Bismarck Tribune

Preliminary Engineering Report

South Bismarck Watershed Model Update and Stormwater Improvement Project

City of Bismarck, ND

January 2017

Apex Engineering Group

14.105.0046

Bismarck

1.0 Executive Summary

The focus of this study was to verify and update the existing south Bismarck watershed model assumptions, methodology, hydrologic and hydraulic computations, design flows and recommended improvements generated by the 2013 South Bismarck Stormwater Management Plan Update. The project needs focused on frequent flooding problems on South 12th Street/Bismarck Expressway and was expanded to include additional areas in South Bismarck from Bowen Avenue to Bismarck Expressway. See Figure 1 for a map of the South Bismarck watershed.

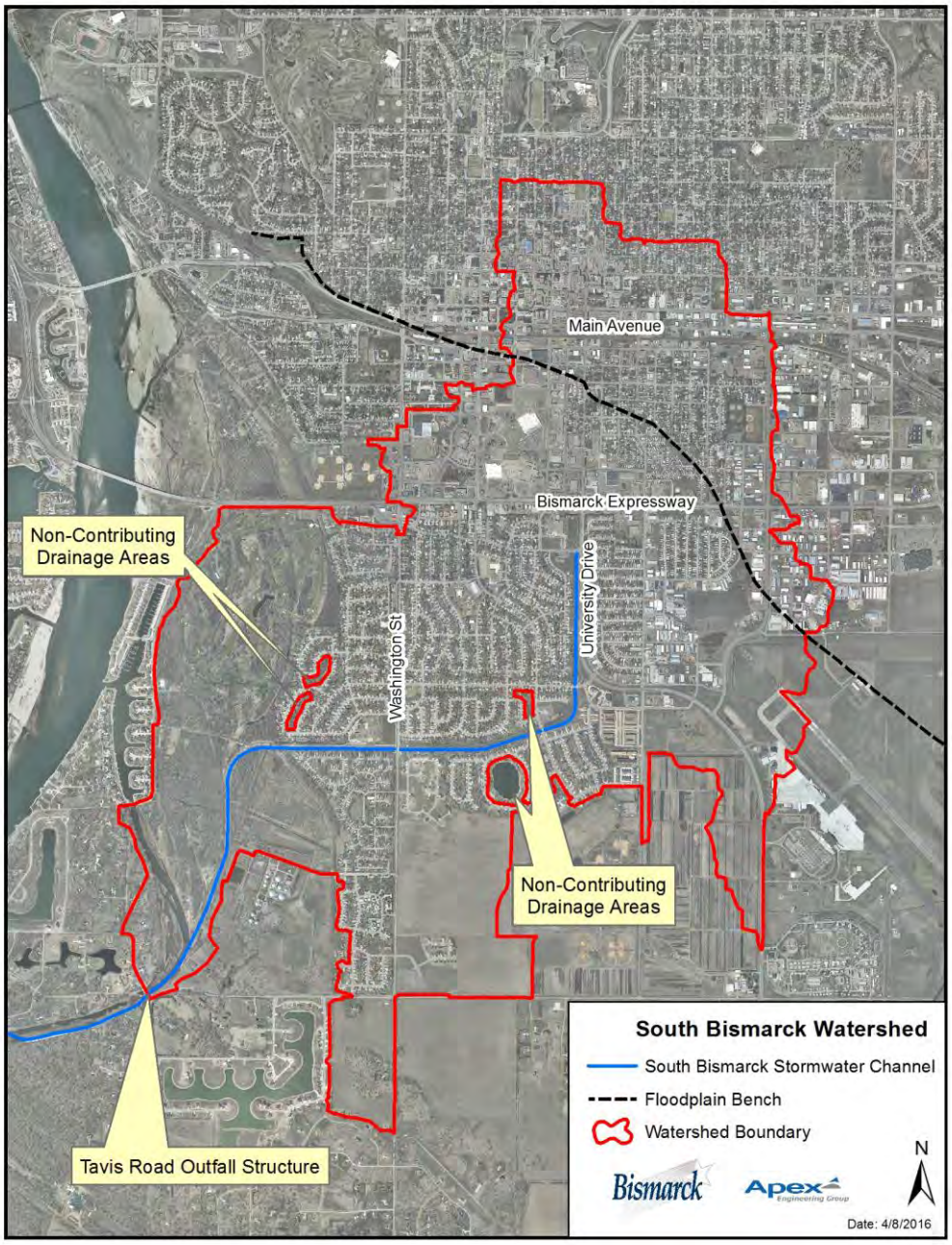

Figure 1. South Bismarck Watershed

1.1 South 12th Street / Bismarck Expressway Alternatives

1.1.1 Preferred South 12th Street Alternatives

The 2013 South Bismarck Stormwater Management Plan recommended the construction of two piped bypass systems along the South 12th Street corridor to convey runoff to the South Bismarck Stormwater Channel.

Apex was tasked with the investigation of and recommendations for infrastructure improvements that could potentially be more economical and effective than the proposed improvements from the 2013 plan. The existing conditions, 2-year storm inundation map is shown in Figure 2. Approximately 18.8 acres is inundated on a 2-year event within the area of interest as shown on the map. This map illustrates the effects from the least intense storm that was studied. Larger and more intense rain events result in expanded areas of inundation and increased flood depths.

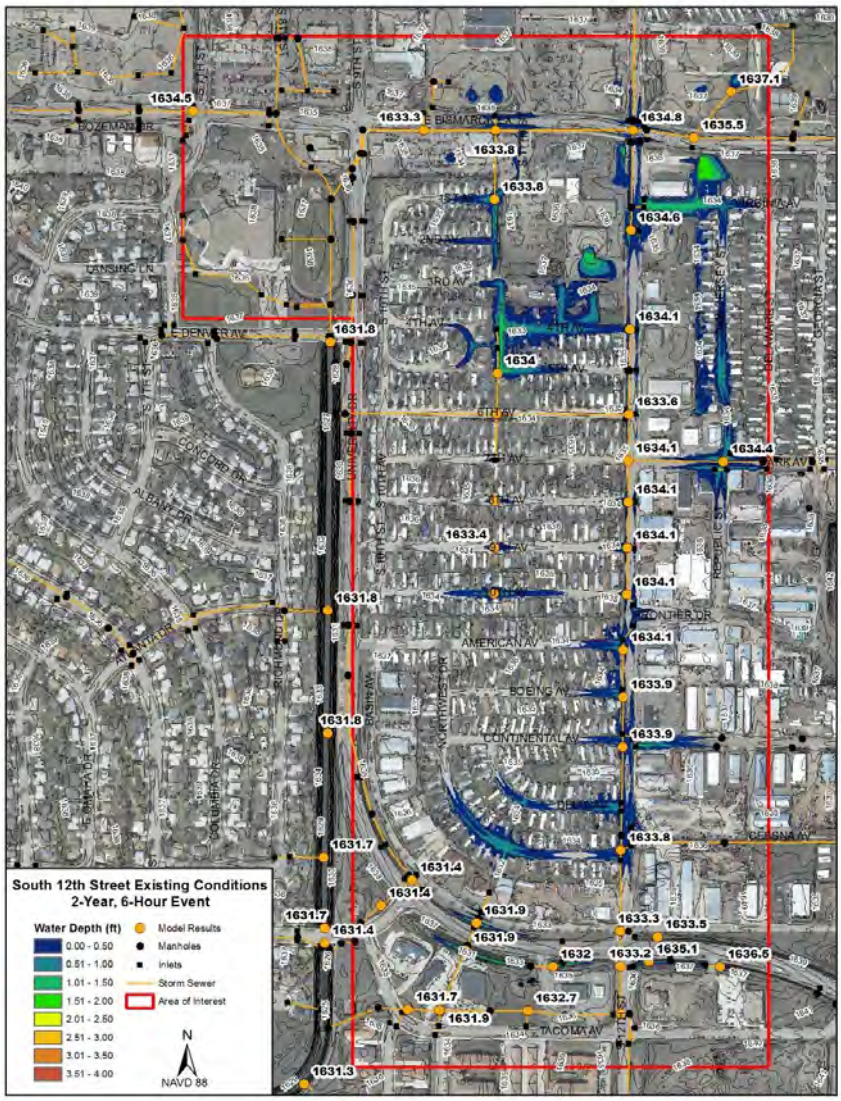

Figure 2. South 12th Street Existing Conditions, 2-Year Inundation Map

Alternatives were investigated in the South 12th Street corridor for three separate local areas. Each alternative is benefitting the area local to the improvement.

- 6th Avenue Improvements

  This improvement includes a new storm sewer system along South 12th Street and 6th Avenue to relieve flooding on Bismarck Expressway and South 12th Street from Bismarck Expressway to 8th Avenue. The proposed route is shown in Figure 3. This improvement reduces the flooding stages on the 2, 5, and 10-year events in areas near the improvement by providing additional conveyance to the storm water channel. Stages are not reduced on events larger than a 10-year event, however the duration of flooding is reduced in all scenarios. On a 2-year event, the area flooded in the vicinity of South 12th Street is reduced from 18.8 acres to 8.2 acres. **The benefiting area is local to the improvements.** Estimated cost of improvements is between $3,400,000 and $4,200,000.

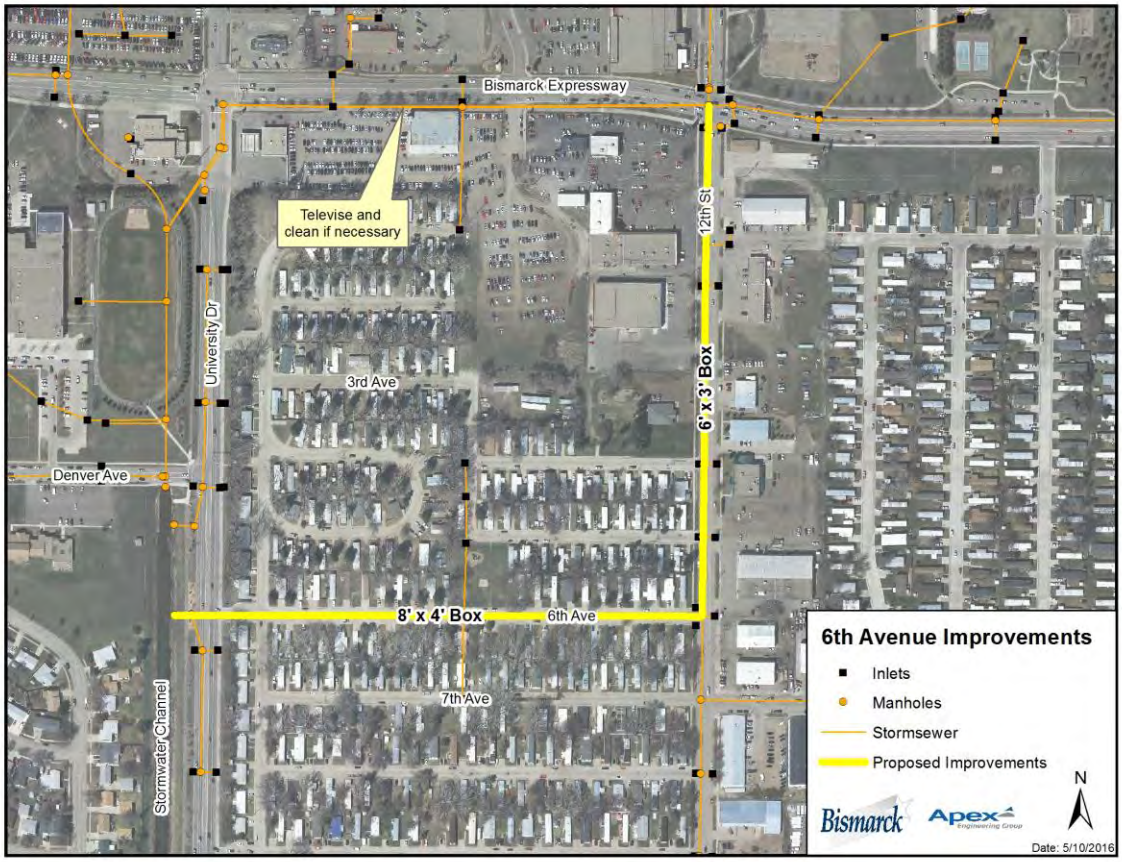

Figure 3. South 12th Street and 6th Avenue Proposed Storm Sewer Improvements

- American Avenue Improvements

  This improvement includes a new storm sewer system along American Avenue which intercepts runoff in low areas on South 12th Street and directs the flows to the south Bismarck stormwater channel. The proposed route is shown in Figure 4. This improvement reduces the flooding stages on the 2, 5, and 10-year events in areas near the improvement by providing additional conveyance to the stormwater channel. Stages are not reduced on events larger than a 10-year, however the duration of flooding is reduced in all scenarios. On a 2-year event, the area flooded in the vicinity of South 12th Street is reduced from 18.8 acres to 8.3 acres. **The benefiting area is local to the improvement.** Estimated cost of improvements is between $1,900,000 and $2,100,000.

Figure 4. American Avenue Proposed Storm Sewer Improvements

- Northwest Drive Improvements

  This improvement includes a new storm sewer system which intercepts runoff on South 12th Street near University Drive and Basin Avenue and directs flows to the south Bismarck stormwater channel via a more direct and efficient route along Northwest Drive. The proposed route is shown in Figure 5. This improvement reduces the flooding stages on the 2, 5, and 10-year events in areas near the improvement by providing additional conveyance to the stormwater channel. Stages are not reduced on events larger than a 10-year,

however the duration of flooding is reduced in all scenarios. On a 2-year event, the area flooded in the vicinity of South 12th Street is reduced from 18.8 acres to 10.6 acres. **The benefiting area is local to the improvements.** Estimated costs of improvements is between $1,600,000 and $2,000,000.

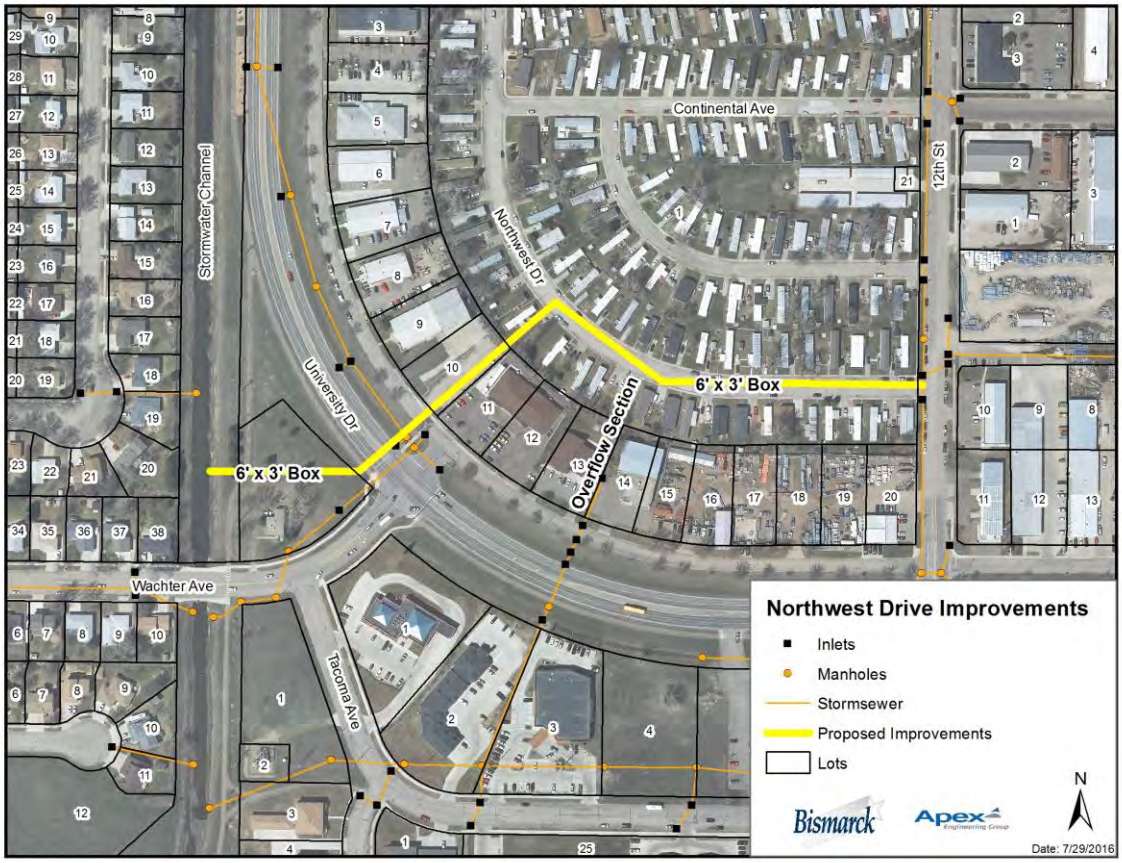

Figure 5. Northwest Drive Proposed Storm Sewer Improvements

If all three storm sewer systems are built, the combined improvements will reduce the inundated area from 18.8 acres to 2.0 acres for the 2-year, 6-hour storm. The result of this improvement is shown in Figure 6. Estimated cost of this improvement scenario is between $6.9 and $8.3 million.

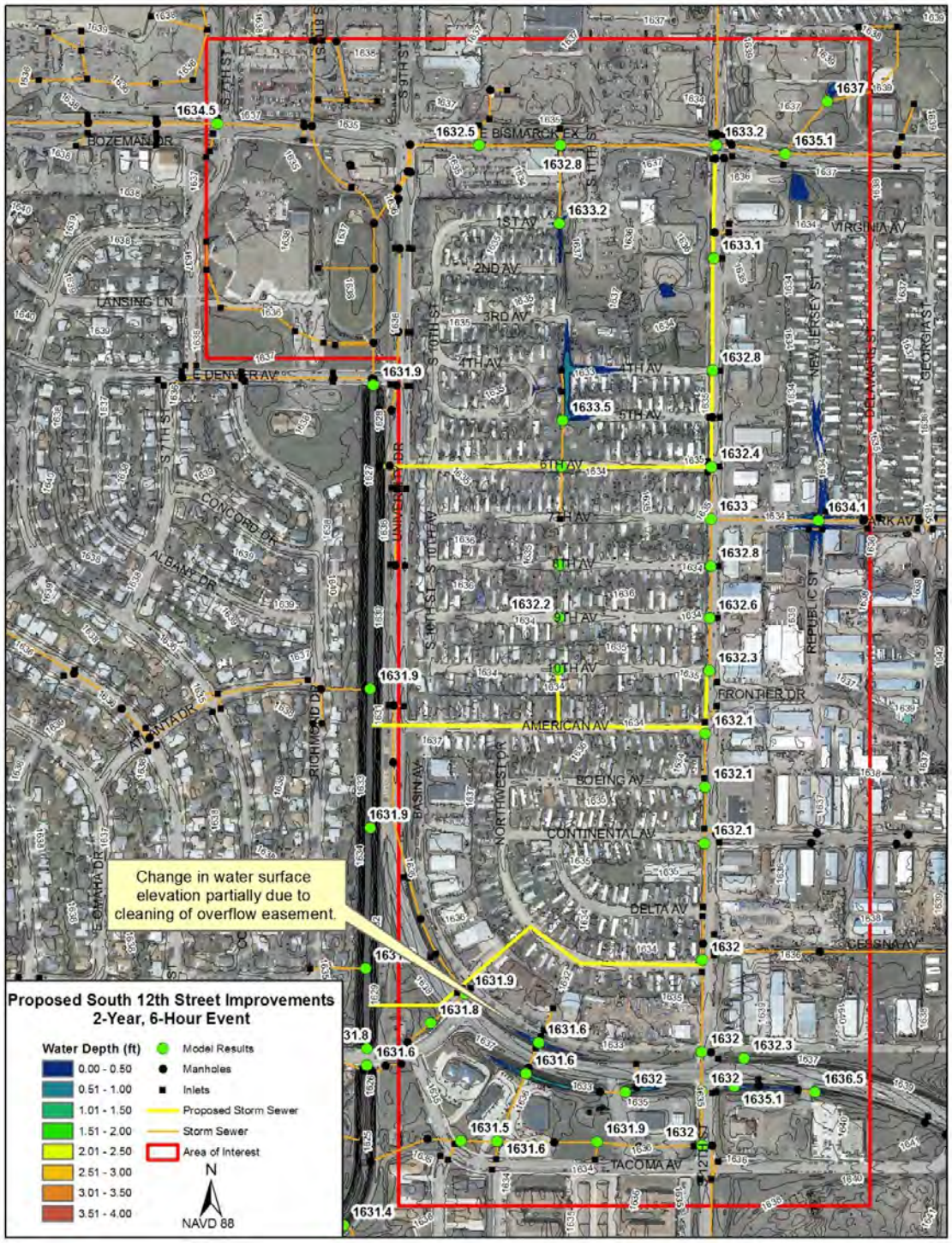

Figure 6. South 12th Street Proposed Conditions, 2-Year Inundation Map

1.1.2 South Bismarck Bypass

Due to the proposed improvements near 12th Street only having benefits on the more frequent events, a more comprehensive solution was sought. The South Bismarck Bypass alternative was developed to reduce flooding along South 12th Street and Bismarck Expressway and at the same time alleviate localized

flooding at other locations in South Bismarck. The South Bismarck Bypass accomplishes this by reducing stages in the south Bismarck stormwater channel, which allows local systems that discharge to the channel to function more efficiently. This alternative has a much larger scope than the local improvements between 12th Street and the stormwater channel. A map of the preferred route investigated for this bypass is shown in Figure 7.

The South Bismarck bypass would divert runoff from approximately 56% of the area contributing to the south Bismarck stormwater channel at Denver Avenue. This system would establish a new storm sewer route to the Missouri River, thereby reducing a major portion of runoff that eventually contributes to capacity problems of the south Bismarck stormwater channel. This major storm sewer system provides flood stage improvements for South 12th Street during larger, less frequent storm events. However local improvements along South 12th Street are still required for smaller, more frequent events because the existing storm sewer is too small to convey the runoff to the ditch. A map of water surface improvements watershed-wide for the 2-year event is shown in Figure 8 with only the bypass. **This alternative, in combination with the local improvements on South 12th Street, provides flood stage reduction in modeled storm event scenarios to the area of Bismarck Expressway and South 12th Street. A secondary benefit to this alternative is the flood stage reduction it provides to the 5th Street and Bowen Avenue intersection, Kirkwood Mall parking lot, 3rd Street, 2nd Street and surrounding areas.**

- Estimated cost of the South Bismarck Bypass improvement is between $15,800,000 and $19,300,000.

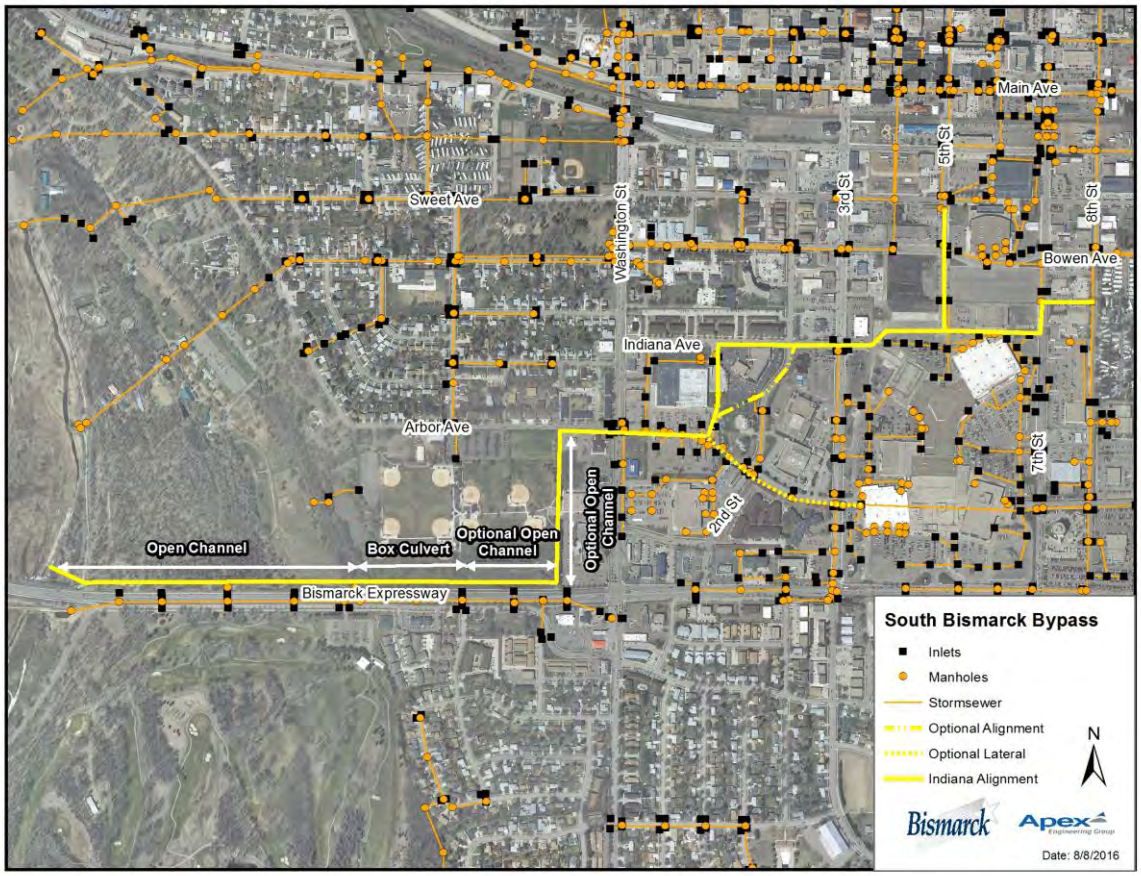

Figure 7. Preferred Route Investigated for the South Bismarck Bypass

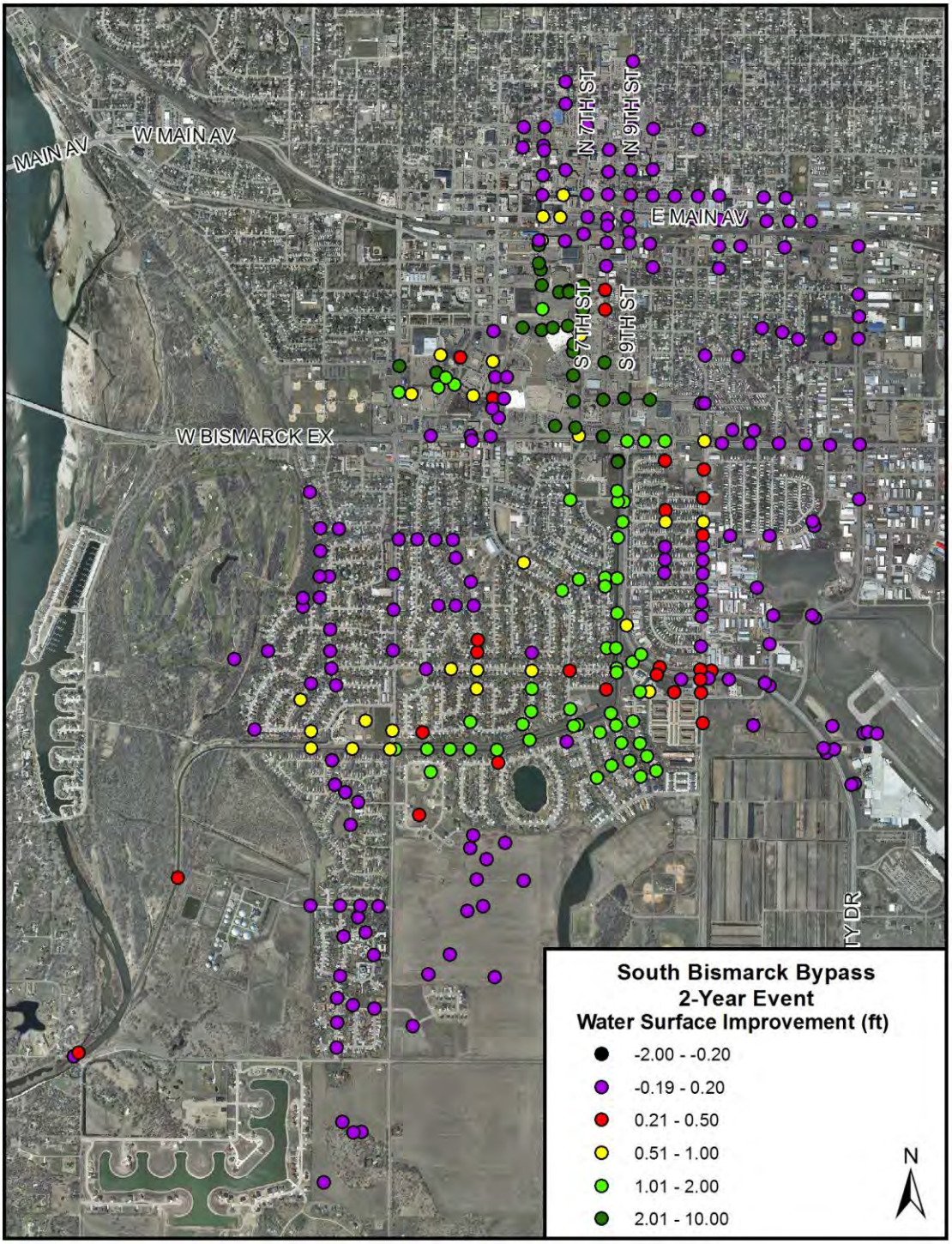

Figure 8. Water Surface Improvement for South Bismarck Bypass on 2-Year Event

1.2 5th Street & Bowen Avenue

During the evaluation of the stormwater improvement alternatives for the South 12th Street corridor, a rain event caused flooding watershed-wide in South Bismarck. The storm produced 0.87 inches of rain in one hour at the Bismarck Municipal Airport, but the severity of street flooding elsewhere in the watershed indicates that higher rainfall totals occurred locally. Several rain events have caused street flooding at the intersection of 5th Street and Bowen Avenue. Due to the localized flooding, the focus of the stormwater modeling was expanded to include investigation of local flooding at 5th Street from Sweet Avenue to the Bowen Avenue intersection. There are significant plans for redevelopment in this area, including improvements to public utilities and infrastructure, thus providing an opportunity to correct these existing problems.

1.2.1 Kiwanis Park Bypass

Understanding that the South Bismarck Bypass alternative is a large and expensive project, a smaller, more local solution was developed to reduce flooding along 5th Street from Sweet Avenue to the Kirkwood Mall. This alternative consists of a new storm sewer system which intercepts stormwater flows coming from the downtown area and redirects it in a westerly direction to an existing storm sewer system that has available excess capacity. The proposed route is shown in Figure 9. The existing and proposed 2-year hydraulic grade lines at the Bismarck Event Center are shown in Figure 10 and Figure 11. Similar results can be observed on larger events. **This system will provide reduced flooding for the intersection of 5th Street and Bowen Avenue for modeled events. The Kiwanis Park Bypass does not provide benefit to the South 12th Street area.**

- Estimated cost of improvements is between $3,500,000 and $4,300,000.

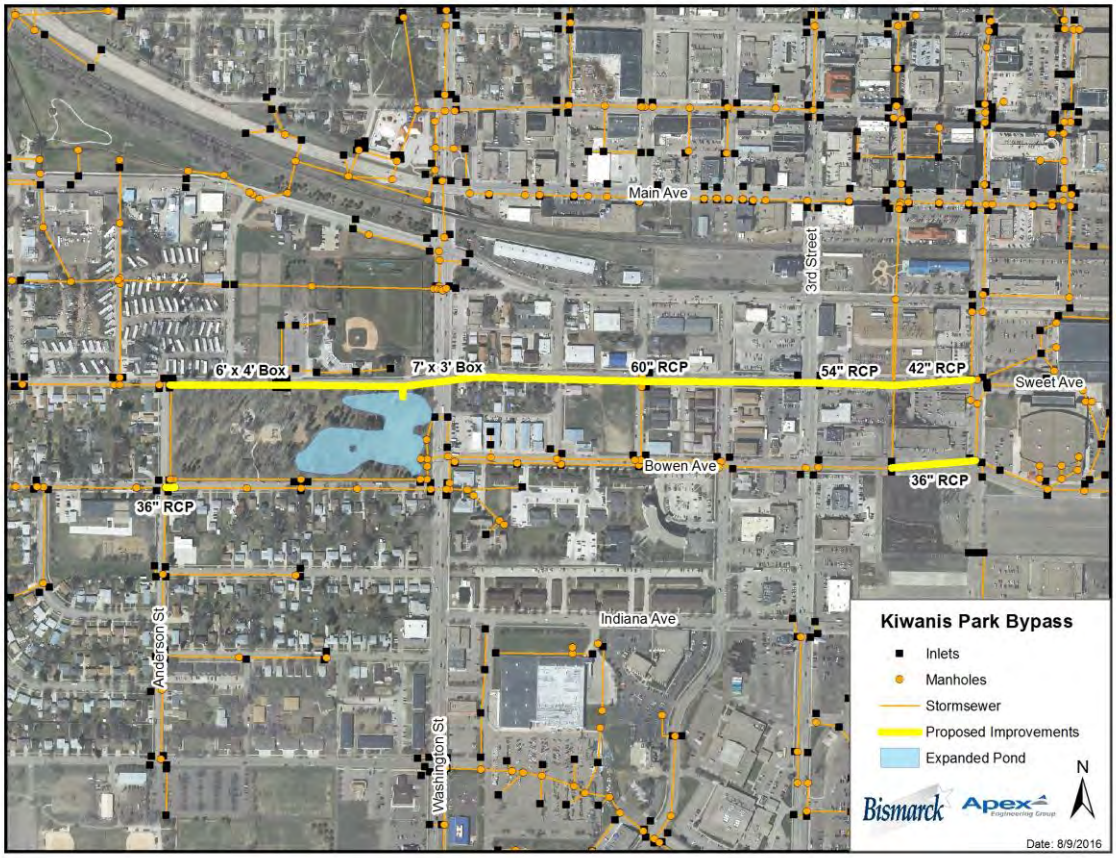

Figure 9. Kiwanis Park Bypass Proposed Storm Sewer Improvements

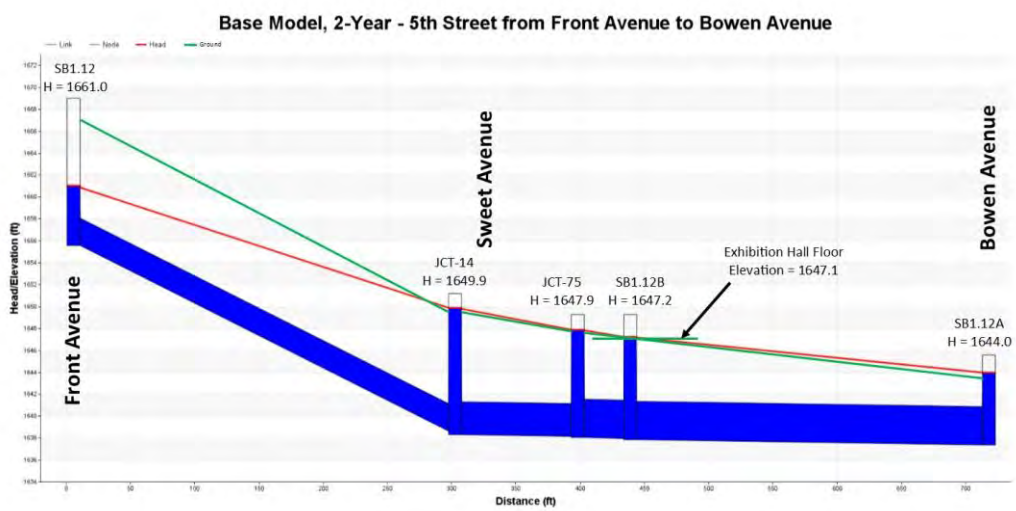

Figure 10. Existing Conditions, 2-Year Hydraulic Grade Line on 5th Street

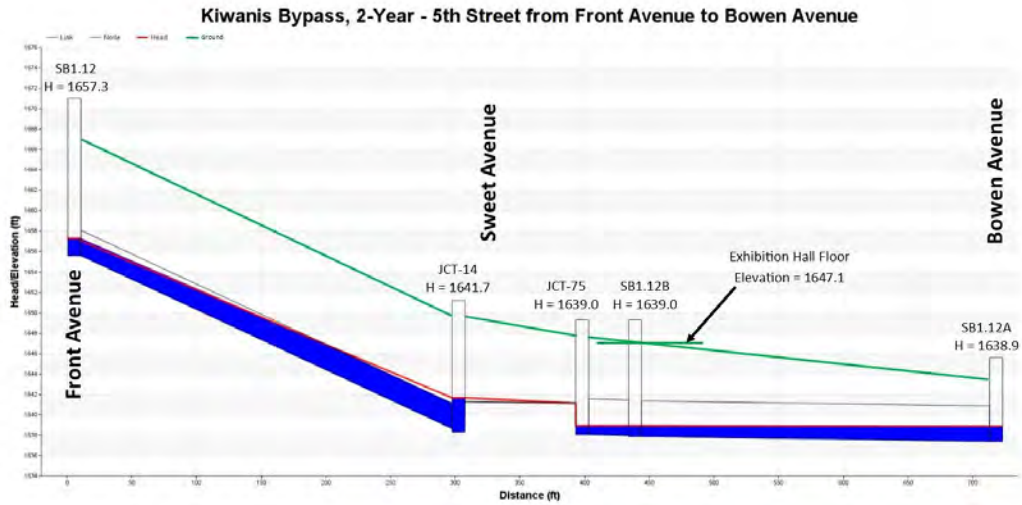

Figure 11. Proposed conditions, 2-Year Hydraulic Grade line on 5th Street

1.3 Other Alternatives Investigated

Several other potential alternatives were examined and abandoned due to their ineffectiveness:

- Concrete lining of the existing south Bismarck stormwater channel.
- Potential detention ponds were evaluated in the Tatley-Eagles Park and Sons of Norway Park.
- Dual storm sewer in 8th Street – A reliever storm sewer system from 5th Street and Bowen Avenue to the outfall system on 8th Street was found to be ineffective due to the fact that the receiving system is currently at capacity for all but very small rain events.

None of the above alternatives provide a significant reduction in the stage of the flood surface nor to the duration of flooding, and were therefore rejected.

Widening and concrete lining the south Bismarck stormwater channel and replacing the box culverts with bridges was effective at reducing stages in the channel, however, these stage reductions did not expand beyond the channel. The local improvements along the South 12th Street corridor recommended in Section 1.1.1 would still be necessary to convey the water to the stormwater channel because the existing pipes are undersized. This alternative was not investigated further because the South Bismarck Bypass provided more benefit to the watershed as a whole.