first-floor elevation.

Table 2 – Culvert Area Scenario 1 Results

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			Culvert Area Scenario 1 Peak Water Surface Elevation (WSEL) (ft)		
			2-year	10-year	100-year	2-year	10-year	100-year
1	3984 (north side)	938.18	937.76	937.99	938.23	937.50	937.54	937.61
2	3984 (south side)	939.24	937.79	938.02	938.26	936.06	936.42	937.22
3	3970	936.26	937.86	938.06	938.29	936.79	937.05	937.48
4	3960	935.32	937.88	938.07	938.30	937.41	937.55	937.75

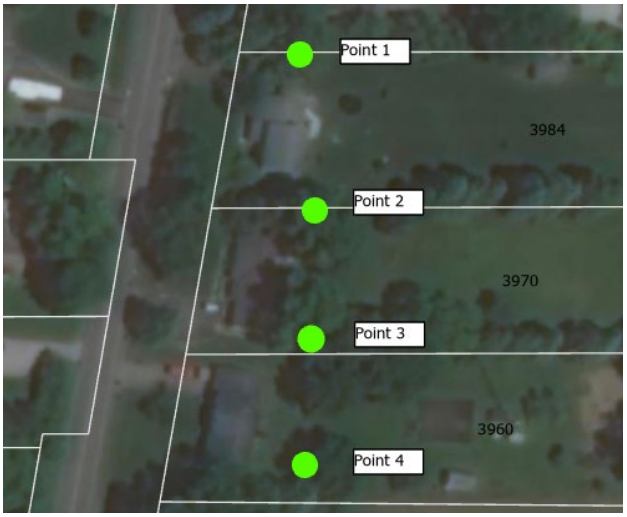


Image 1 - Elevation Point Numbers for the Culvert Area

As shown in Table 2, peak water surface elevations for the larger storm events still remain higher than the first-floor elevations of 3960 and 3970 Scheuneman Road. This is due to the first-floor elevations being nearly at grade in addition to limited space for a drainage swale.

Any additional volume to the landlocked receiving waters may have an impact on the water surface elevation. The existing 100-year peak water elevation of Golf Course Pond is 918.22. The peak water elevation of Golf Course Pond is increased by approximately 0.03 feet during the 100-year design storm for Scenario 1, to an elevation of 918.25. The increase is less for the smaller storms**.** These increases in peak water elevation are minor and do not appear to increase risk of flooding at any structure or land use near the pond. For comparison, the first-floor elevation of 1580 Goose Lake Road is 923.82.

Grading the ditch system/swale upstream will have impacts to the back yards of the 3984, 3970 and 3960 properties. Additionally, this would require removal of the mature bushes adjacent to the 3984 property. The swale/ditch system would be approximately 2-3 feet deep, which would result in average top width of 15 feet ('V' shape with 3:1 side slopes). A narrower top width would

require steeper side slopes. The exact ditch alignment could be modified within final design, however, it will likely impact trees with the alignment shown for scenario 1

7.1.2 Culvert Area – Scenario 2

Scenario 2 for the culvert area includes the following changes, also as shown in Figure 10:

- Replace the 15” CMP cross culvert with two, 30” RCP culverts
- Lower the culvert inverts approximately 2 feet below the existing pipe, in order to maintain cover without raising the roadway. The proposed inverts were modeled at 933.4 feet NAVD (upstream) and 933.0 feet (downstream).
- Modify and extend the ditch system/swale upstream and adjacent to the roadway and downstream to have a ‘V’ shape with 3:1 side slopes with slopes and inverts as shown in Figure 10.
- Replace the 15” driveway culvert with two, 24” CMP/CPP culverts with inverts approximately 3 feet below the existing ground at 934.8 feet NAVD (upstream) and 934.7 feet (downstream), resulting in approximately 1 foot of cover.

The modifications to the cross culvert and downstream of the cross culvert are the same as Scenario 1, however this scenario attempts to minimize the impact to residential yards while increasing drainage efficiency. Currently the surface drainage in this area is forced to flow towards the roadway between the 3970 and 3960 property line. Scenario 2 maintains this drainage pattern.

The driveway culvert at the 3970 Scheuneman Road property is undersized for the expanded contributing area during these conditions. Driveway culverts are not typically sized for larger storm events, such as events with frozen ground or 100-year, 24-hour events. Modifications to the driveway may allow for additional cover as desired, however this was not included in the modeling. During the 2020 culvert inspections, this driveway culvert was in good condition structurally and showed minor signs of sedimentation or erosion.

The swale grading upstream of the cross culvert would likely result in less tree impacts however would still require the removal of the mature bushes adjacent to the 3984 Scheuneman Road property. The roadside swale upstream of the driveway culvert at the 3970 property is limited in modifications due to upstream elevation constraints. The driveway of the upstream 3960 Scheuneman Road property is very close however modifications could continue upstream as necessary. Per the 2020 culvert inspections, this culvert is the same size at the 3970 property and is also in good shape structurally with minor signs of sedimentation or erosion.

7.1.2.1 Culvert Area – Scenario 2 Results

Figure 11, 12, and 13 shows the 2-year, 24 hour (frozen ground), 10-year, 24-hour (frozen ground), and 100-year, 24-hour (non-frozen ground) proposed model results in the culvert area with the Scenario 2 changes, as described above.

Table 3 shows the first-floor elevations, existing, and Scenario 2 proposed peak water surface elevations for the homes near the culvert area. A map showing the elevation point number location is shown in Image 1. Scenario 2 results in peak water surface elevations that are between 0.3 and 0.6 feet lower than existing condition. These elevations result in less impact to

the existing peak water surface elevation than those as described in Scenario 1, however may result in less private property impacts. **Orange** peak water surface elevation values are within 1 foot of the first-floor elevations (i.e. defined as flood risk by this report), while **red** peak water surface elevation values have exceeded the first-floor elevation.

Table 3 – Culvert Area Scenario 2 Results

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			Culvert Area Scenario 2 Peak Water Surface Elevation (WSEL) (ft)		
			2-year	10-year	100-year	2-year	10-year	100-year
1	3984 (north side)	938.18	937.76	937.99	938.23	937.50	937.54	937.62
2	3984 (south side)	939.24	937.79	938.02	938.26	937.30	937.46	937.77
3	3970	936.26	937.86	938.06	938.29	937.37	937.67	937.97
4	3960	935.32	937.88	938.07	938.30	937.41	937.69	937.99

The increase in peak water elevations of Golf Course Pond caused by Scenario 2 is similar to that of Scenario 1, where the peak water elevation of Golf Course Pond is increased by approximately 0.03 feet during the 100-year design storm for Scenario 1, and less for the smaller storms.

7.1.3 Culvert Area – BMP Scenario

As noted above, the City is open to pursuing options that may also benefit water quality through the installation of Best Management Practices (BMPs). The existing low areas located in the backyards east of Scheuneman Road naturally collect drainage, therefore this area could potentially be enhanced to better manage the drainage while promoting water quality. This area is on private property, so the City would need to explore land acquisition, easement, or other permissions to make this option feasible.

Additionally, with both Scenario 1 and Scenario 2, there is still a remaining threat of inundation or flooding at the 3960 and 3970 Scheuneman Road properties. As the homes have first-floor elevations at or below the elevation of Scheuneman Road, removing the flood risk entirely is not feasible by just adding to/modifying the conveyance of the cross culvert under the road and grading swales. However, the additional improvements to create storage with a BMP could further reduce flooding for the 100-year event.

It is unknown if the area would be conducive for infiltration. The soil data obtained from the USDA Web Soil Survey (WSS) indicates that the soils in this low area are urban soils. According to the USDA urban soils exist largely in a built environment and may be human transported, altered, or intact. These soils vary widely, therefore additional investigation would be needed to determine infiltration viability. Filtration was deemed not feasible as there is not adequate elevation to install an underdrain system therefore, this BMP was investigated as a detention pond. Dry detention

ponds do not provide significant benefits to water quality but rather provide more benefit to flood risk mitigation.

The construction of the pond would include minor grading to shape the area and create a berm to hold back drainage and reduce surface drainage from propagating towards the flood risk homes. This ponding area was added to the Scenario 2 model with the following, and as shown in Figure 14:

- Adding a berm at elevation 939.5 (NAVD), which provides a max ponding depth of approximately two feet
- Adding a 6-inch diameter outlet pipe to the proposed ponding area. This outlet would prevent water standing for long durations while still reducing peak flows.
- Adding an overflow path to the east side of the berm. The swale behind the 3960 property could be adjusted to route the overflow away from the at-risk homes.

7.1.3.1 Culvert Area – BMP with Scenario 2 Results

Figures 15 and 16 show the 10-year, 24-hour (frozen ground), and 100-year, 24-hour (non-frozen ground) proposed model results in the culvert area with the BMP with Scenario 2 changes, as described above. As noted above, a dry detention pond provides benefits to flood risk mitigation, therefore the 2-year, 24-hour event was not included in the culvert area BMP scenario analysis as there is limited use.

The pond captures approximately half the contributing drainage area to the cross culvert. Table 4 shows the first-floor elevations, existing, and proposed peak water surface elevations for the homes near the culvert area. A map showing the elevation point number location is shown in Image 1. The BMP with Scenario 2 peak water surface elevations results show an additional 0.2 and 0.3 feet change in elevation beyond that provided by Scenario 2 alone. These elevations result in greater than or equal to the impact provided by Scenario 1, however the BMP would result in additional private property impacts. It is important to note that some flood risk to properties would still remain with this option due to the vertical elevation constraints of the study area.

Table 4 – Culvert Area BMP with Scenario 2 Results

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			Culvert Area BMP with Scenario 2 Peak Water Surface Elevation (WSEL) (ft)	
			2-year	10-year	100-year	10-year	100-year
1	3984 (north side)	938.18	937.76	937.99	938.23	937.54	937.60
2	3984 (south side)	939.24	937.79	938.02	938.26	937.36	937.49
3	3970	936.26	937.86	938.06	938.29	937.49	937.68
4	3960	935.32	937.88	938.07	938.30	937.50	937.70

The increase in peak water elevations of Golf Course Pond caused by the BMP with Scenario 2 with is similar to that of Scenario 1, where the peak water elevation of Golf Course Pond is increased by approximately 0.03 feet during the 100-year design storm for Scenario 1, and less for the smaller storms.

7.1.4 Culvert Area – Scenario Summary

Table 5 shows an overall summary of the first-floor elevations, existing, and proposed scenario peak water surface elevations for the homes near the culvert area. **Orange** peak water surface elevation values are within 1 foot of the first-floor elevations (i.e. defined as flood risk by this report), while **red** peak water surface elevation values have exceeded the first-floor elevation. Table 6 shows the overall summary of the first-floor elevations, existing, and proposed reductions in peak water surface elevations for each scenario for the homes near the culvert area. A map showing the elevation point number location is shown in Image 1.

Table 5 – Culvert Area Results Summary

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			Culvert Area Scenario 1 Peak Water Surface Elevation (WSEL) (ft)			Culvert Area Scenario 2 Peak Water Surface Elevation (WSEL) (ft)			Culvert Area BMP Scenario Peak Water Surface Elevation (WSEL) (ft)	
			2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year	10-year	100-year
1	3984 (north side)	938.18	**937.76**	**937.99**	**938.23**	**937.50**	**937.54**	**937.61**	**937.50**	**937.54**	**937.62**	**937.54**	**937.60**
2	3984 (south side)	939.24	937.79	938.02	**938.26**	936.06	936.42	937.22	937.30	937.46	937.77	937.36	937.49
3	3970	936.26	**937.86**	**938.06**	**938.29**	**936.79**	**937.05**	**937.48**	**937.37**	**937.67**	**937.97**	**937.49**	**937.68**
4	3960	935.32	**937.88**	**938.07**	**938.30**	**937.41**	**937.55**	**937.75**	**937.41**	**937.69**	**937.99**	**937.50**	**937.70**

Table 6 – Culvert Area Reduction from Existing Summary

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			Culvert Area Scenario 1 Reduction in Peak Water Surface Elevation (WSEL) (ft)			Culvert Area Scenario 2 Reduction in Peak Water Surface Elevation (WSEL) (ft)			Culvert Area BMP Scenario Reduction in Peak Water Surface Elevation (WSEL) (ft)	
			2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year	10-year	100-year
1	3984 (north side)	938.18	937.76	937.99	938.23	0.26	0.45	0.62	0.26	0.45	0.61	0.45	0.63
2	3984 (south side)	939.24	937.79	938.02	938.26	1.73	1.60	1.04	0.49	0.56	0.49	0.66	0.77
3	3970	936.26	937.86	938.06	938.29	1.07	1.01	0.81	0.49	0.39	0.32	0.57	0.61
4	3960	935.32	937.88	938.07	938.30	0.47	0.52	0.55	0.47	0.38	0.31	0.57	0.60

7.2 South Area

Three scenarios were investigated in the south area. As previously described, the topography in the surrounding area is mostly flat and essentially landlocked by the adjacent development and land. This causes inundation in front and side yards. The proposed solutions for the south area are intended to reduce peak flood elevations and minimize the threat to structures. The proposed solutions all primarily involve draining low areas via culvert or storm pipe. Due to elevation limitations, open channel surface drainage would be challenging to provide effectively throughout the entire south area, however this also means that the proposed storm sewer systems will be quite shallow. Area drains and culverts may plug with ice or debris during a snow melt therefore maintenance needs should be considered. An additional water quality option was also investigated.

7.2.1 South Area – Scenario 1

Scenario 1 for the south area includes the following changes, also as shown in Figure 17:

- Add an 18-inch pipe shallow storm sewer system, collecting drainage from:
    - The low area at 3809 Scheuneman Road
    - The low area between the driveways of the 3860 and 3848 Scheuneman Road
    - The low area between the 3836 and 3824 Scheuneman Road properties
- Add a flared end section outlet that discharges to the natural low area behind the 3884 and 3880 Scheuneman Road properties.

While it would be possible to drain the low area between the 3836 and 3824 Scheuneman Road properties with a surface swale, it is not feasible to discharge the other properties within the study area via surface flow without significant grading due to differences in elevation. This would likely lead to the loss of trees and other usable yard space.

The cover above the proposed storm sewer system may be as shallow as 1 foot in some areas. If the low area between the driveways of the 3860 and 3848 Scheuneman Road are not problematic, then they would not have to be connected to the proposed storm sewer system.

Due to elevation constraints, an outlet location to a receiving water for this low area behind 3884 and 3880 may not be feasible. An outlet to a non-receiving water area may include north, towards the cross culvert, or east towards the railroad. If this area were routed north, towards the culvert area, there would be additional volume routed towards properties that already have high flood risk. An outlet to the east, within the adjacent railroad bed could be investigated, however may be deemed not permissible by the railroad authority.

7.2.1.1 South Area – Scenario 1 Results

Figure 18 shows the 10-year, 24-hour (frozen ground) results in the south area with the Scenario 1 changes, as described above. The 100-year, 24-hour (non-frozen ground) event produces nearly the same flood and ponding depths as the 10-year, 24-hour (frozen ground) event. This is due to the fact that frozen ground infiltrates less rainfall, increasing runoff.

Table 7 shows the first-floor elevations, existing peak water surface elevations, and Scenario 1 proposed peak water surface elevations for the homes near the south area. A map showing the

elevation point number location is shown in Image 2. **Orange** peak water surface elevation values are within 1 foot of the first-floor elevations (i.e. defined as flood risk by this report), while **red** peak water surface elevation values have exceeded the first-floor elevation.

Scenario 1 results in peak water surface elevations that are between 0.7 and 0.9 feet lower than existing conditions in the most severe ponding areas. Although this shows an improvement in peak water elevations, the existing conditions indicate that there is not significant flood risk to the properties as supported by the first-floor elevations. Although peak elevations are important to consider, the larger issue appears to be that water does not drain properly from this area causing nuisance ponding in front and side yards sometimes lasting for extended period of times.

Figure 19 shows the 10-year, 24-hour (frozen ground) inundation for the existing and proposed scenario 6 hours after the peak of the storm. This demonstrates that under the frozen ground conditions, the inundation remains for longer period of times, such as those observed during previous spring melt events. Although there are significant improvements to the larger ponding areas, some minor ponding persists in the proposed condition in several localized low spots not connected to the proposed storm sewer system.

Table 7 – South Area Scenario 1 Results

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			South Area Scenario 1 Peak Water Surface Elevation (WSEL) (ft)		
			2-year	10-year	100-year	2-year	10-year	100-year
1	3809	956.52	955.28	**955.72**	**955.65**	954.42	955.05	955.44
2	3836	958.91	955.44	955.61	955.62	954.51	954.73	955.08
3	3824	958.86	956.07	956.13	956.16	956.07	956.12	956.16
	3812	961.92						

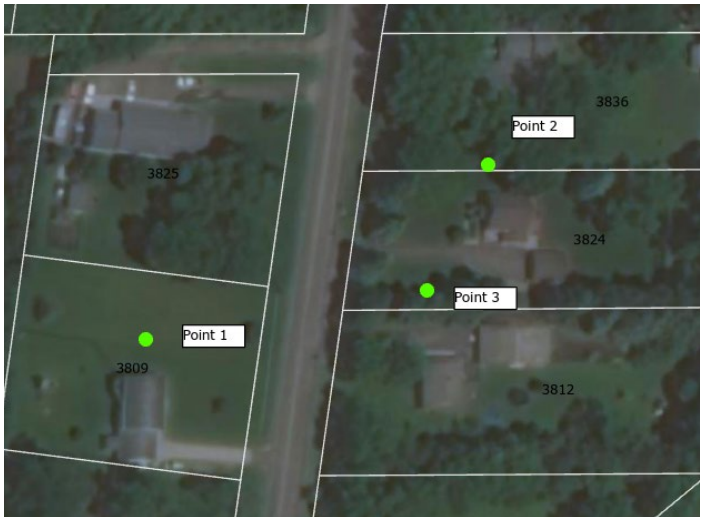


Image 2 - Elevation Point Numbers for the South Area

There is minimal change in the peak water surface elevations near the 3824 and 3812 Scheuneman Road properties for Scenario 1 and the subsequent scenarios. There is however improvement of longer standing inundation and flooding following the peak. Although this is not shown in Table 7, it is shown visually in Figure 19.

This scenario causes the peak water surface elevation at the natural low area behind the 3884 and 3880 Scheuneman Road properties to increase by approximately 0.12 feet for the 10-year, 24-hour (frozen ground) and 100-year, 24-hour (non-frozen ground) storms, and up to 0.45 feet for the 2-year storm, 24-hour (frozen ground) as summarized in Table 8. These increases do not appear to cause additional flood risk to these properties/structures but may be an added nuisance to the private property owners. For comparison, the first-floor elevation of 3884 Scheuneman Road is 947.26.

Table 8 – 3884 and 3880 Scheuneman Road Low Area Peak Water Surface Elevation Summary

Storm Event	Existing Peak Water Surface Elevation (WSEL) (ft)	Scenario 1 Low Area Peak Water Surface Elevation (WSEL) (ft)
2-year	942.57	943.02
10-year	942.88	943.00
100-year	942.85	942.97

7.2.2 South Area – Scenario 2

Scenario 2 for the south area includes the following changes, also as shown in Figure 20:

- Add an 18-inch pipe shallow storm sewer system, collecting drainage from:
    - The low area at 3809 Scheuneman Road
    - The low area between the driveways of the 3860 and 3848 Scheuneman Road
    - The low area between the 3836 and 3824 Scheuneman Road properties
- Add a flared end section outlet that discharges to the low area adjacent to the 27 and 28 Hillary Farm Lane properties.

The low area adjacent to the 27 and 28 Hillary Farm Lane properties appears to be constructed with the area development. This pond discharges north, to an existing wetland area. The proposed storm sewer system described could be on the east or west side of Scheuneman Road. If the low area between the driveways of the 3860 and 3848 Scheuneman Road is not problematic, it would not have to be connected to the proposed storm sewer system, however it would be more efficient to make this connection with the Scenario 2 configuration than with the Scenario 1 configuration.

The cover above the proposed storm sewer system may be as shallow as 1 foot in some areas therefore this proposed storm sewer system may have to exist in the roadside ditch.

7.2.2.1 South Area – Scenario 2 Results

Figure 21 shows the 10-year, 24-hour (frozen ground) results in the south area with the Scenario 2 changes, as described above. The 100-year, 24-hour (non-frozen ground) produces nearly the same flood and ponding depths as the 10-year, 24-hour (frozen ground). This is due to the effect of frozen ground on runoff.

Table 9 shows the first-floor elevations, existing, and Scenario 2 proposed peak water surface elevations for the homes near the south area. A map showing the elevation point number location is shown in Image 2. **Orange** peak water surface elevation values are within 1 foot of the first-floor elevations (i.e. defined as flood risk by this report), while **red** peak water surface elevation values have exceeded the first-floor elevation.

Scenario 2 results in peak water surface elevations that are between 0.3 and 0.5 feet lower than existing condition in the most severe ponding areas. This is in part due to the elevation constraints limiting the available slope for a storm sewer system. Although this shows an improvement in peak water elevations, the existing conditions indicate that there is not significant flood risk to the properties as supported by the low floor elevations. As with Scenario 1, extended inundation remains in several small areas, but is significantly improved for the larger ponding areas. Figure 22 shows the 10-year, 24-hour (frozen ground) inundation for the existing and proposed scenario 6 hours after the peak of the storm.

Table 9 – South Area Scenario 2 Results

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			South Area Scenario 2 Peak Water Surface Elevation (WSEL) (ft)		
			2-year	10-year	100-year	2-year	10-year	100-year
1	3809	956.52	955.28	**955.72**	**955.65**	954.79	955.39	**955.59**
2	3836	958.91	955.44	955.61	955.62	954.67	955.21	955.47
3	3824	958.86	956.07	956.13	956.16	956.07	956.12	956.16
	3812	961.92						

This scenario causes the peak water surface elevation at Hillary Farm Lane Pond to increase by approximately 0.70 feet for the 2-year storm, 0.14 feet for the 10-year storm and 0.05 feet for the 100-year storm as summarized in Table 10. These increases do not appear to cause additional flood risk to these properties/structures but may be an added nuisance to the private property owners. A first-floor elevation was not taken at the properties adjacent to the pond however for comparison, the elevations on the adjacent homes based on LiDAR appear to be around 950.

Table 10 – Hillary Farm Lane Pond Peak Water Surface Elevation Summary

Storm Event	Existing Peak Water Surface Elevation (WSEL) (ft)	Scenario 2 Pond Peak Water Surface Elevation (WSEL) (ft)
2-year	945.05	945.75
10-year	947.44	947.58
100-year	948.04	948.09

It may be possible to mitigate the increase of the peak water elevation of Hillary Farm Lane Pond with modifications to the outlet culvert, however this could lead to an increase in peak water elevations in the wetland north of Hillary Farm Lane.

Additionally, this scenario increases the peak water elevation of Golf Course Pond by approximately 0.11 feet for the 2-year storm, 0.16 feet for the 10-year storm and 0.09 feet for the 100-year storm as summarized in Table 11. These increases include the culvert area analysis to conservatively represent potential increases. These increases in peak water elevation are minor and do not appear to increase risk of flooding at any structure or land use near the pond. For comparison, the first-floor elevation of 1580 Goose Lake Road is 923.82.

Table 11 – Golf Course Pond Peak Water Surface Elevation Summary

Storm Event	Existing Peak Water Surface Elevation (WSEL) (ft)	Scenario 2 Pond Peak Water Surface Elevation (WSEL) (ft)
2-year	917.74	917.85
10-year	918.91	919.07
100-year	918.22	918.31

Enhancement to the existing pond for additional water quality was not considered for this area. Due to the elevations of the adjacent wetland, it is assumed that there is not adequate separation from the water table for infiltration of filtration. A pond expansion would likely not provide any significant change in pollutant removal rates due to the area constraints including space and pollutant loading rates.

7.2.3 South Area – Scenario 3

Scenario 3 for the south area includes the following changes, also as shown in Figure 23:

- Add an 18-inch pipe shallow storm sewer system, collecting drainage from:
    - The low area at 3809 Scheuneman Road
    - The low area between the driveways of the 3860 and 3848 Scheuneman Road
    - The low area between the 3836 and 3824 Scheuneman Road properties
- Add a flared end section outlet that discharges to Gem Lake at the normal water level.

Similar to Scenarios 1 and 2, if the low area between the driveways of the 3860 and 3848 Scheuneman Road is not problematic, it would not have to be connected to the proposed storm sewer system, minimizing the length of the system.

7.2.3.1 South Area – Scenario 3 Results

Figure 24 shows the 10-year, 24-hour (frozen ground) results in the south area with the Scenario 3 changes, as described above.

Table 12 shows the first-floor elevations, existing, and Scenario 3 proposed peak water surface elevations for the homes near the south area. A map showing the elevation point number location is shown in Image 2. **Orange** peak water surface elevation values are within 1 foot of the first-floor elevations (i.e. defined as flood risk by this report), while **red** peak water surface elevation values have exceeded the first-floor elevation.

This proposed Scenario results in 10-year peak water surface elevations that are 0.5 to 0.7 feet lower in the most severe ponding areas. As with Scenario 1 and 2, it is recognized that the ability of the system to prevent standing water may be more valuable than reducing peak elevations. Figure 25 shows the 10-year, 24-hour (frozen ground) inundation for the existing and proposed scenario 6 hours after the peak of the storm. These results demonstrate that the low areas are better drained in Scenario 3 compared to the existing condition.

Table 12 – South Area Scenario 3 Results

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			South Area Scenario 3 Water Surface Elevation (WSEL) (ft)		
			2-year	10-year	100-year	2-year	10-year	100-year
1	3809	956.52	955.28	**955.72**	**955.65**	954.51	955.10	955.39
2	3836	958.91	955.44	955.61	955.62	954.54	955.03	955.33
3	3824	958.86	956.07	956.13	956.16	956.07	956.12	956.16
	3812	961.92						

Any additional volume to receiving waters may have an impact on the water surface elevation. The peak water elevation of Gem Lake is increased by approximately 0.03 feet for the 100-year storm in Scenario 3**.** This was calculated by dividing the volume routed to Gem Lake from the low areas by the approximate surface area of the lake. Gem Lake is mapped as FEMA A zone, so further analysis is warranted to determine whether this impact is acceptable. Permitting through the DNR may be necessary due to the rise as well as the work below the OHWL to install the new FES outlet.

7.2.4 South Area – BMP Scenario

The low area adjacent to the property at 3809 Scheuneman Road naturally collects drainage from approximately 5 acres of the surrounding area, comprised of low density residential and open space areas. Although the pollutant loading of this contributing area is likely low, the soil data obtained from the USDA Web Soil Survey (WSS) indicates that the soils in this low area are a sandy/silty loam, or hydrologic group C, which allow for some infiltration (approximately 0.8 feet – 1.2 feet with a 48 hour drawdown). Soil amendments may increase the infiltration capabilities. Filtration is not feasible in the area due to elevation constraints and the additional depth needed to construct an underdrain system.

Due to the existing concern of water surface elevations of the area, the construction of the infiltration basin would include excavation of the area to the infiltration depth in addition to any storm sewer configuration presented in Scenarios 1-3.

It is important to note that an infiltration basin as described above would have no impact to the peak water elevations experienced during frozen ground conditions. Due to this, no additional

reduction is water surface elevation should be assumed and the inundation as shown in the figures would not change. This area is on private property, therefore the City would need to explore land acquisition, easement, or other permissions to make this option feasible.

7.2.5 South Area – Scenario Summary

Table 13 shows an overall summary of the first-floor elevations, existing, and proposed scenario peak water surface elevations for the homes near the south area. **Orange** peak water surface elevation values are within 1 foot of the first-floor elevations (i.e. defined as flood risk by this report), while **red** peak water surface elevation values have exceeded the first-floor elevation. Table 14 shows the overall summary of the first-floor elevations, existing, and proposed reductions in peak water surface elevations for each scenario for the homes near the south area. A map showing the elevation point number location is shown in Image 2.

Table 13 – South Area Results Summary

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			South Area Scenario 1 Water Surface Elevation (WSEL) (ft)			South Area Scenario 2 Water Surface Elevation (WSEL) (ft)			South Area Scenario 3 Water Surface Elevation (WSEL) (ft)		
			2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
1	3809	956.52	955.28	**955.72**	**955.65**	954.42	955.05	955.44	954.79	955.39	**955.59**	954.51	955.10	955.39
2	3836	958.91	955.44	955.61	955.62	954.51	954.73	955.08	954.67	955.21	955.47	954.54	955.03	955.33
3	3824	958.86	956.07	956.13	956.16	956.07	956.12	956.16	956.07	956.12	956.16	956.07	956.12	956.16
	3812	961.92												

Table 14 – South Area Reduction from Existing Summary

Elevation Point Number	Address	Surveyed First-floor Elevation (FFE) (ft)	Existing Peak Water Surface Elevation (WSEL) (ft)			South Area Scenario 1 Water Surface Elevation (WSEL) (ft)			South Area Scenario 2 Water Surface Elevation (WSEL) (ft)			South Area Scenario 3 Water Surface Elevation (WSEL) (ft)		
			2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
1	3809	956.52	955.28	955.72	955.65	0.86	0.67	0.21	0.49	0.33	0.06	0.77	0.62	0.26
2	3836	958.91	955.44	955.61	955.62	0.93	0.88	0.54	0.77	0.40	0.15	0.90	0.58	0.29
3	3824	958.86	956.07	956.13	956.16	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00
	3812	961.92												

7.3 4076 Scheuneman Road

One scenario was investigated for 4076 Scheuneman Road. As previously described, the stormwater runoff in this northern part of the study area generally drains from north to south, splitting with the crown of Scheuneman Road with the east half discharging towards wetlands east of Scheuneman Road. Approximately 0.2 acres drain to this area and gets captured between the 4086 and 4076 Scheuneman Road driveways, causing ponded water. The existing conditions model does show a small area of inundation however the inundation does not put any properties at flood risk. The inundation is due to the presence of the driveway without a culvert crossing.

The scenario for the 4076 Scheuneman Road area includes the following changes:

- Add a 15-inch driveway culvert, with an approximate slope of 0.3%, to discharge towards the wetlands east of Scheuneman Road

The culvert is approximately sized to accommodate the contributing area for a 10-year, 24-hour (frozen ground) or 100-year, 24-hour (non-frozen ground) storm event.

7.4 Opinions of Probable Cost

SEH has prepared preliminary cost estimates for construction and engineering fees for the proposed scenarios as discussed within this report. Unit costs were chosen using MnDOT average bid prices and information from recent projects. It was assumed that there would not be wetlands impacts associated with each scenario and thus no cost of mitigation. Any costs associated with obtaining right-of-way, easements, or other permissions to compete work was not included. Detailed cost estimates are in Appendix C and a summary of cost estimation is shown in Table 15.

Table 15 – Summary of Opinions of Probable Cost

Scenario	Estimated Total Cost[1]
Culvert Area – Scenario 1	$105,500.00
Culvert Area – Scenario 2	$121,500.00
Culvert Area – BMP Scenario	$167,500.00
South Area– Scenario 1	$469,000.00
South Area– Scenario 2	$570,500.00
South Area– Scenario 3	$724,500.00
South Area– BMP Scenario[2]	$111,500.00
4076 Scheuneman Road – Scenario 1	$3,500.00

[1]Rounded to the nearest $500.00
[2]South Area– BMP Scenario is for the cost to construct the BMP only and should be added to the South Area Scenarios 1-3 for a total estimated project cost

8 Recommendations

The flood risk reduction, nuisance inundation reduction and water quality scenarios described within this report is a high level analysis to assist the City in determining the next steps for the North Scheuneman Road area. It is recommended that the City pursue the following:

8.1 Culvert Area

Currently the homes at 3960, 3970, and 3984 Scheuneman Road are at risk of flooding. Completely eliminating the flood risk to these homes is not feasible as their first-floor elevations are below the crown of Scheuneman Road and within a natural drainageway. Although it is not feasible to completely remove the flood risk, the proposed changes are expected to reduce the risk.

It is recommended that the City pursue Culvert Area – Scenario 2, where flow is directed between 3960 and 3970 properties through a graded swale. This option has peak water surface elevations that are slightly higher than Scenario 1 however has less impacts to private properties. Increasing the culvert size alone provides minimal benefit without additional grading.

The BMP Scenario would reduce elevations slightly further, however the cost may outweigh the benefit as the potential pollutant reduction is likely low due to assumed low initial loading relative and the pond would have a large impact to private property.

It is recommended that the 3960 and 3970 Scheunemann Road properties obtain flood insurance, if they have not already.

8.2 South Area

Currently, 3809 Scheuneman Road is at risk of flooding during the 10-year, 24-hour (frozen ground) and 100-year, 24-hour (non-frozen ground) storm events. Other properties in the south area experience nuisance ponding but are not at risk for flooding.

Correcting the flood risk and ponded water at the south end of Scheuneman Road will likely require a solution that uses underground piping due to the surrounding topography. It is important to consider that any scenario in the south area will reduce the duration of standing water in the most problematic areas. There is improvement in the peak water surface elevation for the larger storm events as well however, this was not the primary focus of the south area analysis.

Option 1 is not recommended unless an alternate outlet is identified to a receiving water area. Discharging elsewhere may increase risk to areas with existing flood concern. Option 3 is expected to have additional permitting concerns associated with discharging to Gem Lake.

8.3 4076 Scheuneman Road

The property at 4076 Scheuneman Road experiences nuisance ponding due to drainage becoming trapped between driveways. It is recommended that the property owner pursue to installation of a driveway culvert if they wish to alleviate the nuisance ponding.

8.4 Water Quality Improvements

Water quality options in the study area are limited due to the site restrictions such as vertical elevation constrains, low infiltrating soils, areas of perceived high groundwater, and lack of City owned land, easements, or other drainage permissions.

The BMPs investigated are for the purposes of improving water quality and will likely have no impact on the peak water surface elevations experienced during frozen ground conditions or larger storm events.

It is recommended that the City further investigate the feasibility of water quality options at the culvert area and south study area, including:

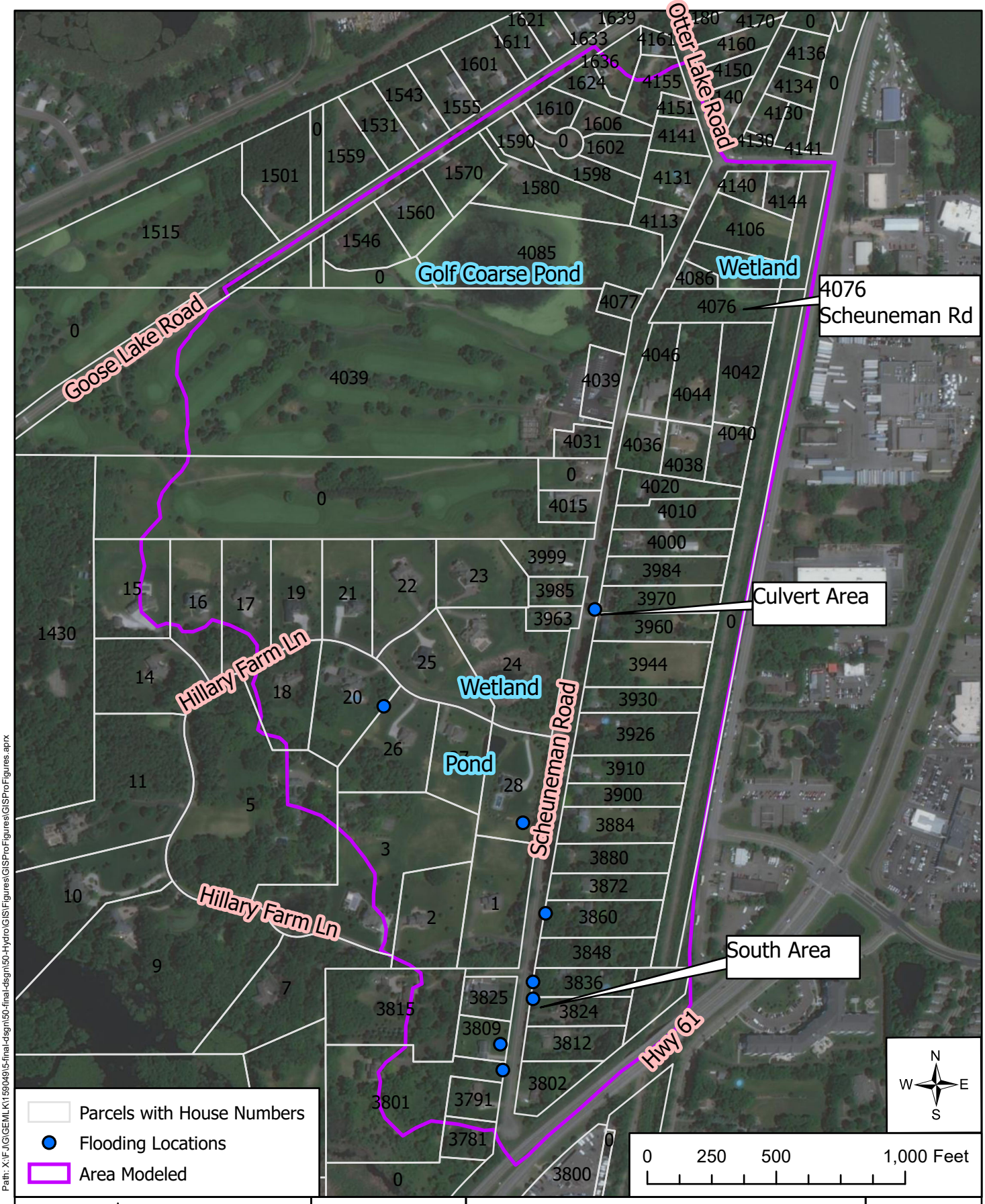
- Soil investigation to determine soil types and infiltration rates
- Private property owner interest in selling land, easements, or other drainage permissions

It is also recommended that the City further investigate other water quality options in the study area, through outreach activities such as:

- Residential rain gardens
- Partnerships with the Gem Lake Hills Golf Course, to investigate additional ponding areas, enhancements to Golf Course Pond, or water reuse from Golf Course Pond

EKJ

Figures



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Print Date: 7/16/2021

Map by: rmondloch
Projection: Ramsey County Coord.
Source: ESRI, SEH

Project Location

Gem Lake Stormwater Study
Gem Lake, MN

Figure 1

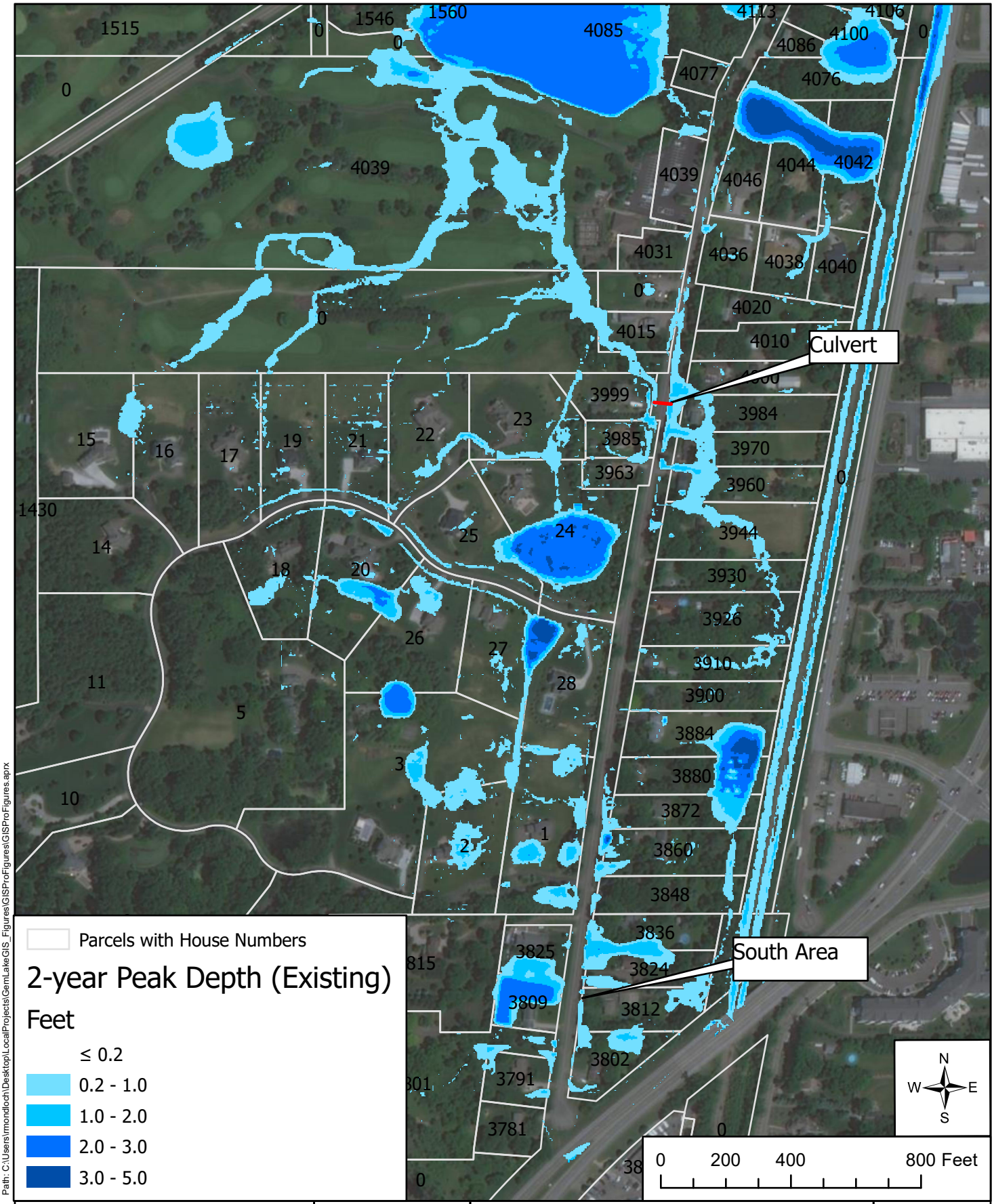
Figure 2 - USDA Web Soil Survey Map

Tables — Hydrologic Soil Group — Summary By Map Unit

Summary by Map Unit — Ramsey County, Minnesota (MN123)

Summary by Map Unit — Ramsey County, Minnesota (MN123)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
158B	Zimmerman fine sand, 1 to 6 percent slopes	A	1.8	1.0%
161	Isanti loamy fine sand, depressional	A/D	7.9	4.4%
166	Ronneby fine sandy loam	B/D	3.9	2.2%
266	Freer silt loam	C/D	19.1	10.6%
342B	Kingsley sandy loam, 2 to 6 percent slopes	C	6.4	3.5%
342C	Kingsley sandy loam, 6 to 12 percent slopes	C	72.7	40.4%
342D	Kingsley sandy loam, 12 to 18 percent slopes	C	6.3	3.5%
452	Comstock silt loam, 0 to 3 percent slopes	B/D	13.4	7.4%
859B	Urban land-Zimmerman complex, 1 to 8 percent slopes		10.5	5.8%
861C	Urban land-Kingsley complex, 3 to 15 percent slopes		33.3	18.5%
W	Water		4.7	2.6%
Totals for Area of Interest			**180.1**	**100.0%**



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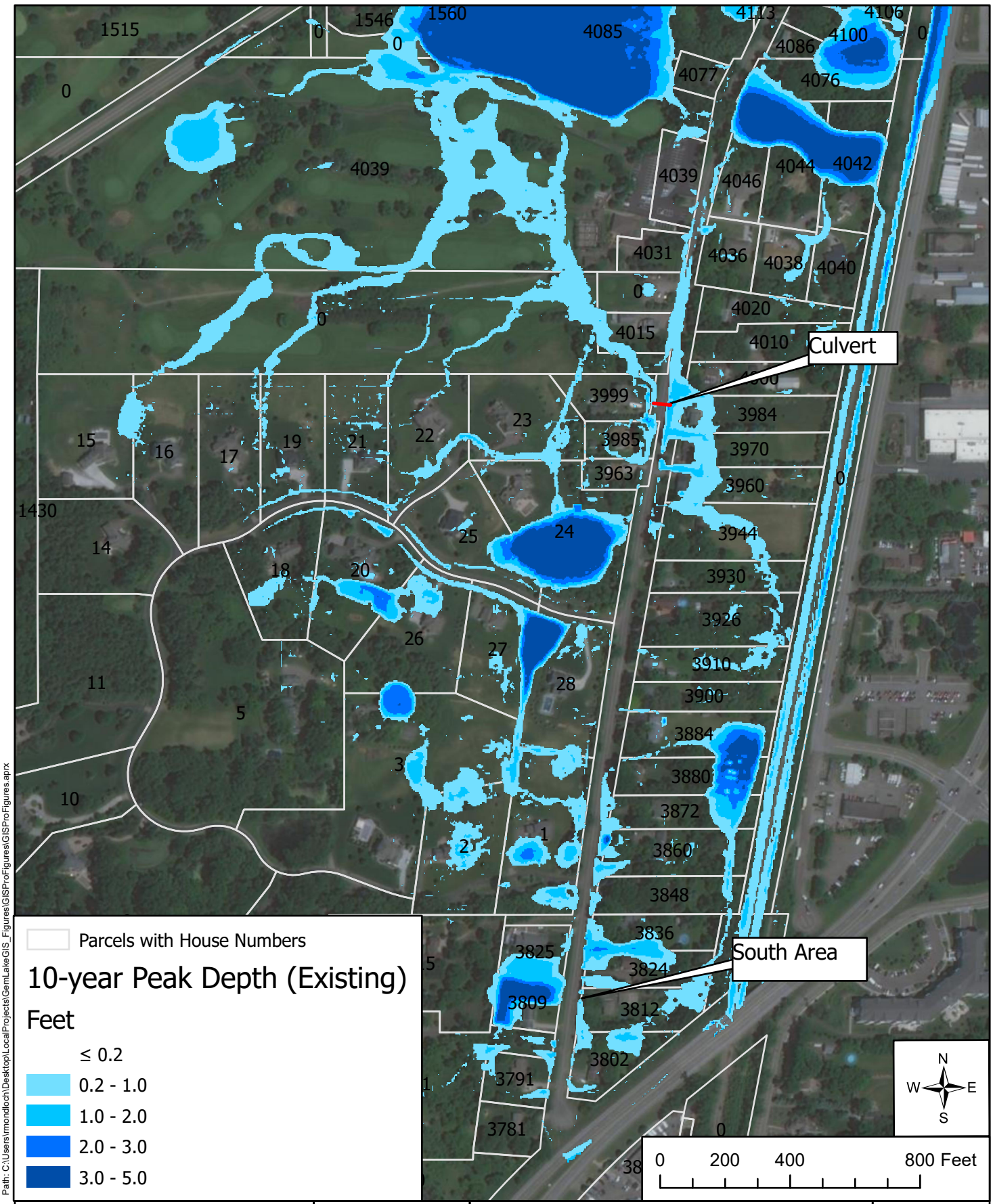
Print Date: 5/27/2021

Map by: rmondloch
Projection: Ramsey County Coordinates
Source: ESRI, SEH

Existing 2-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 3



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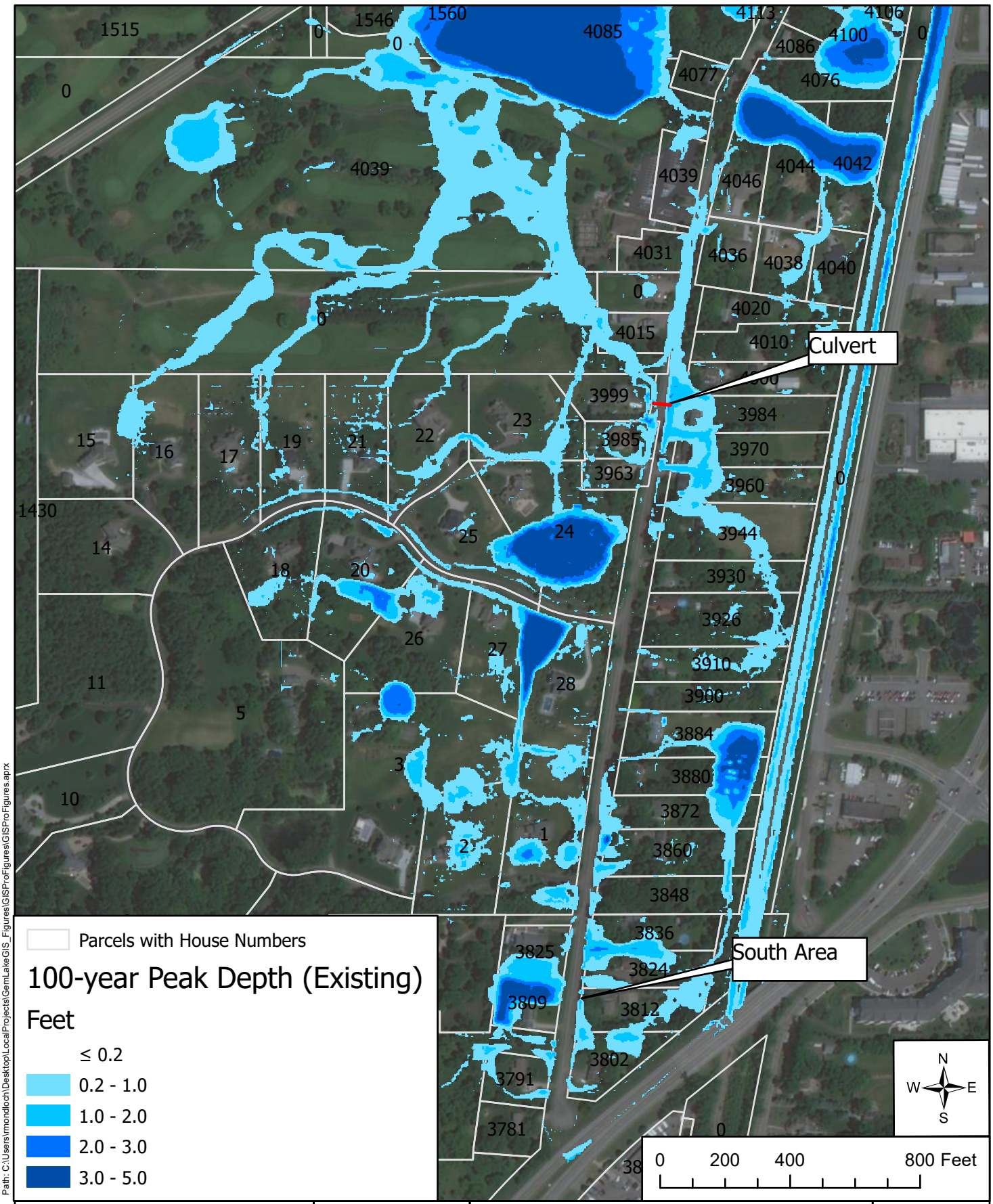
Existing 10-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 4



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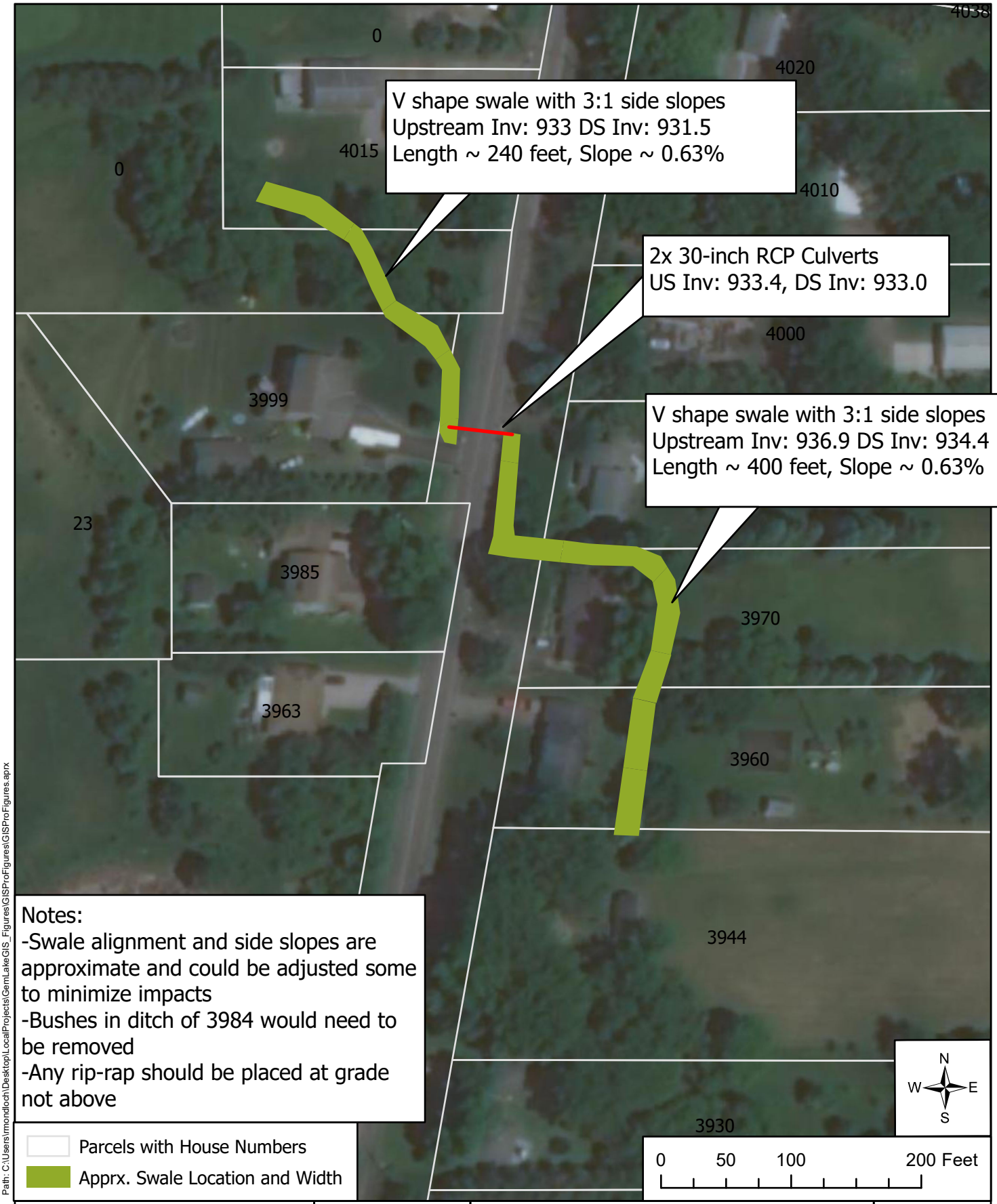
Existing 100-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 5



Notes:
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Parcels with House Numbers
Apprx. Swale Location and Width

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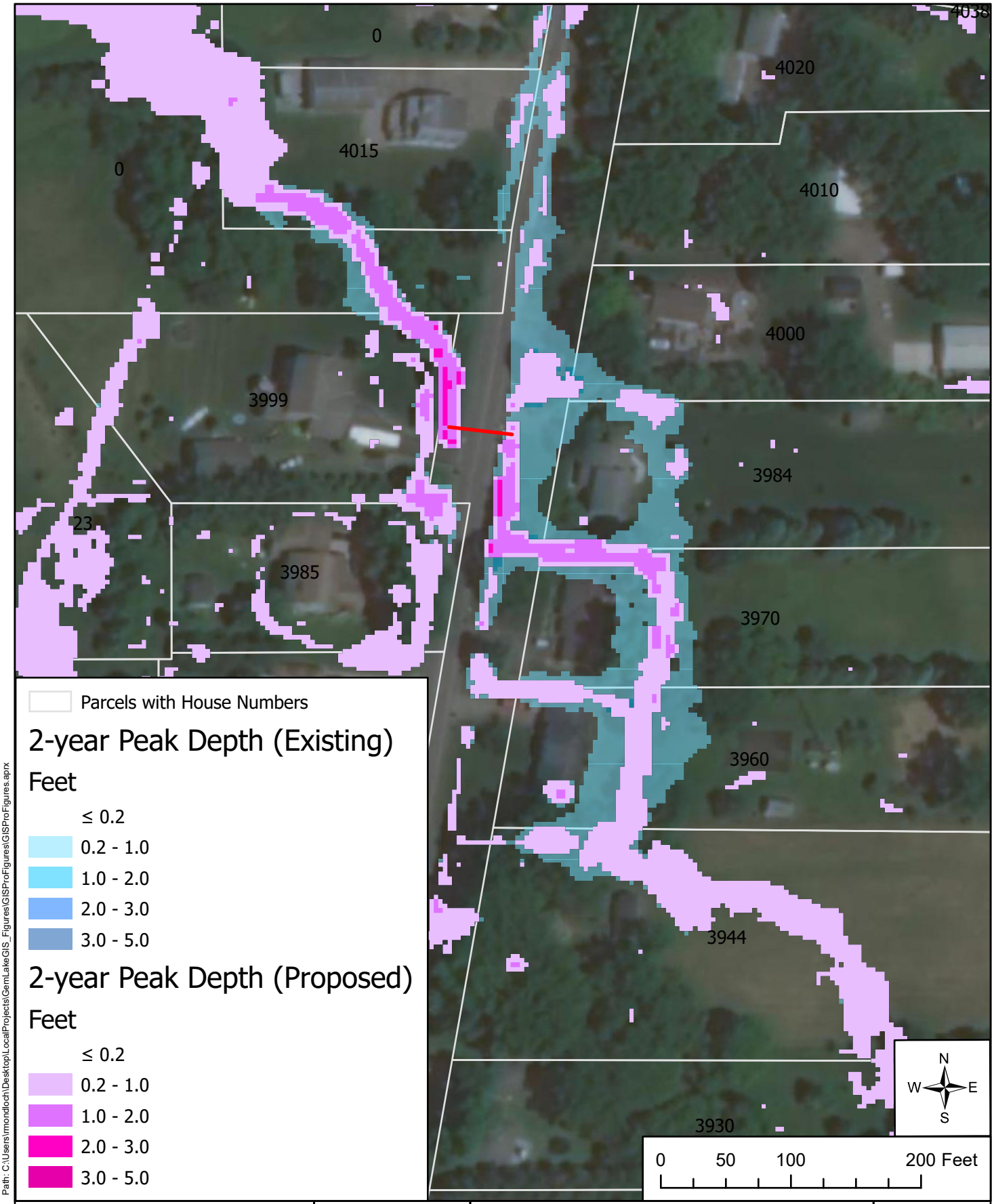
Culvert Area Scenario 1

Gem Lake Stormwater Study
Gem Lake, MN

Figure 6



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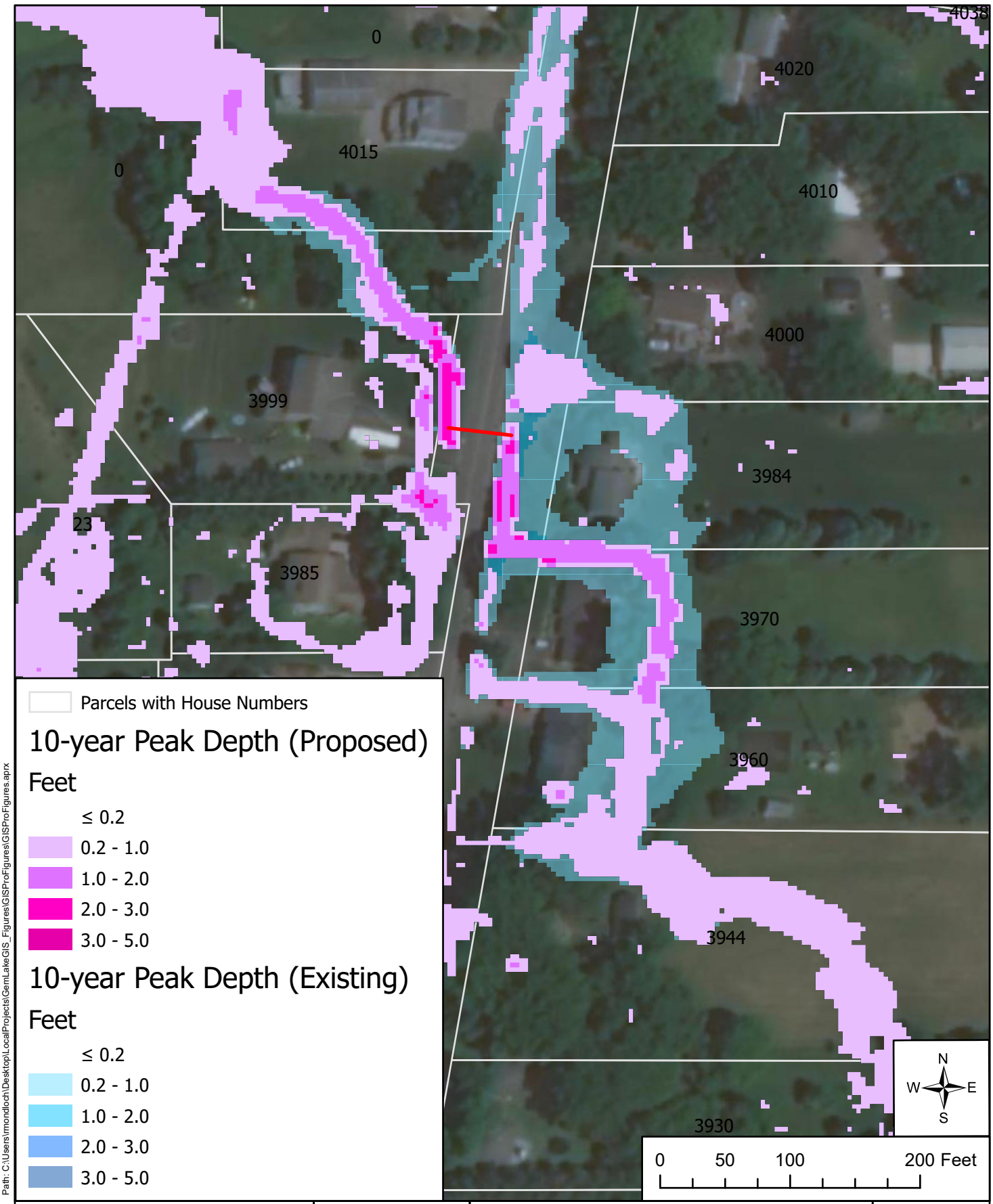
Culvert Area Scenario 1
2-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 7



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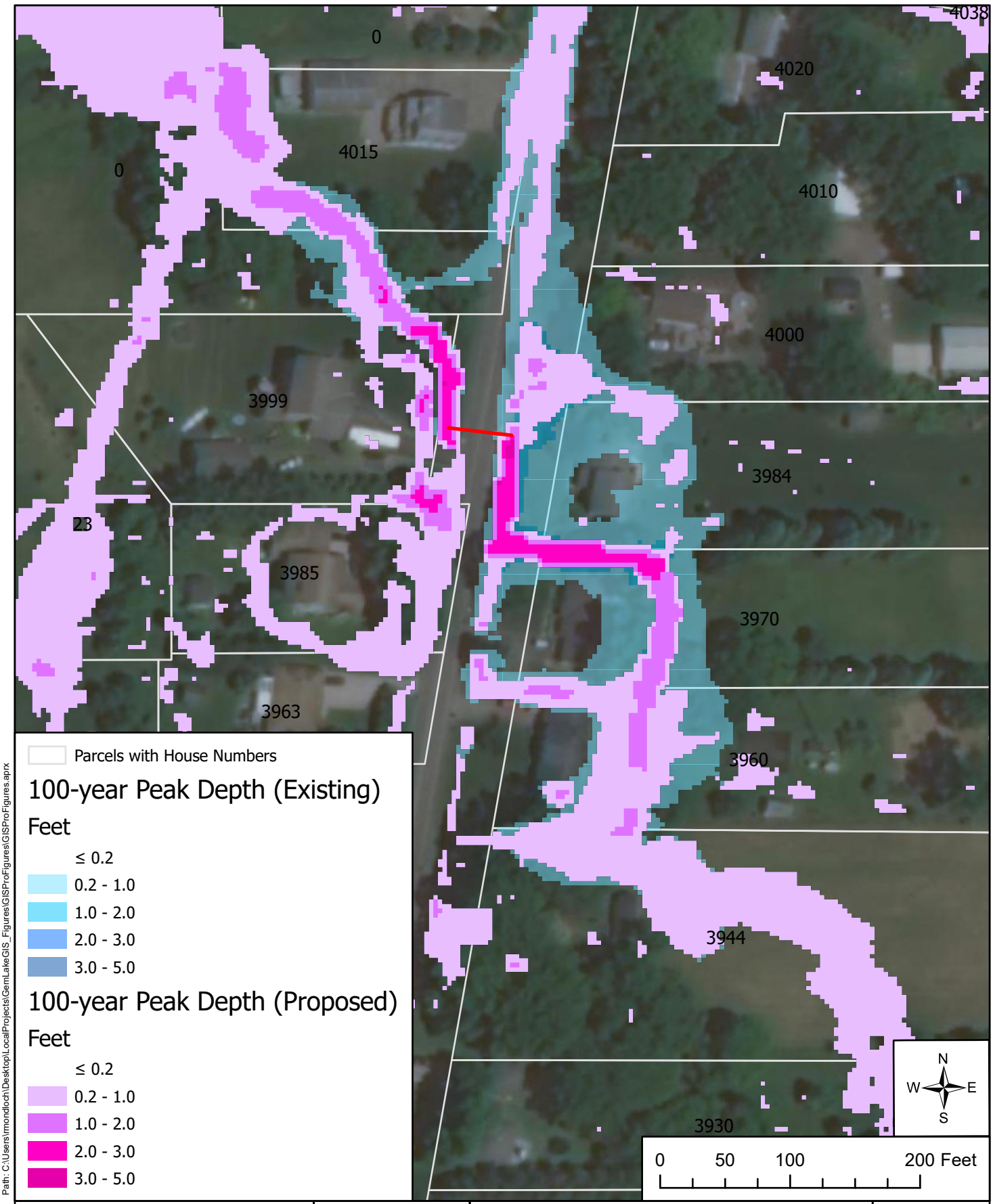
Culvert Area Scenario 1
10-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 8



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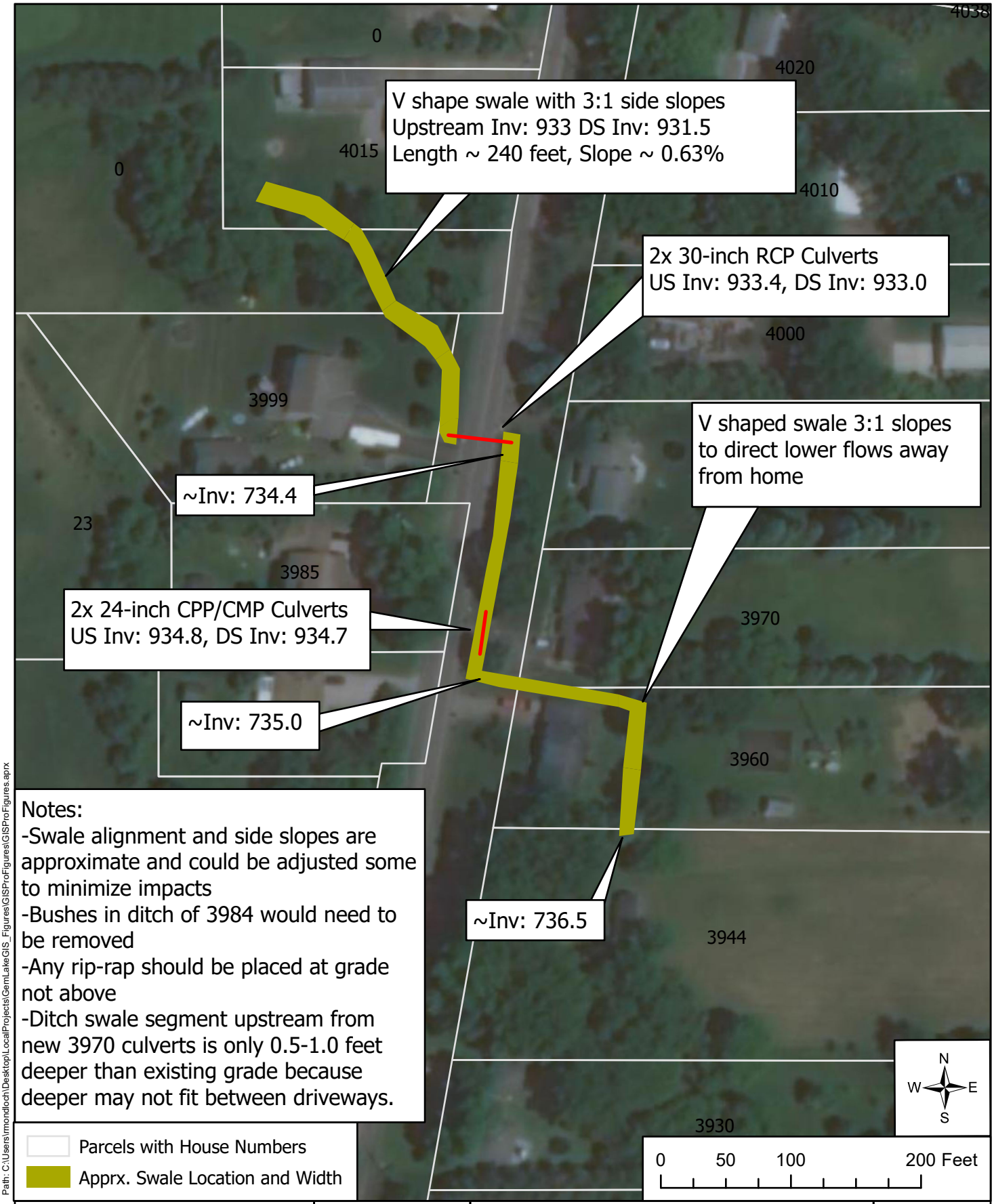
Culvert Area Scenario 1
100-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 9



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Parcels with House Numbers
Apprx. Swale Location and Width

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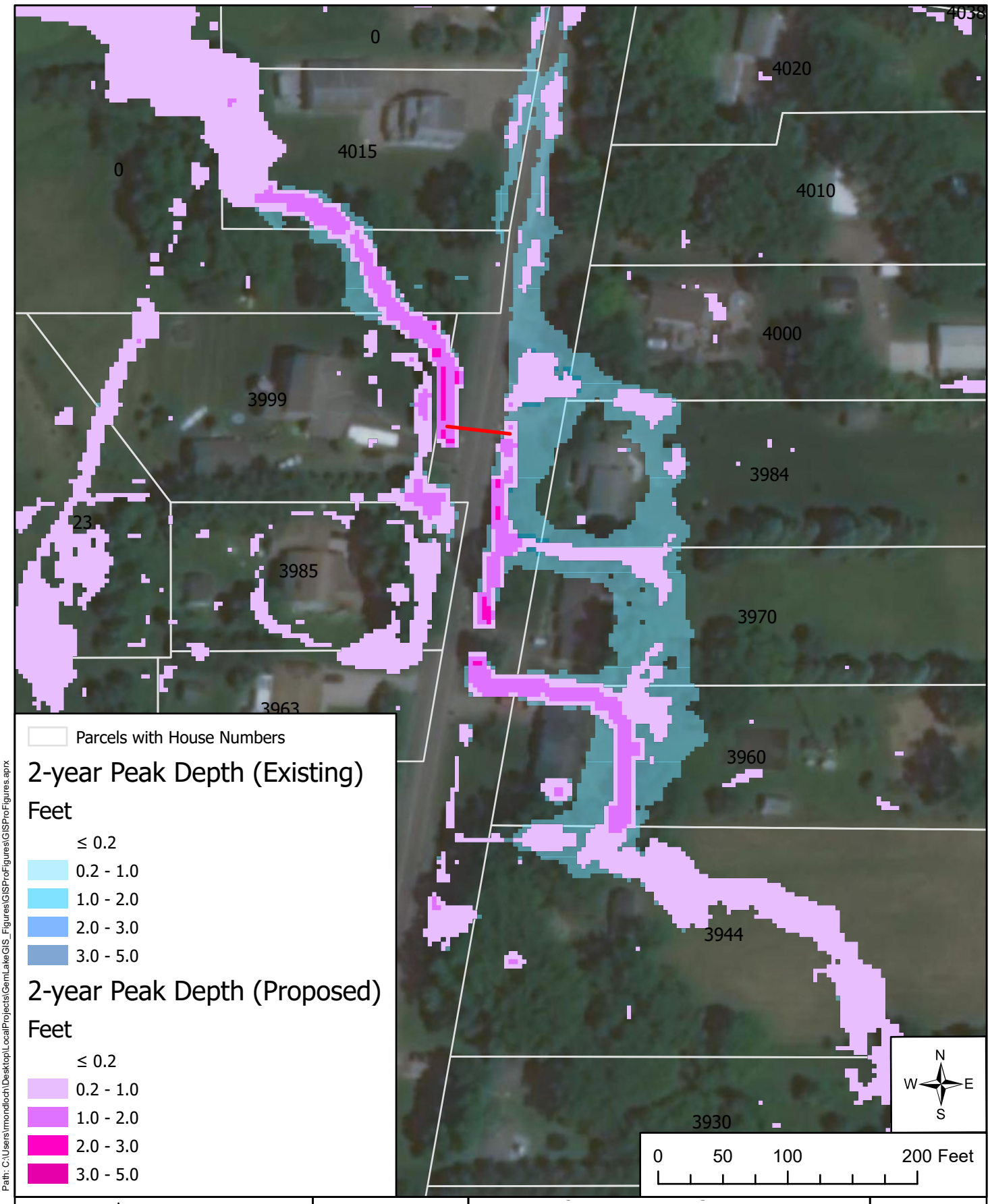
Culvert Area Scenario 2

Gem Lake Stormwater Study
Gem Lake, MN

Figure 10



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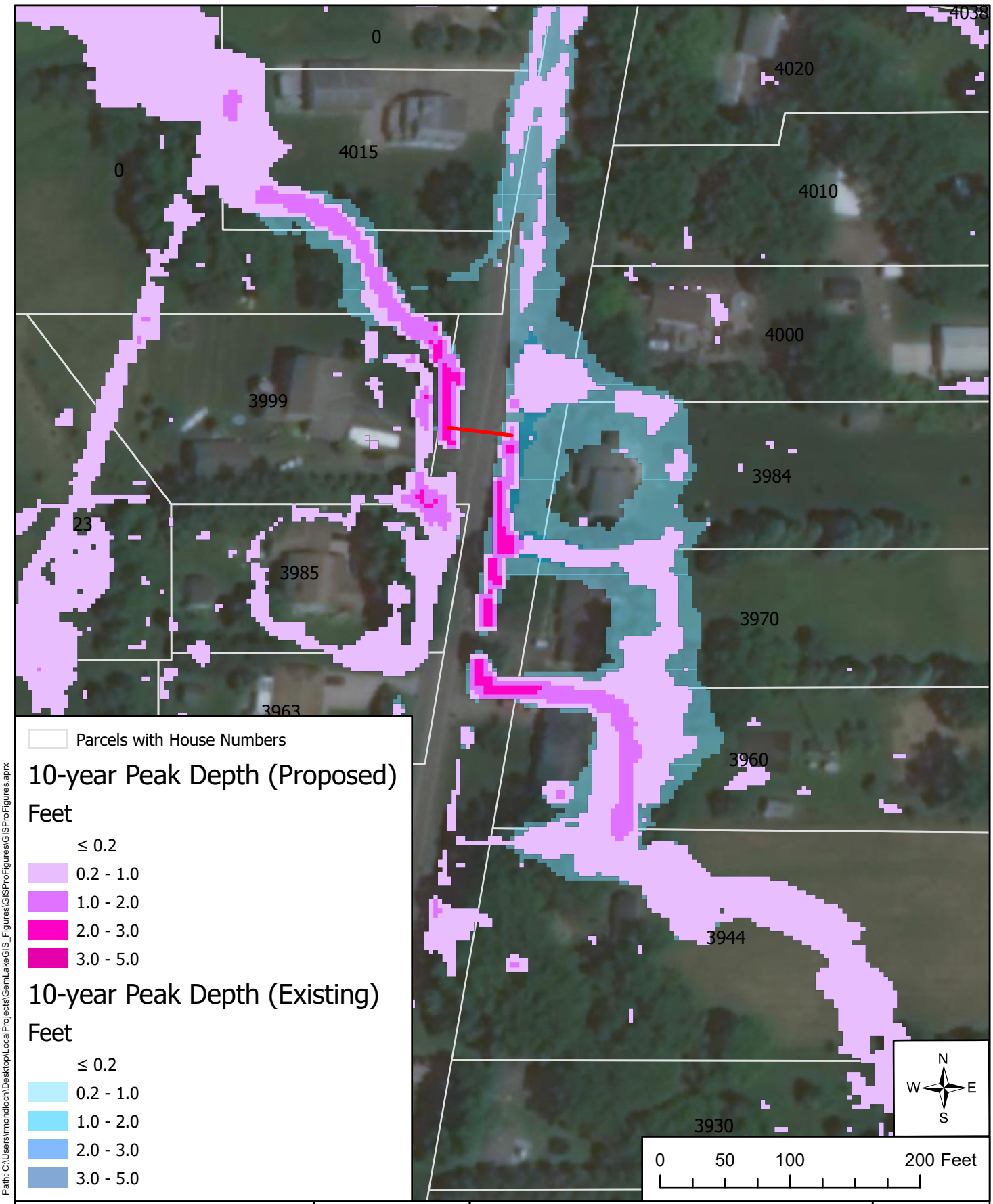
Culvert Area Scenario 2
2-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 11



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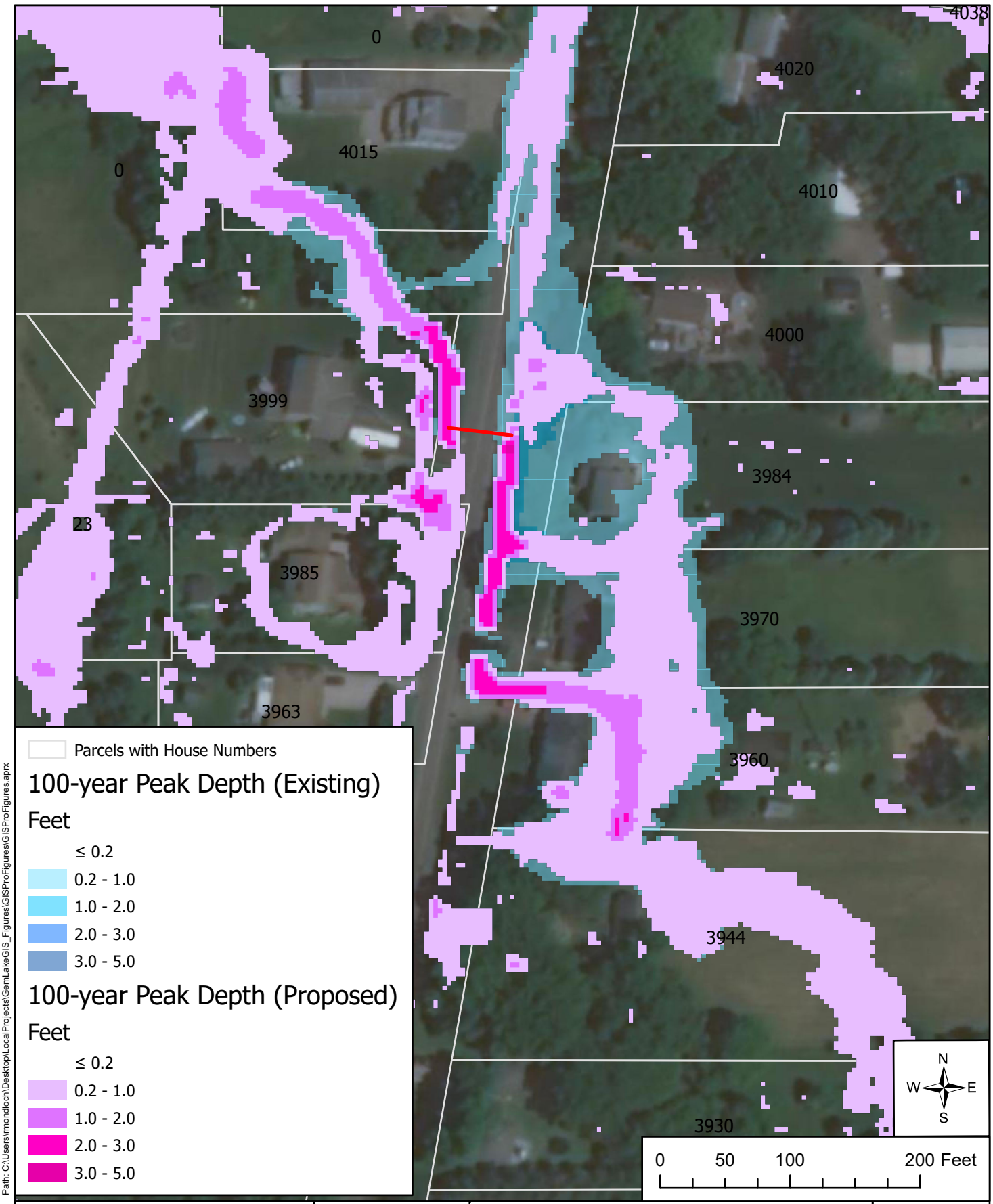
Culvert Area Scenario 2
10-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 12



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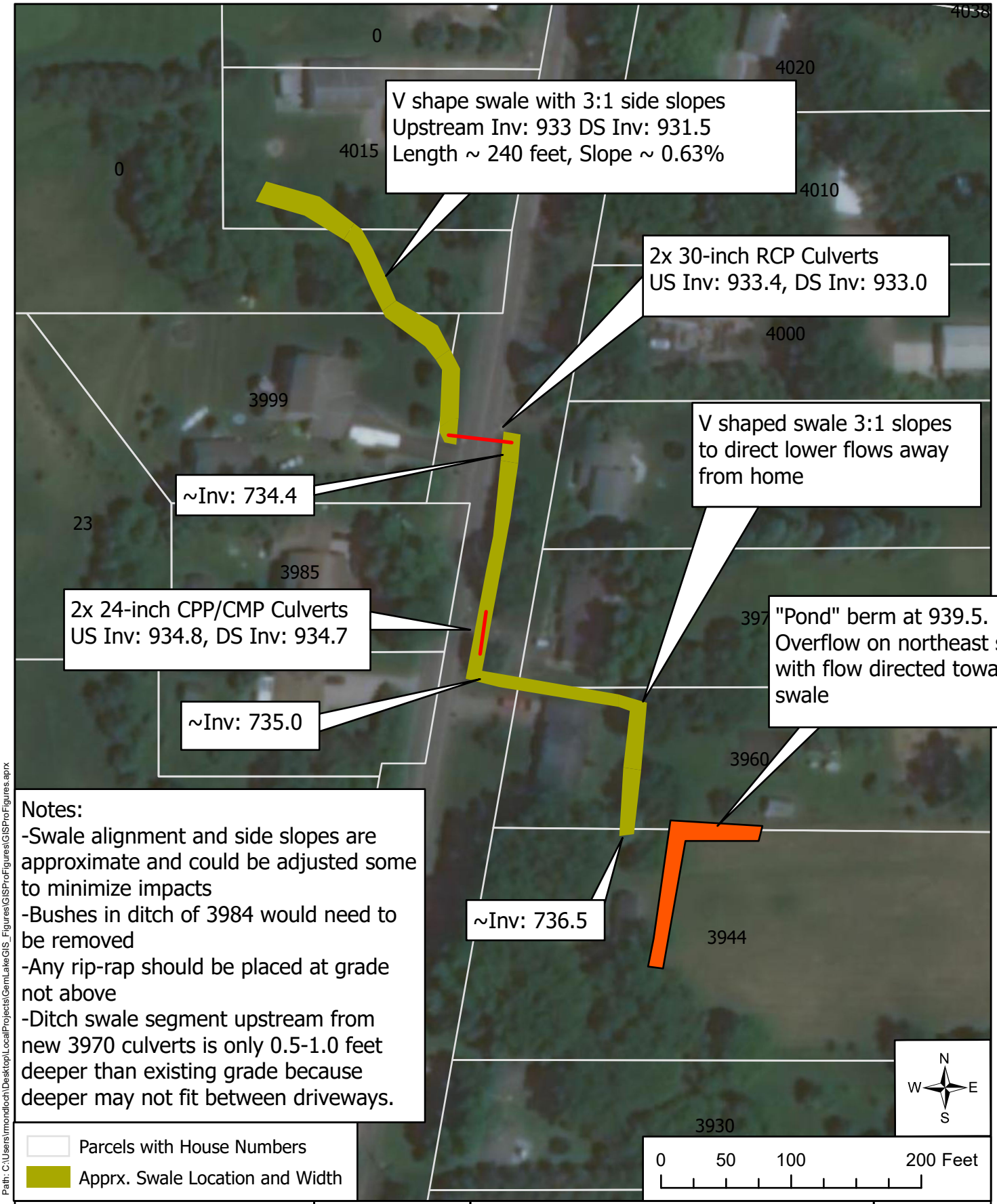
Culvert Area Scenario 2
100-year Storm Depth/Inundation

Gem Lake Stormwater Study
Gem Lake, MN

Figure 13



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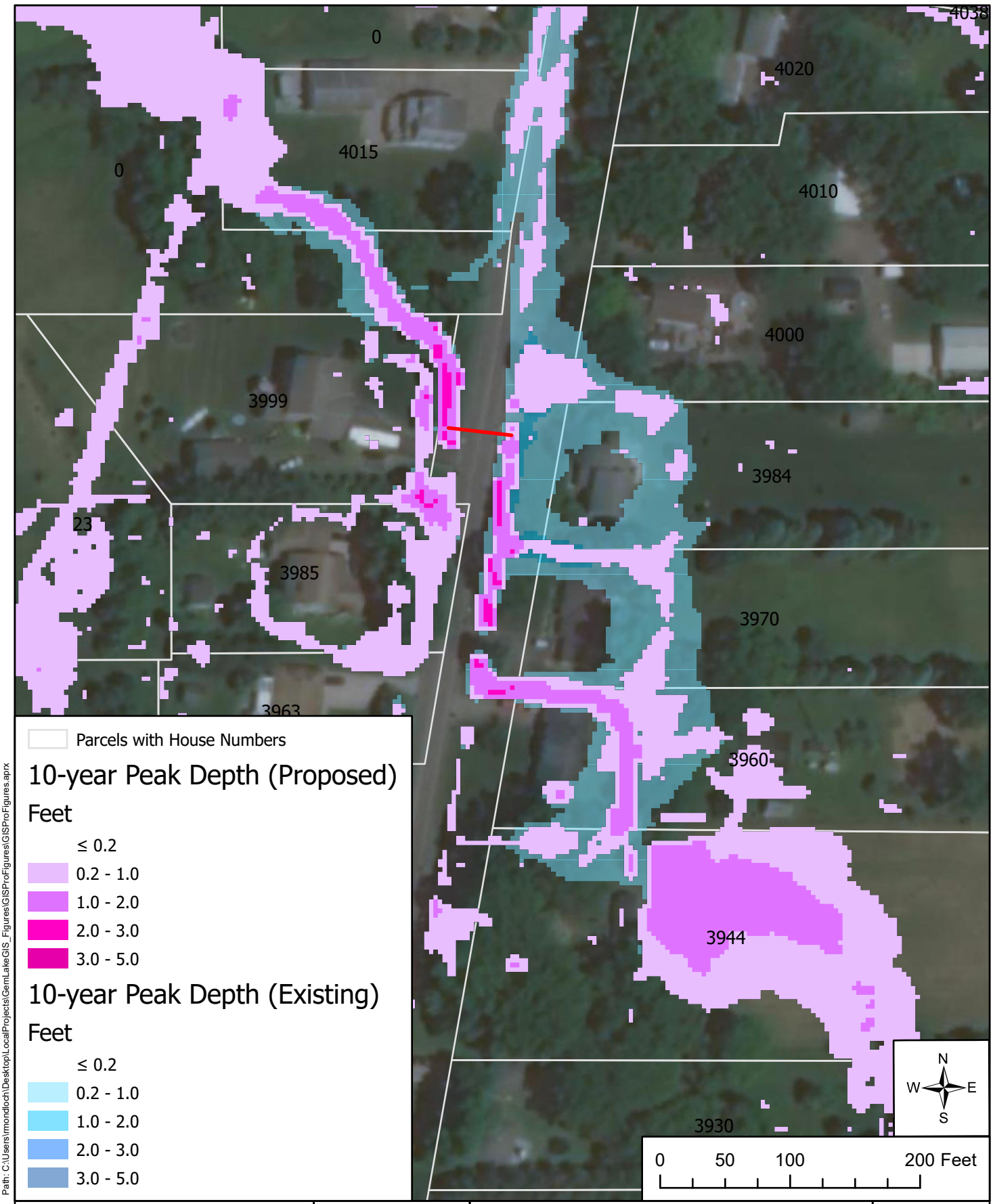
Culvert Area BMP Scenario

Gem Lake Stormwater Study
Gem Lake, MN

Figure 14



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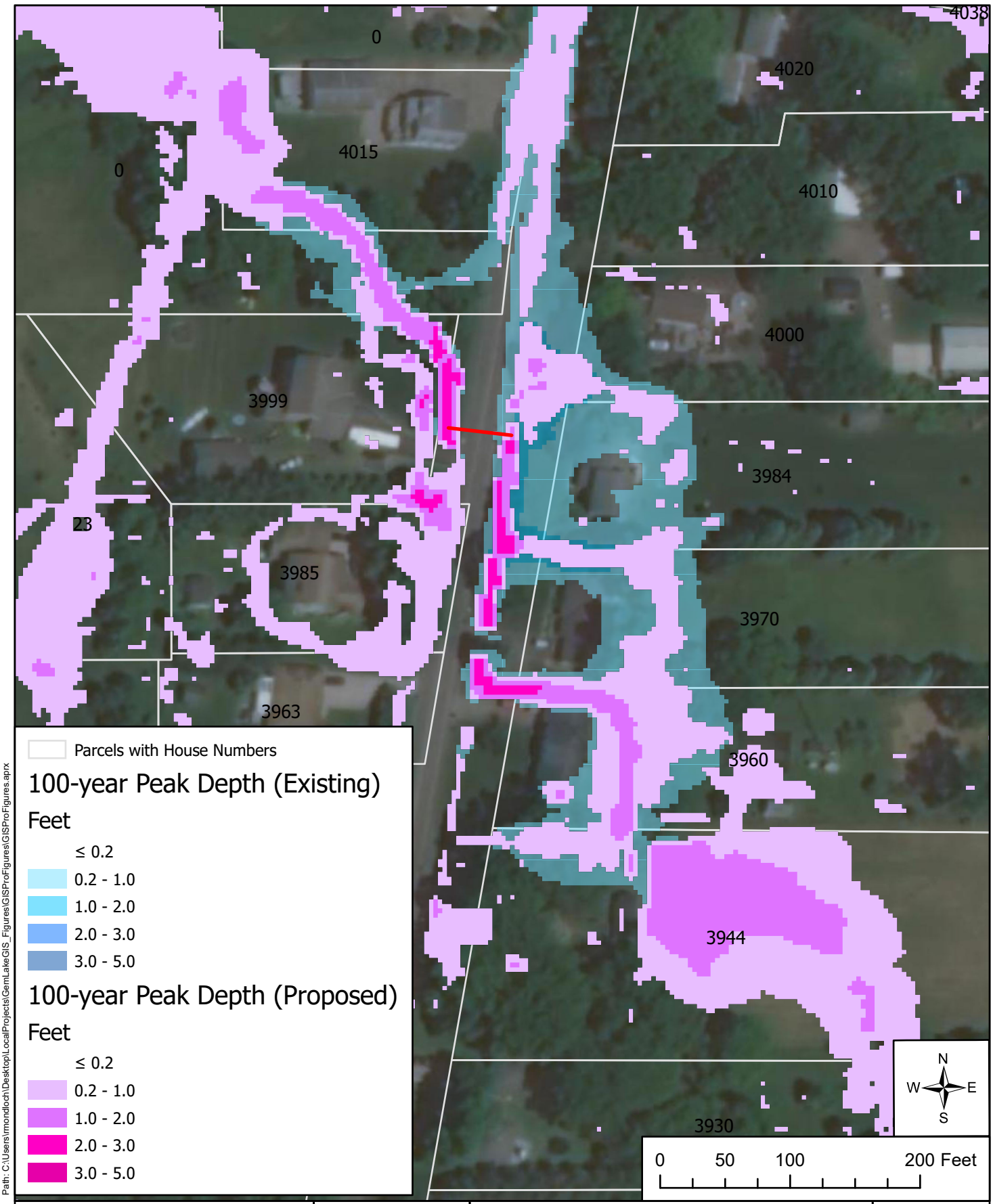
Culvert Area BMP Scenario
10-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 15



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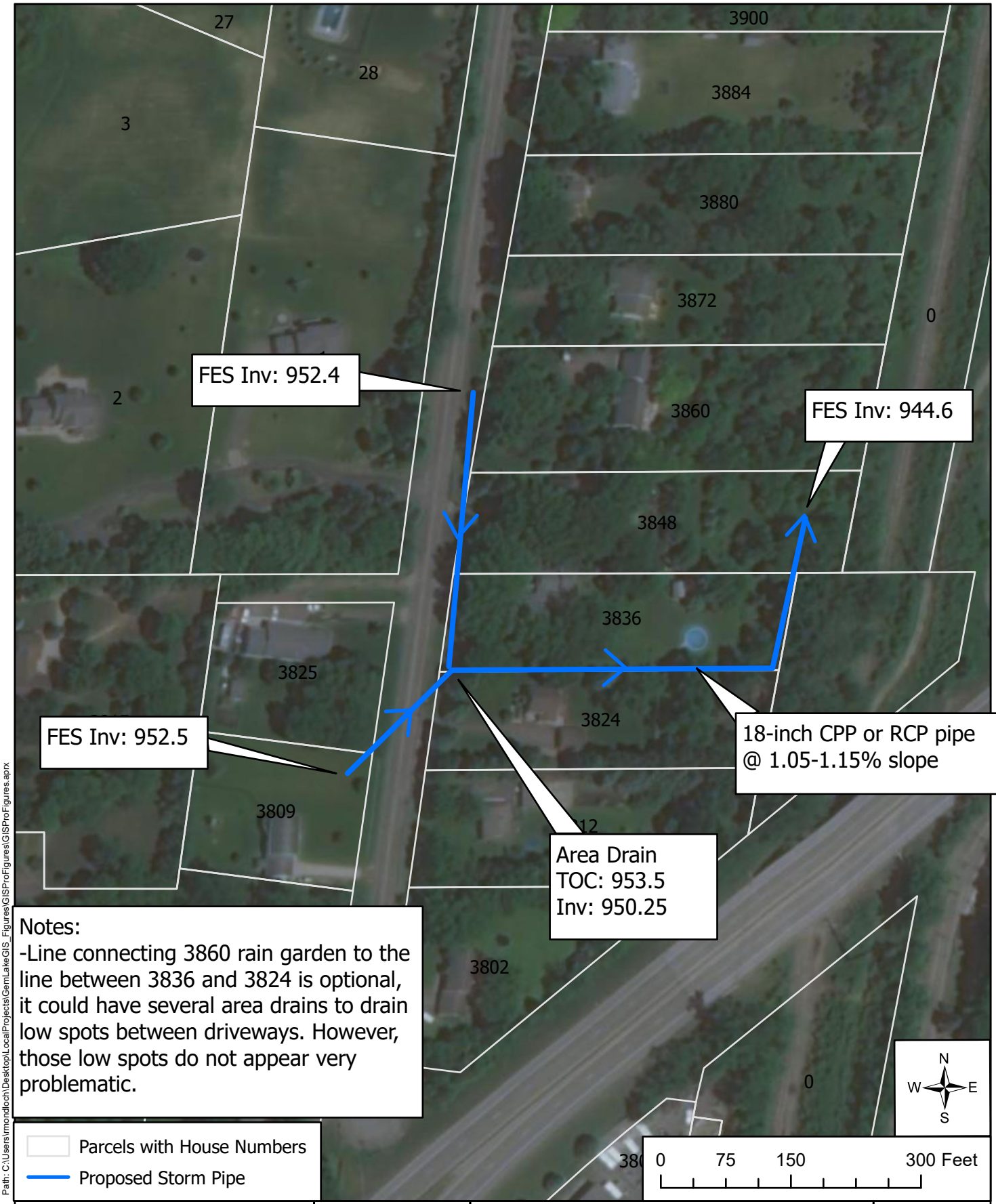
Map by: rmondloch
Projection: Ramsey County Coordinates
Source: ESRI, SEH

Culvert Area Scenario 2
10-year Storm Depth/Inundation

Gem Lake Stormwater Study
Gem Lake, MN

Figure 16



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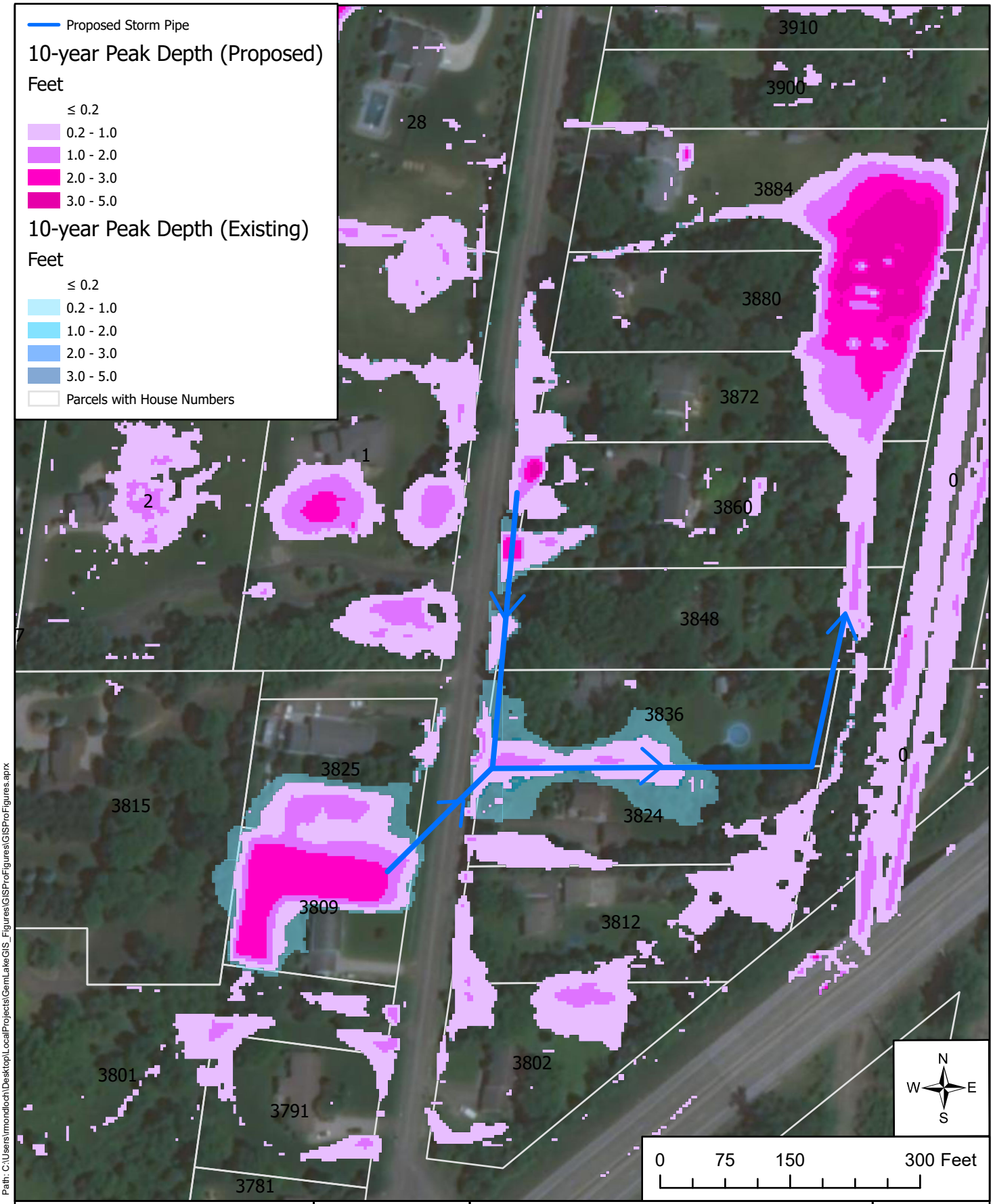
South Area Scenario 1

Gem Lake Stormwater Study
Gem Lake, MN

Figure 17



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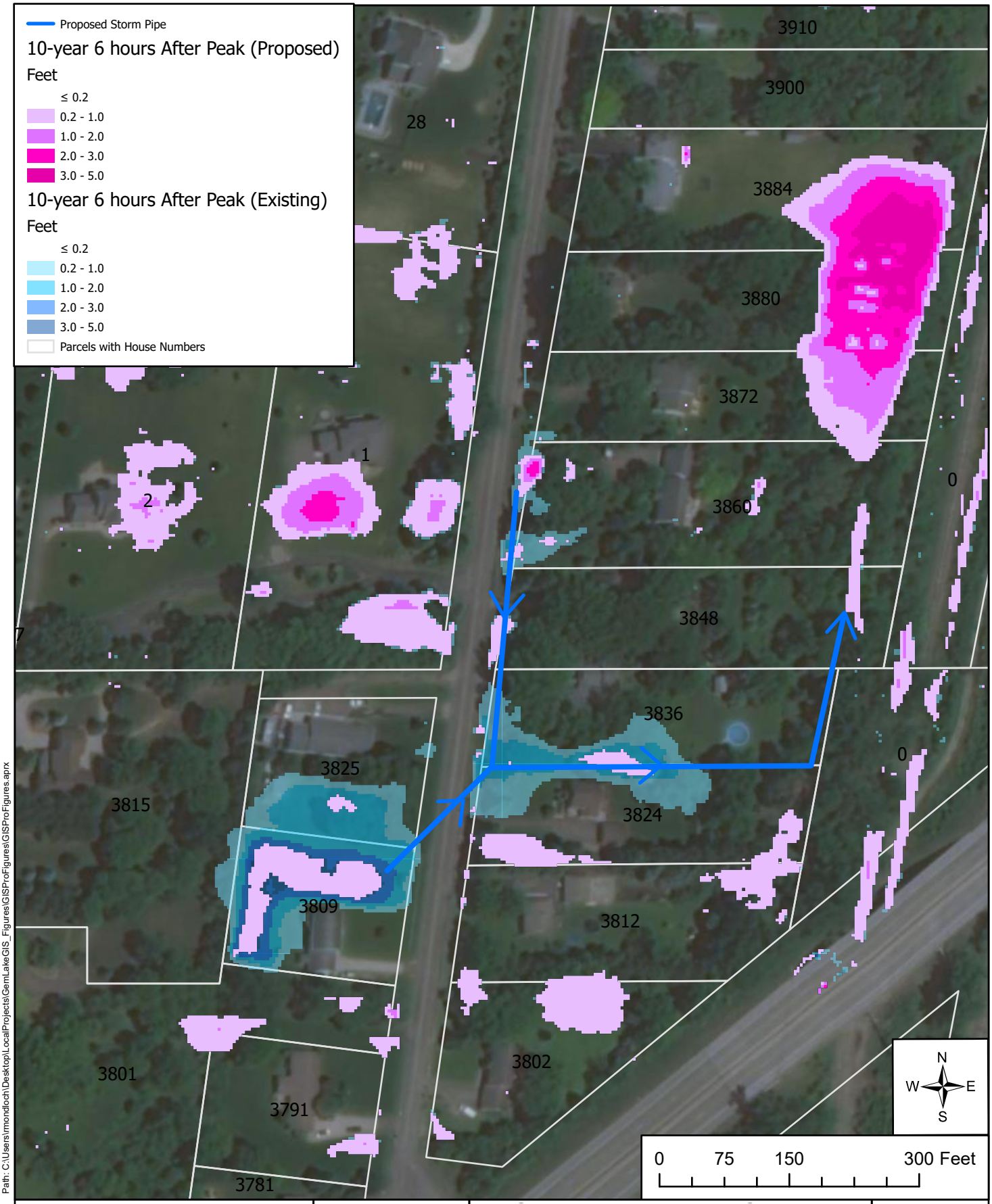
South Area Scenario 1
10-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 18



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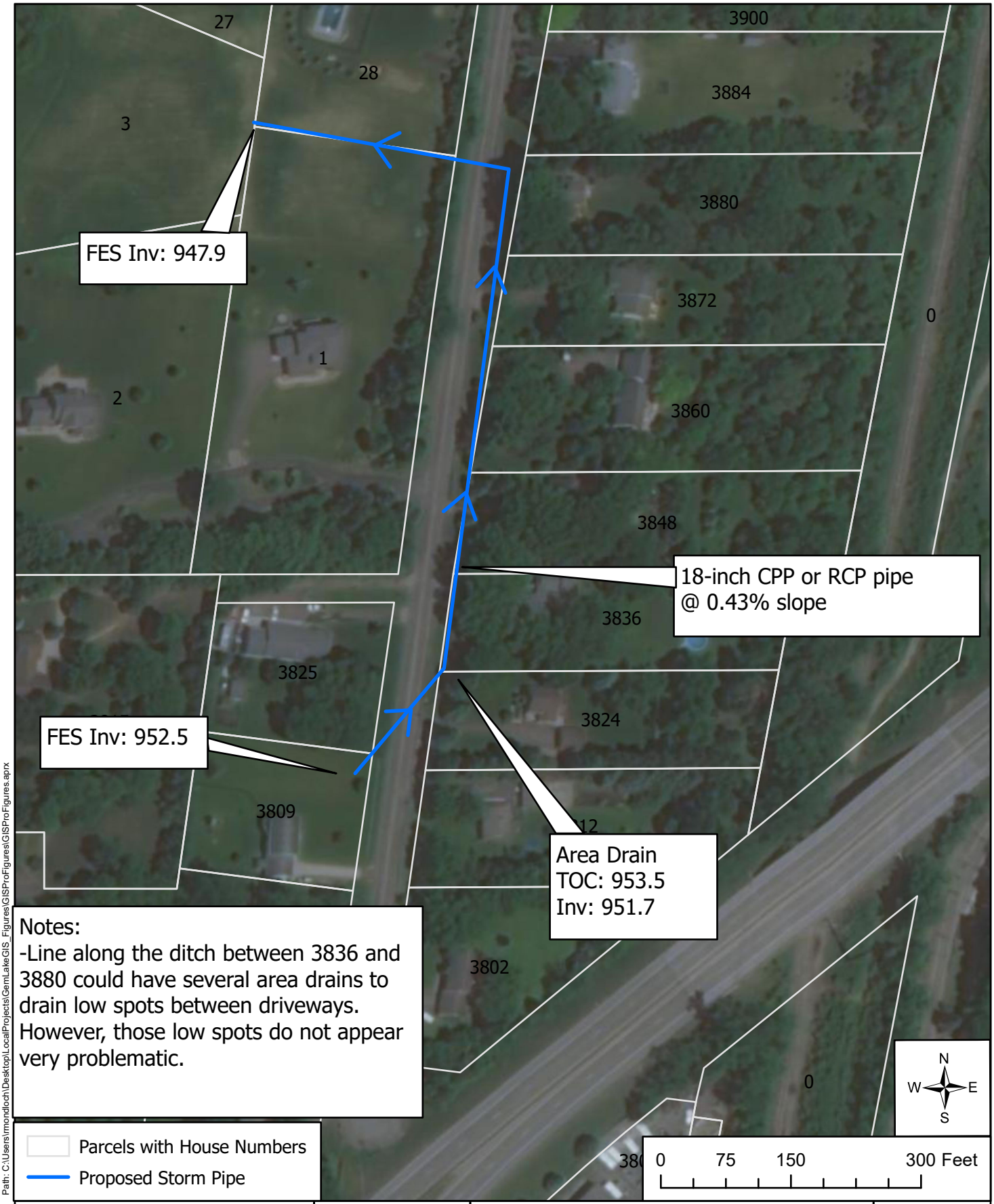
South Area Scenario 1
10-year Storm - 6 hours after peak
Gem Lake Stormwater Study
Gem Lake, MN

Figure 19



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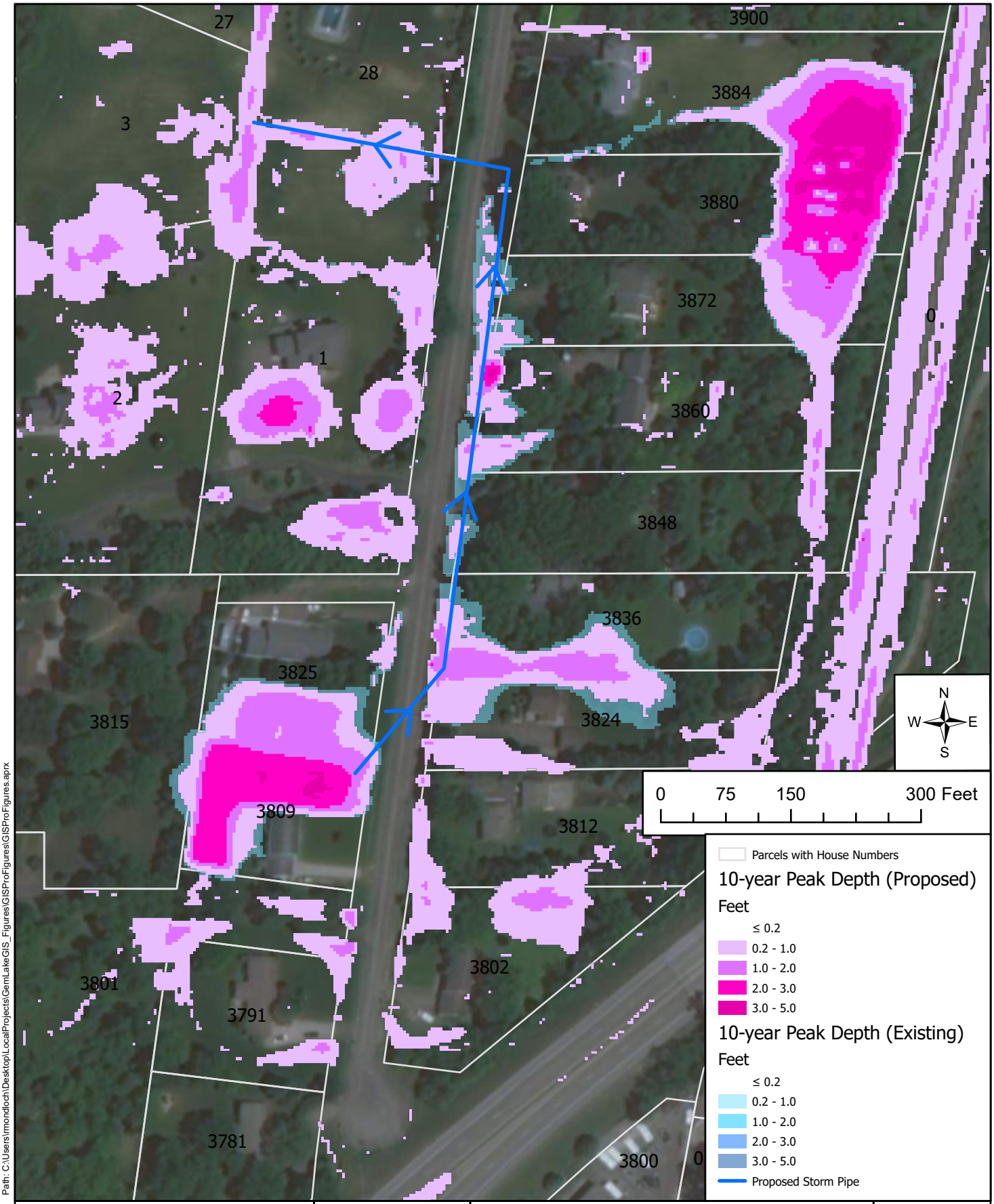
South Area Scenario 2

Gem Lake Stormwater Study
Gem Lake, MN

Figure 20



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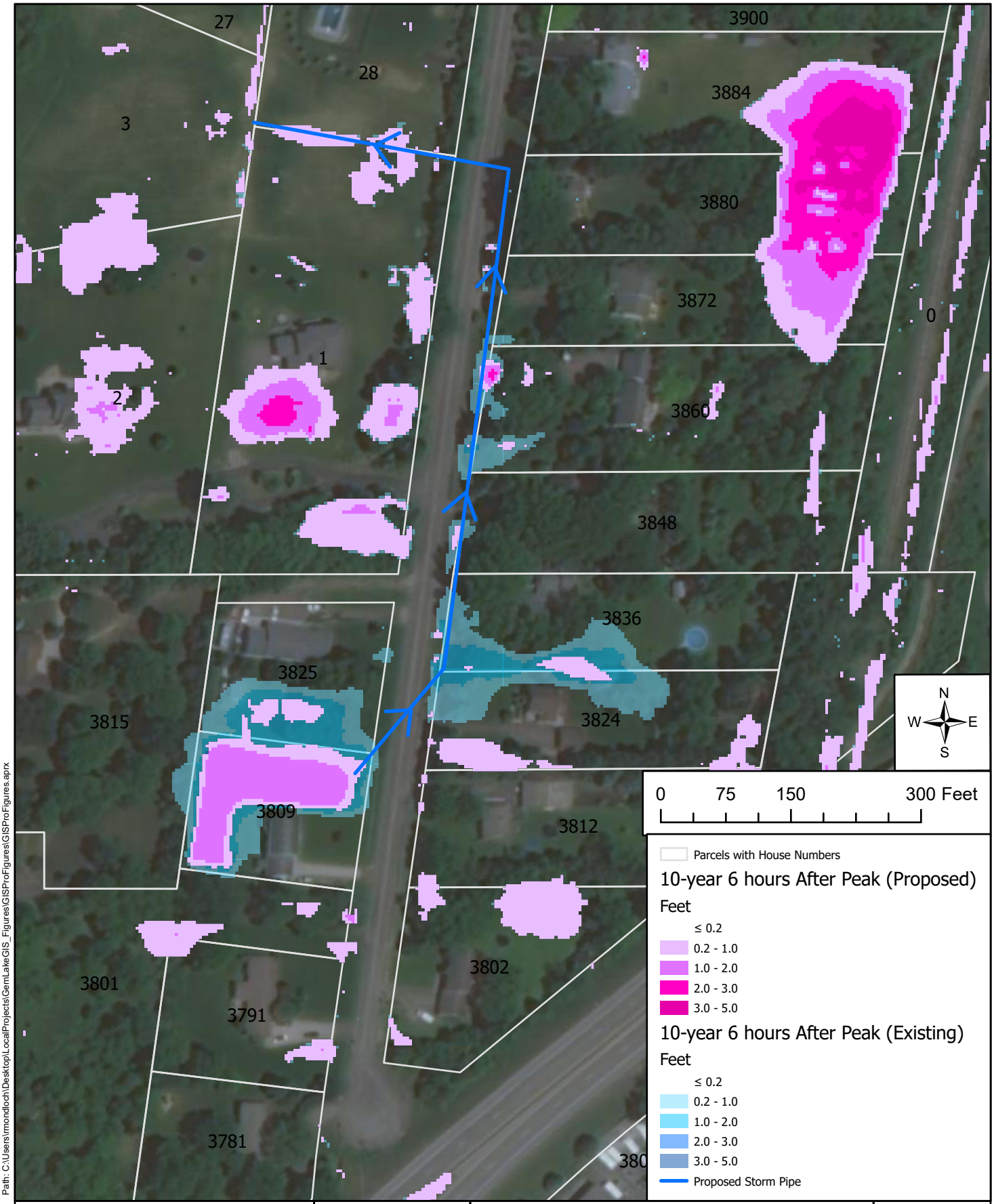
South Area Scenario 2
10-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 21



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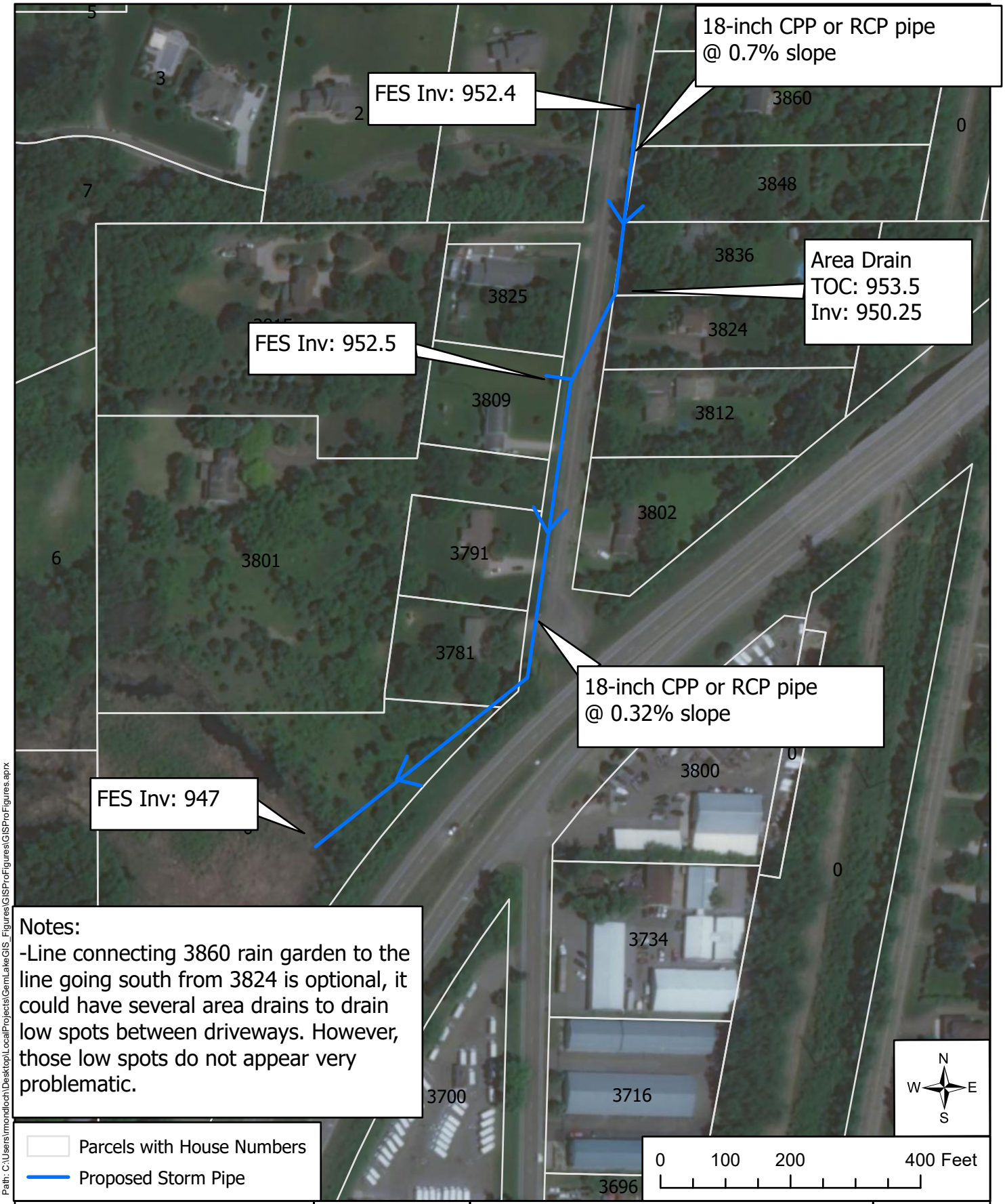
South Area Scenario 2
10-year Storm - 6 hours after peak
Gem Lake Stormwater Study
Gem Lake, MN

Figure 22



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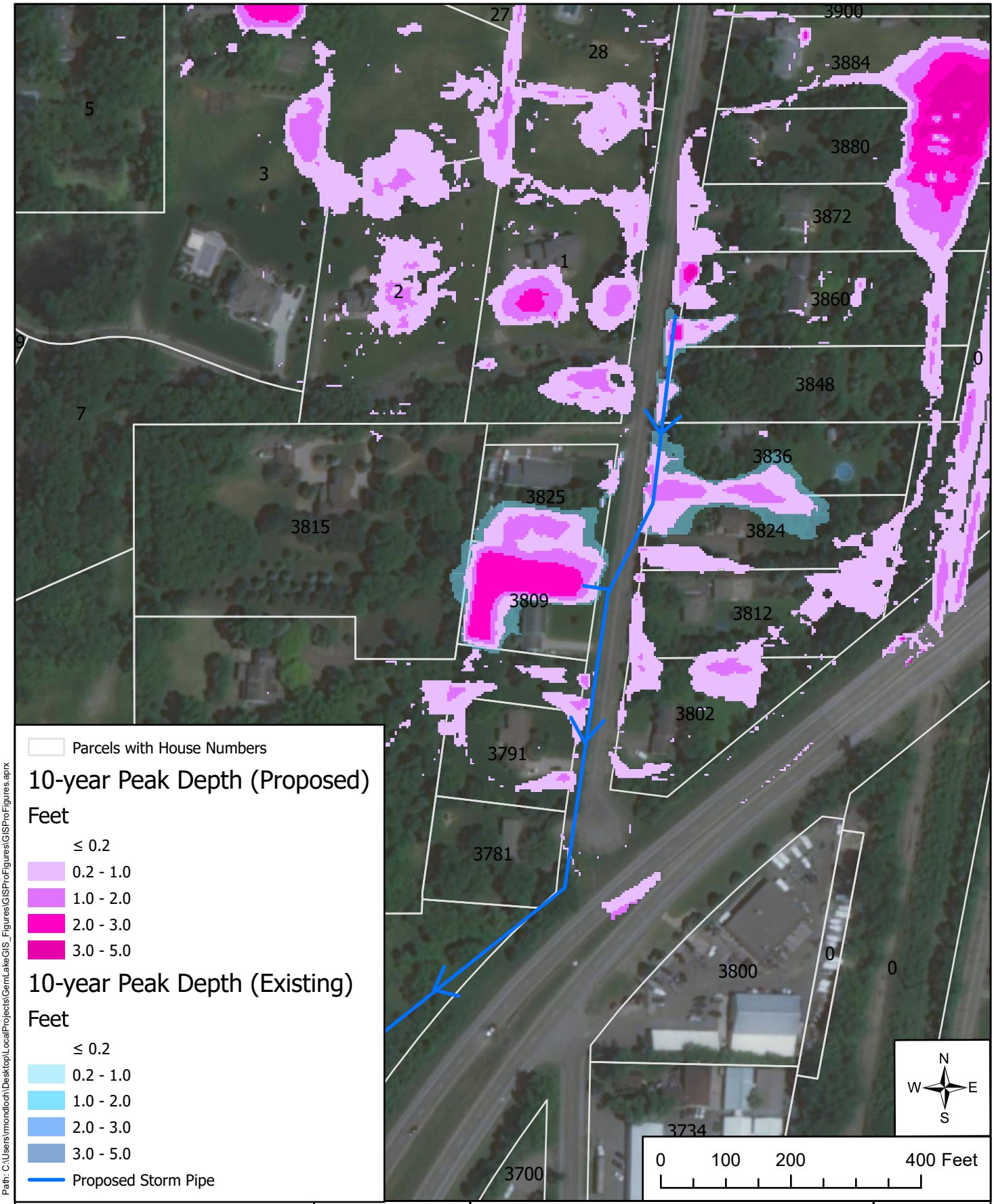
South Area Scenario 1

Gem Lake Stormwater Study
Gem Lake, MN

Figure 23



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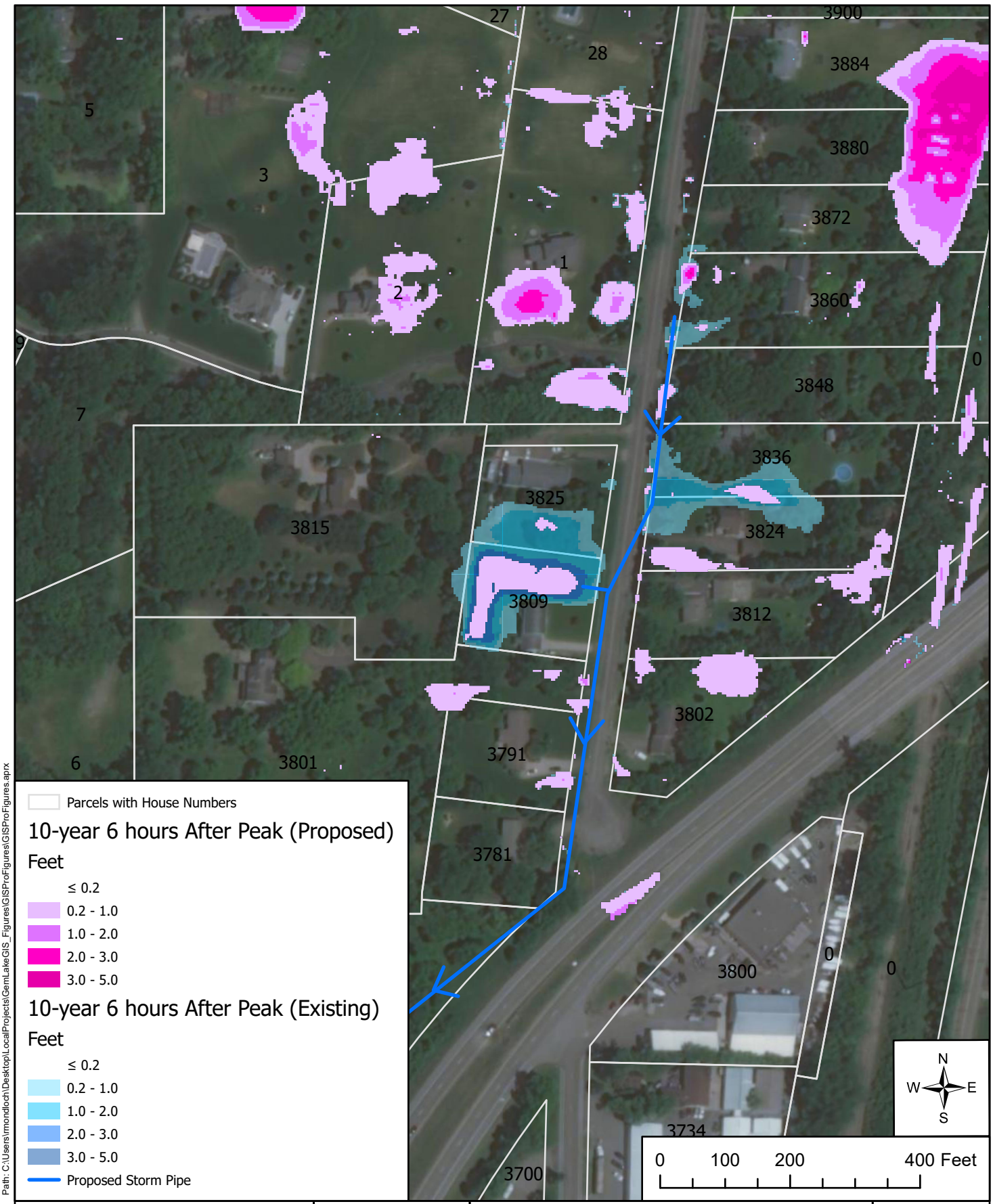
South Area Scenario 3
10-year Storm Depth/Inundation
Gem Lake Stormwater Study
Gem Lake, MN

Figure 24



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Source: ESRI, SEH

South Area Scenario 3
10-year Storm - 6 hours after peak
Gem Lake Stormwater Study
Gem Lake, MN

Figure 25

Appendix A

Past Studies and Documentation

Building a Better World for All of Us®

MEMORANDUM

TO: Mayor Uzpen

FROM: Justin Gese, PE
Erik Bye

RE: Flooding on Scheuneman Road in Gem Lake
SEH No. 145993 14.00

The minor flooding issues around Scheuneman Road were the result of an unusually large amount of late winter snow, rain, and an expedited melt due to weather conditions. At the time, the frost depth was still near the ground surface and did not allow for any infiltration into the soil, essentially causing homeowners' yards to act as an impervious surface. This combination led to standing water and abnormal flooding issues caused by frozen soil, frozen culverts, and excess runoff. The lack of storm sewer conveyance infrastructure within Sheuneman Road compounded the issue. The major conveyance problems that were discovered during field observations were improper drainage of ditches that had not been properly maintained, plugged or damaged culvert pipes, and property grading that enabled the standing water. While there are visible issues with the drainage system, the underlying cause of these spring flooding issues was the extremely abnormal climatic conditions that occurred this winter and early spring. The following section highlights each specific flooded area with information regarding location and the expected cause. Photos associated with the flooded sites can be found in Appendix A. A map of the flooded areas on Scheuneman road with elevation, flow patterns, and the site locations is also attached (figure 1).

- Site 1 (3809 Scheuneman Rd. St. Paul, MN 55110)
    - This is a low point and the runoff should flow north through a culvert. The culvert may be frozen, causing melt water to pool here. Water here should flow to site 2 from here.
- Site 2 (3809 Scheuneman Rd. St. Paul, MN 55110)
    - This flooded area is graded lower than the surrounding home lots and roadway and doesn't appear to have an outlet. The site collects runoff from the entire upstream area southwest of it towards the wetland and drained quicker than most sites SEH observed (figure 1).
- Site 3 (3824 Scheuneman Rd. St. Paul, MN 55110)
    - This site experienced flooding in the front and side yard, which were points of low elevation in the area. The ditch and culvert system at this site should convey this water north along the Scheuneman Road ditch, however, improper grading and frozen or damaged culverts caused meltwater and runoff to pool in these yards.

- Site 4 (3836 Scheuneman Rd. St. Paul, MN 55110)
    - This site had flooding in the front yard, which was a point of low elevation in the area and received runoff from site 3. Based on field observations, the culvert was also likely frozen. The ditch and culvert system at this site should convey this water north along the Scheuneman Road ditch, however, improper grading and frozen or damaged culverts caused meltwater and runoff to pool in these yards.
- Site 5 (3860 Scheuneman Rd. St. Paul, MN 55110)
    - Flooding at this site occurred in a low elevation area in the front yard of this house. Site 3 and 4 should both drain to this area and north along Scheuneman Road to the north side of 3880 Scheuneman Rd. St. Paul, MN 55110 where it follows the topography east to a low area in that backyard near the railroad. However, the meltwater and runoff did not reach this low spot in the backyard this year because of low spots in the ditch and damaged or frozen culverts.
- Site 6 (3970 Scheuneman Rd. St. Paul, MN 55110)
    - Flooding at this site seems more likely to be caused by an improperly maintained ditch and frozen culvert than poor ditch grading. This area should convey water west under Scheuneman Road and then northwest towards the golf course when the ditches and culverts work correctly.
- Site 7 (20 Hillary Farm Ln. St. Paul, MN 55110)
    - This is an existing stormwater pond that was full during field investigation and functioning as planned.
- Site 8 (28 Hillary Farm Ln. St. Paul, MN 55110)
    - The flooding in this area should be draining into the swale directly west and then into a stormwater pond. This issue is most likely caused by a low spot that was improperly graded (figure 1).

SEH was hired by the City of Gem Lake to come up with some potential solutions to the drainage concerns along Sheuneman Road. Costs associated with potential solutions were estimated using the following assuptions:

- MnDOT 2017 average bid prices
- Trapezoid ditch with a 3:1 slope grade
- Common excavation with no rock or muck
- Replacement of all culverts in regraded ditch path
- Sod lawn replacement
- Impact percentages are estimated based on the number of sites where the following improvement options could reduce flooding

Options for improvement include:

1. Status quo
    a. This option has no cost and only requires landowners to maintain their own ditches and culverts to ensure they are working properly. Flooding should be mitigated during typical spring snow melt, but no change will occur during conditions like this spring.
2. Regrade ditch to convey water
    a. This option would regrade approximately the first seven front yard ditches beginning at 3812 Scheuneman Rd. St. Paul, MN 55110 and replace the damaged culverts to route the water north along Scheuneman Road ditch to just north of 3880 Scheuneman Rd. St. Paul, MN 55110 where ditch will go east to a low point near the railroad in the backyard. This will be a relatively low cost compared to a road reconstruction and will make about a 60% impact on the flooding issue by mitigating all of the flooded sites on the east side of Scheuneman Rd (Sites 3, 4, 5, 6).
3. Regrade ditch and add swale to convey water
    a. In this option, instead of regrading all of the front yard ditches north to 3880 Scheuneman Rd. St. Paul, MN 55110 like option 1, an easement would allow for a swale on the north side of 3824 Scheuneman Rd. St. Paul, MN 55110 to drain the flooded front yards at site 3 and 4 to the low spot in the backyard at 3880 Scheuneman Rd. St. Paul, MN 55110. The ditch from site 5 to the north side of 3880 Scheuneman Rd. St. Paul, MN 55110 would also be regraded in this option to drain that area back to the backyard low area. This will be a relatively low cost compared to a road reconstruction and will also make about a 60% impact on the flooding issue by mitigating all of the flooded sites on the east side of Scheuneman Rd (Sites 3, 4, 5, 6).
4. Total road reconstruction
    a. This option is a complete road reconstruction including the installation of water main pipes, storm sewer pipes, and a new stormwater pond to treat runoff. The stormwater pond would be required as part of Minnesota Construction Stormwater General Permit. The reconstruction should significantly improve spring flooding and general drainage along Scheuneman Road as well as provide a water main extension to the area. This option will also be the most expensive and time consuming but it should have a 100% impact on the flooding issue with the addition of stormwater infrastructure.

Improvement options	**Cost rank**	**Cost estimate**	**% Impact**
1. Status quo	4	$0	0
2. Regrade ditch	3	$88,000	60
3. Regrade ditch and add swale	2	$90,000	60
4. Road reconstruction	1	$2.9 million	100

Appendix A:

Site 1.

3-19-19

3-23-19

3-25-19

Site 2.

3-19-19

3-23-19

3-25-19

Site 3.

3-19-19

3-23-19

3-25-19

Site 4.

3-23-19

3-25-19

Site 5.

3-23-19

3-25-19

Site 6.

3-19-19

3-23-19

Site 7.

3-25-19

Site 8.

3-25-19

ewb

c: JG, EE
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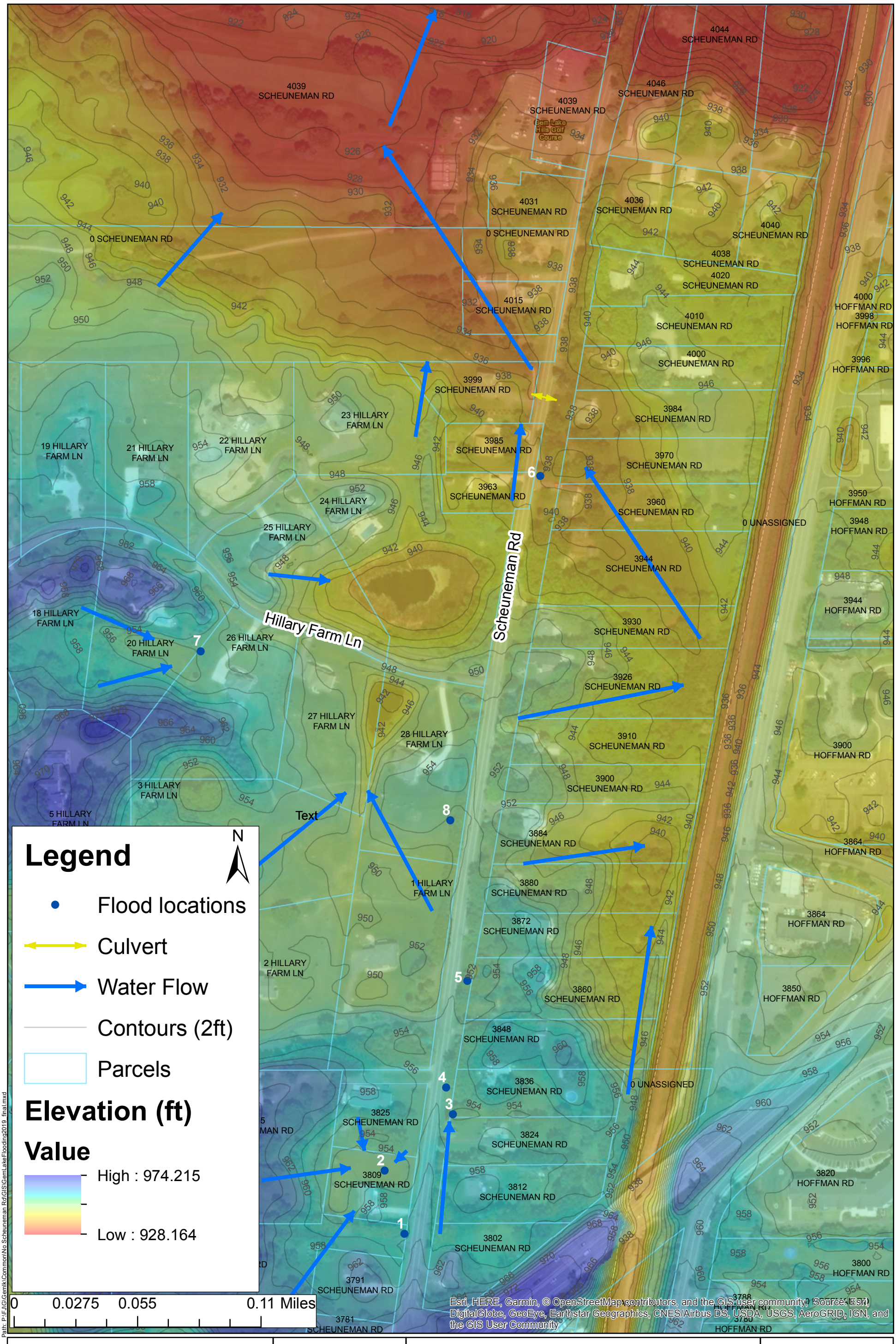

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Project: Gemlk
Print Date: 4/16/2019

Map by: ebye
Projection:
NAD_1983_HARN_Adj_MN_Ramsey_Feet
Source: SEH, MnTOPO, Ramsey County

Gem Lake Spring 2019 Flooding

Gem Lake

Figure 1

Building a Better World for All of Us®

MEMORANDUM

TO: Justin Gese, City Engineer
SEH

FROM: Emily Jennings, Water Resources Engineer
SEH

DATE: October 19, 2020

RE: Gem Lake Drainage – Scheuneman Road Flooding and City Wide Culvert Inspections Summary and Next Steps
SEH No. GEMLK 145993 14.00

Background
In spring 2019, an unusually large amount of late winter snow, rain, and an expedited melt caused flooding throughout portions of the Scheuneman Road. SEH inspected these areas and prepared a memorandum of the observations and listed some potential solutions to the drainage concerns.

To gain a better understanding of the overall drainage system within the City of Gem Lake, SEH was hired by the City of Gem Lake following the spring flooding at Scheuneman Road to inspect culvert crossings within the City, including both City owned culverts and privately owned driveway/entrance culverts. At request from the City, inspections were delayed one year and completed in spring of 2020. Any inspection summary, reports, and maps were prepared for the City.

The purpose of this memorandum is to identify some next steps for the City with a focus on the Schueneman Road.

Private Culvert Crossings
During the 2019 Scheuneman Road site visits, culvert conditions were not identified due to snow pack. During the city wide culvert inspections, each crossing was inspected for the following criteria:

- Structural Condition
- Submerged Condition
- Sedimentation
- Erosion

Generally speaking, culverts throughout the City of Gem Lake were in overall good shape. Throughout the City, the most prevalent of the inspection criteria identified was sedimentation. For the purposes of the inspections, sedimentation was defined as settled or deposited sediment or other materials that may be affecting culvert capacity, entrance, or exit. Over time, these deposits can often become disguised as part of lawn or other landscaped areas.

Figure 1 shows the flooding locations identified in the Scheuneman Road Flooding Memorandum with the Culvert Inspection Results for this area. As identified on the figure, those areas that are not natural low points, may have had exacerbated flooding issues due to sedimentation within the private culvert crossings.

It is also important to note that some areas naturally flow away from City right-of-way. These natural flow paths discharge through private property.

Public Culvert Conditions
In addition to the several driveway culverts within Scheuneman Road Flooding Area, there is one publically owned cross culvert that flows from east to west at approximately 3984 Scheuneman Road to 3999 Scheuneman Road. This crossing is just downstream of an area of flooding concern (6) identified in the Scheuneman Road Flooding Memorandum. This particular area is not a natural low point and does not have a natural flow path away from City right-of-way.

This crossing is a plastic, approximately 12" - 15" diameter pipe and is in good shape structurally. The upstream end of the crossing includes a flared end section. There was some minor seasonal debris accumulation but there did not appear to be sedimentation or debris levels that would significantly restrict drainage however, the surrounding area of the upstream crossing is surrounded by mature shrub vegetation.

Downstream of the crossing, there is a riprap swale that extends approximately 80 feet downstream of the crossing towards the Gem Lake Golf Course, prior to reaching the ultimate discharge point of Gem Lake. The rip rap swale appears to be more mounded within the bottom of the swale. This mounding may be causing a tailwater condition to the culvert crossing.

Limitations
A hydraulics evaluation was not included in the Scheuneman Road Flooding evaluation or the city wide culvert inspections. Therefore, it should be noted that a culvert may not have adequate capacity based on hydraulics regardless of structural condition, submerged condition, sedimentation, or erosion condition.

In addition, it is important to note that there are natural low areas throughout the City of Gem Lake. During snow, rain, or melt conditions, it is expected that these areas will experience inundation.

Recommendations and Next Steps
The following recommendations from the Culvert Inspections Memorandum still apply:

- Increase Public Education: During inspections, a resident shared with the SEH inspector that they were not clear on whose responsibility it was to clean and maintain their driveway culvert and roadside ditch adjacent to their property. It is recommended that the City of Gem Lake increase the public education on the purpose of driveway culverts and roadside ditches, the ownership of this conveyance, and the expectations for the overall system. This may help residents better understand the overall system and encourage residents to keep culverts and ditches clear from landscaping and vegetation, which may prohibit capacity.
- Clean Out Sedimentation: It is recommended that the City initiate a culvert and ditch clean out program, in the spring, fall, or as needed, to keep culverts and other conveyance free from obstructions.

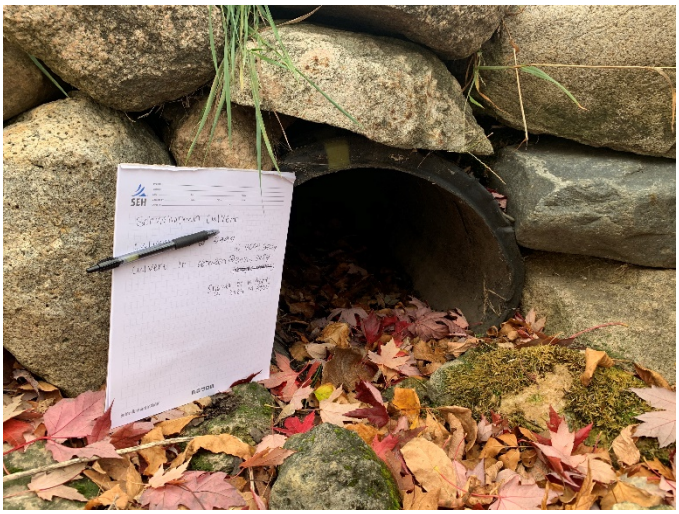
In addition to the aforementioned recommendations it is also recommended that an elevation survey be completed at the cross culvert and upstream ditch with elevations taken at the flowline and surrounding areas both up and downstream. This information should be use to complete a hydraulics evaluation of the area. This information will help the City to determine the appropriate size, and up and downstream flow line conditions necessary as to not exacerbate any area flooding concerns.

Final Notes
An additional site visit was completed following the City wide culvert inspections. It appears that there have been some recent culvert cleanings in the Scheuneman Road area.

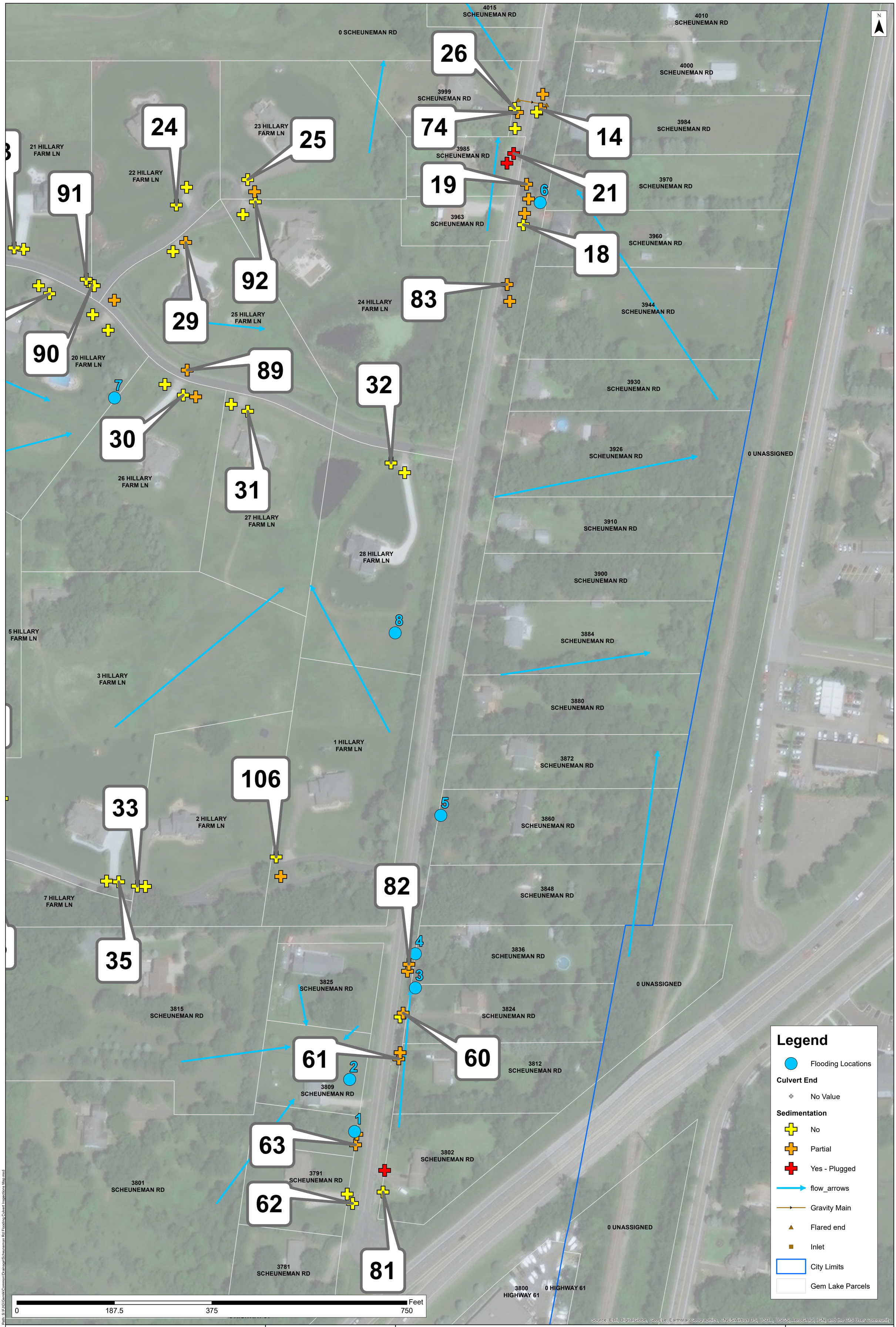
EKJ
S:\FJ\G\Gemlk\Common\Drainage

Photos
Crossing Upstream

Crossing Downstream



Inside Crossing (Looking Downstream)



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Project: GEMLK 129481
Print Date: 10/20/2020

Map by: LO
Projection: NAD_1983_HARN_Adj_MN_Ramsey_Feet
Source: Esri, City of Gem Lake, Ramsey County, SEH

Scheuneman Road Flooding and Culvert Inspections Drainage

Gem Lake, MN

Figure 1

Appendix B

First-floor Elevation Survey Data Summary

Table B1 – First-floor Elevation Survey Data

Address	Elevation (NAVD)	Notes
3809 Scheuneman Road	956.52	Walkout
3812 Scheuneman Road	961.92	
3824 Scheuneman Road	958.86	
3825 Scheuneman Road	960.28	
3836 Scheuneman Road	958.91	
3884 Scheuneman Road	947.26/955.22	Walkout
3960 Scheuneman Road	935.32	Walkout
3970 Scheuneman Road	936.26	Egress Window
3984 Scheuneman Road	938.18	Garage Floor
3999 Scheuneman Road	937.05	Windowsill
4077 Scheuneman Road	929.88	
4085 Scheuneman Road	945.27	
1560 Goose Lake Road	930.54	Walkout
1570 Goose Lake Road	928.41	Walkout
1580 Goose Lake Road	923.82	Walkout

Appendix C

Cost Estimates

North Scheuneman Road
Culvert Area - Scenario 1

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
2021501/00010	Mobilization	LS	1	$ 6,000.00	$ 6,000.00
2101501/00020	Clearing and Grubbing	LS	1	$ 5,000.00	$ 5,000.00
2104607/00490	Salvage Random Riprap	CY	24	$ 50.00	$ 1,200.00
2105507/00015	Common Excavation	CY	285	$ 30.00	$ 8,550.00
2503603/20300	Trench Excavation	LF	40	$ 15.00	$ 600.00
2104503/00255	Remove Pipe Culverts	LF	40	$ 15.00	$ 600.00
2501503/13302	30" RC Pipe Culvert	LF	80	$ 90.00	$ 7,200.00
2501502/05030	30" RC Pipe Apron	EA	4	$ 1,400.00	$ 5,600.00
2411507/04050	Granular Backfill (CV)	CY	434	$ 12.00	$ 5,208.00
2211507/00170	Aggregate Base (CV) Class 5	CY	67	$ 35.00	$ 2,345.00
2232618/00010	Remove and Patch Bituminious Pavement	SF	1,800	$ 10.00	$ 18,000.00
2573503/00060	Sediment Control Log Type Straw	LF	80	$ 3.00	$ 240.00
2574507/00100	Common Topsoil Borrow	CY	95	$ 40.00	$ 3,800.00
2575508/25141	Seed Mixture 25-141	LB	12	$ 5.00	$ 60.00
2575504/00073	Erosion Control Blankets Category 3N	SY	855	$ 2.50	$ 2,137.50
2573501/00025	Stabilized Construction Exit	LS	1	$ 1,000.00	$ 1,000.00
CONTINGENCY @ 20%					**$ 13,508.10**
SUBTOTAL					**$ 81,048.60**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 24,314.58**

TOTAL	**$ 105,363.18**

North Scheuneman Road
Culvert Area - Scenario 2

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
2021501/00010	Mobilization	LS	1	$ 7,000.00	$ 7,000.00
2101501/00020	Clearing and Grubbing	LS	1	$ 3,000.00	$ 3,000.00
2104607/00490	Salvage Random Riprap	CY	24	$ 50.00	$ 1,200.00
2105507/00015	Common Excavation	CY	298	$ 30.00	$ 8,940.00
2503603/20300	Trench Excavation	LF	40	$ 15.00	$ 600.00
2104503/00255	Remove Pipe Culverts	LF	65	$ 15.00	$ 975.00
2501503/13302	30" RC Pipe Culvert	LF	80	$ 90.00	$ 7,200.00
2501502/05030	30" RC Pipe Apron	EA	4	$ 1,400.00	$ 5,600.00
2501503/12024	24" CS Pipe Culvert	LF	50	$ 65.00	$ 3,250.00
2501502/01024	24" CS Pipe Apron	EA	4	$ 500.00	$ 2,000.00
2411507/04050	Granular Backfill (CV)	CY	479	$ 12.00	$ 5,748.00
2211507/00170	Aggregate Base (CV) Class 5	CY	82	$ 35.00	$ 2,870.00
2232618/00010	Remove and Patch Bituminious Pavement	SF	2,200	$ 10.00	$ 22,000.00
2573503/00060	Sediment Control Log Type Straw	LF	80	$ 3.00	$ 240.00
2574507/00100	Common Topsoil Borrow	CY	99	$ 40.00	$ 3,960.00
2575508/25141	Seed Mixture 25-141	LB	12	$ 5.00	$ 60.00
2575504/00073	Erosion Control Blankets Category 3N	SY	894	$ 2.50	$ 2,235.00
2573501/00025	Stabilized Construction Exit	LS	1	$ 1,000.00	$ 1,000.00
CONTINGENCY @ 20%					**$ 15,575.60**
SUBTOTAL					**$ 93,453.60**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 28,036.08**

TOTAL	**$ 121,489.68**

North Scheuneman Road
Culvert Area - BMP Scenario

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
2021501/00010	Mobilization	LS	1	$ 9,000.00	$ 9,000.00
2101501/00020	Clearing and Grubbing	LS	1	$ 5,000.00	$ 5,000.00
2104607/00490	Salvage Random Riprap	CY	24	$ 50.00	$ 1,200.00
2105507/00015	Common Excavation	CY	298	$ 30.00	$ 8,940.00
2503603/20300	Trench Excavation	LF	40	$ 15.00	$ 600.00
2105603/00015	Minor Grading	LF	550	$ 10.00	$ 5,500.00
2106507/00130	Common Embankment (CV)	CY	178	$ 40.00	$ 7,120.00
2104503/00255	Remove Pipe Culverts	LF	65	$ 15.00	$ 975.00
2501503/13302	30" RC Pipe Culvert	LF	80	$ 90.00	$ 7,200.00
2501502/05030	30" RC Pipe Apron	EA	4	$ 1,400.00	$ 5,600.00
2501503/12024	24" CS Pipe Culvert	LF	50	$ 65.00	$ 3,250.00
2501502/01024	24" CS Pipe Apron	EA	4	$ 500.00	$ 2,000.00
2411507/04050	Granular Backfill (CV)	CY	479	$ 12.00	$ 5,748.00
2211507/00170	Aggregate Base (CV) Class 5	CY	82	$ 35.00	$ 2,870.00
2232618/00010	Remove and Patch Bituminious Pavement	SF	2,200	$ 10.00	$ 22,000.00
2573503/00060	Sediment Control Log Type Straw	LF	280	$ 3.00	$ 840.00
2574507/00100	Common Topsoil Borrow	CY	368	$ 40.00	$ 14,720.00
2575508/25141	Seed Mixture 25-141	LB	12	$ 5.00	$ 60.00
2575508/33261	Seed Mixture 33-261	LB	17.5	$ 30.00	$ 525.00
2575504/00073	Erosion Control Blankets Category 3N	SY	1339	$ 2.50	$ 3,347.50
2573501/00025	Stabilized Construction Exit	LS	1	$ 1,000.00	$ 1,000.00
CONTINGENCY @ 20%					**$ 21,499.10**
SUBTOTAL					**$ 128,994.60**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 38,698.38**

TOTAL	**$ 167,692.98**

North Scheuneman Road
South Area - Scenario 1

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
2021501/00010	Mobilization	LS	1	$ 27,500.00	$ 27,500.00
2101501/00020	Clearing and Grubbing	LS	1	$ 7,500.00	$ 7,500.00
2503603/20300	Trench Excavation	LF	1040	$ 30.00	$ 31,200.00
2501503/12024	18" RC Pipe Sewer Design 3006	LF	1040	$ 90.00	$ 93,600.00
2501502/05018	18" RC Pipe Apron	EA	3	$ 1,000.00	$ 3,000.00
2506502/06000	Casting Assembly	EA	1	$ 900.00	$ 900.00
2506503/03020	Construct Drainage Structure Design 60-4020	LF	5	$ 725.00	$ 3,625.00
2411507/04050	Granular Backfill (CV)	CY	912	$ 12.00	$ 10,944.00
2211507/00170	Aggregate Base (CV) Class 5	CY	365	$ 35.00	$ 12,775.00
2232618/00010	Remove and Patch Bituminious Pavement	SF	9,850	$ 10.00	$ 98,500.00
2573503/00060	Sediment Control Log Type Straw	LF	80	$ 3.00	$ 240.00
2574507/00100	Common Topsoil Borrow	CY	156	$ 40.00	$ 6,240.00
2575508/25141	Seed Mixture 25-141	LB	18	$ 5.00	$ 90.00
2575504/00073	Erosion Control Blankets Category 3N	SY	1406	$ 2.50	$ 3,515.00
2573501/00025	Stabilized Construction Exit	LS	1	$ 1,000.00	$ 1,000.00
CONTINGENCY @ 20%					**$ 60,125.80**
SUBTOTAL					**$ 360,754.80**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 108,226.44**

TOTAL	**$ 468,981.24**

North Scheuneman Road
South Area - Scenario 2

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
2021501/00010	Mobilization	LS	1	$ 33,500.00	$ 33,500.00
2101501/00020	Clearing and Grubbing	LS	1	$ 3,000.00	$ 3,000.00
2503603/20300	Trench Excavation	LF	1040	$ 30.00	$ 31,200.00
2501503/12024	18" RC Pipe Sewer Design 3006	LF	1040	$ 90.00	$ 93,600.00
2501502/05018	18" RC Pipe Apron	EA	2	$ 1,000.00	$ 2,000.00
2506502/06000	Casting Assembly	EA	2	$ 900.00	$ 1,800.00
2506503/02420	Construct Drainage Structure Design 48-4020	LF	10	$ 600.00	$ 6,000.00
2411507/04050	Granular Backfill (CV)	CY	1402	$ 12.00	$ 16,824.00
2211507/00170	Aggregate Base (CV) Class 5	CY	561	$ 35.00	$ 19,635.00
2232618/00010	Remove and Patch Bituminious Pavement	SF	15,150	$ 10.00	$ 151,500.00
2573503/00060	Sediment Control Log Type Straw	LF	80	$ 3.00	$ 240.00
2574507/00100	Common Topsoil Borrow	CY	88	$ 40.00	$ 3,520.00
2575508/25141	Seed Mixture 25-141	LB	12	$ 5.00	$ 60.00
2575504/00073	Erosion Control Blankets Category 3N	SY	793	$ 2.50	$ 1,982.50
2573501/00025	Stabilized Construction Exit	LS	1	$ 1,000.00	$ 1,000.00
CONTINGENCY @ 20%					**$ 73,172.30**
SUBTOTAL					**$ 439,033.80**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 131,710.14**

TOTAL	**$ 570,743.94**

North Scheuneman Road
South Area - Scenario 3

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
2021501/00010	Mobilization	LS	1	$ 42,000.00	$ 42,000.00
2101501/00020	Clearing and Grubbing	LS	1	$ 5,000.00	$ 5,000.00
2503603/20300	Trench Excavation	LF	1335	$ 30.00	$ 40,050.00
2501503/12024	18" RC Pipe Sewer Design 3006	LF	1335	$ 90.00	$ 120,150.00
2501502/05018	18" RC Pipe Apron	EA	3	$ 1,000.00	$ 3,000.00
2506502/06000	Casting Assembly	EA	3	$ 900.00	$ 2,700.00
2506503/02420	Construct Drainage Structure Design 48-4020	LF	15	$ 600.00	$ 9,000.00
2411507/04050	Granular Backfill (CV)	CY	1744	$ 12.00	$ 20,928.00
2211507/00170	Aggregate Base (CV) Class 5	CY	698	$ 35.00	$ 24,430.00
2232618/00010	Remove and Patch Bituminious Pavement	SF	18,850	$ 10.00	$ 188,500.00
2573503/00060	Sediment Control Log Type Straw	LF	80	$ 3.00	$ 240.00
2574507/00100	Common Topsoil Borrow	CY	118	$ 40.00	$ 4,720.00
2575508/25141	Seed Mixture 25-141	LB	13	$ 5.00	$ 65.00
2575504/00073	Erosion Control Blankets Category 3N	SY	1061	$ 2.50	$ 2,652.50
2573501/00025	Stabilized Construction Exit	LS	1	$ 1,000.00	$ 1,000.00
CONTINGENCY @ 20%					**$ 92,887.10**
SUBTOTAL					**$ 557,322.60**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 167,196.78**

TOTAL	**$ 724,519.38**

North Scheuneman Road
South Area - BMP Scenario

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
2021501/00010	Mobilization	LS	1	$ 6,500.00	$ 6,500.00
2101501/00020	Clearing and Grubbing	LS	1	$ 500.00	$ 500.00
2105507/00015	Common Excavation	CY	333	$ 30.00	$ 9,990.00
2105603/00015	Minor Grading	LF	500	$ 5.00	$ 2,500.00
2573503/00060	Sediment Control Log Type Straw	LF	500	$ 3.00	$ 1,500.00
2574507/00100	Common Topsoil Borrow	CY	93	$ 40.00	$ 3,720.00
2574507/00103	Filter Topsoil Borrow	CY	1110	$ 40.00	$ 44,400.00
2575508/33261	Seed Mixture 33-261	LB	7	$ 30.00	$ 210.00
2575504/00073	Erosion Control Blankets Category 3N	SY	834	$ 2.50	$ 2,085.00
CONTINGENCY @ 20%					**$ 14,281.00**
SUBTOTAL					**$ 85,686.00**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 25,705.80**

TOTAL	**$ 111,391.80**

North Scheuneman Road
4076 Scheuneman Road - Scenario 1

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
2021501/00010	Mobilization	LS	1	$ 250.00	$ 250.00
2503603/20300	Trench Excavation	LF	30	$ 15.00	$ 450.00
2501603/26018	18" Pipe Culvert	LF	30	$ 35.00	$ 1,050.00
2411507/04050	Granular Backfill (CV)	CY	15	$ 12.00	$ 180.00
2573503/00060	Sediment Control Log Type Straw	LF	20	$ 3.00	$ 60.00
2574507/00100	Common Topsoil Borrow	CY	2.5	$ 40.00	$ 100.00
2575508/25141	Seed Mixture 25-141	LB	0.3	$ 50.00	$ 15.00
2575504/00073	Erosion Control Blankets Category 3N	SY	22.5	$ 2.50	$ 56.25
CONTINGENCY @ 20%					**$ 432.25**
SUBTOTAL					**$ 2,593.50**

ENGINEERING, ADMIN AND LEGAL FEES @ 30%	**$ 778.05**

TOTAL	**$ 3,371.55**

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