

US 83/ND 1804 WATERSHED

FOR



CITY OF BISMARCK,
ND

STORMWATER MASTER PLAN UPDATE

Allowable Unit Rate
Discharge

August 2019

AE2S Project #: P00501-2018-000 TO#4

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**US 83/ND 1804 WATERSHED
STORMWATER MASTER PLAN UPDATE
ALLOWABLE UNIT RATE DISCHARGE
CERTIFICATION**



August 2019

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

This document was originally issued and sealed by

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Registration Number PE-5403

on

August 23, 2019

and the original documents are stored at the offices of
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1.0 BACKGROUND & SUMMARY

The City of Bismarck continues to experience growth along its fringes. The focus of this stormwater master plan is the US83/ND1804 Watershed located generally north of 57th Avenue NW, west of Highway 83, and east of North Washington Street. (**Figure 1**). This watershed encompasses an area of approximately 2.9 square miles (1883 acres). The watershed drains to an unnamed tributary to Hay Creek (**Figure 2**).

1.1 MASTER PLAN PURPOSE

The overarching purpose of this Master Plan is to develop a comprehensive approach that manages the peak flow and water quality of stormwater on a watershed scale and provides adequate drainage consistent with the City's ordinances.

As the watershed urbanizes, increased stormwater runoff can lead to local flooding and degradation of water quality. In order to mitigate for the increased stormwater runoff and water quality degradation, the City's general policy is to proactively develop stormwater master plans for the larger watershed region prior to areas developing. The overall goal of a stormwater master plan is to outline the key stormwater and drainage infrastructure and/or policies that will be needed to address watershed specific challenges, provide the appropriate level of service for roadways, and meet the City's stormwater management ordinance and design criteria. This Master Plan was developed to act as a stormwater management and drainage guide for the City, landowners, developers, and associated stakeholders as the US83/ND1804 Watershed develops.

1.2 UPDATED MASTER PLAN MODELING SUMMARY

Conclusions and recommendations of this Master Plan were developed based on the results from project specific hydrologic and hydraulic modeling. Detailed descriptions of the model inputs and results are included in the project electronic GIS and InfoSWMM files.

Stormwater management and updated Master Plan recommendations for the US83/ND1804 Watershed are based on the following modeling scenarios that are generally referenced in this report:

1. **Existing Conditions:** Utilized the existing land use, soils, road system, and drainage conveyance systems that were in-place at the start of the Master Plan process. Development Stormwater Management Plans that were approved by the City at the commencement of this Master Plan process were incorporated into existing conditions. The Light of Christ, Daybreak Addition, Daybreak Medical and Koch Creek Commercial developments are all included in the existing conditions scenario. **Figure 7** shows the existing land use and existing developments. Detention within natural depressions and upstream of existing road crossings is accounted for in existing conditions.
2. **Master Planned Conditions, Unit Rate:** Utilized the future land-use plan, the Fringe Area Road Master Plan, Section 9 revised roadway alignments as provided by the City,

and recommended drainage system improvements to show the performance of the watershed when implementing a Unit Rate stormwater detention methodology throughout the watershed. This scenario assumes on-site or local detention basins will be used meet the Unite Rate criteria.

3. **Hydraulic Design for Future Crossings:** Utilized the existing land use, existing soils, and future road system. This scenario was used to size future road crossings. Existing conditions hydrology was used because although complete implementation of the Unit requirement may result in lower discharge at some crossings, those crossings may be completed prior to complete implementation of the Unit Rate requirements. As such, the existing land use condition may act as the “worst case scenario” for peak flows at road crossings (existing and future) in the major drainage-ways for many areas in the watershed. This scenario will occur within the watershed when an improvement is implemented prior to full build-out upstream.
4. **Future Conditions, Local Pre-Post:** Utilized the future land-use plan, future road system, and recommended drainage system improvements estimating the watershed response to the planned future conditions with the implementation of local or onsite stormwater detention basins meeting the City’s ordinance for peak discharge compliance. This does not assume discharge at the recommended Unit Rate.

1.3 DATA SOURCES

The following data sources were utilized in this study:

- 2016 LIDAR data (contours and DEM) obtained from the Metropolitan Planning Organization;
- Bismarck 2016 aerial photograph, obtained from the City of Bismarck;
- 2014 Fringe Area Road Master Plan (FARMP) prepared by SRF and HDR, obtained from the City and modified per City comments;
- 2014 Bismarck Growth Management Plan (GMP) prepared by URS Corporation, obtained from the City as a shapefile;
- AutoCAD file for future Section 9 alignments obtained from the City and prepared by Swenson Hagen;
- Design plans for the Burleigh County Washington Street North Improvements from Ridgeland Loop to 84th Ave. NE project (Project Number 0098), obtained from Burleigh County Highway Department;
- Design plans for NDDOT Junction of ND Highway 1804 and North Washington Street Intersection Improvements project (Project Number HEU-1-804(047)084 and PCN Number 22191), obtained from the City of Bismarck and considered “Existing Conditions” for this study;
- Design plans for the Burleigh County Washington Street North Improvements from 57th Ave. NW to Highway 1804 project (Project Number SU-1-981(113)123 and PCN Number

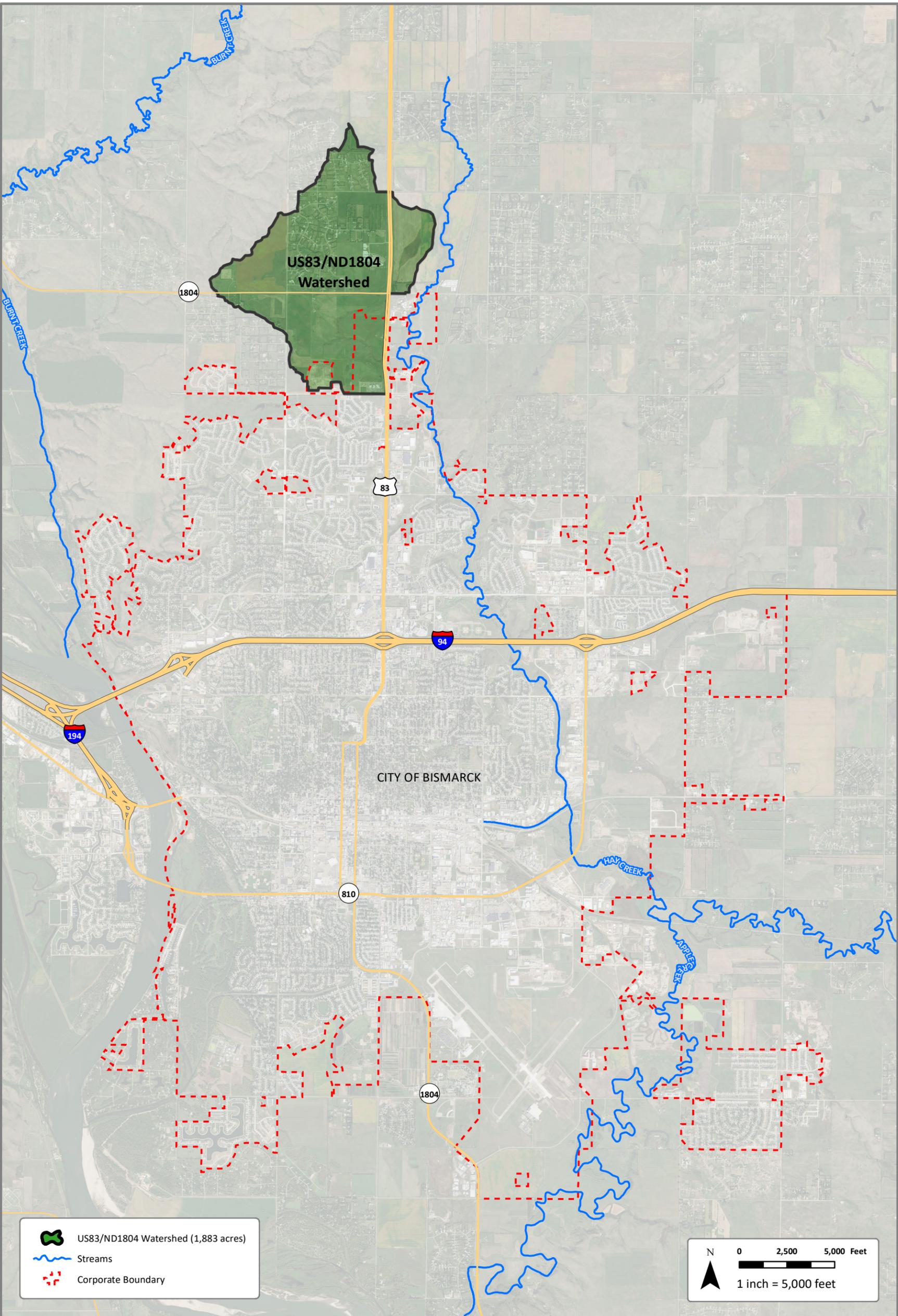
21728), obtained from the City of Bismarck and considered "Existing Conditions" for this study;

- NRCS soils database, Version 36 for Burleigh County, obtained from the NRCS Geospatial Data Gateway December 2018;
- Rainfall depths from the City of Bismarck 2017 Stormwater Design Standards Manual;
- Site visits (various dates);
- Various Stormwater Management Plans and Record Drawings provided by the City of Bismarck; and

1.4 VERTICAL DATUM

Elevations presented throughout the Master Plan are in the North American Vertical Datum of 1988 (NAVD88), unless otherwise noted.

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 Coordinate System: NAD 1983 HARN StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: diee | C:\Data\Projects\WAFS\B\Bismarck\00501-2018-000\GIS\TOA\Report_Figure 01- Project Location Map.mxd



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City of Bismarck
 Burleigh County, ND

Figure 1

**PROJECT LOCATION
 MAP**

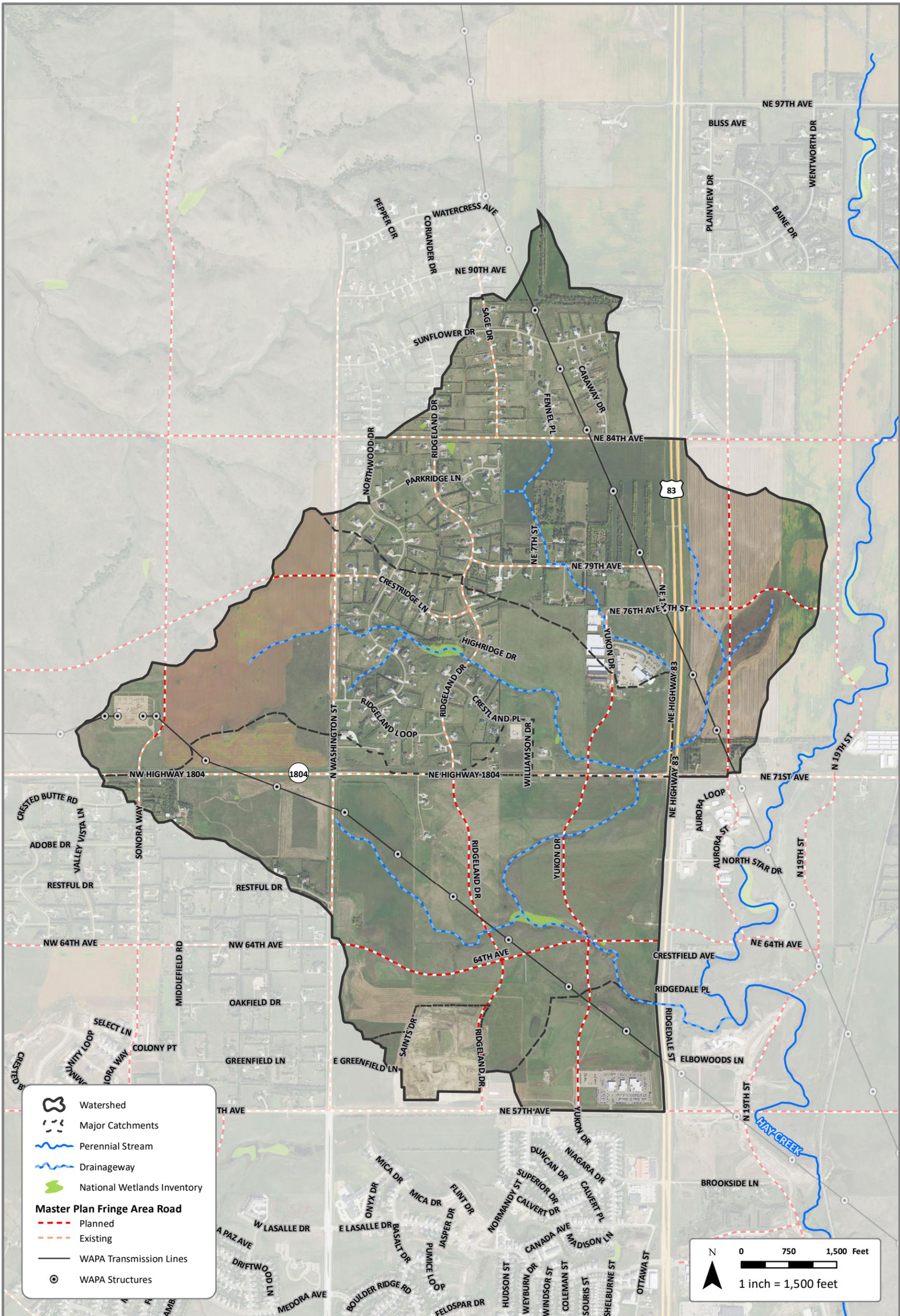


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City of Bismarck
 Burleigh County, ND

Figure 2

**US83/ND1804
 WATERSHED**



US 83 / ND 1804
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2.0 STORMWATER MASTER PLAN GOALS

The overarching purpose of this Master Plan is to develop a comprehensive approach that manages stormwater on a watershed scale and provides adequate drainage consistent with the City's ordinances. Achieving this purpose requires compliance with specific goals developed in conjunction with a City designated working group. The intent of the group is to bring the major City departments tasked with implementing this plan into the Master Plan development process. The City Working Group consisted of the following representatives:

- Michelle Klose, P.E. – Director of Utility Operations, Bismarck Public Works
- Gabe Schell, P.E. – City Engineer, Bismarck Engineering Department
- Mike Greer, P.E. – Project Manager, Bismarck Engineering Department
- Kim Lee, AICP – Acting Director of Community Development, Bismarck Community Development Department, Planning Division
- Terry Halstengard – Stormwater Program Coordinator, Bismarck Public Works
- Linda Oster, P.E. – Design & Construction Engineer, Bismarck Engineering Department

The goals developed with the City Working Group were divided into primary and secondary goals.

Primary goals were developed to steer the overall Master Plan direction. The primary goals of the US83/ND1804 Stormwater Master Plan are to:

1. Update the 2014 US83/ND1804 Watershed Master Plan to utilize an allowable Unit Rate discharge as the method for stormwater peak flow mitigation and transition to concepts accepted in the 2018 utility cost of service study;
2. Integrate the proposed stormwater recommendations and infrastructure with other applicable planning documents within the City and County, such as the 2014 City of Bismarck Growth Management Plan (Future Land Use Plan) and the 2014 MPO Bismarck Burleigh Fringe Area Road Master Plan;
3. Identify a Development Setback Line to maintain drainage conveyance through the watershed; and
4. Determine minimum roadway elevations and conceptual culvert crossings for future road crossings based on anticipated flood elevations.

3.0 STORMWATER MASTER PLAN RECOMMENDATIONS

The Stormwater Master Plan recommendations were developed in a collaborative process with the City Working Group. The following summarizes the key recommendations for this Master Plan, provides a brief justification, and where applicable, references the section where additional information can be found.

RECOMMENDATION #1 - Peak runoff within US83/ND1804 watershed shall not exceed the designated unit rate.

Description:

The maximum post-construction flow rate from a development or redevelopment site shall meet Unit Rate peak runoff criteria for the 2- and 100-year events. The peak runoff requirements are based on total site area (pervious and impervious) and shall not exceed 0.07 cfs/acre for the 2-year storm and 0.65 cfs/acre for the 100-year storm as summarized in in **Table 3**.

The Unit Rate recommendation accounts for an amount of pervious ground discharging directly offsite and not routed through a peak flow compliance post-construction Best Management Practice (BMP). The area discharging offsite must be 100% pervious and in no cases should the area allowed to discharge directly offsite be allowed to exceed 10% of the total site.

The Unit Rate Method and justification is more fully described in **Section 4.3**. Stormwater Design Standards for development activities is included in **Section 4.6**

Justification:

The Unit Rate release requirement meets all the Primary Goals developed for this Master Plan. One of the main reasons this requirement was selected is that it allows for stormwater practices to be designed and constructed when and where development occurs and provides flexibility in the location of the stormwater facilities. The performance of the Unit Rate method are further described in **Section 4.3**.

An allowance of up to 10% of the pervious portion of the site not being routed to the peak flow compliance BMP was accounted for in the development of the allowable Unit Rate as recognition that there will be topographic and other constraints that may make capturing 100% of the site not practical.

RECOMMENDATION #2 - Developer is responsible for construction costs of required stormwater BMPs.

Description:

For the US83/ND1804 Watershed, post-construction peak flow compliance will be achieved using onsite and/or local stormwater facilities. The developer of a site is responsible for funding,

designing, and constructing post-construction stormwater infrastructure in accordance with this Master Plan update, the City of Bismarck Stormwater Design Standards Manual (SWDSM), and the City of Bismarck Code of Ordinances, including facilities required to meet the Unit Rate peak runoff criteria.

Specifically, the revised US83/ND1804 Stormwater Master Plan does not include any recommended regional stormwater basins constructed by the City to provide post-construction peak flow compliance. The past practice of City constructed regional facilities has been problematic from the timing of the construction and the resulting amount of special assessment held in abeyance that were paid for by Utility rate payers. The adopted recommendations from the 2018 Utility cost of service study removed the unannexed surcharge and that funding mechanism for this watershed.

Stormwater Design Standards for development activities, including a description of construction cost responsibility, is included in **Section 4.6**.

Justification:

This Master Plan recommends that all stormwater basins be constructed at the time of development to match the pace of urbanization of the watershed. This recommendation is much like other infrastructure that the development community designs and constructs; this practice puts all stormwater infrastructure in line with other infrastructure design and construction required of developers by the City.

Additionally, installation of peak flow compliance stormwater basins at the time of development has the added benefit of potentially reducing the size of downstream conveyance structures and reducing the erosion in natural channels.

RECOMMENDATION #3 - Implement a Development Setback Line to maintain drainage and runoff storage corridors.

Description

A development setback line was developed along major drainages and is presented on **Figure 3** along with cross sections showing the elevation of the setback. At the discretion of City staff, areas within the development setback may be filled if mitigation is provided to offset the changes in volume and/or flow area. Anyone proposing to encroach on a development setback line shall do the following:

1. Document that the proposed encroachment does not reduce the ability of the conveyance to carry the 2- and 100-year design flows without increasing elevations upstream or downstream of the property;

2. Document that the proposed encroachment does not reduce the runoff storage capacity of the area or provide for additional, equivalent storage adjacent to the encroachment; and
3. Document that any structures placed in the proposed encroachment area are sufficiently elevated to protect against flooding.

Note that some areas have been shown on **Figure 3** as "Potential Fill Areas" and equivalent storage capacity is not required in those areas, but the areas must be filled to the elevations noted prior to any development activities occurring with the "Potential Fill Area".

Documentation of the analysis to determine the limits of the Development Setback Line are include in the project GIS and modeling files.

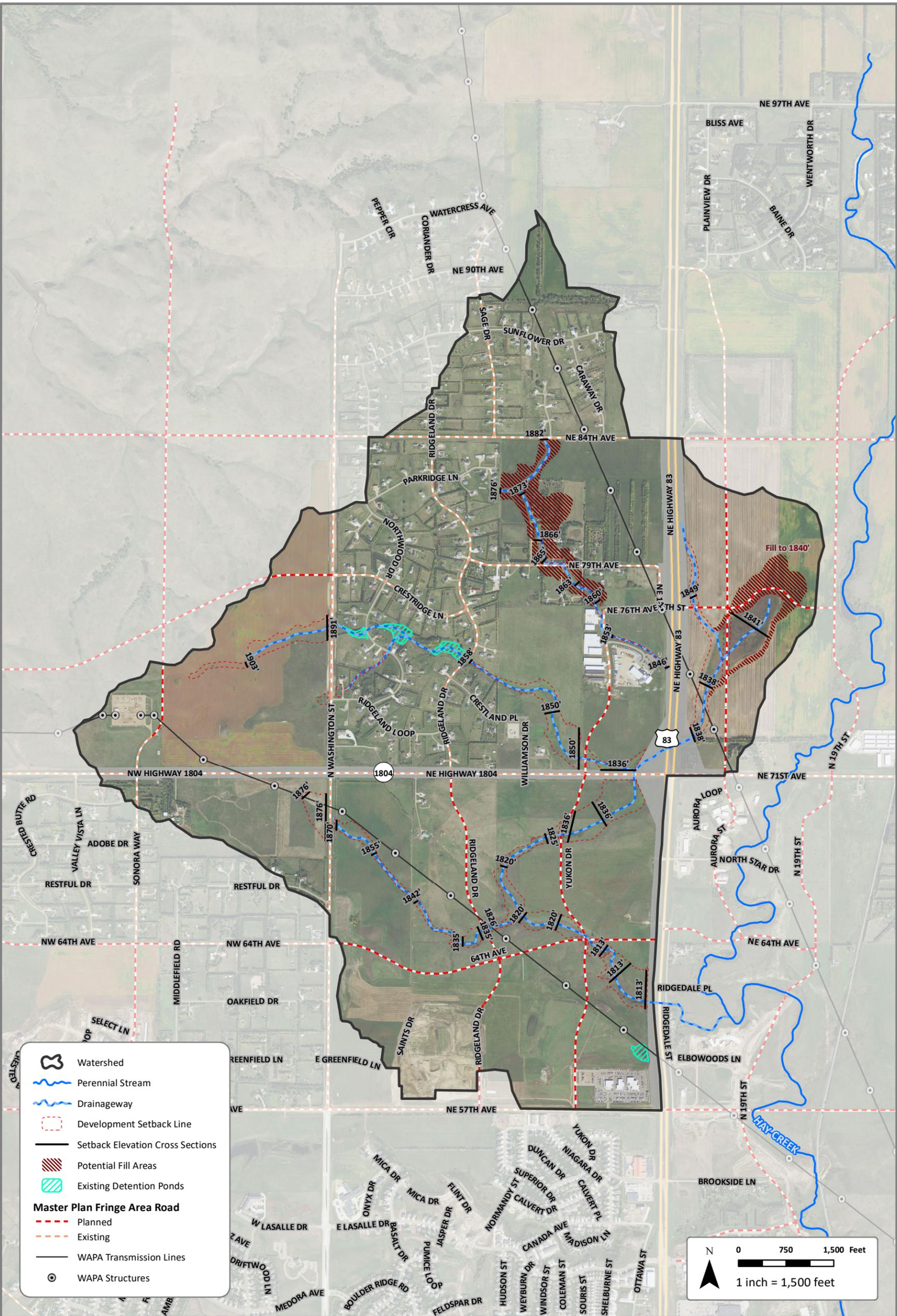
Justification

Preservation of large drainage areas and associated stormwater storage is key to protecting the public safety and minimizing the potential for damage or destruction of property.

Table 1 Master Plan Recommendations Summary

	Description	Justification
<p>RECOMMENDATION #1 Peak runoff within US83/ND1804 Watershed shall not exceed designated Unit Rate.</p>	<p>The maximum post-construction flow rate from a development or redevelopment site shall meet Unit Rate peak runoff criteria for the 2- and 100-year events such that post-construction runoff rates do not exceed 0.07 cfs/acre for the 2-year storm and 0.65 cfs/acre for the 100-year storm as shown in Table 3</p> <p>The Unit Rate Method is more fully described in Section 4.3.</p> <p>The Unit Rate recommendation allows for an amount of pervious ground, not to exceed 10% of site's total area, discharging directly offsite without mitigation through a peak flow compliance post-construction facility.</p> <p>Stormwater Design Standards for development activities is included in Section 4.6</p>	<p>The Unit Rate release requirement meets all of the Primary Goals developed for this Master Plan.</p> <p>The Unit Rate method allows for stormwater practices to be designed and constructed when and where development occurs and provides flexibility in the location of the stormwater facilities.</p> <p>An allowance of up to 10% of the pervious portion of the site not being routed to the peak flow compliance facility was accounted for in the development of the allowable Unit Rate as a recognition that there will be topographic and other constraints that make capturing 100% of the site may not be practical.</p>
<p>RECOMMENDATION #2 Developer is responsible for construction costs of required stormwater BMPs.</p>	<p>Peak flow compliance will be met using onsite or local facilities.</p> <p>Costs for the design and construction of stormwater management basins are to be paid by the developer.</p> <p>The Master Plan does not include any regional stormwater basins or conveyance improvements constructed by the City.</p>	<p>Utilizing local facilities allows the impact from urbanization to match the pace of development potentially reducing the size of downstream conveyance structures and reducing the erosion in natural channels.</p> <p>Stormwater Design Standards for development activities, including a description of construction cost responsibility, is included in Section 4.6.</p>
<p>RECOMMENDATION #3 Implement a Development Setback Line to maintain drainage and runoff storage corridors.</p>	<p>A Development Setback Line was developed along major drainages and is presented on Figure 3 along with cross sections showing the elevation of the setback.</p>	<p>Preservation of large drainage areas and associated stormwater storage is key to protecting the public safety and minimizing the potential for damage or destruction of property.</p>

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Figure 3

MASTER PLAN IMPROVEMENTS AND DEVELOPMENT SETBACK LINE



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4.0 STORMWATER MASTER PLAN

Included in the following sections are:

1. Recommended stormwater management strategies;
2. Locations for the compliance and reporting locations for the Master Plan;
3. Compliance requirements used to develop the Master Plan; and
4. Stormwater Design Standards applicable for Post-Construction Stormwater Management Permits (PCSMP) issued in the US83/ND1804 Watershed.

4.1 KEY MODIFICATIONS FROM THE ADOPTED 2014 WATERSHED MASTER PLAN

This updated Stormwater Master Plan for US83/ND1804 Watershed does not include any regional detention facilities or conveyance improvements. The 2014 Master Plan relied on regional stormwater facilities to control peak discharge rates whereas this revised Master Plan uses the Unit Rate Method. **Figure 4** shows the comparison of the revised development setback limits to the 2014 Master Plan as well as the proposed regional detention and conveyance facilities.

4.2 STORMWATER MANAGEMENT

The Stormwater Master Plan for US83/ND1804 Watershed consists of stormwater management recommendations for:

1. Post-Construction Peak Discharge Compliance;
2. Post-Construction Water Quality Compliance; and
3. Drainage & Conveyance Implementation.

Developments within the US83/ND1804 Watershed shall meet the requirements for peak discharge compliance, water quality compliance and drainage & conveyance implementation as discussed in the following sections of this Master Plan.

4.2.1 Peak Discharge Compliance

The proposed Stormwater Master Plan utilizes a Unit Rate approach for managing post construction peak flow rates. A Unit Rate approach refers to the development of recommended peak runoff rates that are dependent on the size of a development or project site.

Post-construction peak discharge requirements are accomplished for the US83/ND1804 Watershed by utilizing the Unit Rate Method such that the post-construction runoff rate does not exceed 0.07 cfs/acre for the 2-year storm and 0.65 cfs/acre for the 100-year storm shown in **Table 3**.

Utilizing these Unit Rate recommendations for the US83/ND1804 Watershed results in post-development flows not exceeding pre-development flows in any of the compliance points

chosen for this master plan. The proposed flows are reduced from the existing flows by different amounts and the controlling compliance locations within this watershed for the 2-yr event is the Highway 83 South locations while the Highway 83 North and Washington South locations control for the 100-yr event. Additionally, based on analysis of watershed performance, compliance with the Unit Rate recommendations for the 2- and 100-year events achieves compliance for the 10-year storm event.

The Unit Rate recommendation accounts for an amount of pervious ground, not to exceed 10% of site's total area, discharging directly offsite without mitigation in a Post-Construction BMP. The area discharging offsite must be 100% pervious and in no case should the area allowed to discharge offsite be allowed to exceed 10% of the total site.

The performance of the Unit Rate methodology in meeting peak runoff compliance is presented in **Figure 5** and **Figure 6**.

4.2.2 Water Quality Compliance

Post-construction water quality compliance for the US83/ND1804 Watershed is accomplished by utilizing development specific BMPs to meet the requirements of the City's MS4 permit that is effective at the time of the development.

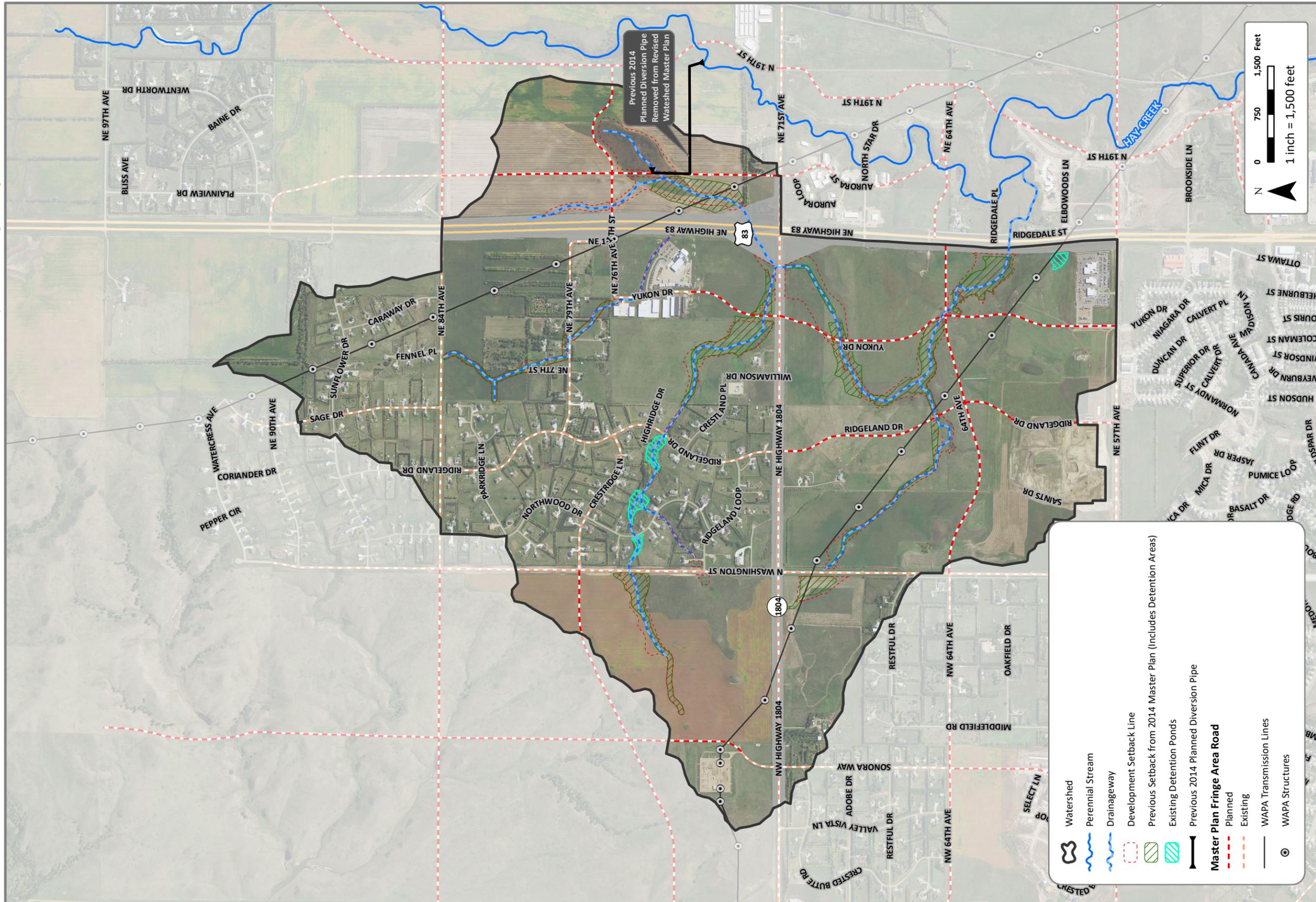
4.2.3 Land Use

The Existing Condition land use is shown on **Figure 7**.

Master Planned condition land use is shown on **Figure 8**.

4.2.4 Drainage & Conveyance Implementation

Future crossings were sized to meet City requirements assuming existing land use coverage. There are four existing crossings that will not meet level of service criteria under Master Planned conditions. These four crossings are 84th Avenue NE, the intersection at Sunflower and Sage Drive, and two crossings at 79th Avenue NE. In the future, if these roads are improved, the culvert crossings should be upgraded to meet the City's design requirements. **Figure 15** highlights these crossings as well as the future crossings.



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Figure 4

**COMPARISON OF
2014 MASTER PLAN
AND
PROPOSED
DEVELOPMENT
SETBACK LINE**

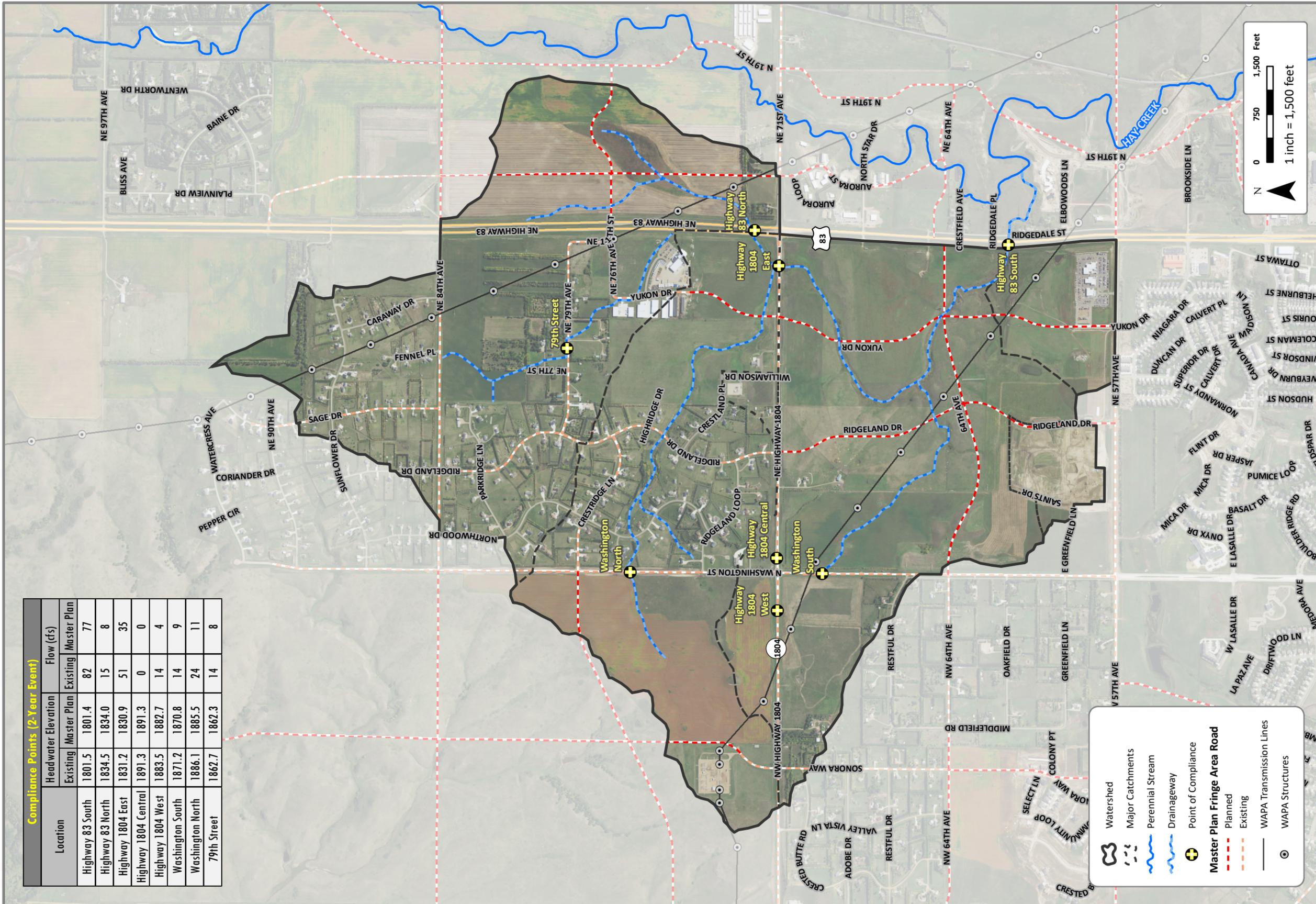
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Figure 5
2-YEAR FLOW COMPLIANCE

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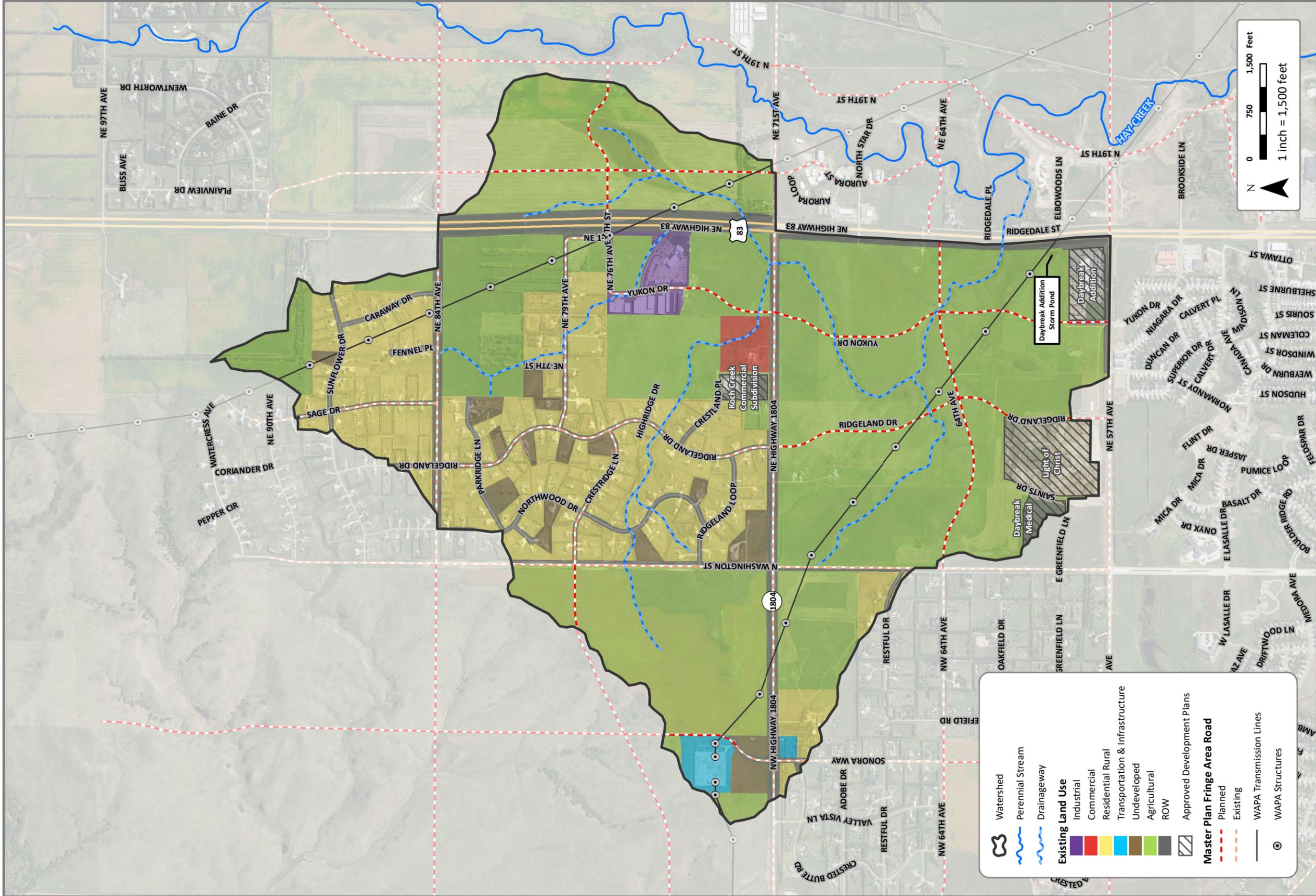
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Burleigh County, ND

Figure 7
**EXISTING
LAND USE**

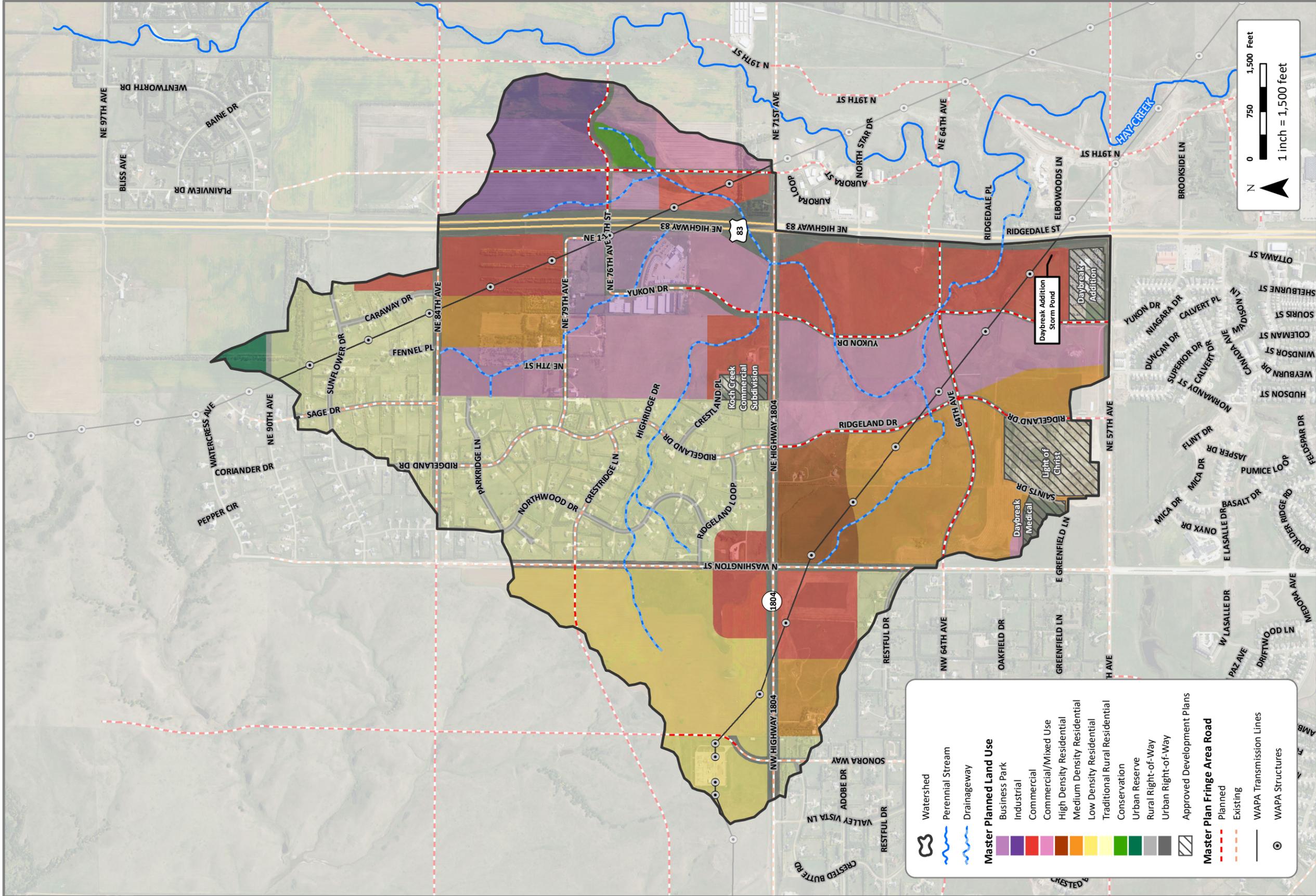
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City of Bismarck
Burleigh County, ND

Figure 8
**MASTER PLANNED
LAND USE**

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4.3 UNIT RATE METHOD PERFORMANCE

The performance of the Unit Rate Method versus existing conditions and local BMPs conforming to the pre-post requirement is shown in **Figure 9** and **Figure 10**. Determination of an allowable Unit Rate discharge for the watershed required analysis at multiple compliance points throughout the study area. **Figure 9** shows the US 83 South compliance point, which controls for the 2-yr event. **Figure 10a** and **Figure 10b** show the US 83 North and Washington South compliance points, which control for the 100-yr event.

Figure 9: 2-Year Storm Unit Rate Performance at US 83 South Compliance Point

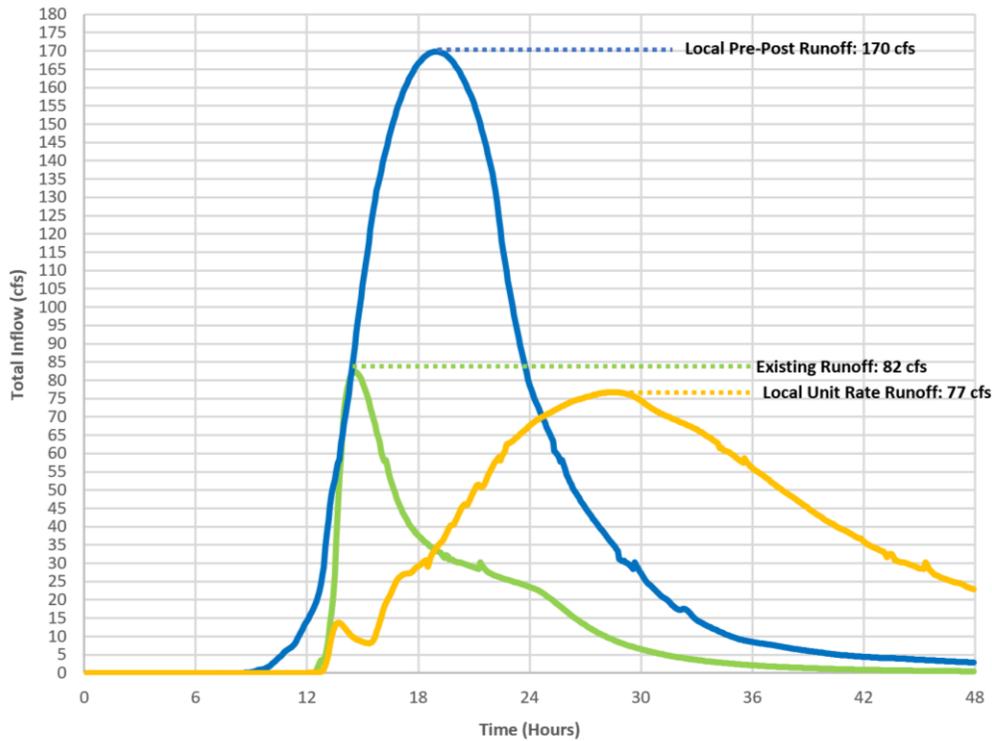
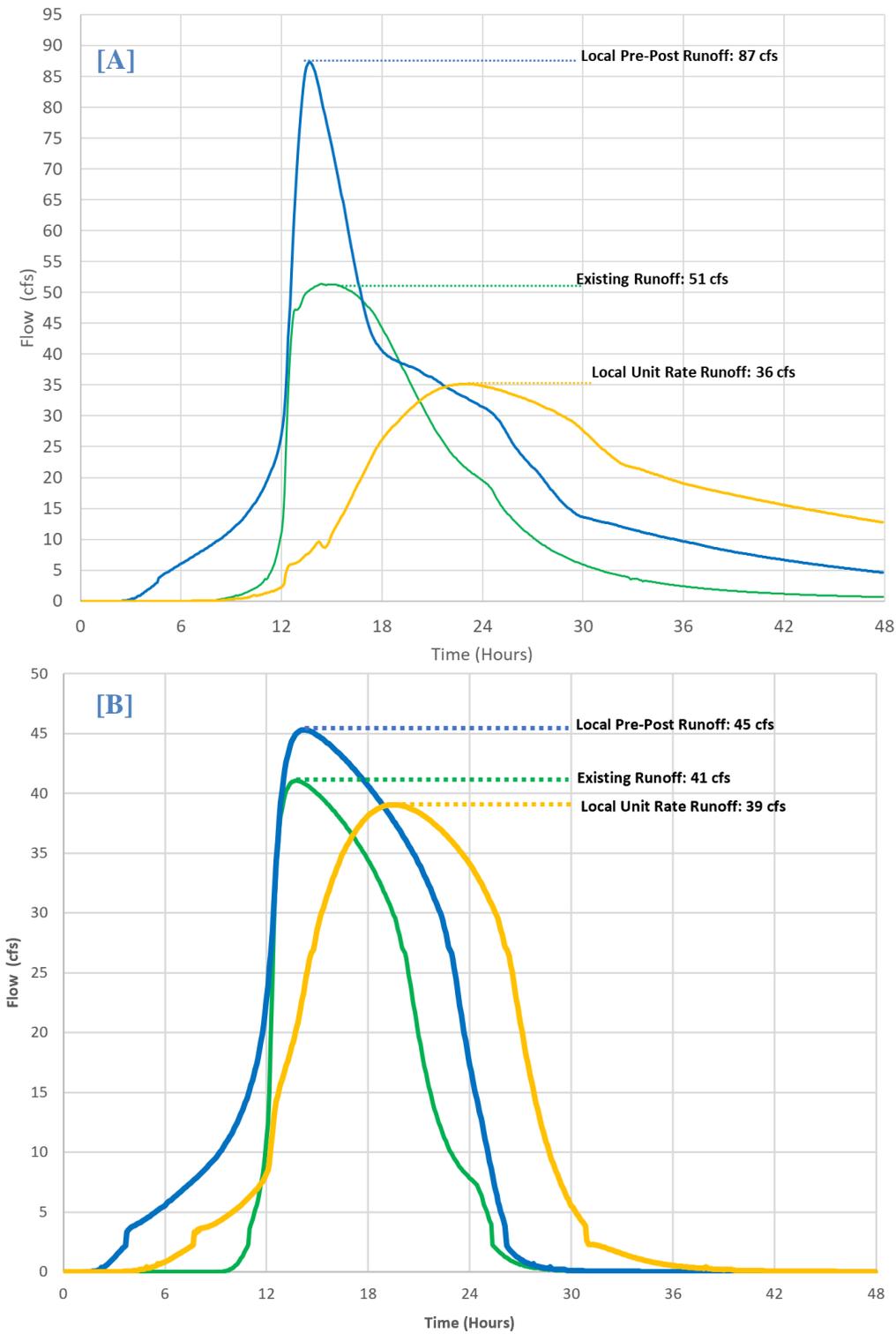


Figure 10: 100-Year Storm Unit Rate Performance at [A] US 83 North Compliance Point and [B] Washington South Compliance Point



4.4 MASTER PLAN REPORTING LOCATIONS

Master Plan performance is presented at designated Points of Compliance, Points of Analysis, and Flow Reporting Points. Watershed performance and goal achievement was reviewed at select Points of Compliance and Flow Reporting Points throughout the watershed, located mainly on the perennial streams and drainageways shown on **Figure 2**. The following sections provide a brief summary of the specific Points of Compliance and Flow Reporting Points identified or utilized by this Master Plan.

4.4.1 Points of Compliance

Points of Compliance are key locations where changes in flow rate or flow depth would have adverse impacts to significant existing infrastructure or downstream users. To achieve the Master Plan goals at Points of Compliance, master planned flows and water surface elevations need to be equal to or less than the existing condition. The following Points of Compliance were identified and are presented on **Figure 5** and **Figure 6** along with tables presenting Existing and Unit Rate flows and headwater elevations:

1. Highway 83 South (south of proposed 64th Avenue)
2. Highway 83 North (north of Highway 1804)
3. Highway 1804 East (west of Highway 83)
4. Highway 1804 Central (east of North Washington Street)
5. Highway 1804 West (west of North Washington Street)
6. Washington Street South (north of Highway 1804)
7. Washington Street North (south of Crestridge Lane)
8. 79th Street (east of 7th Street)

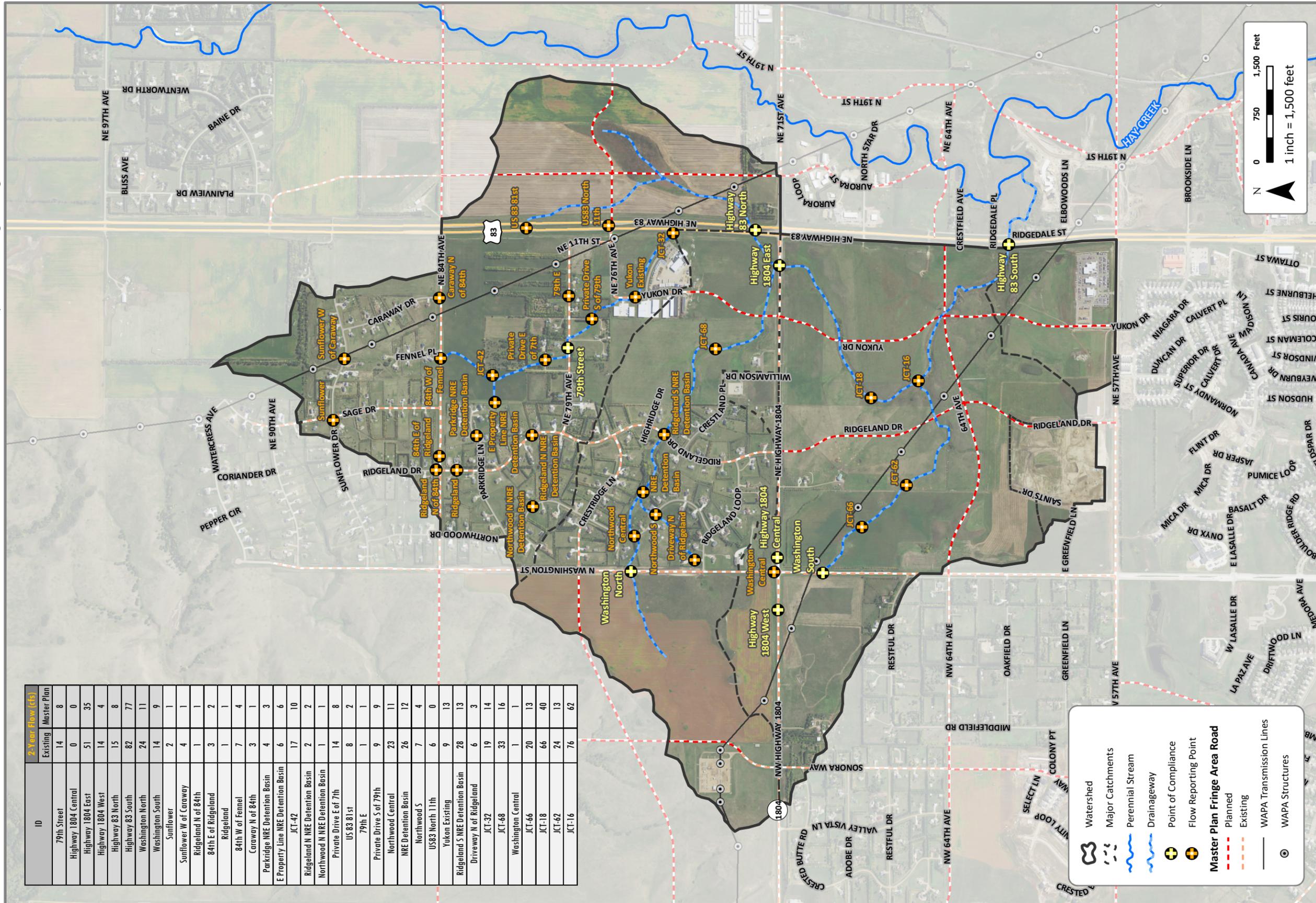
4.4.2 Flow Reporting Points

In general, Flow Reporting Points are existing roadway crossings requiring upgrades, select future roadway crossings, or intermediate locations on significant drainages that are designated as Flow Reporting Points. Flow Reporting Points are intended to act as reference points for reviewing existing and design flows as well as to aid in the design of possible future crossings not identified by this Master Plan.

At Points of Analysis, flows are presented as either existing or Master Plan. The designer should use the higher of the two flows, typically the existing flow, when considering design of facilities since they represent the worst-case scenario at each point.

The Flow Reporting Points identified in this Master Plan are presented on **Figure 11**, **Figure 12** and **Figure 13** along with tables presenting existing and master plan flows.

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Locator Map Not to Scale

City of Bismarck
Burleigh County, ND

Figure 11
**2-YEAR
DESIGN FLOW**

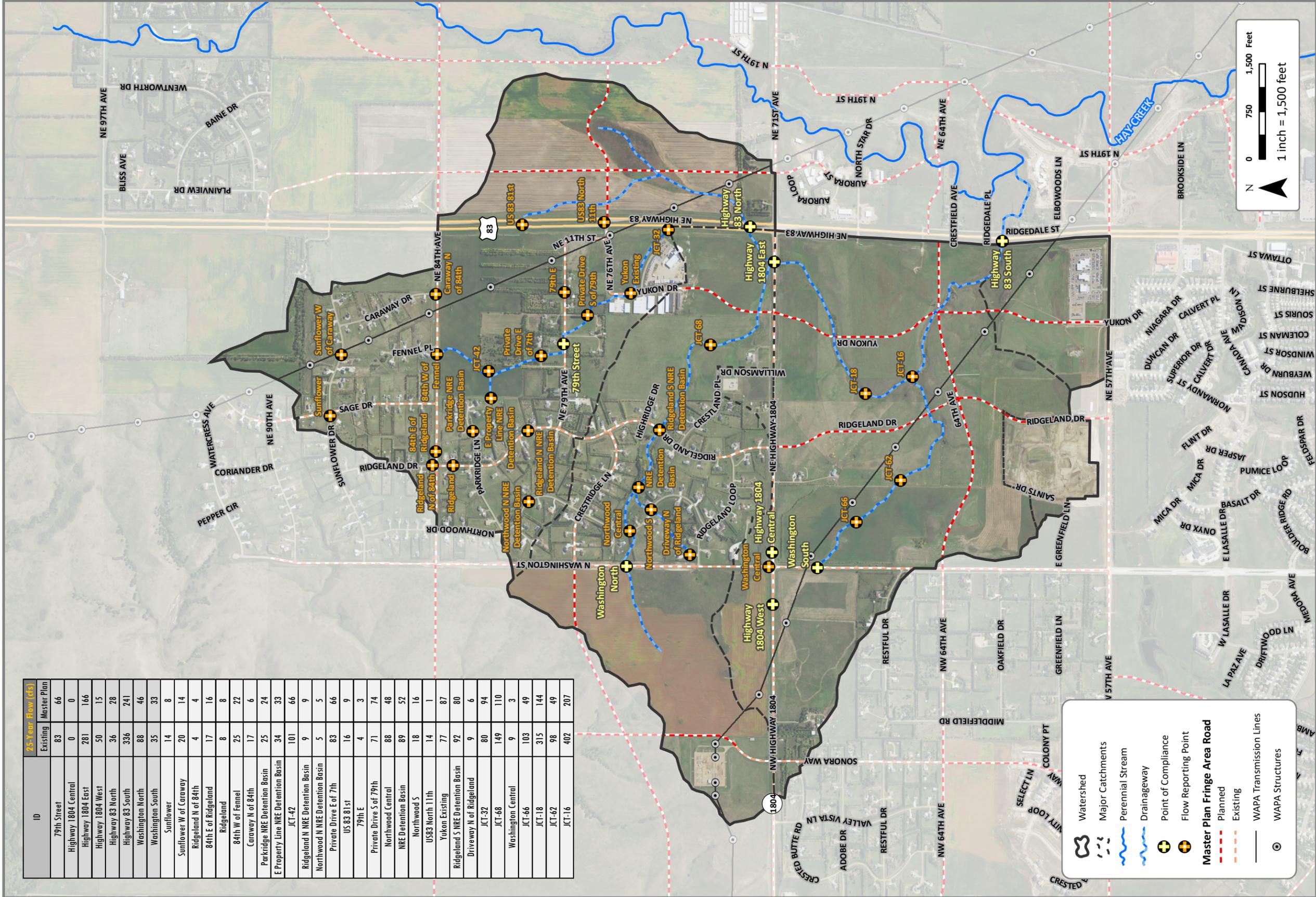
US 83 / ND 1804
STORMWATER
MASTER PLAN UPDATE

Date: 8/23/2019



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Information depicted may include data unverified by AE2S. Any reliance upon such data is at the user's own risk. AE2S does not warrant this map or its features are either spatially or temporally accurate.
 Coordinate System: NAD 1983 HARN StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: dlee | C:\Data\Projects\WAFS\B\Bismarck\00501-2018-000\GIS\TO4\Report Figure 12- 25-Year Design Flow.mxd



Locator Map Not to Scale

City of Bismarck
Burleigh County, ND

Figure 12
**25-YEAR
DESIGN FLOW**

US 83 / ND 1804
STORMWATER
MASTER PLAN UPDATE

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4.5 STORMWATER COMPLIANCE REQUIREMENTS

Development of this Master Plan included meeting requirements for local, county, and State drainage regulations. The following sections summarize the general requirements for each jurisdiction.

4.5.1 City Requirements

The City of Bismarck includes performance criteria within Title 14.1 of the City's Code of Ordinances. Additional City design criteria are included within the City's Stormwater Design Standards Manual. Specific applicable criteria are as follows:

1. Unit Rate recommendations and proposed infrastructure is designed such that flows meet the City's requirements at Points of Compliance located throughout the Master Planning area. These requirements are summarized as follows:
 - a. No increase in post-development flows compared to pre-development flows for the 2-, 10-, and 100-year storm events (14.1-02-03 6.a.).
 - i. Based on analysis of watershed performance, compliance with the Unit Rate recommendations for the 2- and 100-year events achieves compliance for the 10-year storm event.
 - ii. Because of this, the recommended Master Plan approach of utilizing a Unit Rate method does not require the 10-year event to be analyzed.
 - b. For the purposes of this Master Plan, "pre-development" is defined as current conditions and existing land use including previously approved temporary stormwater ponds.
 - c. This Master Plan utilizes a 24-hour storm consistent with the City's SWDSM.
 - d. The Unit Rate Method will likely require utilizing smaller than the 4-inch diameter minimum orifice allowed by the SWDSM. **Figure 14** demonstrates a schematic design of an engineered outlet for low flow protection.
2. Meet the City's MS4 permit requirements as outlined in Appendix 1 of the Authorization to Discharge under the North Dakota Pollutant Discharge Elimination System Permit No. NDR04-0000, or the current effective MS4 permit requirements.
3. Future road crossing structures are to be sized to meet Section 6 of the SWDSM.
 - a. Allowable headwater over culvert crossing per Table 6-7 of the SWDSM which states that the 25-year, 24-hour event shall be less than 1.5 times the culvert diameter or rise.
 - b. Allowable Street overtopping per Table 6-8 of the SWDSM.

- i. Local Streets: No overtopping in the 25-year storm and no more than 6" of depth over the highest point on the street section in the 100-year storm; and
- ii. Collector & Arterial Streets: No overtopping in the 100-year storm.

4.5.2 County Requirements

For the purposes of this Master Plan, all areas within the US83/ND1804 Watershed are considered to be within the jurisdiction of the City of Bismarck when approved by the City Commission.

4.5.3 State Requirements

The US83/ND1804 watershed includes drainages that cross US Hwy 83 and ND 1804 therefore, both North Dakota Department of Transportation (NDDOT) and State Water Commission (SWC) criteria for stream crossings, level of service, and backwater are applicable. Meeting the requirements of NDAC Article 89-14 Public Highway Stream Crossings is required at these locations. In general, the requirements of NDAC 89-14 are summarized as follows:

1. Design flood frequency is determined by section 89-14-01-03.
 - a. For regional and urban State Highway roads in the urban system, no roadway overtopping shall occur up to the 25-year event.
 - b. For non-interstate State Highway roads in the rural system, no roadway overtopping shall occur up to the 25-year event.
2. Allowable headwater over culvert crossings is determined by section 89-14-01-05.
 - a. For the Master Plan area, streambed slopes are greater than 10 feet/mile (entire study area).
 - b. The allowable headwater when passing the design flood frequency shall be no greater than two pipe diameters.

The State Engineer/State Water Commission regulates construction of dams. Per NDCC Article 61-16.1-38, permits are required for structures retaining more than 25 acre-feet of water for medium- or high-hazard dams. Since these facilities will be constructed in an urban area, it is likely that any detention facility exceeding 25 acre-feet of storage, even if temporary, would be classified as a dam and would require formal approval through the State permitting process.

4.5.4 Street Crossing Criteria Hierarchy

To balance the potential impact of headwater elevations at existing and future roadway crossings, the hierarchy presented in **Table 2** shall be utilized to size the minimum culvert pipe size at each significant crossing.

Table 2: Stream Crossing Design Hierarchy

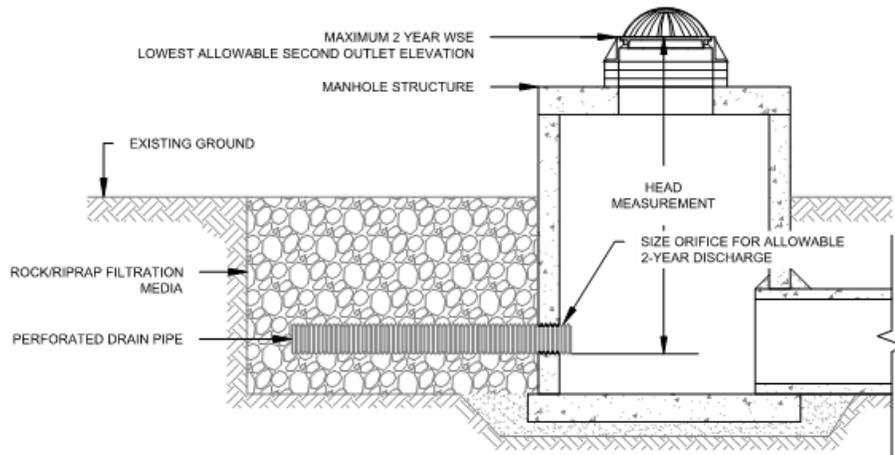
Situation	Road Crossing Criteria
Crossing is not within a FEMA Floodplain or designated "Open Space"	<ul style="list-style-type: none"> ➤ 25-year HW < 1.5 x Culvert Diameter ➤ 100-year HW < Overtopping Elevation ➤ Engineer's judgement used to determine the appropriate balance between infrastructure recommendations and 100-year WSE inundation area.
All Crossings	If feasible, provide 1-foot of freeboard in the 100-year event.

Notes:

"HW" = Headwater measured from the channel invert.

"WSE" = Water Surface Elevation

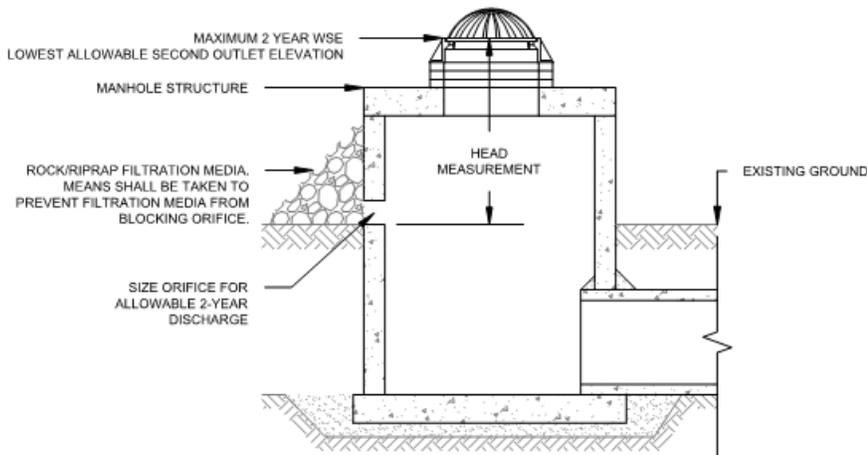
Figure 14: Engineered Outlet for Low Flow Protection



GENERAL NOTES

1. ACTUAL DEPTH OF DRAIN PIPE, SIZE OF MEDIA, AND QUANTITY OF MEDIA WILL VARY. THESE DETERMINATIONS SHALL BE MADE PER ENGINEERS JUDGEMENT.

1 LOW FLOW STRUCTURE - UNDERDRAIN
 NOT TO SCALE



GENERAL NOTES

1. ACTUAL DEPTH SIZE OF MEDIA, AND QUANTITY OF MEDIA WILL VARY. THESE DETERMINATIONS SHALL BE MADE PER ENGINEERS JUDGEMENT.

2 LOW FLOW STRUCTURE - ORIFICE W/ FILTRATION MEDIA
 NOT TO SCALE

4.6 US83/ND1804 WATERSHED STORMWATER DESIGN STANDARDS

Stormwater design standards in the City of Bismarck are defined by Title 14.1 of the City Code of Ordinances and the Stormwater Design Standards Manual (SWDSM). To meet the specific stormwater management goals of the US83/ND1804 Master Plan area, watershed specific revisions to the requirements of the SWDSM are recommend for development and redevelopment activities in the Master Plan area.

The following sections and tables summarize the recommended modifications to the performance requirements, analysis and reporting requirements, design standards and analysis methodologies for the US83/ND1804 Master Plan area.

Not every development or redevelopment scenario has been identified during the development of the US83/ND1804 Master Plan. Additional requirements or modifications to the SWDSM may be identified by the City Engineer during the mandatory stormwater scoping sheet submittal described in the SWDSM.

4.6.1 Post-Construction Peak Flow Compliance

Post-construction peak flow compliance for development and redevelopment projects shall meet the requirements of the SWDSM with the following modifications:

Performance Requirements

The requirements of Section 4.1 of the SWDSM are to be replaced with the following:

Projects that require a Post-Construction Stormwater Management Permit (PCSMP) are subject to Peak Discharge Control requirements and shall include peak discharge post-construction structural or non-structural BMPs to conform to the requirements of **Table 3** of the US83/ND1804 Master Plan and *Section 4.1.1* of the SWDSM.

Table 3: Point of Discharge Peak Flow Compliance Unit Rate Method

Point of Discharge Location	Peak Discharge Control Requirement
Public Storm Sewer System, New Outfalls to Surface Waters, or Other Location Designated by the City Engineer	Post-Construction runoff resulting from the 2- and 100-year 24-hour rainfall events shall not exceed the runoff rate of the Post-Construction Unit Rate values of: <ul style="list-style-type: none"> • 2-year Storm = 0.07 cfs/acre • 100-year Storm = 0.65 cfs/acre The Unit Rate recommendation accounts for an amount of pervious ground, not to exceed 10% of site's total area, discharging directly offsite without mitigation in a Post-Construction BMP.

Clarifications to *Section 4.1.1* of the SWDSM are as follows:

1. Projects located inside of the US83/ND1804 Master Plan that require a PCSMP will need to provide an on-site or local post-construction BMPs to address peak discharge compliance performance requirements of **Table 3**
2. The allowable post-construction discharge is determined by the total site area times the Unit Rate values of **Table 3**. A maximum of 10% of the site area (all pervious) may not be routed to a peak flow compliance BMP due to topographic or other constraints.
3. Area designated as "Green Space" in the Future Land Use Plan that remain open space or pervious area after development activities are exempt from meeting the requirements of the Unit Rate allowable discharge and do not need to be routed to the peak discharge compliance BMP.
4. Areas inside of the Development Setback Line and outside of designated "Green Space" shall meet the requirements of the Unit Rate allowable discharge.
5. Projects located inside of the US83/ND1804 Master Plan that require a PCSMP and are located in an area with a previously approved PCSMP\SWMP shall provide documentation that the project meets the requirements for Peak Discharge Compliance by utilizing one of the scenarios described in Section 4.1.1 of the SWDSM.
6. Post-construction peak flow compliance with other design storms is not required. Note that post-construction design storm requirements for other stormwater BMPs (i.e. storm sewers, street conveyance, and other structures necessary to convey post-construction flows to the peak flow BMP) need to meet applicable requirements of the SWDSM.
7. Flows entering a site from undeveloped offsite areas are to be determined per the requirements of the SWDSM. PCSMP applications are not to consider these undeveloped offsite areas when calculating the allowable Unit Rate value for the PCSMP application.

Analysis and Reporting Requirements

PCSMP applications utilizing the Unit Rate method are not required to provide the Existing Conditions hydrologic analysis included in *Section 4.2.1* of the SWDSM or *Item 4.2* of the PCSMP Checklist (SM-05).

For projects requiring a PCSMP in the US83/ND1804 Master Plan area, the Existing Conditions hydrologic summary and analysis is to be replaced with:

Summary Table for of the Project Site Catchments by Point of Analysis that Includes:

1. Tributary Area of Onsite Project,
2. Tributary Area of Offsite Run-on Areas, and
3. Report the Post-Construction Allowable Unit Rate Runoff consistent with **Table 4**.
4. Reporting of total storm volumes is not required.

Following is a recommend summary table to be included in the SWMP as required by the PCSMP Checklist (SM-05).

Table 4: PCSMP SWMP Recommended Unit Rate Report Table

Project Hydrologic Modeling Summary – Allowable Unit Rate Discharge					
Point of Analysis	Site Area (Ac)	Allowable Post-Construction Peak Flow (cfs)		Area to BMP (Ac)	% to BMP
		2-Year	100-Year		
Point of Analysis 1					
Point of Analysis 2					
Point of Analysis 3					
Point of Analysis 4					
Total Site					

Required Exhibit 3.0 noted by PCSMP Checklist (SM-05) must include the following:

Documentation showing how the entire site area, both pervious and impervious, is conveyed to the post-construction peak flow compliance BMP and note any areas that cannot be routed to the BMP.

Design Standards

In addition to the minimum design standards presented in Section 4.3 of the SWDSM, the following considerations will be applied to Unit Rate sized post-construction peak flow compliance BMPs:

1. Design of BMPs are to account for undeveloped offsite flows by:
 - a. Routing undeveloped flows around proposed detention basin; or
 - b. Route undeveloped flows to the detention basin and design a stabilized overflow accounting for offsite flowrates. Note that the BMP should be designed to meet the Unit Rate requirements not including the off-site flows.
2. Engineered Outlets for Unit Rate detention basins smaller than 4-inches in diameter are to provide clog protection consistent with **Figure 14** or other approved method.
3. Due to topographic constraints, a maximum of 10% of pervious area of the site may be allowed to drain without being routed to a post-construction BMP.

Analysis Methodologies

Per the requirements of the SWDSM, no revisions for the US83/ND1804 Master Plan.

4.6.2 Post-Construction Water Quality Compliance

Post construction peak flow compliance for development and redevelopment projects should meet the requirements of the SWDSM with the following modifications:

Performance Requirements

Per the requirements of the SWDSM, no revisions for the US83/ND1804 Master Plan.

Analysis and Reporting Requirements

Per the requirements of the SWDSM, no revisions for the US83/ND1804 Master Plan.

Design Standards

In addition to the minimum design standards presented in Section 5.3 of the SWDSM, the following considerations will be applied to Unit Rate sized post-construction water quality compliance BMPs:

1. Engineered Outlets for Unit Rate detention basins smaller than 2-inches in diameter are to provide clog protection consistent with **Figure 14** or other approved method.

Analysis Methodologies

Per the requirements of the SWDSM, no revisions for the US83/ND1804 Master Plan.

Post Construction Drainage and Conveyance

Per the requirements of the SWDSM, no revisions for the US83/ND1804 Master Plan.

Table 5: US83/ND1804 Master Plan Stormwater Design Standards Summary

Stormwater Design Standard Requirements	Performance Requirement	Analysis & Reporting Requirements	Design Standards	Analysis Methodologies
SWDSM Section 4.0 - Post Construction Peak Discharge Compliance	<ol style="list-style-type: none"> Post-Construction runoff rates are required to meet a maximum rate as determined by the total site area times the applicable post-construction "Unit Rate." Post-Construction Unit Rate values are: <ul style="list-style-type: none"> ➤ 2-year Storm = 0.07 cfs/acre ➤ 100-year Storm = 0.65 cfs/acre The Unit Rate shall be applied to the overall development area (pervious and impervious) including any areas diverted from the peak flow compliance BMP. A maximum of 10% of the site area may be diverted from the peak flow compliance BMP due to topographic or other constraints. Areas designated as "Green Space" in the Future Land Use Plan that remain open space or pervious area after development activities are exempt from meeting the requirements of the Unit Rate allowable discharge. Compliance with design storms other than the 2- and 100-year storm events is not required. Undeveloped offsite flows are to be determined per the requirements of the SWDSM, rather than the Unit Rate. 	<ol style="list-style-type: none"> Report the allowable "Unit Rate" discharge from the entire site. <ol style="list-style-type: none"> Existing Condition hydrologic analysis, or reporting, is not required for projects utilizing the Unit Rate method. References in the SWDSM to "Existing Conditions" hydrologic analysis are to be replaced with documentation of the allowable Unit Rate discharge from the subject site. (Table 4) Provide a figure that documents how Post-Construction BMPs capture runoff from the entire project site (pervious and impervious) and notes any areas that cannot be routed to the BMP. The total rate discharge from the site, including any pervious areas not routed through the BMP, must be less than the allowable Unit Rate. 	<ol style="list-style-type: none"> Offsite flows shall be accounted for in the design of post-construction BMPs by one of the following methods: <ol style="list-style-type: none"> Route undeveloped flows around proposed detention basin; or Route undeveloped flows to the detention basin and design a stabilized overflow for offsite flows. Said overflow shall be set above the 100-year WSE produced by onsite developed flows. Unit Rate flows may necessitate engineered outlets smaller than 4-inches in diameter. In such situations, low flow structures with appropriate clog protection shall be utilized consistent with Figure 14 or other approved method. Pervious area of up to 10% of the total site area may be allowed to drain to the downstream drainageway without being routed to a post-construction BMP, at the discretion of City staff. 	Per the SWDSM
SWDSM Section 5.0 - Post-Construction Stormwater Quality Compliance	Per the SWDSM.	Per the SWDSM	<ol style="list-style-type: none"> All impervious areas must be routed through the post-construction water quality BMP. Post-construction water quality requirements may necessitate engineered outlets smaller than 2-inches in diameter. In such situations, low flow structures with appropriate clog protection shall be utilized consistent with Figure 14 or other approved method. 	Per the SWDSM
SWDSM Section 6.0 - Post Construction Drainage and Conveyance	<ol style="list-style-type: none"> Street Drainage per the SWDSM Storm Sewer System per the SWDSM Culverts per the SWDSM except: <ol style="list-style-type: none"> Flow rates, provided by Figure 11, Figure 12 and Figure 13 were developed by reporting Existing or Master Plan flow rates. The higher of the two flow rates should be used. Local Streets 100-Year Allowable WSE < the Upstream Development Setback Line elevation provided by Figure 3 Collector and Arterial Street design WSE that meet the preliminary design presented in Section 5.0 and/or Table 2 Open Channels per the SWDSM Outlet Protection per the SWDSM 	Per the SWDSM	Per the SWDSM	Per the SWDSM

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5.0 IMPROVEMENT PLAN

Included in the development of the Master Plan are specific improvement recommendations necessary to achieve the master plan goals. In general, because the stormwater management concept for this Master Plan is to utilize local BMPs with unit rate methodology there are no specific regional improvements to be implemented other than at future road crossings.

5.1 ROAD CROSSINGS

Conceptual design for future roadway crossings were developed for arterial streets identified in the master planning area. A summary of these crossings is included in **Figure 15**.

5.2 STORM SEWER TRUNK MAINS

Trunk mains were not developed as part of this Master Plan due to the unknown location of peak flow compliance facilities. Trunk mains should be designed in conformance with the SWDSM requirements.

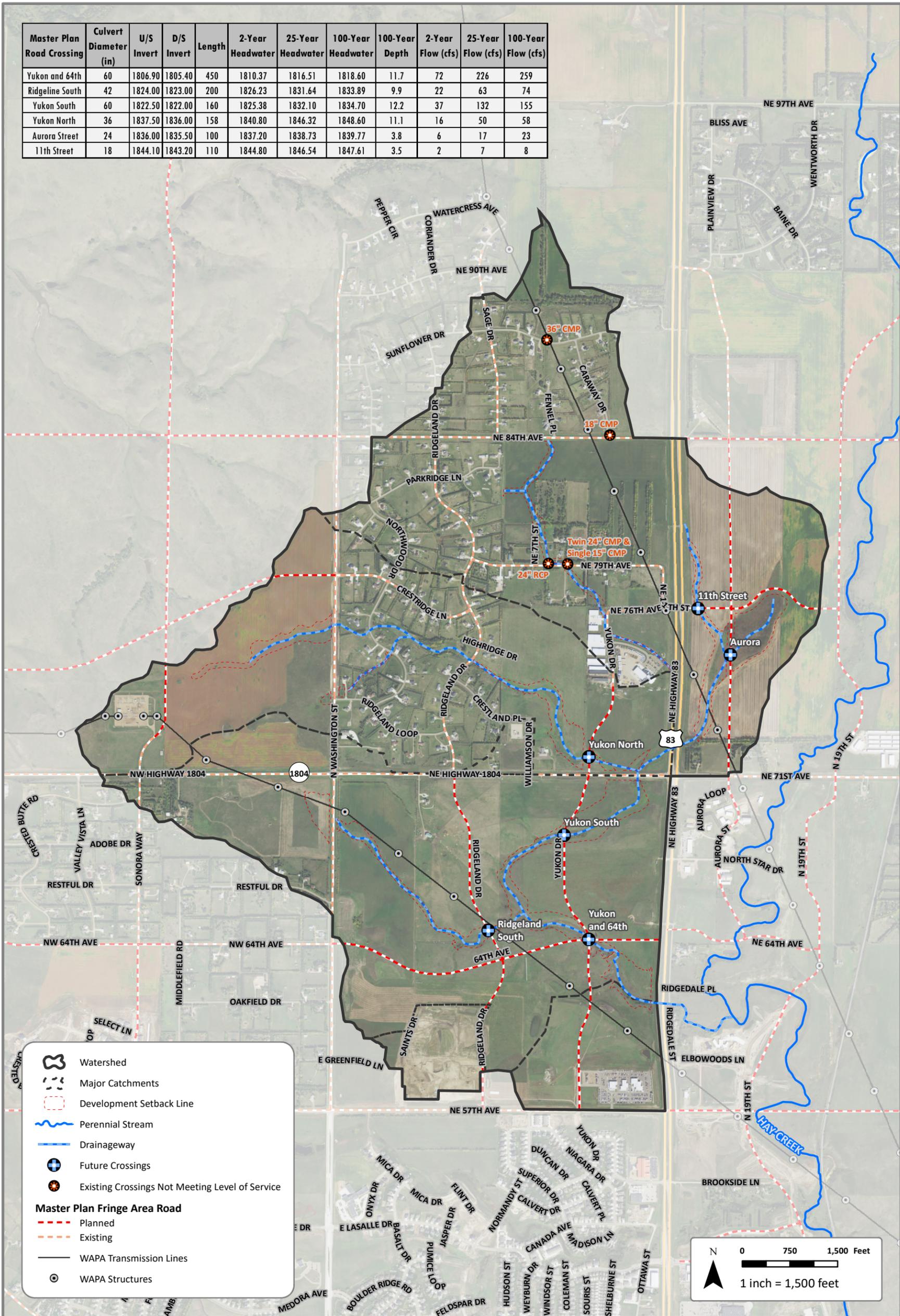
5.3 REGIONAL PEAK DISCHARGE BMPS

No specific regional peak discharge compliance BMPs are recommend for the implementation of the Master Plan. Peak discharge compliance in the Master Plan condition will be completed using facilities designed and constructed in conformance with the Unit Rate requirements to match the pace of development.

There is significant storage upstream of the future Aurora Street crossing within the designated conservation area east of Aurora Street and south of 7th Avenue. **Figure 3** shows the proposed development setback for this area which is based on the 100-year headwater elevation plus 1-foot of freeboard.

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Master Plan Road Crossing	Culvert Diameter (in)	U/S Invert	D/S Invert	Length	2-Year Headwater	25-Year Headwater	100-Year Headwater	100-Year Depth	2-Year Flow (cfs)	25-Year Flow (cfs)	100-Year Flow (cfs)
Yukon and 64th	60	1806.90	1805.40	450	1810.37	1816.51	1818.60	11.7	72	226	259
Ridgeline South	42	1824.00	1823.00	200	1826.23	1831.64	1833.89	9.9	22	63	74
Yukon South	60	1822.50	1822.00	160	1825.38	1832.10	1834.70	12.2	37	132	155
Yukon North	36	1837.50	1836.00	158	1840.80	1846.32	1848.60	11.1	16	50	58
Aurora Street	24	1836.00	1835.50	100	1837.20	1838.73	1839.77	3.8	6	17	23
11th Street	18	1844.10	1843.20	110	1844.80	1846.54	1847.61	3.5	2	7	8



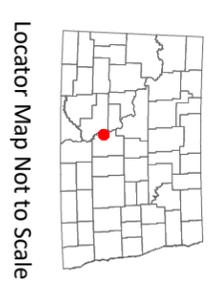
Information depicted may include data unverified by AE2S. Any reliance upon such data is at the user's own risk. AE2S does not warrant this map or its features are either spatially or temporally accurate. Coordinate System: NAD 1983 HARN StatePlane North Dakota South FIPS 3302 Feet Intl | Edited by: diee | C:\Data\Projects\WAFS\Bismarck\00501-2018-000\GIS\T04\Report\Figure 15- Master Plan Future Crossings.mxd



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**MASTER PLAN
FUTURE
CROSSINGS**

City of Bismarck
Burleigh County, ND
Figure 15



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