WENCK File #0647-0012
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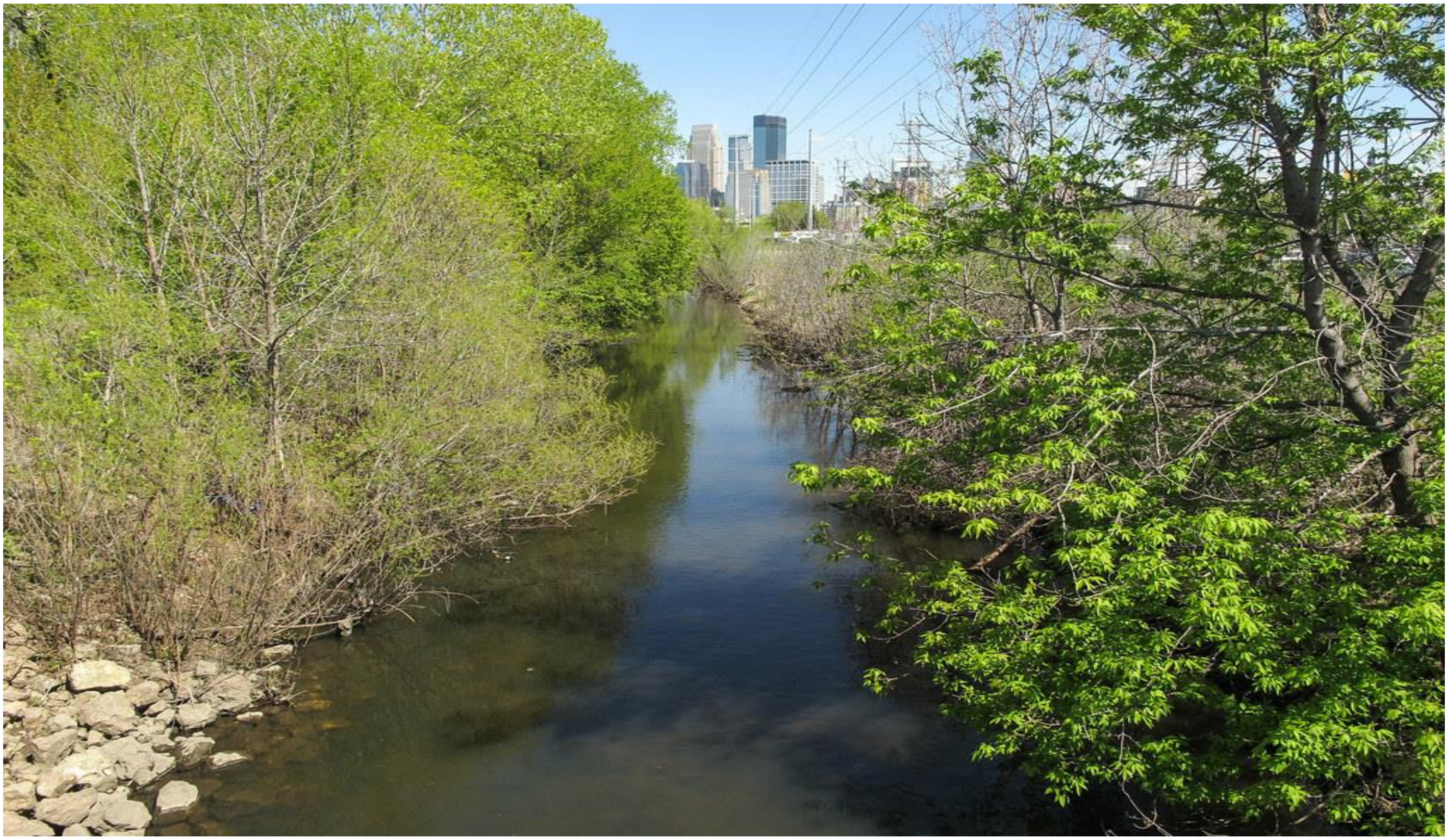
Bassett Creek Valley – Floodplain and Stormwater Management Study



Prepared for:

Bassett Creek Watershed Management Commission and City of Minneapolis

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Executive Summary

The Bassett Creek Valley Floodplain and Stormwater Management Study identified and evaluated numerous scenarios, or potential projects, to manage flood waters within Bassett Creek Valley. The project focused on managing water resources on a regional scale with the goal of unlocking land while providing flood storage, water quality and ecological benefits, land use opportunities and additional amenities. The process included the active involvement of key partners to develop and evaluate scenarios to address flooding concerns that could limit the redevelopment of the Bassett Creek Valley Development Area. The technical team evaluated site conditions, ran hydrologic models, and prepared cost estimates to evaluate the impacts of the scenarios on flooding in the area to complete these improvements. These technical findings are accompanied by information about other factors, such as the potential for partner funding and consistency with City, watershed, and MPRB plans.

Through the scenario development process, two areas within Bassett Creek Valley became the focus of large-scale flood mitigation projects: Bryn Mawr Meadows Park and Bassett Creek corridor between Cedar Lake Rd and Van White Blvd. Each area was reviewed for multiple scenarios to determine specific influences on the flood elevation, flood extent, and the ability to provide regional amenities.

Scenarios in Bryn Mawr Meadows Park reduce the flood elevation in Bassett Creek Valley Development Area but only around the existing flood boundary. It does not remove full parcels from the floodplain for redevelopment. Scenarios within the Bassett Creek corridor, which are directly connected to the Creek, relocate the flood waters to precise locations to remove numerous parcels from the floodplain.

Funding partnerships among benefited parties will likely be necessary to allow for regional amenities and development. It is anticipated that full redevelopment of the area designed with a Regional Surface Water Management Plan could provide new market value for the area of over $300 million dollars which would generate real estate taxes of over $10 million a year. If the development were completed with parcel-by-parcel approach, the estimated market value and real estate taxes would be significantly less and would likely not provide regional amenities and valuable connections. Funding of these projects will need to be a combined effort between public and private sectors.

Next steps include bringing additional government agencies and developers to the table to create a Regional Surface Water Management Plan. This Plan is intended to provide a road map for future development to ensure compliance with regulatory requirements. In conjunction with creating the Regional Surface Water Management Plan, additional environmental investigation should be completed in the area to gain a better understanding of the level of cleanup needed and potential impacts to project cost.

1.0 Background, Purpose and Scope

1.1 BACKGROUND

The Bassett Creek Valley Development Area in the City of Minneapolis currently contains the city's Impound Lot, Pioneer Paper, abandoned CP rail lines, vacant lots, other older industrial properties and rental housing properties. The area has begun to redevelop, and several challenges and opportunities have emerged. Bassett Creek flows through the study area though it is hidden from view, which limits opportunities for serving as a natural amenity and focal point for public use and adjacent redevelopment. More problematic, Bassett Creek's flood stage encompasses much of the potential redevelopment area and site conditions include contaminated soils, unstable soils, limited opportunity for storm water quality treatment and infiltration, and existing utilities. These large-scale challenges are difficult to address on a site by site basis, which is the approach typically used in areas with multiple and varied uses and ownership.

Seeing the potential for redevelopment in this area while also recognizing the advantage of a systematic and comprehensive approach, the Basset Creek Watershed Management Commission, City of Minneapolis Public Works and Community Planning and Economic Development Departments, and the Minneapolis Park and Recreation Board worked together to strategize regional solutions to integrate floodplain and stormwater management into the Bassett Creek Valley to facilitate redevelopment. This group is collectively known as the Partners.

1.2 PURPOSE AND SCOPE

The purpose of the Bassett Creek Valley Floodplain and Stormwater Management Study is to integrate natural resources, recreation, and redevelopment into a regional solution that provides adequate floodplain storage and stormwater quality treatment to support the redevelopment of the Bassett Creek Valley Development Area and bring regional amenities to the area.

The scope of the study included establishing guidelines, quantifying floodplain and water quality needs to meet regulatory requirements for redevelopment areas, and the development of siting analyses for key project locations, conceptual designs, cost estimates, implementation timeline, construction constraints, and funding opportunities.

1.3 STUDY AREA

The area of focus (Study Area) for the floodplain mitigation options extends through the Bassett Creek corridor between the creek crossing of Glenwood Avenue and I-94 to I-394 on the south and Glenwood Ave on the north and is approximately 300 acres. Bassett Creek Valley Area is similar to the Study Area but does not include the corridor area west of Cedar Lake Rd, it is approximately 230 acres. The Development Area is a smaller subset of Bassett Creek Valley and is bound by Cedar Lake Rd on the west, Van White Memorial Blvd on the east, 2nd Ave on the north and existing railroad tracks on the south and is approximately 60 acres. Bassett Creek is roughly 1.2 miles in length between Hwy 55 and the tunnel, which eventually discharges to the Mississippi River. See Figure 1-1 for the Study Area, Bassett Creek Valley, and the Development Area.

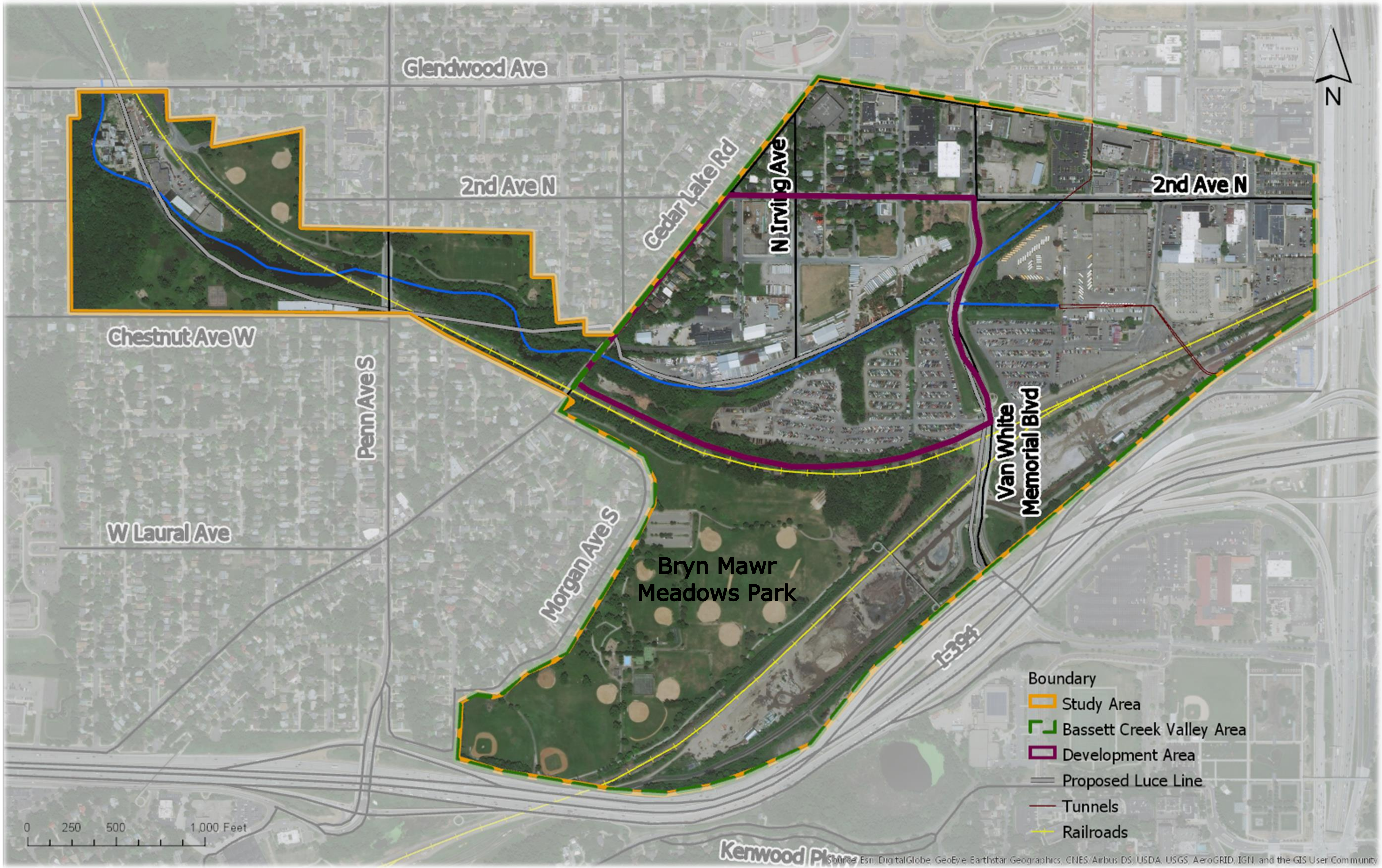

Figure 1-1. Study Area, Bassett Creek Valley Area, Development Area.

2.0 Site Conditions and Prior Studies

2.1 SITE CONDITIONS

Bassett Creek flows through the 230-acre Bassett Creek Valley, located just west of downtown Minneapolis and north of Interstate 394. Small area planning has been done with the Van White Station Area Plan for the Bottineau LRT line adopted in December 2018 and an earlier master plan adopted in 2007. The planning envisions redeveloping the area into commercial and flex space, multifamily housing and a linear park along Bassett Creek. As large tracts of land area owned by the City of Minneapolis, high quality redevelopment on those properties is viewed as catalytic for spurring more new investment. More information about the Van White Station Area Plan can be found at: http://www.minneapolismn.gov/cped/projects/vanwhitestationareaplan

2.2 PRIOR STUDIES, REPORTS AND PROJECTS

Various entities over the last few decades have undertaken studies and projects in the Bassett Creek Valley that centered around natural resources, transportation, redevelopment and environmental cleanup. The projects ranged from small, single parcel sites to regionally scaled plans.

The Bassett Creek Redevelopment Oversight Committee (ROC) was established by the City Council in 2000 and includes representatives from the Harrison and Bryn Mawr neighborhoods including business owners and residents, and City Council Member and Mayoral appointments. ROC directed the development of the Master Plan and has continued to play a role in reviewing redevelopment projects and issues in the area.

Bassett Creek Watershed Management Commission (BCWMC) has included streambank restoration projects, water quality basins in Bryn Mawr Meadows Park and wetland restoration projects in Bassett's Creek park as part of its Capital Improvement Program (CIP). In addition to the CIP plan, BCWMC is currently updating their Hydrology and Hydraulic XP-SWMM model, water quality P8 model, has continuous water monitoring of Bassett Creek at Irving Ave and completed a 2015 Watershed Management Plan.

The Minneapolis Parks and Recreation Board (MPRB) developed the Luce Line Regional Trail Master Plan and North Service Plan, which includes both Bryn Mawr Meadows Park and Bassett's Creek Park. These Master Plans provide direction for local and regional amenities such as trails, play areas, recreational sport fields and gathering places. The Luce Line Master Plan also provides details on necessary land acquisitions and potential funding sources.

City of Minneapolis Community Planning & Economic Development (CPED) has funded redevelopment studies within the Development Area. The Predevelopment Study (2018) reviewed area near Van White and 2nd Ave, including the portion of the impound lot west of Van White Memorial Boulevard that will be emptied of impounded vehicles and transferred to CPED for redevelopment. Constraints such as environmental contamination, geotechnical limitations of existing soils, existing utilities, and floodplain mitigation were identified. The Study also provided alternative site layouts that focused on maximizing development area, minimizing impacts and meeting BCMWC/City redevelopment requirements. The environmental studies have provided additional information regarding level and location of environmental contamination. The concept designs for the CPED study were informed by the following design principles and is shown in Figure 2-1.

- Ponds should be placed in areas directly adjacent to existing floodplain elevations to reduce soil impacts
- Prioritize density adjacent to roadways.
- Reduce significant excavation through known contamination areas.
- An elongated creek allows for more mitigation/storage.
- Parking structures would reduce surface parking needs.
- Buildings in the western portion of the impound lot should be multistory, of a height to rise above the Van White Memorial bridge structure.

The Predevelopment Study recommended proceeding using the following strategies:

- Start with Phase 1 - Creekside at Van White - a multistory commercial building with structured parking underneath (designed to allow flooding on occasion)
- Investigate potential 9-acre public green space and water feature south of Bassett Creek to leverage additional development on Impound West and 2nd Ave & Van White Blvd area parcels
- Explore transferring some property to another public agency in order to leverage federal and state environmental clean-up funding
- Work to secure more study funding to design creative ways to construct innovative ponds/creek enhancements that address pollution and flood mitigation
- Explore partnerships with public agencies and community stakeholders to address design, planning and implementation

Figure 2-1: Re-development Feasibility Study Concept Design

2.3 ONGOING SITE INVESTIGATIONS AND DEVELOPMENT

CPED has ongoing site investigation work underway, in the West Impound Lot. The evaluation is necessary to advance redevelopment of the area for buildings, utilities and stormwater/flood management and soil management planning. The investigation includes completing 50 test pits to evaluate upper soils, debris and contamination just south of Bassett Creek in the West Impound Lot. This investigation is anticipated to be completed by March 2020.

The City of Minneapolis Public Works (Surface Waters & Sewers) is currently reviewing layout options for replacement of the sanitary sewer line in the Irving Avenue area that bisects Bassett Creek Valley. This study may impact the potential location of floodplain storage.

Wellington Management, Inc -a private developer- recently completed and has additional projects planned in the area, including the LEEF properties. The LEEF properties are located in the northwestern portion of near Irving and 2nd Ave. A three-story office building was completed in early 2019, while a 100 unit affordable housing facility began construction in November 2019, to be completed in early 2021. Another, larger office building will be constructed in 2020 on an adjacent site south of Currie. These projects are located just north of the floodplain and are designed to meet BCWMC and City requirements.

2.4 DATA ACQUISITION FOR STUDY AREA

In addition to the above referenced information, the following data was acquired from partners and open sources and used as a basis for this study.

City of Minneapolis Public Works:

- GIS for municipal utilities
- XP-SWMM and supporting files (GIS, LiDAR, storm sewer info, pipesheds, etc.)
- GIS-based water quality model

Bassett Creek Watershed Management Commission:

- 2017 XP-SWMM Model and supporting files (GIS, LiDAR, storm sewer info, pipesheds, etc.)
- 2017 P8 Model and supporting files (GIS, LiDAR, storm sewer info, pipesheds, etc.)

CPED

- 2040 Land Use
- LRT Plans

Hennepin County

- Parcel data
- Areawide Groundwater Study

3.0 Regulations, Problems, Opportunities

3.1 DEVELOPMENT REQUIREMENTS

Development within the Bassett Creek Valley Development Area will need to meet City of Minneapolis and Bassett Creek Watershed Management Commission requirements for development and redevelopment. This study focused on the floodplain and stormwater runoff requirements of both entities.

3.1.1 Floodplain

Portions of the Study Area are considered part of the BCWMC trunk system and therefore under BCWMC jurisdiction. Other areas are under City of Minneapolis jurisdiction. Figure 3-1 is from the BCWMC H&H Analysis- Phase 2 XPSWMM Model Report, Figure 3-19 (Barr, 2017) and illustrates the different locations for jurisdictional boundaries within the study area.

Section 4.0 of BCWMC regulations deals with floodplain policy. Requirements that are relevant to this study are summarized below:

- BCWMC regulations apply to the floodplain of the Bassett Creek trunk system only.
- There shall be no net loss in floodplain storage and no increase in flood level along the trunk system.
- Land use cannot be damaged by floodwaters or increase flooding.
- The lowest floor elevation must be at least two-feet above the 100-year flood level.

The City of Minneapolis maintains a Floodplain Overlay Ordinance that regulates land use and development within the floodplain. The floodplain regulated under the City's ordinance include the Flood Insurance Study for Hennepin County, Minnesota, and the flood insurance rate map panels dated November 4, 2016. This ordinance establishes Floodway and Flood Fringe Districts and specifies allowable land uses and standards for conditional uses. The Regulatory Flood Elevation is established as one foot above the 100-year flood elevation. A limited amount of fill for purposes other than elevating a building above the regulatory flood elevation is allowed as a conditional use.

The City of Minneapolis does not reference the BCWMC jurisdictional flood elevations for the Bassett Creek trunk system. However, the City does have the ability to prescribe the BCWMC floodplain management regulations and adopted floodplain elevations during any development approval process.

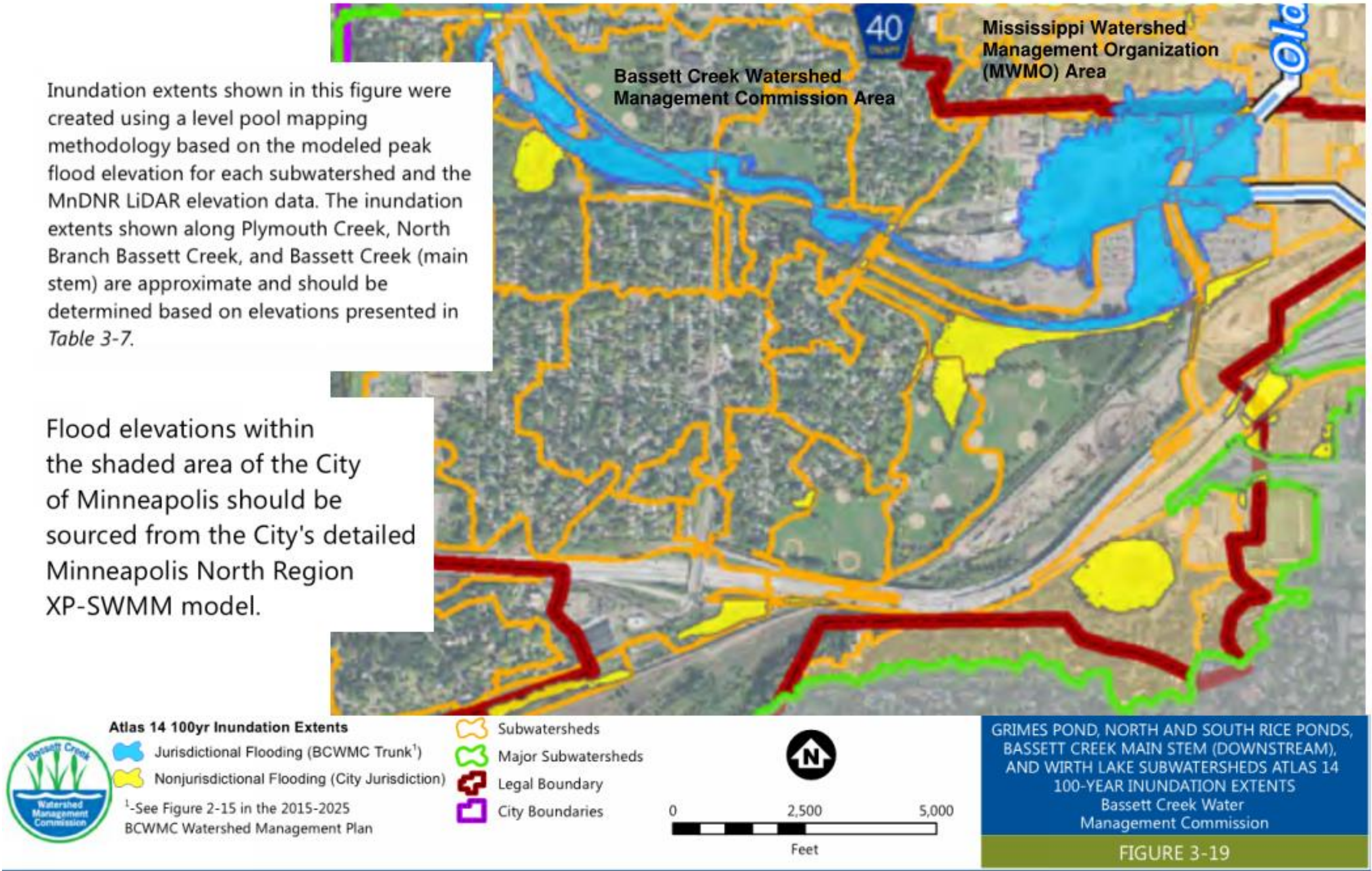

Figure 3-1. Jurisdictional and nonjurisdictional flooding.
Source: BCWMC H&H Analysis- Phase 2 XPSWMM Model Report, Figure 3-19.

3.1.2 Stormwater Runoff

Sections 5.0 and 6.0 of BCWMC regulations sets forth rate control and water quality requirements. Requirements that are relevant to this study are summarized below.

- Proposed peak flow rates leaving the site for the 2-, 10-, and 100-yr events must be equal or less to existing flow rates and use Atlas-14 precipitation values.
    - Trails and sidewalks and other miscellaneous disconnected impervious surfaces are exempt from BCWMC rate control policies.
- All stormwater must be treated in accordance to BCWMC performance goals or flexible treatment options if site constraints exist.
    - Full requirement (infiltrate 1.1-inch)
    - Flexible treatment option #1: 0.55-inch and 75% TP removal
    - Flexible treatment option #2: Volume reduction to the maximum extent practicable and 60% TP removal
    - Flexible treatment option #3: Off-site mitigation equivalent to the volume reduction performance goal

Contaminated soils and shallow groundwater are existing site constraints within the Project Area. Infiltration practices must maintain a three-foot separation from seasonally high groundwater.

City of Minneapolis Stormwater and Sanitary Sewer Guide Section 4.3.1.2 currently requires proposed peak flow rates leaving the site for the 2-, 10-, and 100-yr events to be equal or less than existing flow rates and must use MSE-3 rainfall distribution. Section 4.3.1.2 also requires development projects to provide 70% TSS removal from a 1.25-inch storm event.

Updates to City of Minneapolis stormwater requirements are expected to be approved in 2020 to align with recent permit and plan changes.

3.1.3 Other

Section 8.0 of BCWMC regulations requires any projects that involve streambank restorations or development directly adjacent to the Creek be consistent with City buffer rules and requirements. BCWMC does require member cities to maintain and enforce wetland and stream buffer requirements that are listed in Appendix B of the Requirements Document.

City of Minneapolis Shoreland Overlay District requirements specifies a minimum setback of 50 feet from the ordinary high water mark of any protected water.

3.2 PRIMARY DEVELOPMENT CONSTRAINTS

3.2.1 Floodplain

In 2017, the Bassett Creek Watershed Commission updated its XP-SWMM model, which established new flood elevations throughout the watershed. The model was revised to incorporate updated NOAA precipitation data (Atlas 14), topographic data and more detailed stormwater pond and pipe information. The update was done to protect structures from damaging floodwaters given increasing and changing precipitation patterns.

Because of higher precipitation amounts, the new flood elevations for Bassett Creek Valley are approximately two feet higher than previously calculated and resulted in an additional 25 acres (38% of the Development Area) subject to BCWMC floodplain policies. Figure 3-2 illustrates the updated flood elevations produced from the BCMWC XP-SWMM model.

BCMWC floodplain policy requires that lowest floor elevation of new buildings be two feet above the flood elevation. If properties are developed without a regional system, it is likely that the existing streets and sidewalks would remain at existing grade while buildings are required to build well above the existing grade to remain out of the floodplain. This disconnect between businesses and sidewalks/streets could lead to a development that is disjointed and lacks a feeling of community.

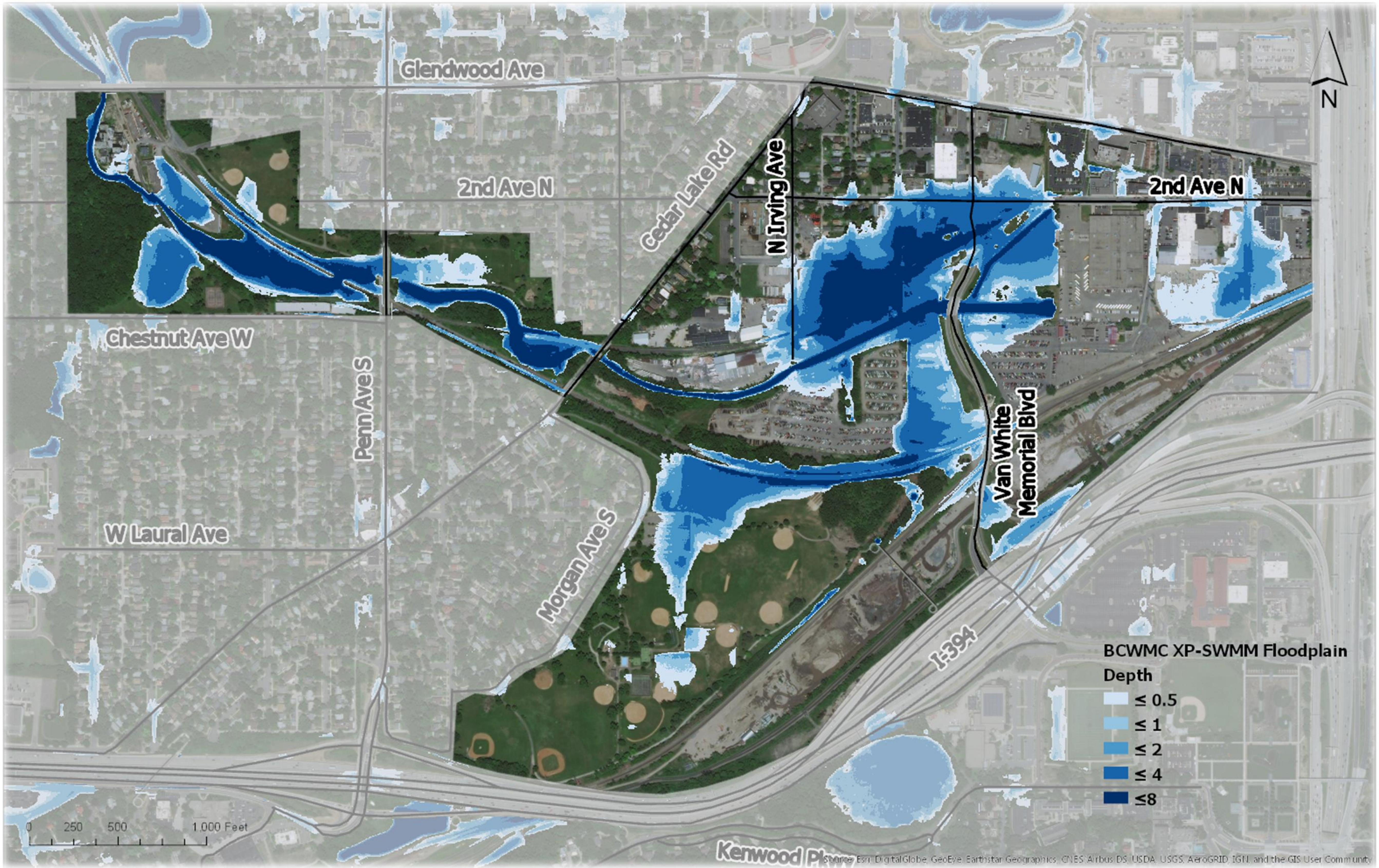

Figure 3-2. Floodplain location and depth within the Study Area.

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3.2.2 Contaminated Soils

Historical land uses in the Bassett Creek Valley Development Area included industrial operations for storage of bulk chemicals, petroleum, scrap metal operations and unpermitted dumping from the early 1900's through 2000. Significant contamination remains in the soil, groundwater, and soil vapor.

Planning efforts will need to consider potential clean-up requirements and the risk of further disseminating of contaminants during site activities. Contaminated soils may disqualify infiltration practices onsite and may require stormwater features to be lined. Figure 3-3 is from the 2006 Bassett Creek Valley Master Plan and illustrates locations of existing contamination.

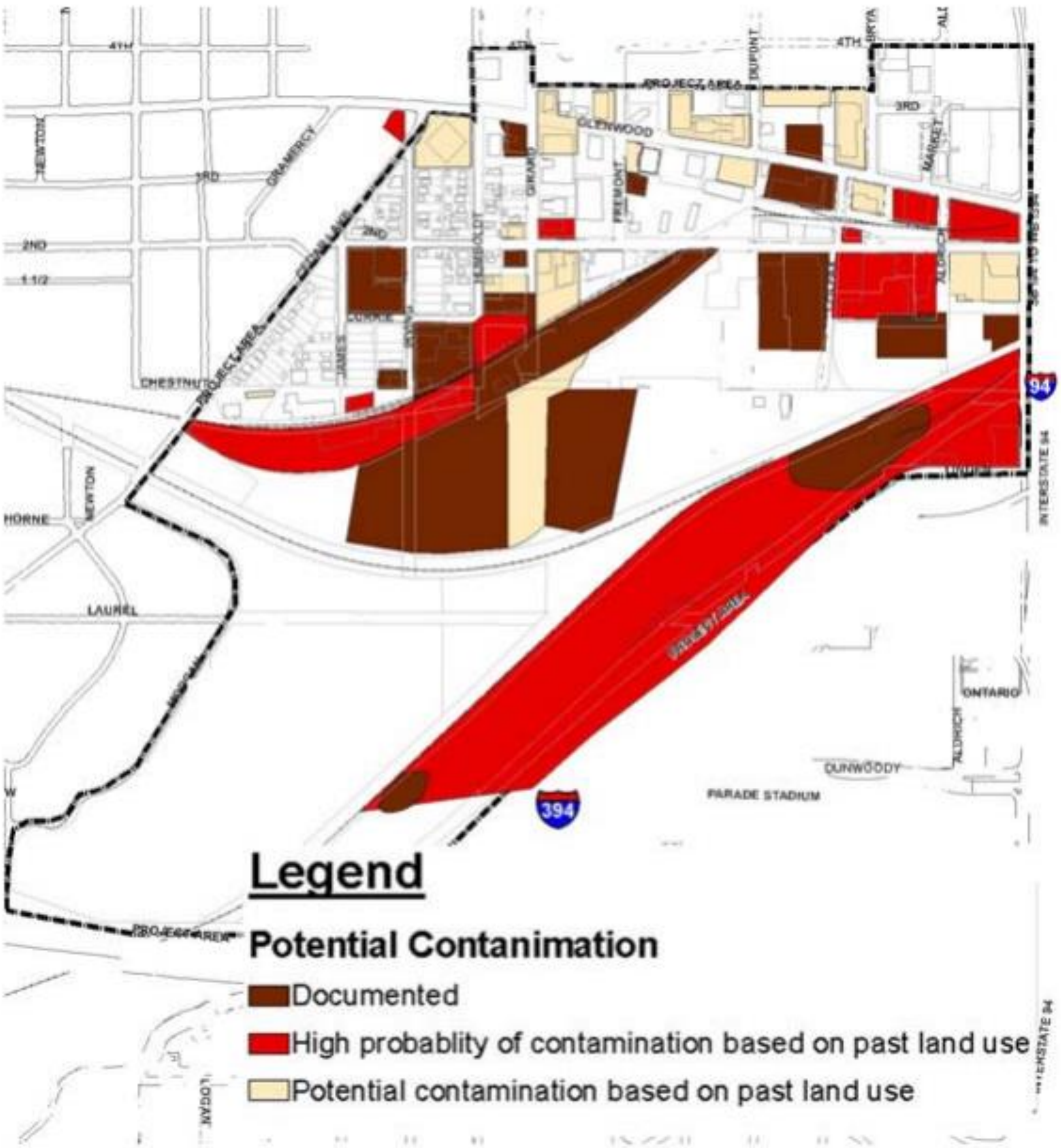

Figure 3-3. Contamination within the Bassett Creek Valley Development Area.

3.2.3 Groundwater

Shallow groundwater may restrict project types, locations and infiltration ability within Bassett Creek Valley. Figure 3-4 illustrates the depth to groundwater based on Minnesota Department of Health data. Most of the study area has groundwater within 10 feet of the surface.

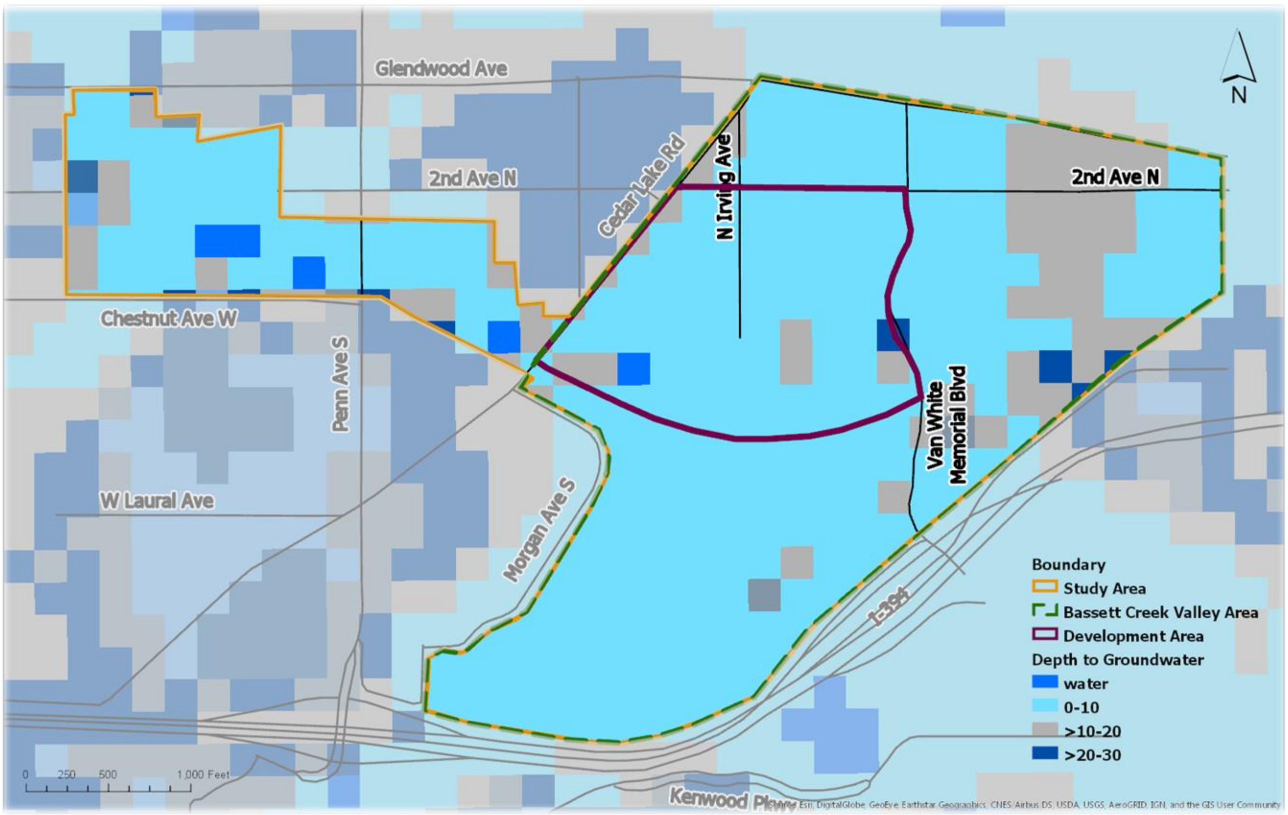

Figure 3-4. Minnesota Department of Health depth to groundwater.

3.2.4 Geotechnical Challenges

Geotechnical challenges are present in the entirety of Bassett Creek Valley due to soft soils extending to great depths overlain by dump fill. Raising the grade to comply with the two-foot flood elevation separation requirement could compress the soils and result in significant settlement.

Figure 3-5 from the Basset Creek Valley Master Plan shows generalized soil conditions and probable foundation types. Buildings will require deep foundation systems (piers/pilings) with a structural slab. Slab on grade or shallow foundations are not feasible due to excessive settlement. Paved areas will likely require more frequent maintenance due to settlement. One option is to reduce settlement by surcharging soil with successive layers of soil until it reaches a stable consolidated base. This process can take several years depending on the properties of the underlying soils.

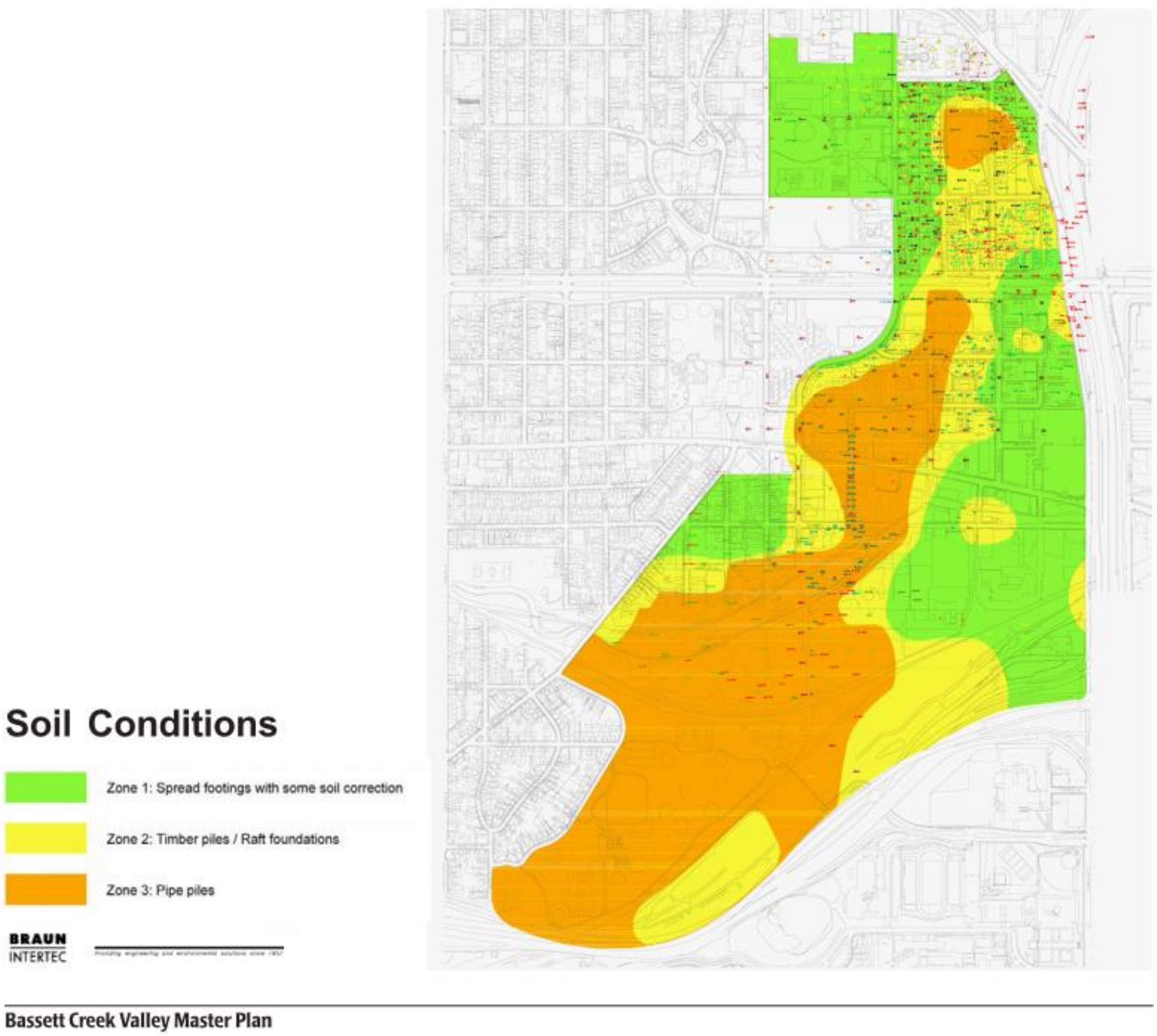

Figure 3-5. Probably foundation need based on soil type.

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3.2.5 Land Ownership

Land ownership within Bassett Creek Valley is a mix of public and private entities and ranges from residential to industrial and office space to rail systems. Parcel ownership was obtained from Hennepin County GIS, June 2019. Developing a regional solution requires cooperation with multiple property owners. Figure 3-6 illustrates land ownership in the Bassett Creek Valley. Areas not colored are privately owned parcels.

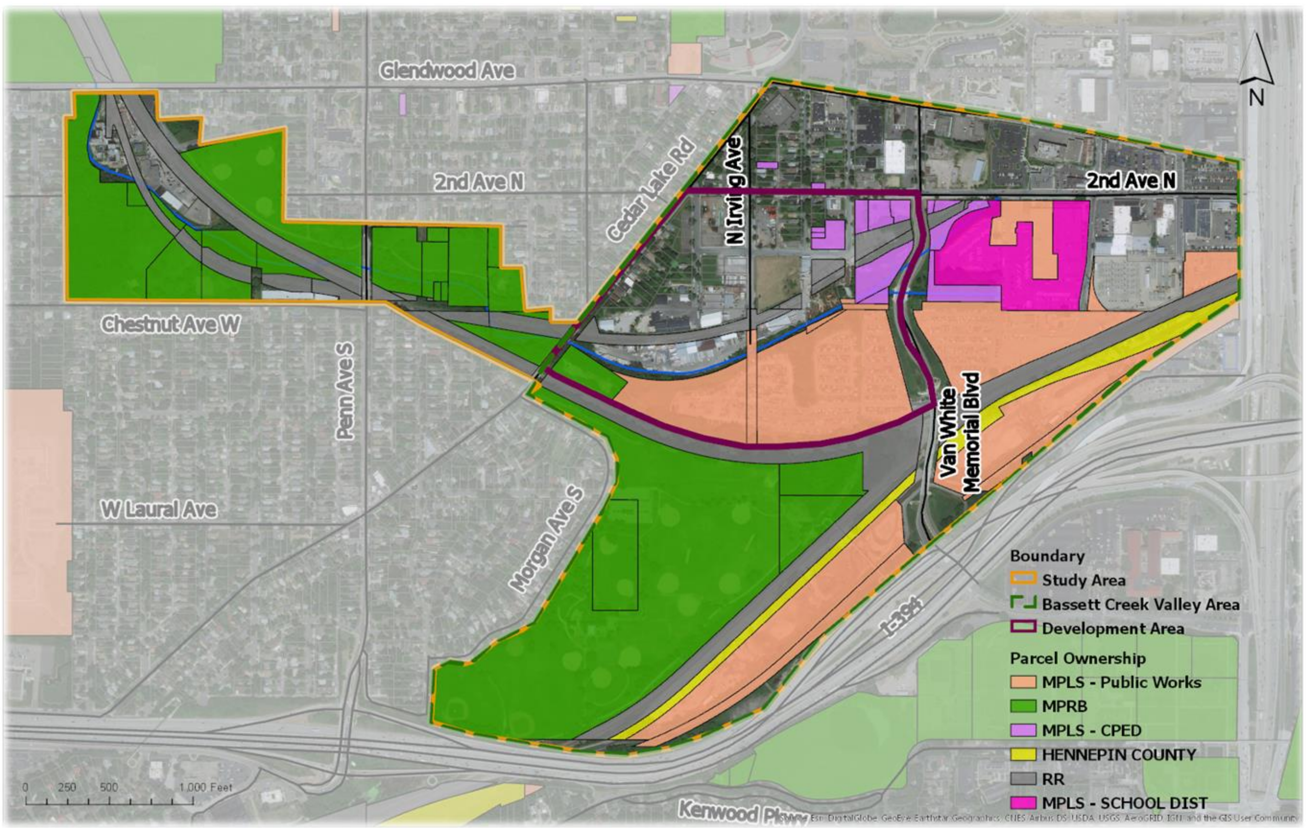

Figure 3-6. Parcel ownership.

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4.0 Goals, Objectives, and Scenarios

4.1 PLANNING OBJECTIVES

The Partners began the study process by reviewing the above information, known or potential development, capital project opportunities, and creating a Decision Matrix (Table 4-1). The Decision Matrix established factors that the Partners agreed were important considerations and could be used to compare design scenarios.

The scenarios consider various design options to take advantage of the existing site conditions and overcome or limit constraints to create opportunities for sustainable water resources management through comprehensive planning. This Regional Surface Water Management Plan strategy can maximize the built and natural environmental potential within the Bassett Creek Valley by layering natural, ecological and cultural resources with community amenities to create a destination corridor.

Table 4-1. Bassett Creek Valley decision matrix.

Factor	Definitions
Ecological and Additional Water Quality Benefits	1. Will it support habitat and a green corridor concept and connect already existing or proposed green spaces? 2. Does it provide additional water quality above regulatory compliance? i.e., does it assume 2040 Plan land use?
Regulatory Compliance	1. Scenario provides direct compliance with regulations or additional practices (BMPs) need to be installed to meet requirements (rate, WQ, flood)? 2. Can it be constructed prior to development and over time to mitigate floodplain fill?
Land Use and Stacked Benefit	1. Does it optimize land use (park land used as flood control; new creek XS with trails, platform overlooks)? 2. Does it remove parcels from floodplain for development?
Funding	1. Do projects allow for budgets associated with Partner Plans to be a potential funding source? 2. Could other entities/groups that would benefit from projects that could be leveraged for funding?
Cost	1. How does the ballpark capital cost compare to other potential projects? 2. Is parcel swapping or acquisitions needed?

4.2 ASSUMPTIONS AND LIMITATIONS

4.2.1 Assumptions

The scenarios were developed conceptually and do not represent a final design; the potential impacts and range of costs are estimated and comparable to each other. The underlying assumption is that all scenarios will comply with City/Watershed requirements and do not harm to the public. It is also assumed that projects specific to this Study would not be subjected to the “no net loss of storage” requirement if modeled results illustrate no increase in flood level but would require a variance and/or approval form the BCWMC. The approved BCMWC model must be used for flood analysis within the Bassett Creek trunk system.

4.2.2 Limitations and Exceptions of Existing and Proposed Models

Outputs from the City of Minneapolis's XP-SWMM model were reviewed as part of the floodplain analysis but was not used as part of the study. The City's XP-SWMM model and BCWMC XP-SWMM are at different scales which results in small variations in runoff values and peak elevations. The City model is scaled down to manholes and catch basins; the BCWMC model is scaled to larger storm sewer trunk lines. Since the BCWMC requires any projects within the trunk system to use their model, it was decided that the analysis proceed with only the BCWMC's XP-SWMM model. To understand the impacts of the project on the localize drainage network, the City of Minneapolis's H&H model should be updated to include projects proposed within Bassett Creek Valley.

The 100-year storm event (equivalent to 7.4 inches in a 24-hour period) was the only model run for this study. To determine the impacts on project for smaller storm events, additional modeling efforts will be required. However, discussion below includes anticipated impacts to the scenarios under smaller storm events.

4.3 OVERVIEW OF SCENARIO DEVELOPMENT

Several brainstorming sessions and design charettes were held with the Partners to discuss project locations, existing and future plans, amenities of interest and project types. Bassett Creek Valley Design Charette meeting minutes (Appendix A) provide details of these brainstorming sessions. The steps below summarize how information from these sessions and data acquired for the project was used to determine final project location.

Step 1: Identified areas of interest based on parcel data.
Step 2: Establish baseline conditions - reviewed existing regional and local drainage areas influences on regulatory floodplain.
Step 3: Siting analysis - overlaid areas of interest with highly influential drainage areas to determine potential project locations.
Step 4: Establish potential project scenarios - determined the influence of proposed project scenarios on flood elevations.

4.4 STEP 1: AREAS OF INTEREST

The first step of the process was to identify areas of interest by locating parcels owned by partners, parcels that may offer land swapping opportunities, and parcels where land use was predicted to change based on the 2040 Plan. Potential land use change between current land use and the 2040 Plan indicated that redevelopment is likely to occur and therefore stormwater management could be integrated into the design. Locations that meet one or more of these criteria are presented in Figure 4-1.

Figure 4-1. Potential project locations based on various parcel information.

4.5 STEP 2: ESTABLISH BASELINE CONDITIONS

The second step in the scenario development process was to establish the baseline condition for flood extent, elevation, volume and runoff routing in the Bassett Creek Valley Development Area. The BCWMC XP-SWMM model discussed in Section 3.1 (used to establish the flood elevations) was also used as the baseline conditions model for this study. Since the start of this study, the BCWMC XP-SWMM model has been updated but is not reflected in the XP-SWMM model used for this study. The updated model is currently undergoing review by the Minnesota Department of Natural Resources (DNR) as part of a state-wide FEMA floodplain review. After the model is approved by the DNR, it will be submitted to FEMA. Once FEMA updates the flood insurance rate maps, the modeled flood elevations will be recognized as the regulatory flood elevation. It is anticipated that future work within the Bassett Creek Valley will utilize the current XP-SWMM model available from the BCWMC. All elevations in the report reference the NAVD 88 datum.

The baseline conditions helped to determine the influences of regional and local drainage areas on the floodplain within the Development Area. The regional drainage area was defined as land upstream of Hwy 55 that drains to Bassett Creek, and encompasses over 20,000 acres. The local drainage area includes land that drains to Bassett Creek downstream of Hwy 55 and upstream of the tunnel entrance. It is approximately 900 acres in size and is shown in Figure 4-3.

The model indicates that the local drainage area has a significantly larger influence on the flood elevation than the regional drainage area. The local drainage enters the creek rapidly, producing the peak elevation of 811.1 feet at Irving Avenue. Regional drainage enters this location about 10 hours later and results in a flood elevation of 809.1 feet at Irving Avenue. This is illustrated by the hydrograph (river stage versus time) in Figure 4-2. Figure 4-2 also illustrates that the peak flood elevation occurs for only a few hours. The short flooding time allows significantly more opportunities for floodplain mitigation than if the peak flood elevation lasted for multiple days.

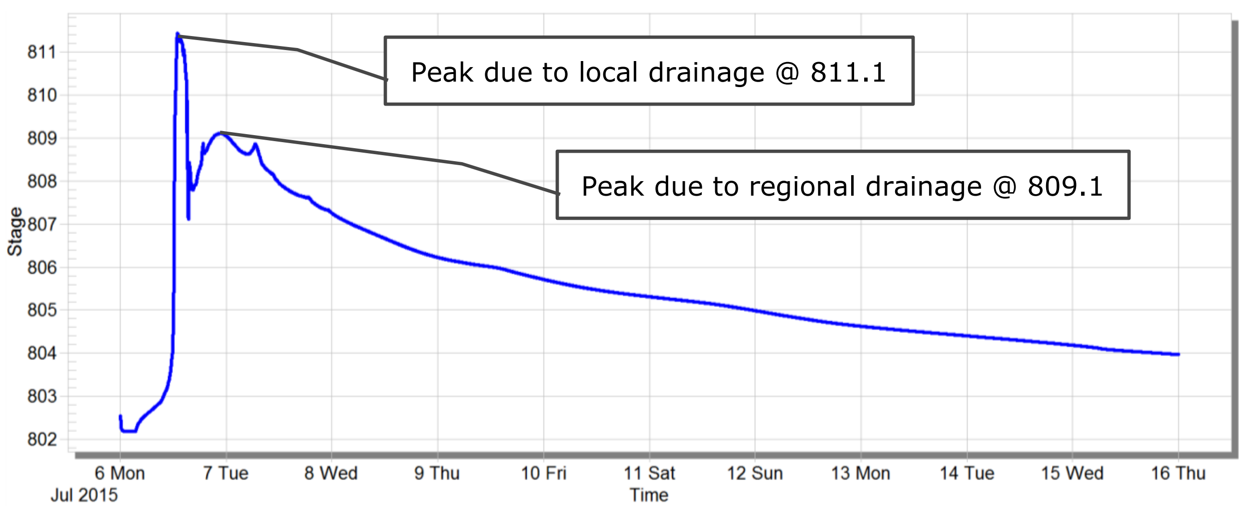

Figure 4-2. Local and regional drainage influence on floodplain elevation at Irving Avenue.

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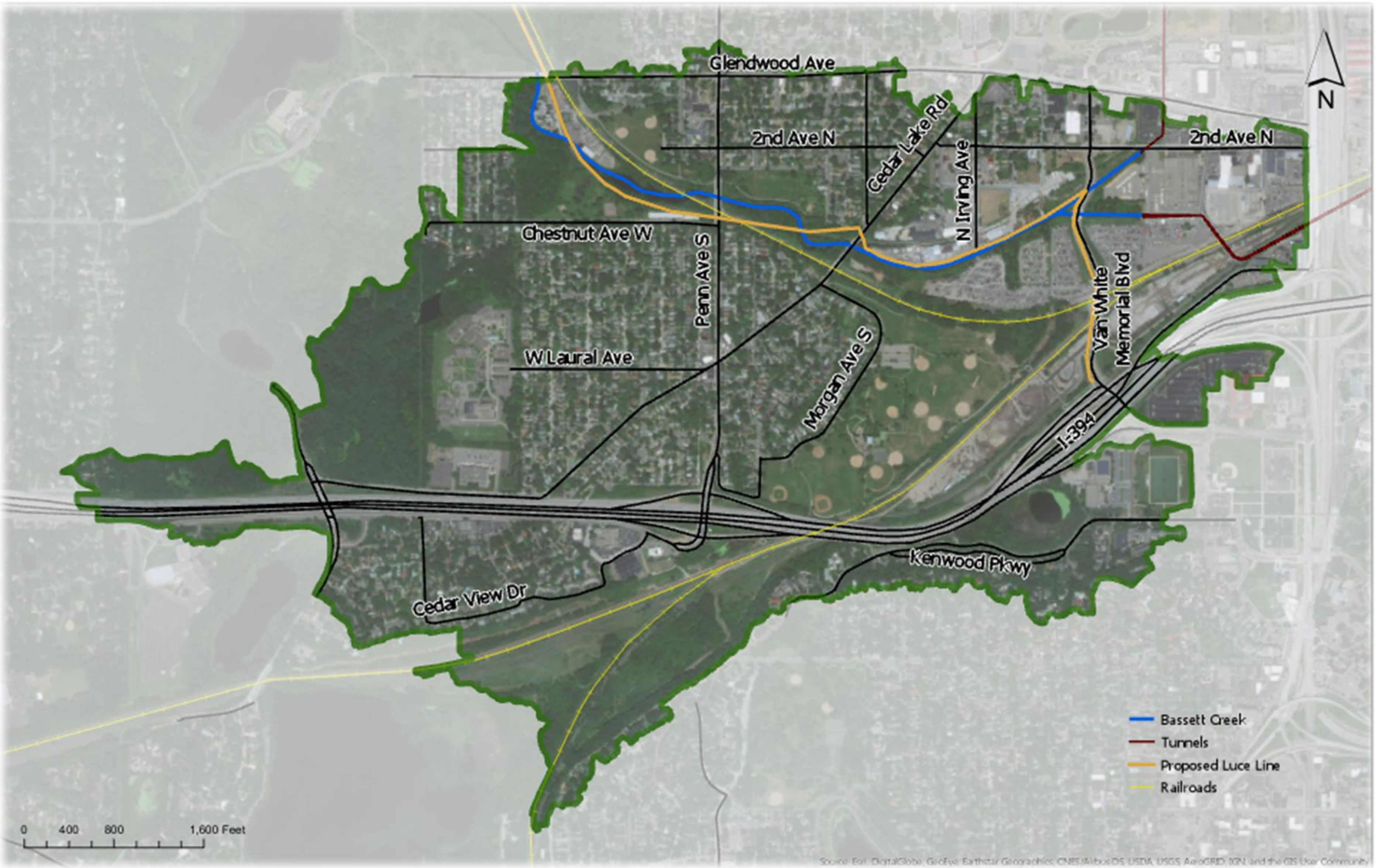

Figure 4-3. Local drainage area.

Once it was established that the local drainage area had higher influence on the flood elevation in the Bassett Creek Valley Development Area, an in-depth review of how the City's storm sewer network and overland flow influences specific drainage points at the Creek was completed.

Figure 4-4 illustrates the influence of smaller storm sewer drainage areas within the local drainage area on the flood elevation. The arrows indicate where storm sewer pipes and overland flow generally enter Bassett Creek. To estimate the impact of runoff from these smaller drainage areas on the flood elevation, the model was run assuming there was no flow contributing from them. The depth presented indicates how much the flood elevation at Irving Avenue would be lowered without that flow. For example, if there was no flow contributed from the north development area, the flood elevation would be 0.4 feet lower. Based on this analysis, flows from the south, including the I-394 corridor, had the largest influence on the water surface elevation at Irving Avenue.

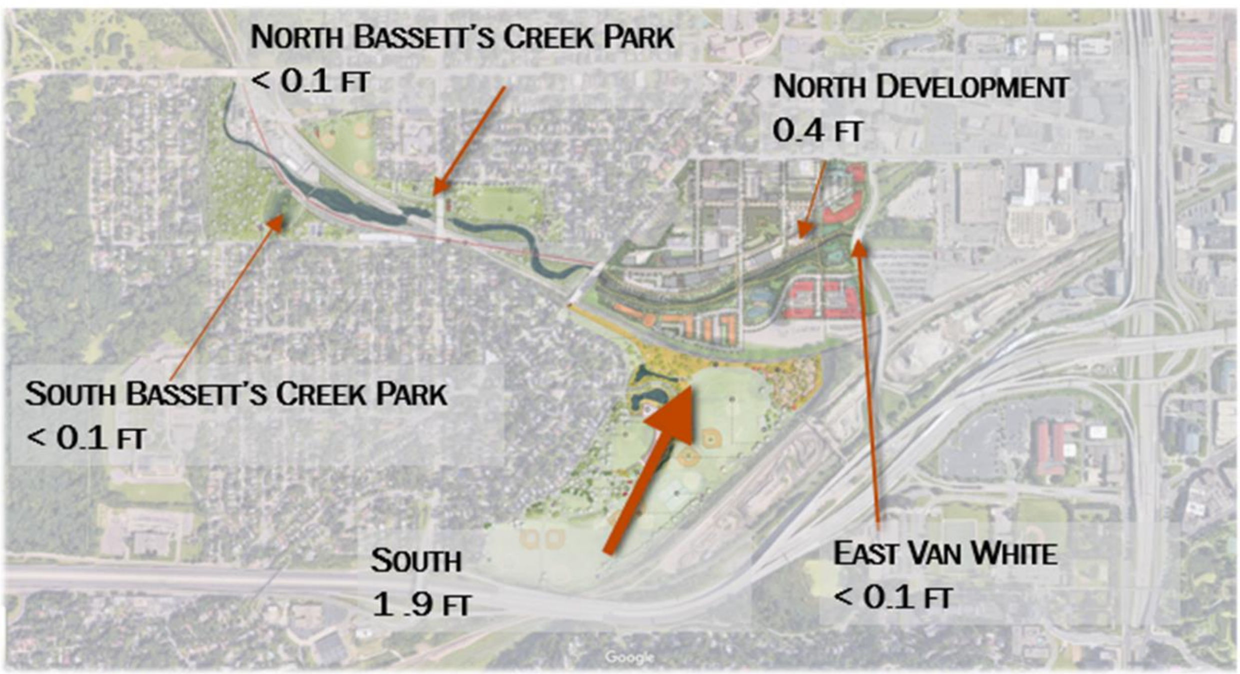

Figure 4-4. Local drainage influence on floodplain elevation at Irving Avenue.

4.6 STEP 3: SITING ANALYSIS (POTENTIAL PROJECT LOCATIONS)

Step 3 used the results from the first two steps to determine potential project locations. These sites were then reviewed for other site constraints present that would impact scenario options. Site constraints included topography that would prevent water from being routed to a project location, wetland impacts, and development that was already under or soon to be constructed. Areas of interest identified in Step 1 were either eliminated in Step 3 or kept for further review in Step 4.

4.6.1 Project Locations Eliminated

Figure 4-5 shows the locations of areas eliminated based on the overlapping potential or existing site constraints listed above. These options could be considered for alternative water quality project sites.

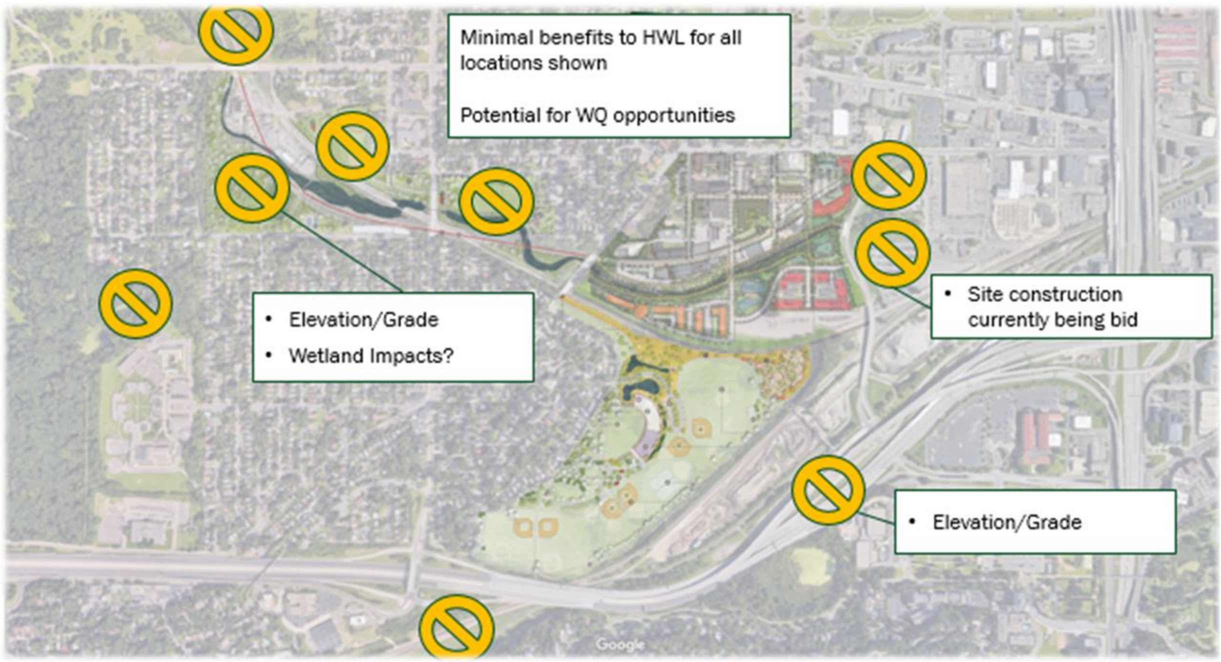

Figure 4-5. Project locations eliminated for flood projects.

4.6.2 Project Locations Further Reviewed

Two main areas were identified for further review: Bassett Creek corridor in the Bassett Creek Valley Development Area and Bryn Mawr Meadows Park (Figure 4-6). These project locations have an ability to store water, could be integrated into future construction plans and had significant influences on reducing the flood elevation in Bassett Creek Valley Development Area.

Figure 4-6. Project locations kept for further evaluation.

4.7 STEP 4: ESTABLISH POTENTIAL PROJECT SCENARIOS

Step 4 further evaluated project opportunities in Bassett Creek corridor and Bryn Mawr Meadows Park as identified in Step 3. Project scenarios included either surface storage, underground storage or expansion of Bassett Creek channel top width between Cedar Lake Road and Van White Blvd. Table 4-2 provides an overview of the scenarios and are discussed in detail below. Each scenario is presented under four different conditions to understand the influences of the designs on the landscape. The baseline and conditions include:

1. Existing land use (baseline)
2. Land use that reflects approved MPRB Master Plans and CPED Concept plan
3. Proposed scenario during the
    - 2-year storm event (2.9 inches of rainfall in 24 hours) for projects within Bryn Mawr Meadows Park.
    - 10-year storm event (4.9 inches of rainfall in 24 hours)) for projects within Bassett Creek Development Area
4. Proposed scenario during the 100-year storm event (7.4 inches of rainfall in 24 hours))

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Table 4-2. Scenario Overview.

Scenario	Location	Storage Description
1	Bryn Mawr Meadows Park	Underground
2	Bryn Mawr Meadows Park	Surface
3	Bryn Mawr Meadows Park	Underground +Surface
4	Development Area	Creek Expansion to 150 feet top width
5	Development Area	Creek Expansion to 235 feet top width
6	Development Area	Creek Expansion to 280 feet top width
7	Bryn Mawr Meadows Park & Development Area	Surface and Creek Expansion to top width of 235 feet

The proposed scenario models revised the storage and/or routing of existing XP-SWMM parameters within the Study Area to determine the influence on flood elevation and extent within Bassett Creek Valley. All other model inputs match existing conditions inputs. See Appendix B for details related to the proposed scenario models. Downstream of Irving Avenue, the established Bassett Creek flood elevation is 811.1 feet. The flood waters cover approximately 24.0 acres or 40% of the Development Area.

A summary of the scenarios impacts to the floodplain is provided in Section 4.7.6. Also presented in the summary is the anticipated interaction between the proposed Scenarios and BCWMC CIP projects: water quality basins in Bryn Mawr Meadows and reducing erosion and streambank stabilization along the Bassett Creek corridor.

4.7.1 Scenario 1: Underground Storage in Bryn Mawr Meadows Park.

Scenario 1 Setup Scenario 1 integrates subsurface storage beneath athletic fields in Bryn Mawr Meadows Park. Figure 4-7 shows the 8.5-acre footprint of the underground storage system and has a depth of 5.75 feet The scenario would route flow from storm sewer pipes and surface runoff from south and west of the park into the underground storage prior to discharging to Bassett Creek; flow is illustrated by blue arrows in the figures. The area south and west of the park overlaps the 45.1 acres directed to BCWMC CIP water quality basins in Bryn Mawr Meadows. See Figure 4-3 in the BCWMC Bryn Mawr Meadows Feasibility Study (Barr, 2019) for the area. See Section 4.7.6 for details on the anticipated interaction between the proposed scenario and BCWMC CIP water quality basins project in Bryn Mawr Meadows. The underground storage could provide both water quality treatment and the option for water reuse through irrigation or integrated into the proposed splash pad. Special treatment would be required for water reuse that will result in human contact.

All rainfall events would be directed to the system with the goal of having no impacts to surface activities, even during the 100-year flood. To ensure the best use of MPRB park space, the scenario would require the installation of planned athletic fields at the time the underground storage was constructed and would allow MPRB funding to be focused on other aspects of the Master Plan and complete full reconstruction of the park sooner.

Scenario 1 Results Scenario 1 retains 50 AF of runoff volume during the 100-year storm event from the drainage area south of Bassett Creek. This results in an updated flood elevation of 810.3 feet, or a reduction of 0.8 feet, and removes 30% of Bassett Creek Valley Development Area from the floodplain (16.9 acres, down from 24.0 acres). Figure 4-8 illustrates the difference between existing flood extent to Scenario 1 flood extent. As shown, Scenario 1 flood reductions do not remove full parcels from the floodplain but do remove area along the fringe. This change in floodplain extent does not provide a significant improvement of unlocking developable land in Bassett Creek Valley.

1. Existing land use

2. Proposed master plan land use; includes WQ Basins as part of BCWMC CIP plan

3. Proposed scenario under the 2-year storm event. Rainfall directed to underground system, no impacts to athletic fields.

4. Proposed scenario under 100-year storm event. Rainfall directed to underground system, no impacts to athletic fields.

Figure 4-7. Scenario 1: Underground storage in Bryn Mawr Meadows Park.

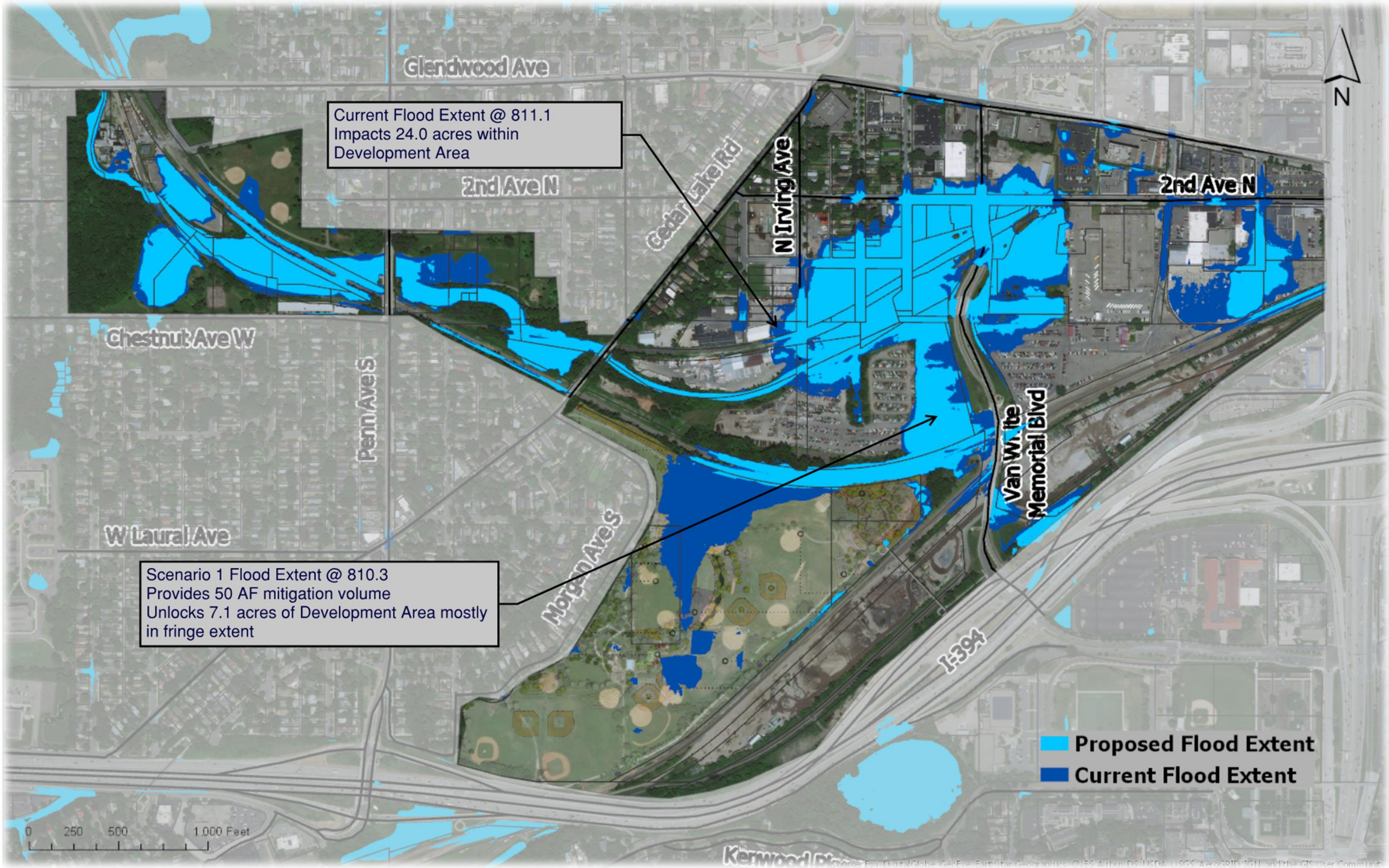


Figure 4-8. Updated flood extent for Scenario 1.

4.7.2 Scenario 2: Surface Storage in Bryn Mawr Meadows Park

Scenario 2 Setup Scenario 2 integrates surface storage at the athletic fields in Bryn Mawr Meadows Park. Figure 4-9 shows the 14-acre footprint of the surface storage system with a maximum depth of three feet. Surface runoff would only be routed to the system during events that produced greater than 2.9 -inches of rain in 24 hours, which is the event at which MPRB cancels games and would not use the athletic fields. Under larger rainfall events, runoff would pool at the surface but would drawdown within 24 hours to prevent damage to athletic field vegetation. The fields would need to be tiered to allow for storage over a large, linear area; the tiers would utilize existing grade to the maximum extent practical. See the cross section at the bottom of Figure 4-9 for illustration of Scenario 2 under the 2-year and 100-year storm events below.

Scenario 2 Results Scenario 2 retains 42 AF of runoff volume during the 100-year storm event from the drainage area south of Bassett Creek. This results in an updated flood elevation of 809.9 feet, or a reduction of 1.2 feet, and removes 34% of the Development Area from the floodplain (15.8 acres down from 24.0 acres). Figure 4-10 illustrates the difference between existing flood extent to Scenario 2 flood extent. Again, Scenario 2 flood reductions do not remove many full parcels from the floodplain but do remove area along the fringe. This change in floodplain extent does not provide a significant improvement of unlocking developable land in Bassett Creek Valley.

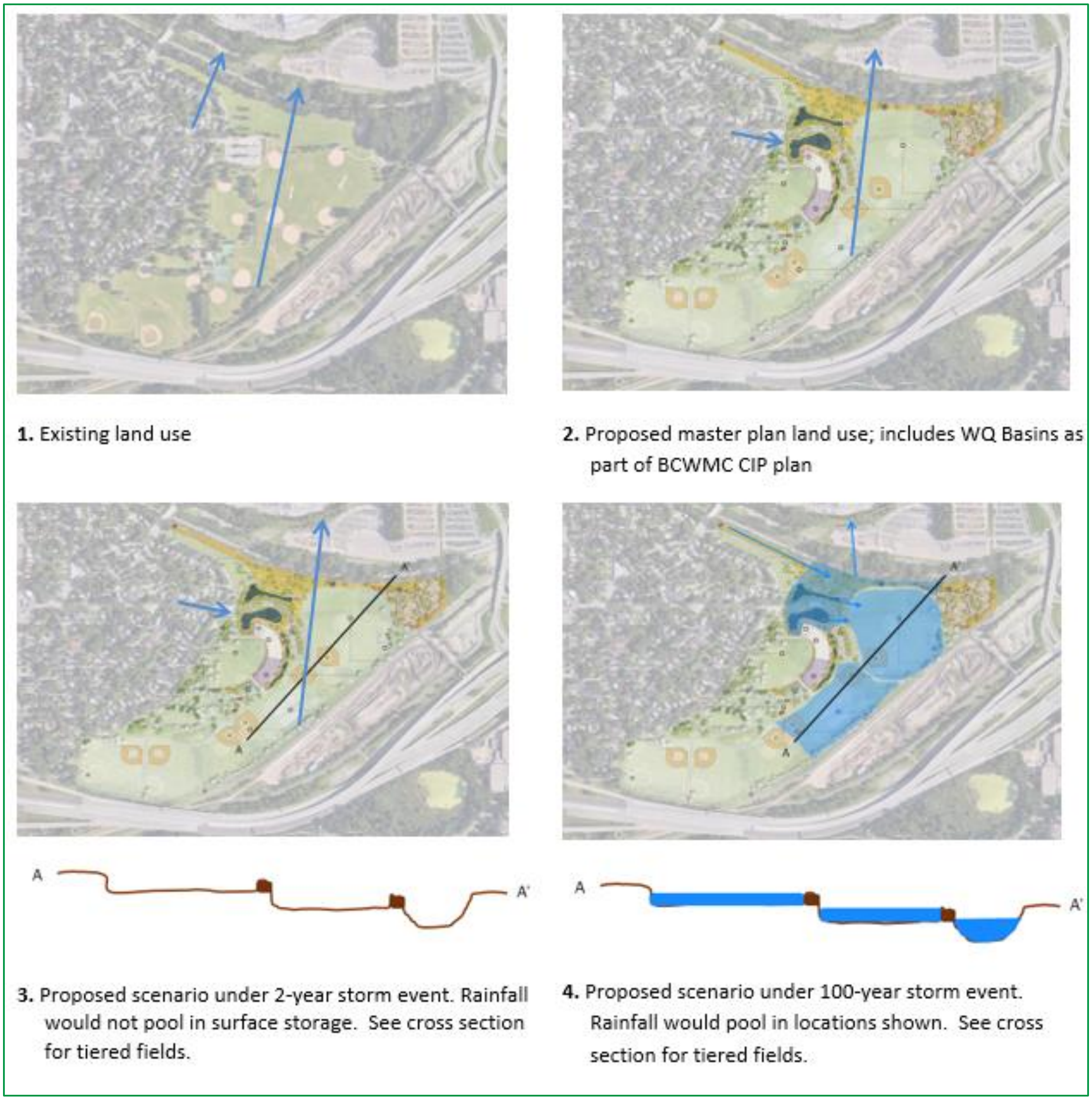


Figure 4-9. Scenario 2: Surface storage in Bryn Mawr Meadows Park.

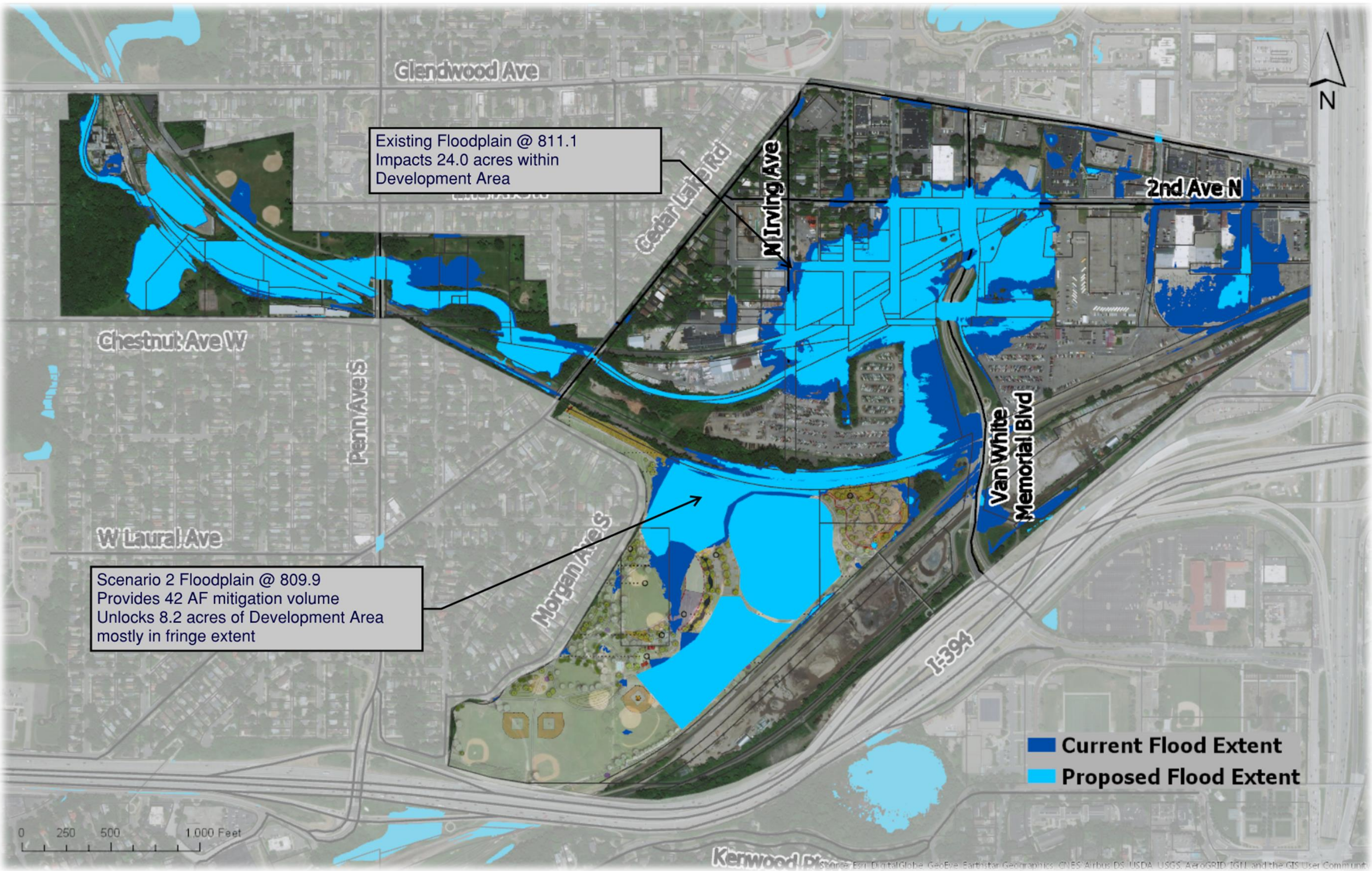


Figure 4-10. Updated flood extent for Scenario 2.

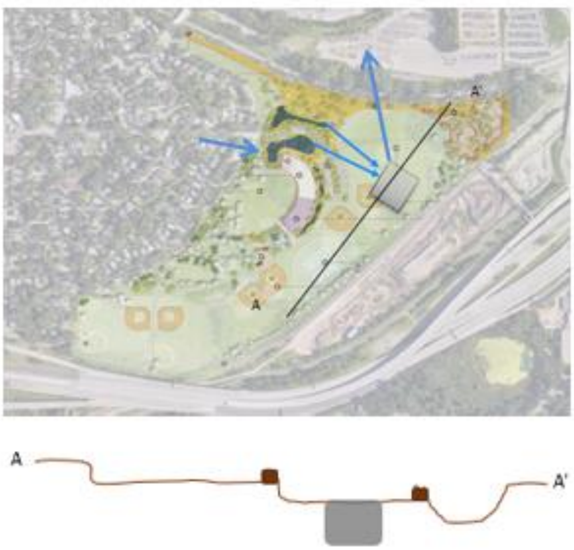
4.7.3 Scenario 3: Surface and Underground Storage in Bryn Mawr Meadows Park

Scenario 3 Setup Scenario 3 is a combination of subsurface and surface storage at the athletic fields in Bryn Mawr Meadows Park. Figure 4-11 shows the 8-acre footprint of surface storage (3-foot depth) and 3.6-acre footprint (5.75 feet) of the underground system. Similar to Scenario 2, the surface storage would only pool water from overland flow during large storm events and the athletic fields would be tiered. Runoff would be directed to the underground system under all rainfall events.

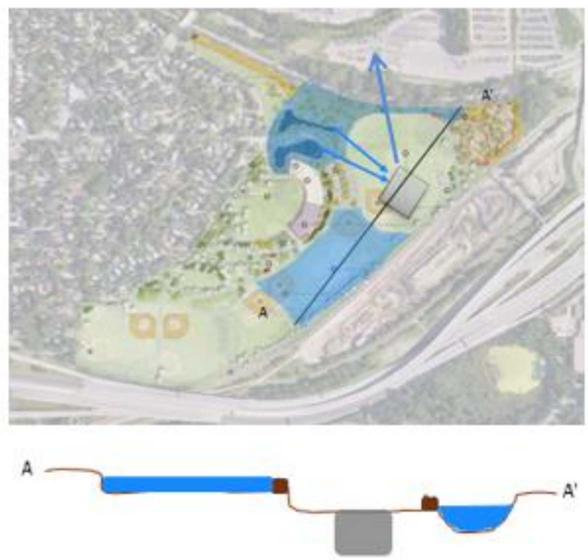
Scenario 3 Results Scenario 3 retains a total of 44 AF (21 AF of underground and 23 AF of surface storage) of runoff volume during the 100-year storm event from the drainage area south of Bassett Creek. This results in an updated flood elevation of 810.2 feet, or a reduction of 0.9 feet, and removes 31% of Bassett Creek Valley Development Area from the fringe of the floodplain (16.5 acres as compared to 24 acres). Figure 4-12 illustrates the difference between existing flood extent to Scenario 3 flood extent. As with Scenarios 1 and 2, Scenario 3 does not remove many full parcels from the floodplain. This change in floodplain extent does not provide a significant improvement of unlocking developable land in Bassett Creek Valley.

1. Existing land use

2. Proposed master plan land use; includes WQ Basins as part of BCWMC CIP plan



3. Proposed scenario under 2-year storm event. Rainfall would not pool in surface storage but would be directed to underground storage. See cross section for tiered fields.



4. Proposed scenario under 100-year storm event. Rainfall would pool in surface storage and be directed to underground storage. See cross section for tiered fields.

Figure 4-11. Scenario 3: Combination storage in Bryn Mawr Meadows Park.

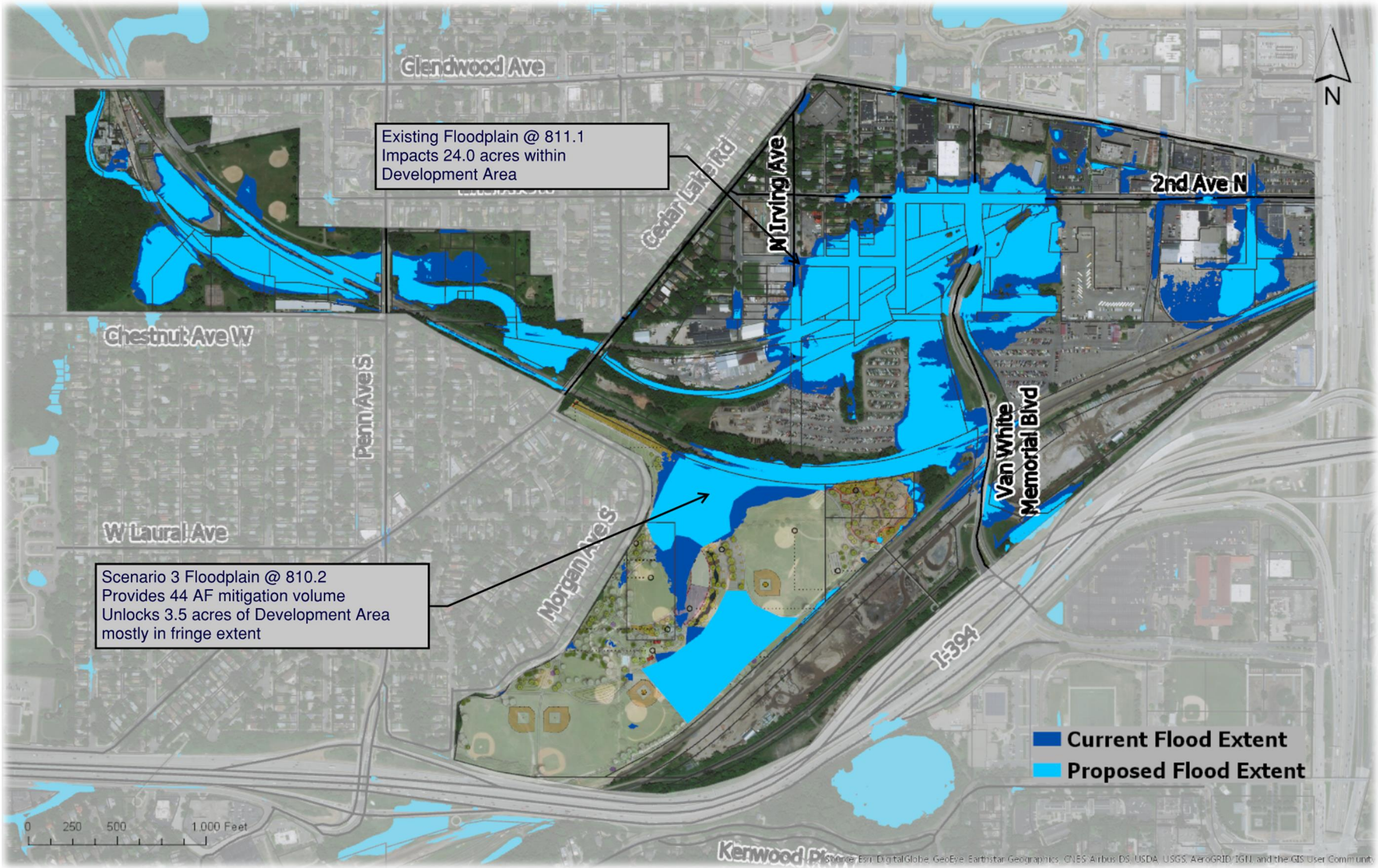


Figure 4-12. Updated flood extent for Scenario 3.

4.7.4 Scenarios 4, 5 and 6: Bassett Creek Corridor

Scenarios 4-6 Setup These Scenarios involve enlarging the Bassett Creek channel cross section between Cedar Lake Rd and Van White Blvd. The current top width of the channel is approximately 40 feet wide but does not contain the floodplain. The updated cross section was modeled to be tiered with a channel to contain storm events equal to or less than the 10-year storm event, and a floodplain bench where a new Luce Line trail could be constructed. During the 100-year event, the floodplain would be contained within the channel and submerge the trails.

Figure 4-13 provides one example of a cross section design and illustrates what was used in the model. However, as long as the volume provided in the cross section is maintained and connected to the floodplain, the proposed cross section can be manipulated to include braided channels, online or offline basins, trails on both sides and other amenities. The modeled cross section has a wider bottom then in existing conditions during normal flow but a final design could include a refined channel configuration to match existing conditions during normal flow and the 2-year storm event. Due to the short flood duration, the terrace would be designed to be flooded for less than 24-hours.

- Scenario 4 would expand the top width of the channel to about 150 feet from Cedar Lake Rd to Van White Blvd.
- Scenario 5 would expand the top width of the channel to about 150 feet between Cedar Lake Rd and Irving Avenue and to 235 feet from Irving Avenue to Van White Boulevard.
- Scenario 6 to would expand the top width of the channel to about 150 feet between Cedar Lake Rd and Irving Avenue and to 280 feet from Irving Avenue to Van White Boulevard.

The distance from Cedar Lake Rd to Irving Ave is approximately 1,100 feet and the distance from Irving Ave to Van White Blvd is approximately 900 feet for a total length of 2,000 feet.

Scenarios 4-6 Results are summarized in Table 4-3 below and illustrate as the channel storage increases, the flood elevation is reduced. However, the larger cross sections have a greater top width which uses more of the Development Area land and therefore removes less of the existing floodplain. Scenarios 4-6 were designed to strategically relocated the floodplain into the proposed Bassett Creek channel to remove numerous parcels from the floodplain.

Table 4-3. Bassett Creek corridor Scenario results.

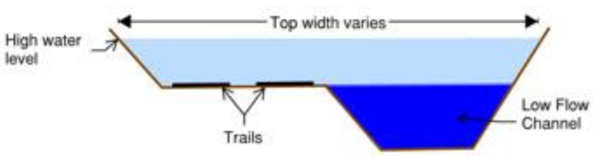
Scenario	Average Top Width (ft)	Mitigation Storage Provided (AF)	Flood Elevation (ft)	Surface Area Floodplain (ac)[1]	Floodplain Removal (%)
4	150	34	811.1	6.9	71
5	235	48	810.3	8.8	63
6	280	62	809.9	10.0	58

[1] Surface area within Bassett Creek Valley Development Area

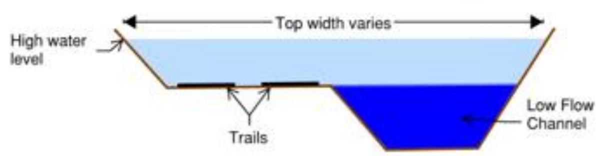
Figure 4-15 illustrates top width (flood extent) associated with Scenario 5. As indicated, flood waters are contained within the updated channel cross section between Cedar Lake Rd and Van White Blvd and also removes flooding from Bryn Mawr Meadows Park. Scenarios 4 and 6 flood extents scale to the top width noted in Table 4-4 but are similar to the extent shown in Figure 4-15 for Scenario 5.

Existing land use

Predevelopment Study Concept Design



Proposed scenario under the 10-year storm event. Water would remain in low flow channel with trails accessible. See cross section for tiered creek cross section.



Proposed scenario under 100-year storm event. Flood would use entire channel, submerging trails.

Figure 4-13. Scenarios 4-6: Creek expansion.

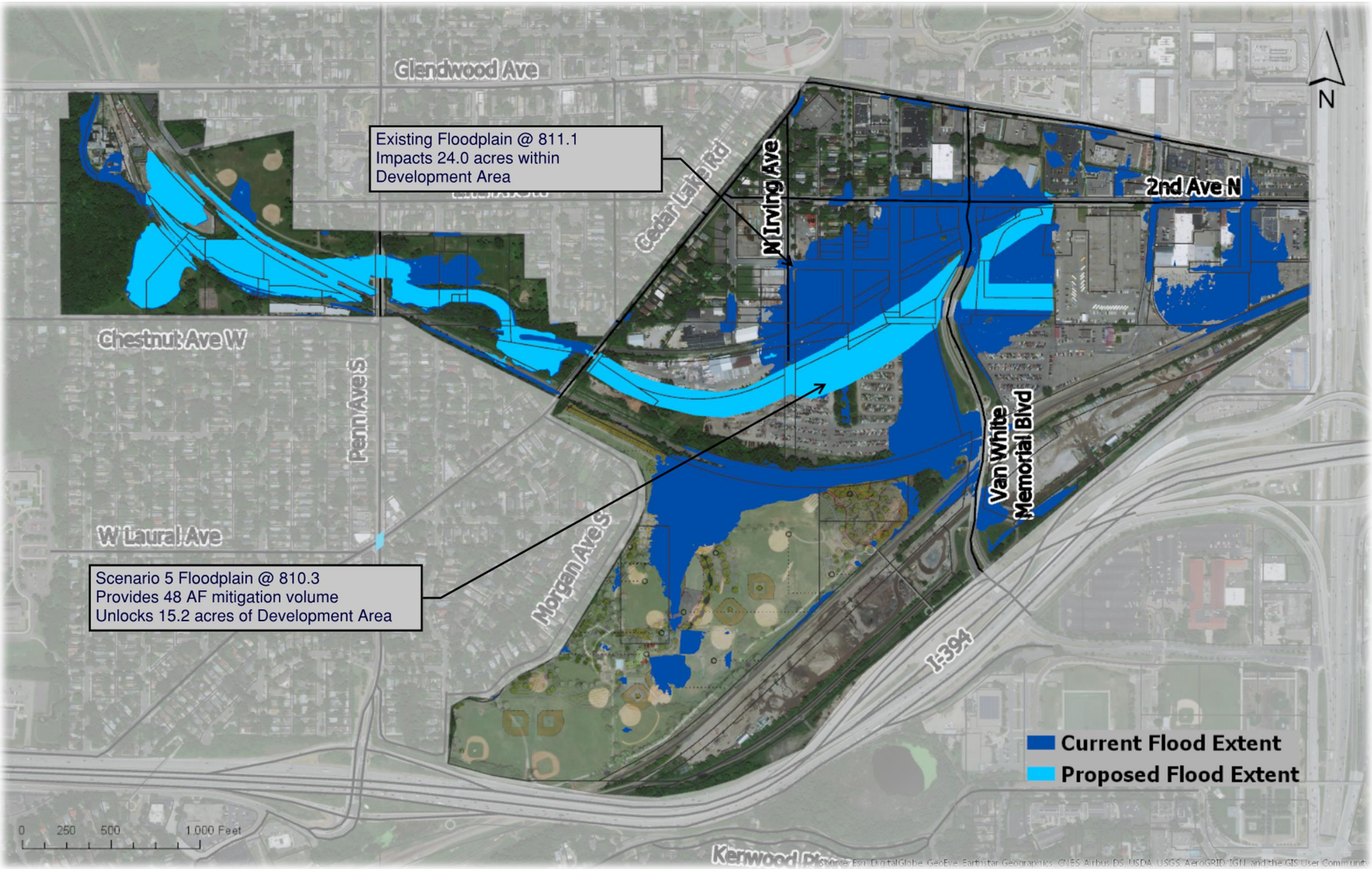


Figure 4-14. Updated flood extent for Scenario 5.

4.7.5 Scenario 7 Channel Expansion and Surface Storage in Bryn Mawr Meadows Park

Scenario 7 Setup This scenario combines surface storage from Scenario 2 with the expansion of the creek noted in Scenario 6 and is shown in Figure 4-15. The scenario is meant to illustrate how combining projects for both areas of interest can have additive impacts on reducing the flood elevation, relocate the flood extent, and potentially provide amenities that a single project area could not.

Scenario 7 Results Scenario 7 retains 105 AF of runoff volume during the 100-year storm event from the drainage area south of Bassett Creek and within the Creek itself. This results in an updated flood elevation of 809.0 feet, or a reduction of 2.1 feet, and removes 63% of Bassett Creek Valley Development Area from the floodplain, or 15.0 AF. Figure 4-16 illustrates the difference between existing flood extent and Scenario 7 flood extent.

1. Existing land use

2. Master Plan & Predevelopment Study Concept Design

3. Proposed scenario under the 10-year storm event. Water would remain in low flow channel with trails accessible. No pooling within athletic fields.

4. Proposed scenario under 100-year storm event. Flood would use entire channel, submerging trails and use surface storage in Bryn Mawr Meadows Park.

Figure 4-15. Scenario 7: Storage and creek expansion.

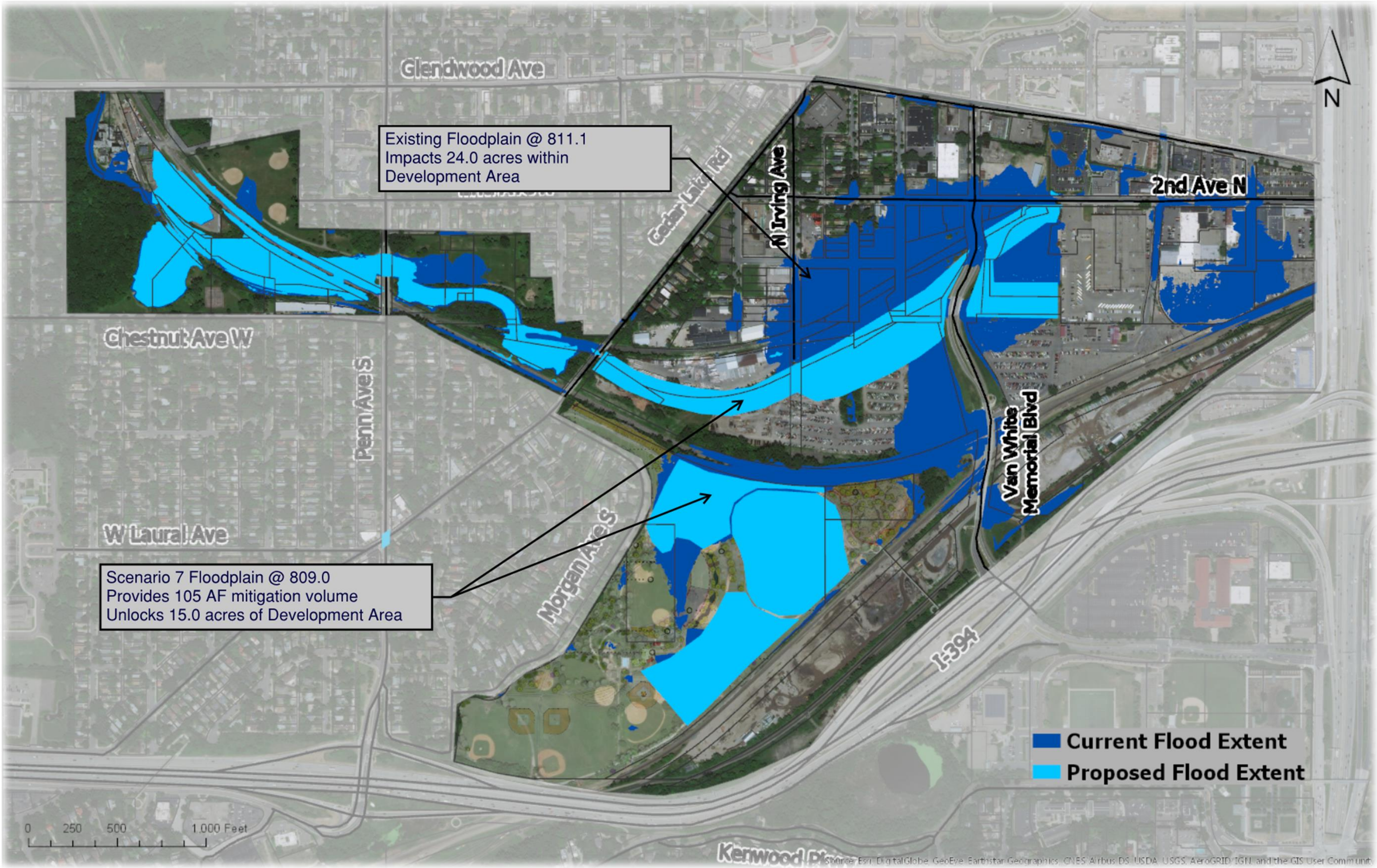


Figure 4-16: Flood extent for Scenario 7

4.7.6 Scenarios Summary

Table 4-4 provides a summary of the mitigation storage volume provided, flooded surface area within Bassett Creek Valley Development Area and the updated flood elevation downstream of Irving Ave as a result of the proposed scenario models.

Scenario 2 provides only surface storage in Bryn Mawr Meadows Park whereas Scenarios 1 and 3 provide less surface storage but includes underground storage for a greater total storage amount. Based on the proposed model, the larger the storage provided at the surface appears to have a greater influence on reducing the flood elevation at Irving Ave.

Scenarios 2 and 6 have the same flood elevation but have significantly different impacts on the proposed flood location. Scenario 6 involved relocating the floodplain to a precise location to unlock as many parcels in the Development Area as possible. Scenario 2 does reduce the flood extent and depth of flooding but doesn't necessarily unlock developable areas to a great extent.

Scenario 4 produces the smallest flood extent and keeps the floodplain within the proposed channel. However, the flood elevation still requires proposed structures in the area to be built up a few feet from existing ground elevation to meet the two-foot freeboard. This disconnect between businesses and sidewalks/streets could lead to a development that is disjointed and lacks a feeling of community.

Scenarios 5 and 7 have similar surface areas for the floodplain in the Development Area but the flood elevation for Scenario 7 is about one-foot lower. This is the result of combining storage in Bryn Mawr Meadows Park and expanding the creek. The storage in the park reduces the total runoff to the Creek during peak conditions which also requires less storage in the proposed cross section.

Table 4-4. Scenario influences on flooding at Irving Avenue.

Scenario	Storage Provided (AF) (1)	Surface Area Floodplain (ac)(2)	Reduction in Flooded Area (ac)	Flood Elevation (3)
Existing	-	24.0		811.1
1	50	16.9	7.1	810.3
2	42	15.8	8.2	809.9
3	44	16.5	7.5	810.2
4	34	6.9	17.1	810.7
5	48	8.8	15.2	810.3
6	62	10.0	14.0	809.9
7	105	9.0	15.0	809.0

1 For Scenarios 4-6, volume provided between Cedar Lake Rd and Van White Blvd in the channel

2 Surface area within Development Area

3 Flood elevation downstream of Irving Ave

BCWMC CIP plan includes projects for water quality improvement opportunities in Bryn Mawr Meadows Park and erosion control and stream bank improvements through Bassett Creek corridor. Scenarios 1 – 3 and 7 would potential enhance the BCWMC proposed water quality basins in Bryn Mawr Meadows Park. The Bryn Mawr Meadows Park Water Quality Feasibility Study (Barr, 2019) presented three scenarios. BCWMC has decided to move forward with the third scenario which diverts 45.1 acres from residential areas west of Bryn Mawr Meadows Park and treats low flow from Penn Pond and provides 5.4 AF of treatment.

As noted in the Water Quality Feasibility Study, consideration was given to direct all flows from Penn Pond and downstream of I-394 to the water quality basins but was determined to not be feasible (at the water quality study level) due to significant cost and necessary land consumption. The scenarios presented in this Study, which included a larger study level could provide additional treatment volume for the full flow from Penn Pond and downstream of I-394. The additional storage could be used as an overflow for the water quality basins or as a standalone system.

Scenarios 4-7 design includes improvements to the stream banks from Cedar Lake Rd and Van White Blvd and therefore, will reduce or control current erosion concerns.

4.8 WATER QUALITY

The BCWMC's P8 water quality model and City's GIS water quality model were reviewed to establish existing watershed sediment and phosphorus loading from regional and local drainage areas. Comparing regional versus local drainage areas, the local area accounts for less than 10% of the total phosphorus load entering Bassett Creek.

The model outputs were compared to the Bassett Creek water quality monitoring station located at Irving Ave. The BCWMC P8 model appears to produce similar results to the actual conditions observed at the monitoring station. The 2015 Water Quality Report for the Irving Ave monitoring station indicates that all water quality parameters meet MPCA requirements.

Due to the uncertainty of future changes within the Development Area, the existing water quality models were not used to determine watershed phosphorus and sediment loading and potential reductions. Based on current and future land use, it is anticipated that the loading would be less than or equal to existing conditions. Table 4-5 and Figure 4-17 illustrate that future land use may have a slight decrease in impervious with additional park land being predicted in the 2040 Plan which would results in less loading and, redevelopment in the area would include improvements to degraded site conditions.

Table 4-5. Land use comparison between 2016 and 2040.

Landuse Type	Existing (ac)	Proposed (ac)	Change (ac)
Park/Open Space	8	20	+12
Production Mixed Use	102	90	-12

BCWMC regulations require 1.1-inch volume retention from new or redevelopment impervious surfaces. Unlike previous land use definitions, the 2040 land use does not assume an impervious area but instead refers only to type of land use. Assumptions used in this study for land use and associated impervious values are

- 20% impervious for parks,
- 85% for production mixed use.

Using the impervious percentages listed above, 1.1-inch volume would equate to 3.2 AF of volume retention for parcels assumed to be redeveloped in the Bassett Creek Development Area (Figure 4-18). This calculation assumes that lots currently under 1 acre (47 of the 60 parcels) will likely be developed with adjacent parcels so water quality requirements will be triggered. If contamination and high groundwater are confirmed site constraint throughout the Development Area, flexible treatment options would be followed and would reduce water quality volume required.

For Bryn Mawr Meadows Park reconstruction, there may be close to 5 acres of new impervious which would require 0.5 AF of storage. BCWMC CIP project for water quality basins in Bryn Mawr do not provide treatment for Bryn Mawr Meadow reconstruction.

The Bryn Mawr Meadows scenarios offer water quality benefits via settlement of sediment and pollutants in an underground chamber. Small storms are meant to bypass the surface storage to minimize impacts on the athletic fields. These small storms are what produce the majority of pollutants so surface storage may offer only minimal benefits to water quality. As noted in the Scenario Summary section, underground storage could provide the additional volume needed to treat full flow from Penn Pond and downstream of I-394, enhancing the proposed CIP water quality basins. The area south and west of the park noted in Scenario 1 overlaps the 45.1 acres directed to BCWMC CIP water quality basin project in Bryn Mawr Meadows. See Figure 4-3 in the BCWMC Bryn Mawr Meadows Feasibility Study (Barr, 2019) for the area.

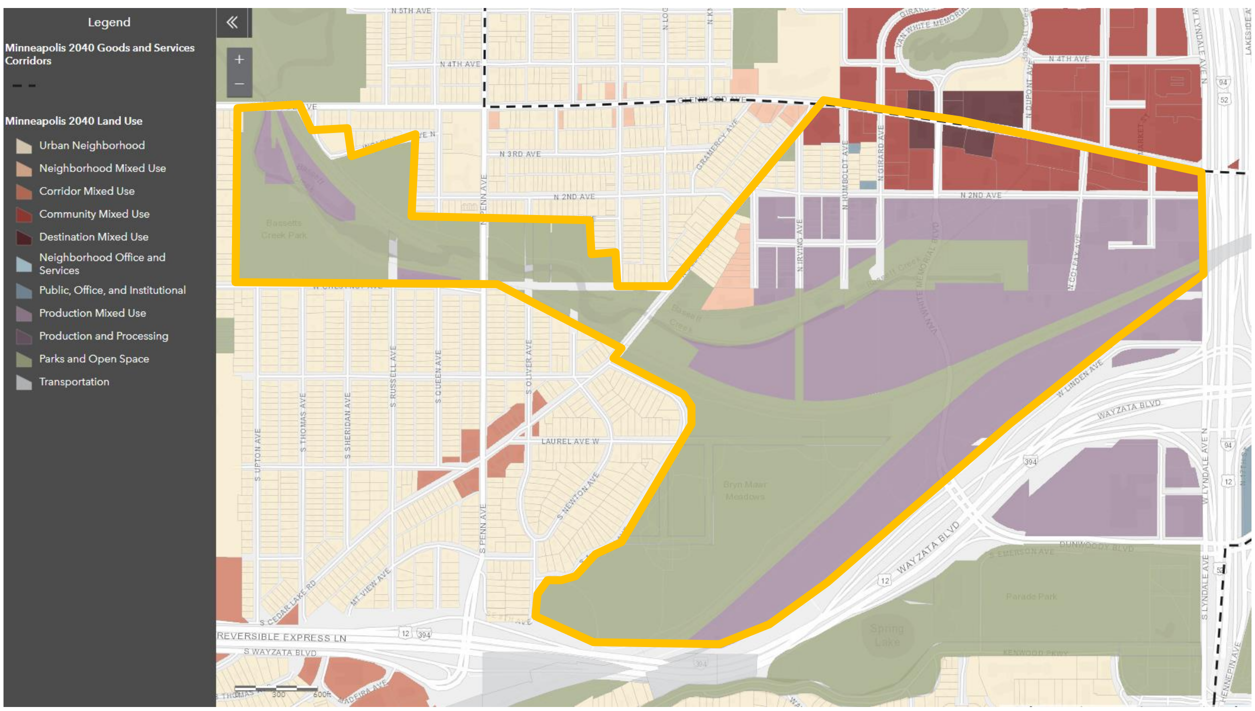


Figure 4-17. City of Minneapolis 2040 Plan land use.

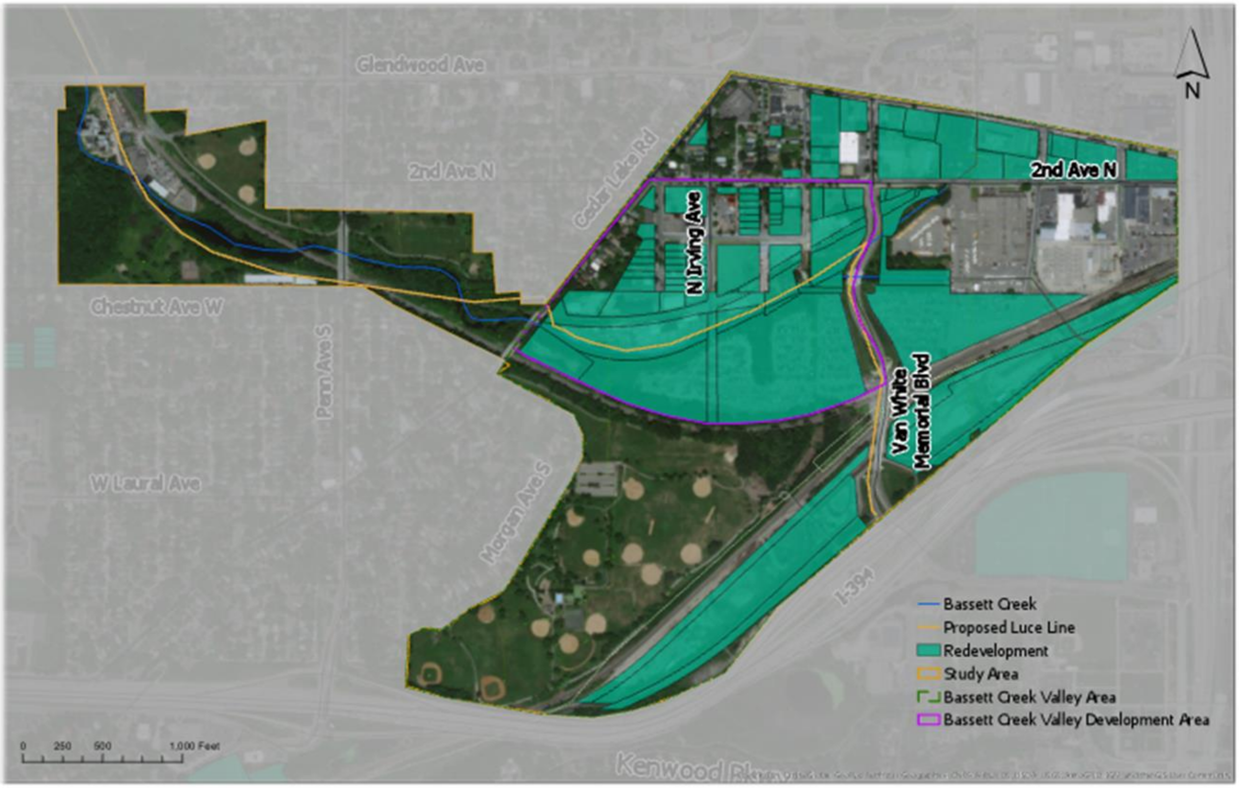


Figure 4-18. Anticipated redevelopment locations.

5.0 Cost and Project Phasing

5.1 COST CONSIDERATIONS

Scenarios discussed in Section 4 identified various floodplain management options to unlock land in the Bassett Creek Valley Development Area. This section presents ballpark level opinion of cost for those scenarios. These generalized estimated costs are based on conceptual designs focused on flood storage and floodplain enhancements.

The costs reflect the following assumptions:

- The construction line item includes mobilization/demobilization, excavation, soil disposal, material cost and utility removal and installation.
- Engineering and Construction Management is 30% of construction cost and contingency is 20% of construction cost.
- Includes cost of athletic field installation for scenarios within Bryn Mawr Meadows Park.
- Includes cost of 12-foot wide bituminous trail for scenarios within Bassett Creek Valley Development Area.
- Water reuse options do not include pumping system or additional treatment required to meet City code (RO filters, chlorination, UV)
- The costs for projects within Bassett Creek Valley are shown as an upper and a lower cost. The low range assumes no soil contamination while the high range assumes all soil is contaminated throughout the Development Area.
- Accuracy range is -30%, +40%.

Table 5-1. Estimated capital costs and unit cost in millions.

Scenario	Flood Elevation	Reduction in Flooded Area (ac) [1]	Estimated Capital Cost ($M) [2]	Cost per Acre Flood Reduction ($M/ac)
1	810.3	7.1	$30.0 - $60.0	$4.2 - $8.5
2	809.9	8.2	$1.9 - $3.7	$0.23 - $0.45
3	810.2	7.5	$13.2 - $26.4	$1.8 - $3.6
4	810.7	17.1	$2.0 - $4.0 $6.6 - $13.1	$0.12 - $0.23 $0.39 - $0.77
5	810.3	15.2	$2.3 - $4.5 $8.3 - $16.9	$0.15 - $0.31 $0.55 - $1.1
6	809.9	14.0	$2.5 - $5.0 $9.7 - $19.4	$0.18 - $0.36 $0.70 - $1.4
7	809.0	15.0	$4.4 - $8.7 $11.6 - $23.1	$0.30 - $0.58 $0.77 - $1.5

[1] Existing condition has 24.0 acres of flooding in Bassett Creek Valley Development Area
[2] Scenarios 4-7: lower range assumes no soil contamination; upper range assumes all soil contaminated

Funding partnerships among benefited parties will likely be necessary to allow for regional amenities and development. It is anticipated that full redevelopment of the area designed with a regional concept could provide new market value for the area of over $300 million dollars which would generate real estate taxes of over $10 million a year. If the development were completed with a parcel-by-parcel approach, the estimated market value and real estate taxes would be significantly less and would likely not provide regional amenities and valuable connections (natural/transportation).

The MPRB can utilize state and regional funding, including bonds, for approved MPRB Master Plans that have been adopted by the Met Council. Within Bryn Mawr Meadows Park, the projects would be designed to be consistent with the existing MPRB Master Plan. To use MPRB park space, the scenario would require the construction of the athletic fields at the time storage was constructed (underground or surface storage). This could allow MPRB funding to be focused on other aspects of the Master Plan and complete the full reconstruction of the park sooner.

The MPRB also has a Master Plan for the Luce Line Regional Trail which is currently designed to use land adjacent to the Bassett Creek corridor. If projects within Bassett Creek corridor support or enhance the Luce Line plan, state funding could potentially be used for scenarios within the corridor.

Mechanisms for funding a regional system could also include park dedication fees. The MPRB has implemented funding agreements with other groups (agencies/developers) in the past and could assist with developing a similar agreement for Bassett Creek Valley. As an abbreviated explanation, the park dedication fees follow a hierarchy system with the following (government agencies are exempt):

1. Dedicated land on the parcels being developed. The amount of land to be dedicated is based on acres/unit or up to 10% of land if supported by MPRB Master Plans for the area near or including the development site. The MPRB can choose any area of the parcel to use as park lands.
2. Developers can pay a fee that must be spent by the MPRB within the neighborhood for park related amenities. This is the system used 99% of the time by the MPRB.
3. Land in-lieu. An example of this is a developer who creates/pays for/constructs a park, but the park is eventually bought by the MPRB. Requires approval by the Board, whereas the first two can be decided by staff.

In addition to funding options related to MPRB, CPED or other City of Minneapolis entities could potentially work on creating a special taxing district that developers could pay into to help fund the cost of the flood mitigation projects prior to development. Also, Brownfield Redevelopment funding from Hennepin County and potentially funding from MnDOT if the project provides treatment necessary for the I-394 corridor.

Thirty-year life cycle analysis for the scenarios have not been included in current cost considerations. However, it is recommended that as concept designs move forward with details, a life cycle analysis should be completed to aid in planning for long term operating and maintenance costs.

5.2 PROJECT PHASING

To meet BCWMC floodplain policy, there can be no net loss in floodplain storage and no increase in flood level along the trunk system. Also, land use cannot be damaged by floodwaters or increase flooding issues. In order to redevelop Bassett Creek Valley Development Area, flood storage will need to be provided prior to construction. Figure 5-1 illustrates the potential phasing of Bassett Creek Valley Development Area.

As demonstrated in this study, mitigation projects would need to occur in Bassett Creek Valley Development Area to unlock, or remove from the floodplain, the majority of the developable land. Projects in Bryn Mawr Meadows Park reduce the flood extent within the Development Area but have minimal impact on removing entire parcels from the floodplain. Therefore, construction of the expanded creek section should occur first to unlock the greater number of parcels. The creek expansion could be completed in sections with Bryn Mawr Meadows Park scenarios being constructed second.

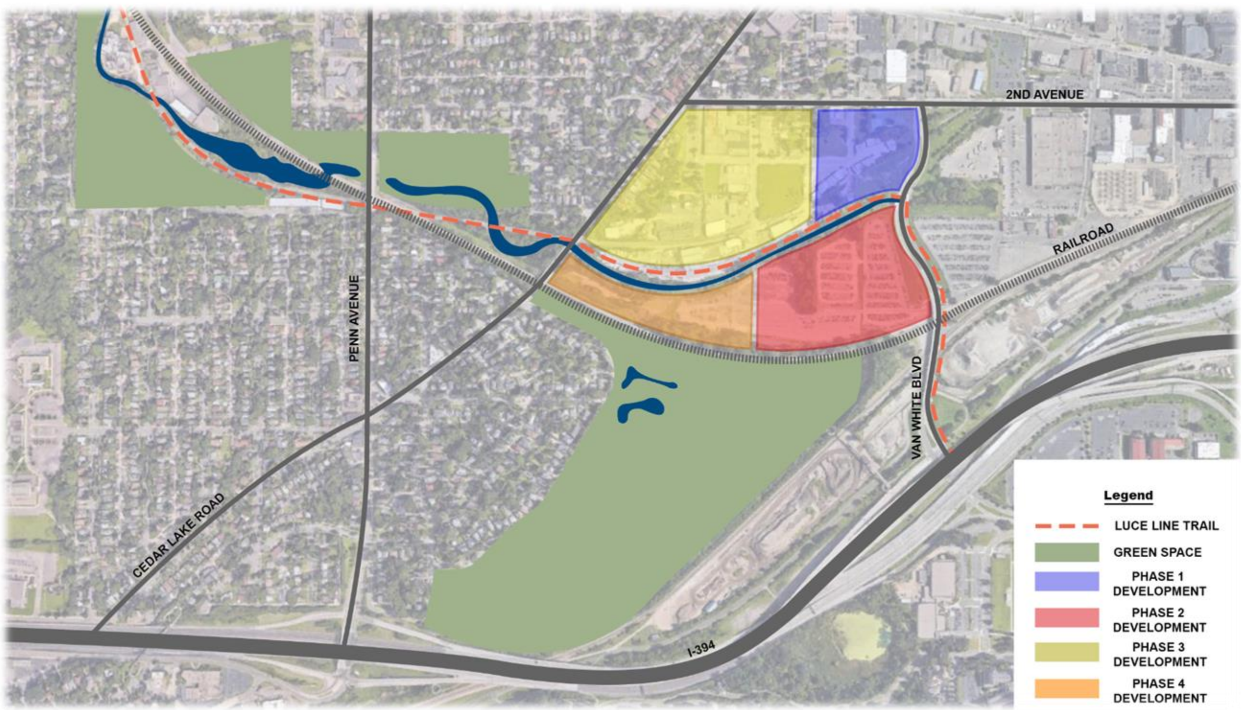


Figure 5-1. Anticipated construction phases of redevelopment.

6.0 Conclusion and Recommendations

6.1 SUMMARY

Through the scenario development process, two areas within Bassett Creek Valley became the focus of large-scale flood mitigation projects: Bryn Mawr Meadows Park and the Bassett Creek corridor between Cedar Lake Rd and Van White Blvd (Figure 4-6). Each area was reviewed for multiple scenarios to determine specific impacts not only to the flood elevation but also to the flood extent of the region and ability to provide regional amenities.

6.1.1 Bryn Mawr Meadows Park

Scenarios 1, 2 and 3 are in Bryn Mawr Meadows Park and have underground storage, surface storage or a combination of the two within the park boundary. An underlying assumption of the scenarios is that they can be integrated into the exiting MPRB Master Plan. This means that they would not displace proposed amenities such as ball fields but be designed to support or enhance the ball fields. For underground storage, the ball fields would need to be raised from current grade to reduce impacts of groundwater on the system. These higher fields would create drier conditions then existing conditions, potentially reducing vegetation maintenance in the park. Underground storage could also be used to promote water reuse through irrigation or integrated into the proposed splash pad. For surface storage, runoff would only be directed to pooled areas during rainfall events that the MPRB would cancel activities and be designed to drawdown within 24 hours. Scenarios within Bryn Mawr Meadows Park do not include any grading within the Development Area.

To reduce disruption to park activities, scenarios within Bryn Mawr Meadows Park have minimal additional ecological benefits and do not extend the concept of the green corridor within the region. For example, the short storage duration and use of vegetation associated with ball fields would discourage native plantings or wetland restoration. The layout required to fit the proposed amenities within the park requires water features in specific areas instead of throughout the park.

As shown in Table 4-3, the lowest flood elevation achieved for scenarios in Bryn Mawr Meadows Park is 809.9 feet. Even though this is a reduction of 1.2 feet, it only reduces the flooded area within the Development Area by 4.5 acres and mostly around the fringe. There is still significant flooding to overcome for high valued areas: 2nd Ave and Van White Blvd area and the west impound lot- (Figures 4-8, 4-10, and 4-12). Additional projects would be required to reduce the flood elevation. If flood elevations were not reduced further, large scale development would be difficult to achieve and may lead to parcel-by-parcel development. This may prevent regional amenities and reduce estimated market value of the parcels; thus, reducing real estate taxes.

Concept design for the currently approved MPRB Master Plan for Bryn Mawr Meadows Park will begin in 2020 with some park amenities being constructed/installed as early as 2021. The scenarios in Bryn Mawr Meadows Park will likely need to follow a similar timeline and could be constructed prior to significant development. The projects require no additional land acquisitions or swapping.

To eliminate multiple construction phases within the park, scenarios would require the installation of planned athletic fields at the time mitigation storage was constructed. The cost of ball fields impacted by project locations were included in the capital cost of the scenarios (Table 5-1). The inclusion of the ball fields in the capital cost would allow MPRB funding to be focused on other aspects of the Master Plan and complete the full reconstruction of the park sooner.

As noted in the Water Quality Feasibility Study, consideration was given to direct all flows from Penn Pond and downstream of I-394 to the water quality basins but was determined to not be feasible (at the water quality study level) due to significant cost and necessary land consumption. The scenarios presented in this Study, which included a larger study level could provide additional treatment volume from the full flow from Penn Pond and downstream of I-394. The additional storage could be used as an overflow for the water quality basins or as a standalone system.

The estimated capital costs of scenarios within Bryn Mawr Meadows Park have significant cost variation between underground storage and surface storage; see Table 6-2. The underground system itself is costly to build and install and becomes even more costly with the requirement to construct on piles due to poor soil conditions. Costs presented assume contaminated soil is not present in Bryn Mawr Meadows Park.

See Scenario Summary Section (4.7.6) for additional discussion on storage provided and its influence on flood elevations.

Table 6-1. Bryn Mawr Meadows Park scenarios estimated capital costs and unit cost in millions.

Scenario	Storage Type	Mitigation Storage Volume (AF)	Flood Elevation (ft)	Estimated Capital Cost ($M)	Cost per Acre Flood Reduction ($M/ac)
1	Underground	50	810.3	$30.0 - $60.0	$4.2 - $8.5
2	Surface	42	809.9	$1.9 - $3.7	$0.23 - $0.45
3	Combination	44	810.2	$13.2 - $26.4	$1.8 - $3.6

6.1.2 Bassett Creek Corridor

Scenarios 4, 5 and 6 utilize the existing Bassett Creek corridor through the Bassett Creek Valley Development Area -Cedar Lake Rd to Van White Blvd. The scenarios include reconstructing the channel and adjacent land into a multipurpose tiered cross section. The fundamental assumption of the design includes a low flow channel with a terrace that can be used for the proposed regional Luce Line trail up to a 10-year storm event (4.9-inches in 24-hr). For rainfalls greater than the 10-year, the terrace would act as floodplain, submerging the trail for less than 24 hours and being inaccessible to the public.

Figure 4-14 provided one example of a cross section design. However, as long as the volume provided in the cross section is maintained and connected to the floodplain, the proposed cross section can be manipulated to include braided channels, online or offline basins, wetland restoration, trails on both sides and other amenities. The design should also include aspects of the Luce Line Regional Trail Master Plan and other activities to enhance the community and make the corridor a destination. Amenities that could be incorporated in the design could include activities that focus on the natural corridor such as loop trails, birding, landscape painting opportunities, and play areas that offer activities not currently included in nearby parks (natural wading pools, in-water play areas). Design could also include overlooks and piers that extend over Bassett Creek. These amenities would not only promote Bassett Creek as a destination but also provide ecological benefits and extend the concept of the green corridor within the region.

Water quality benefits were not explicitly modeled for scenarios within the corridor. However, the design could incorporate features that would promote water quality through channel enhancements and basins adjacent to the creek. Examples include oxbows, rifles, and settling basins at storm sewer outlets in channel. These scenarios would result in reconstructed banks which will reduce or control current erosion concerns.

All scenarios in the Bassett Creek corridor involve manipulation of the channel below the DNR regulated ordinary high-water level. Therefore, the DNR should be included in future discussion regarding design to ensure compliance with their regulations. The modeled cross section has a wider bottom then in existing conditions during normal flow but a final design could include a refined channel configuration to match existing conditions during normal flow and the 2-year storm event.

As shown in Table 4-3, the lowest flood elevation achieved for scenarios in the corridor is 809.9 feet. This is the same elevation achieved for projects within Bryn Mawr Meadows Park but has significantly more influence on reducing the flood extent within the Development Area which unlocks more developable land.

Scenarios in the corridor contain flood waters within the channel as shown in Figure 4-14 instead of the flooded area extending into the Development Area.

- 24.0 acres – existing area impacted by flood waters
- 15.8 acres – smallest extent of flood waters for projects in Bryn Mawr Meadows Park
- 10.0 acres – smallest extent of flood waters to achieve same HWL of 809.9 for projects within Bassett Creek corridor

In addition to reducing the flooded area in the Development Area, Scenarios 4-6 also remove Bryn Mawr Meadows Park from the floodplain which has a positive impact on field conditions and usable land.

The corridor scenarios do not require land acquisitions or swapping; however, acquiring land from properties adjacent to the creek would allow for more flexibility in the design. Properties which may be candidates for acquisition or swapping include Pioneer Paper and abandoned CP rail lines on the north side of Bassett Creek.

Flood mitigation is required prior to filling in the floodplain which means construction of flood mitigation projects in the corridor would be required prior to development of high valued areas at 2nd Ave and Van White Blvd area and west impound lot. Scenarios 4-6 provide needed flood storage for development to move forward in Bassett Creek Valley but also provide regional amenities to the community and enhance MPRB Master Plans and the City's 2040 Plans. Funding of these projects will need to be a combined effort between public and private sectors.

The estimated capital costs of scenarios within the corridor have significant cost range due to unknown levels of contamination within soil and groundwater in the area; see Table 6-2. CPED has on-going investigations to understand extent and levels of contamination south of Bassett Creek in the west impound lot which will greatly impact project costs.

Table 6-2. Corridor Scenarios estimated capital costs and unit cost in millions.

Scenario	Max Top of Bank Width (ft)	Mitigation Storage Volume (AF)	Flood Elevation (ft)	Estimated Capital Cost ($M) (1)	Cost per Acre Flood Reduction ($M/ac)
4	150	34	810.7	$2.0 - $4.0 $6.6 - $13.1	$0.12 - $0.23 $0.39 - $0.77
5	235	48	810.3	$2.3 - $4.5 $8.3 - $16.9	$0.15 - $0.31 $0.55 - $1.1
6	280	62	809.9	$2.5 - $5.0 $9.7 - $19.4	$0.18 - $0.36 $0.70 - $1.4

[1] Lower range assumes no soil contamination, upper range assumes all soil contaminated within Development Area.

6.1.3 Combining Project Locations

Scenario 7 presents a combination of projects in Bryn Mawr Meadows Park and the Bassett Creek corridor. Including both locations for project consideration enhances the overall regional plan, has the potential to benefit additional entities and could therefore have greater funding options.

Scenarios in Bryn Mawr Meadows Park are more likely to provide water quality benefits to both the Development area and areas unable to be treated by the BCWMC's water quality basins in Bryn Mawr Meadows - full flow from Penn Pond/I-394. However, these scenarios do not reduce the flood extent in the Development Area to any significant degree or provide additional ecological benefits.

Scenarios within the corridor provide significant flood reductions and enhance regional amenities but don't necessarily meet water quality requirements and will be required to overcome contamination issues.

Scenario 7 provided a single option to combine these projects. However, influences on the flood elevation could be re-evaluated if the storage volumes change to fit with other project designs such as Bryn Mawr Meadows Park redevelopment, BCWMC sponsored water quality basins.

Table 6-3. Combined Scenario estimated capital costs and unit cost in millions.

Scenario	Max Top of Bank Width (ft)	Mitigation Storage Volume (AF)	Flood Elevation (ft)	Estimated Capital Cost ($M) (1)	Cost per Acre Flood Reduction ($M/ac)
7	280	105	809.0	$4.4 - $8.7 $11.6 - $23.1	$0.3 - $0.58 $0.77 - $1.5

6.1.4 Development Area Water Quality Requirements

Volume management requirements for Bassett Creek Valley Development Area is 3.2 AF - calculations in Section 4.6. Assuming the infiltration will be underground, on pilings, and not factoring in soil contamination, the unit is estimated to be $16-24/CF for a total cost of $2.2M to $3.3M. This cost is to meet water quality requirements, it does not include additional storage that may be required for floodplain compensatory storage. These values are generally below costs provided for the scenarios but provide a comparison of the funds needed to potentially meet only water quality requirements.

The Bryn Mawr Meadows Park Water Quality Feasibility Study (Barr, 2019) presented three scenarios that provided 1.5 AF to 5.4 AF of storage and removed 6 to 30 lbs TP/year, with a final decision to construct the 5.4 AF system for 30 lbs TP/yr removal. As noted in the Water Quality Feasibility Study, providing additional storage was not feasible at the current study level due to significant cost and land usage. The proposed basins were not designed to provide volume management requirements for the reconstruction of Bryn Mawr Meadows Park; assuming 5 acres of new impervious which would require 0.5 AF of storage. Scenarios presented in this study do not look to replace the proposed BCWMC water quality basins but to supplement them to provide additional treatment.

It was assumed that in future land use would result in less watershed loading due to:

- Anticipated that future land use will include less impervious, naturally improving water quality
- Future land use will include improved site conditions such as stabilized banks and fewer degraded surfaces.
- Water quality monitoring at Irving Ave indicates water quality parameters all currently meet MPCA standards
- Can be included in Regional Surface Water Management Plan easier than flood mitigation measures due to smaller volume needed to meet regulatory requirements.

6.2 RECOMMENDATION AND NEXT STEPS

As noted in the Bassett Creek Valley Master Plan (2007) and carried through updated plans for the area, development should not be completed in a single step but a series of actions and smaller projects that follow a "road map" laid out in a comprehensive plan. Development in this area could potentially span decades. However, to meet regulatory requirements and ensure public safety, site constraints such as floodplain and contamination need to be dealt with prior to large scale redevelopment.

This study serves the purpose of understanding how to unlock, or remove from the floodplain, additional land within Bassett Creek Development Area by identifying and evaluating flood mitigation opportunities and understanding design constraints. The following steps are recommendations to continue advancing development within Bassett Creek Valley Development Area while providing opportunity for regional amenities.

Table 6-4. Next Steps

Next Step	Reason
Create mechanism for funding that possibly includes MPRB + CPED + Developers+ Hennepin County +Bonds + Others	Projects will need to be constructed prior to development instead of during.
Refine design for projects within Bryn Mawr Meadows Park, including reuse options and interaction with BCWMC proposed water quality basins	Concept design to begin in 2020 for park design
Meet with MnDOT to discuss water quality treatment options	
Complete geotechnical investigation within Bryn Mawr Meadows Park for foundation design	
Review City Irving sanitary sewer line location for impacts to Scenario designs	
Meet with MnDNR	Understand potential limitations of working within Bassett Creek
Investigate contamination within Development area	Gain better understanding of level of cleanup need and impacts to cost estimate
Create a Regional Surface Water Management Plan for Bassett Creek Valley	Advance concept designs and create a road map for construction opportunities
Updated current BCWMC XP-SWMM Model with scenarios	BCWMC model has been updated since study has started and should be used moving forward. Need to model scenarios under smaller storm events.
Update City H&H model with Floodplain Study scenarios	Determine impacts of proposed scenarios on local level
Consider land acquisitions along Bassett Creek	Allows for more flexibility in design

7.0 References

Land Use Committee, *Bryn Mawr Neighborhood Land Use Plan: A Plan for the Future of the Neighborhood*, December 2005

Bassett Creek Valley Redevelopment Oversight Committee, *Bassett Creek Valley Master Plan*, January 2007

Minneapolis Park and Recreation Board, *Comprehensive Plan 2007—2020*, October 2007

Bassett Creek Watershed Management Committee, *5-Year Capital Improvement Program, 2012—2025*

Hennepin County Department of Environmental Services, *Bassett Creek Areawide Groundwater Study Areawide Survey*, December 2013

Bassett Creek Watershed Management Commission, *2015 Biotic Index Evaluation of Plymouth Creek and Bassett Creek*, April 2016

Minneapolis City of Lakes, *Van White Memorial Boulevard Station Area Plan METRO Blue Line Extension.* Dept. of Community Planning and Economic Development, December 2017

Barr Engineering Co., *90% Design Plans – Bassett Creek Main Stem Stabilization*, October 2017

City of Minneapolis, *Stormwater and Sanitary Sewer Guide*, October 2017

Barr Engineering Co., *Bassett Creek Hydrologic and Hydraulic Analyses, Phase 2 XPSWMM Model Report*, May 2017

Bassett Creek Valley – 2018 Predevelopment Study, Handout

Barr Engineering Co., *Feasibility Report for Bryn Mawr Meadows Water Quality Improvement Project, Minneapolis, MN,* January 2019

Metropolitan Parks and Open Space Commission, *Luce Line Regional Trail Master Plan, Minneapolis Park and Recreation Board, Review File No. 50120-1*, June 2019

Bassett Creek Watershed Management Committee, *Requirements for Improvements and Development Proposals*, October 2019

Appendix A – Design Charrette Meeting Notes

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Bassett Creek Valley Floodplain and Stormwater Study
Design Charrette Meeting Notes
July 24, 2019
12:30 – 4:30
City of Lakes Building, Conference Room 300A

In attendance:
Wenck Associates – Eileen Weigel, Chris Meehan, Jenna Niday
Bassett Creek Watershed Management Commission – Laura Jester
Barr – Karen Chandler
Community Planning & Economic Development – Beth Grosen
Minneapolis Park and Recreation Board – Michael Schroeder
City of Minneapolis – Lisa Goddard, Kelly Moriarity, Paul Hudalla, Jeremy Strehlo, Kelly McIntire
Mississippi Watershed Management Organization – Stephanie Johnson

A. Optimize Floodplain

- a. Benching the creek
    - i. Could bench right along the side of the creek (cross-section)
    - ii. Could act as a tributary and meander away from the creek at times
        - 1. Ox-bow features along the creek
            - a. "offline" features – water quality features
    - iii. Use the creek as more than one linear function
- b. Possibility of using the street to move water
    - i. Larger curb depths to hold more water, create channels on either side of the road to direct water
    - ii. Raise N/S roads above the floodplain and allow E/W to flood in heavy rainfall events
        - 1. Platform crossings for cars – better for pedestrians?
- c. Build a trail within the floodplain
    - i. Waukesha, Wisconsin precedent
    - ii. Boardwalks
    - iii. Future Luce Line Trail connection
- d. Amenities
    - i. Fishing Holes
    - ii. Back Waters
    - iii. Play area (will need to clean the water)
    - iv. Tubing
    - v. Trails
    - vi. "Water Square" parks – Netherlands precedent
    - vii. Reuse of the sports fields
- e. Stormwater within Development

i. Future development can include green roofs to help carry the load of stormwater
ii. Tree trenches can be explored/used in junction with underground stormwater storage
iii. Build with piles, allowing stormwater storage under new developments
    1. Idea of "New Zero" – Wayzata precedent from Michael
iv. Are we able to combine/grow Penn Pond into Bryn Mawr or somewhere south?
v. Look into back-flow using gravity

f. Storage
    i. Store water to irrigate Bryn Mawr
    ii. 2' – 3' of storage under existing impound lot (~20 acres)
        1. Use in junction with benching of the creek to meet flood storage needs
    iii. Storage under newly developed buildings
    iv. Think about stacked features: areas that can be inundated for 1-2 hours, amenities that can be used 98% of the time
    v. Create storage under proposed bike paths
        1. Would we be moving contaminated soil?
    vi. Compensatory storage within the creek – additional provided south of the creek by MnDOT, developers, etc.…
    vii. Terracing Bryn Mawr – each field at a different elevation – bike tack and adult workout circuit would flood periodically
    viii. Can we force water to Bryn Mawr from the north and redirect pipe in Bryn Mawr from the south?
    ix. Look into an "elevator style" parking lot
    x. Store and be able to release water before a big storm hits
    xi. Low flow basin in Bryn Mawr when using above ground storage

g. Reuse
    i. Irrigation
    ii. Green Roofs
    iii. Geothermal use
    iv. Cistern to use as a wash basin to wash school buses – eliminate/reduce flooding in bus parking lot

B. Improved Water Quality

a. Locate treatment further north within the watershed
b. "Special Districts"
    i. Minimal/zero chlorides
    ii. Geothermal – Saint Paul, Incinerator Downtown Minneapolis precedents)
c. More regional treatment options?
d. 7.5-acre feet for infiltration/water quality
e. Propose small treatment trains within amenities in existing parks
f. Park Board and Developers could pay for stormwater BMP's through parkland dedication
g. Minnehaha wetland area precedent

h. Raingardens?
i. Look into possibilities of improving Spring Lake – can it become an amenity?

C. Corridor Connection

a. How do we create connection for the existing north and south neighborhoods?
b. Open trails/boardwalks
    i. Ambiguous within watershed
c. Benching along the creek
d. Ecological
    i. Ponding, backwaters, riffles
    ii. Create/re-establish habitat
e. What is the balance between habitat and open space?
f. Luce Line trail connection
g. How do we frame this creek with vegetation?
    i. Oak Savanna? Existing vegetation?
    ii. Consider the homeless population
h. How do we mix in education through the site?

D. Maximized Land Use

a. Lands on the north of the creek has been slated for development
b. Irving needs a new vehicular bridge to replace the existing
c. New district – "Mixed Use/Processing" – located south of 2nd
d. Future development along Van White will be 12-15 stories
e. Look into precedents that allow underground parking that can flood
f. Work with MnDOT to "reorganize" space under 394
    i. Is there a better place for their 'Penn Pond' so it can be better maintained?

E. Art

a. Curate art to be placed within the creek/side channels for educational or quality benefits (aerate the water ex: windmills)

F. Funding

a. How does Bassett Creek pay for this project?
    i. Is it easier to have other stakeholders pay in for water quality pieces?
    ii. What grants are available?
    iii. Regional funding, MOU within districts

G. Other Things to Consider

a. Barr reviewed underground storage as part of Bryn Mawr (cost prohibitive for small scale project?); Michelle Kimball at Barr is PM for park
b. Explore, plan for, and design for the future 10-year flood (resiliency)
    i. This is a big investment and we should do this right, for both the present and future generations
    ii. Look into 500-year flood projection as future 100-year flood
c. How deep are the organics south of the creek?
d. What does the sequencing of this project look like?

e. What would the neighborhoods like to see done with this project?
f. Avoid permeable concrete if possible due to City experience
g. Geotech is likely similar throughout area (borings associated with SWLRT)

H. Park Master Plan (Meet with Michael Schroeder on 8/1)

a. Amenities in Park Master Plans are completed in phases as funding is available
b. Amenities that are consistently requested
    i. Trails (walk/bike/water)
    ii. Community centers or potential gathering places
    iii. Aquatic recreation
c. Resilience planning
d. Grading plans will be developed in year prior to 1st phase of construction
    i. For Bryn Mawr: construction in 2022 so grading plans in 2021
e. Inundation of park areas is acceptable during rain events and for small durations after (few hours, no long-term impacts)
f. Storage for flood waters v. runoff would be ideal since treatment of chloride is unlikely (saltwater on fields would cause damage); maybe avoid first flush
g. Bryn Mawr
    i. Underground storage would require above ground amenities to be completed as part of the construction, free up funds for other amenities
    ii. Potential park dedication fees
h. Parade Park (Spring Lake)
    i. Potential hydraulic benefits from additional water
    ii. currently, no site amenities
    iii. potential to turn into a City park v Neighborhood park

Appendix B – Hydrology and Hydraulics

Technical Memo

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To: Karen Chandler, Barr

From: Eileen Weigel, Wenck Associates, Inc.

Copy: Laura Jester, Bassett Creek Watershed Management Commission
Lisa Goddard, City of Minneapolis Division of Storm and Sewer
Chris Meehan, Wenck Associates, Inc.

Date: November 12, 2019

Subject: Bassett Creek Valley H&H Proposed Models

This memo provides supplemental information specific to the hydrology and hydraulic analysis part of the Bassett Creek Valley - Floodplain and Stormwater Management Study. The Bassett Creek Valley - Floodplain and Stormwater Management Study Report provides additional details on how the model was used to determine existing conditions and future project opportunities and should be used in conjunction with this H&H Memo.

General Information:

Bassett Creek Watershed Management Commission's (BCWMC) Model (2017) was used as the basis for analysis and was run using XP-SWMM version 16.1. It is anticipated that future work within the Bassett Creek Valley will utilize the updated, DNR approved BCWMC's XP-SWMM model that will likely be completed in 2020. All elevations in the report reference the NAVD 88 datum.

To verify the model, the run period was changed from 7/6 – 7/16 to 7/6 – 7/8 and produce a similar high water level (HWL) to the value provided in BCWMC H&H Analysis- Phase 2 XPSWMM Model Report (Barr, 2017) at Irving Ave (Node N-BCD-009). See Figure 1 for the hydrograph produced as part of the verification process for the Basin Scenario.

The Study analyzed seven scenarios (proposed conditions) that were each run in the verified XP-SWMM model. Each XP-SWMM.xp file has an existing model (Base Scenario) and proposed scenario (Scenario X) for comparison. The changes to the XP-SWMM model for each scenario is discussed in more detail below. The 100-year was the only storm event analyzed as part of the Floodplain Feasibility Study.

The scenarios were developed conceptually and do not represent a final design. Proposed scenarios had negligible impacts on areas outside of Study Area (Bassett Creek Valley).

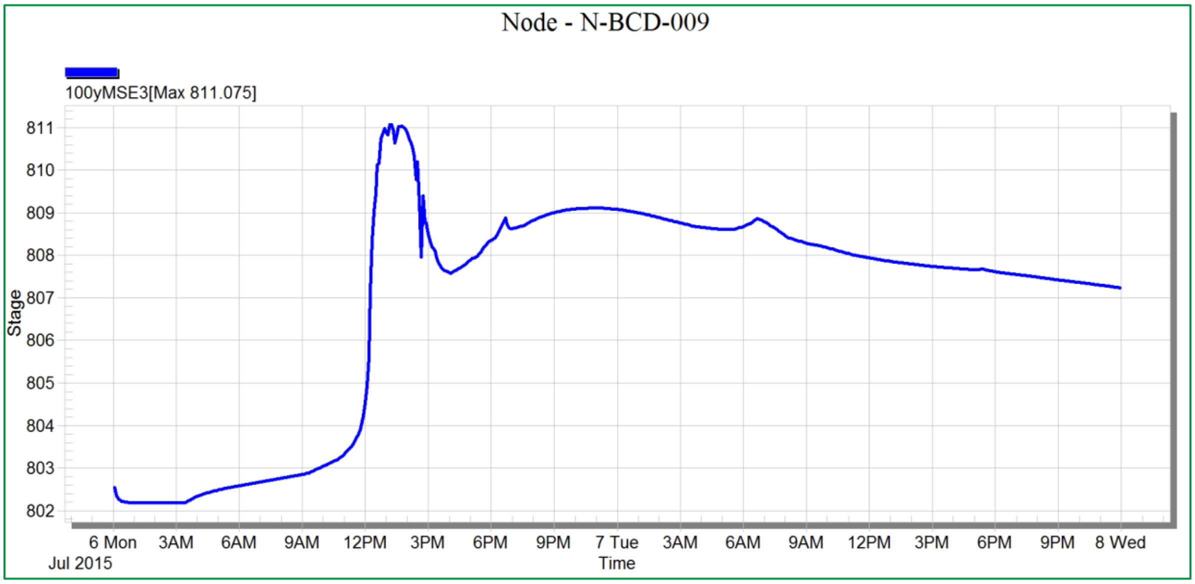

Figure 1: Base Scenario (Existing Conditions) Hydrograph

Scenario 1:

Design Details as related to XP-SWMM model (Table 1):

- Underground storage added to Bryn Mawr Meadows Park
- Assumed 5.75-foot storage depth.
- Bottom of storage is at 807 feet which corresponds to the groundwater table.
- Outlet for underground system designed based on need, currently, no discharge.
- Outlet structure for collecting overland flow directed to underground system will be designed based on need.

See Figure 2 for the comparison between existing flood elevation and proposed flood elevation at Irving Ave.

Table 1: Changes to Existing Model for Scenario 1

Object	**Change**	**Reason**
BCD-048A	Storage Curve	Removed storage from 4.84 and 6.84 depth to reflect raising fields in Bryn Mawr
L-BCD-153	Redirected flow from BCD-048A to Bryn Mawr node	Storm sewer downstream of this node at inverts below bottom of proposed storage system
Bryn Mawr	Added	Reflects underground storage system. Approx. 50 AF.
Links to BCD-048A	Redirected to Bryn Mawr	Redirected overland flow to underground storage system

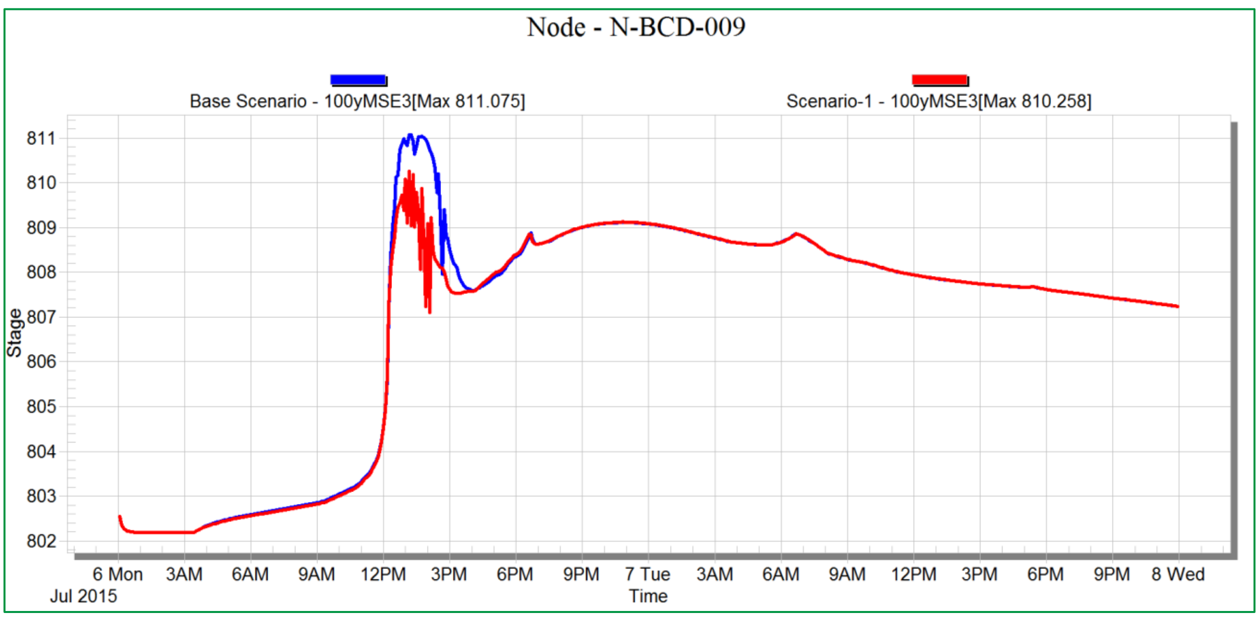

Figure 2: Scenario 1 & Base Scenario (Existing Conditions) Hydrograph

Scenario 2:

Design Details as related to XP-SWMM model (Table 2):

- Surface storage added to Bryn Mawr Meadows Park
- Assumed 3-foot storage depth.
- Bottom of storage is at 810 feet, could be raised as long as overland flow design allows routing.
- Outlet for surface storage will be designed based on need, currently, no discharge.

See Figure 3 for the comparison between existing flood elevation and proposed flood elevation at Irving Ave.

Table 2: Changes to Existing Model for Scenario 2

Object	**Change**	**Reason**
BCD-048A	Storage Curve	Removed storage from 4.84 and 6.84 depth to reflect raising fields in Bryn Mawr
L-BCD-153	Redirected flow from BCD-048A to Bryn Mawr node	Storm sewer downstream of this node at inverts below bottom of proposed storage system
Bryn Mawr	Added	Reflects surface storage system. Approx. 42 AF.
Links to BCD-048A	Redirected to Bryn Mawr	Redirected overland flow to surface storage system

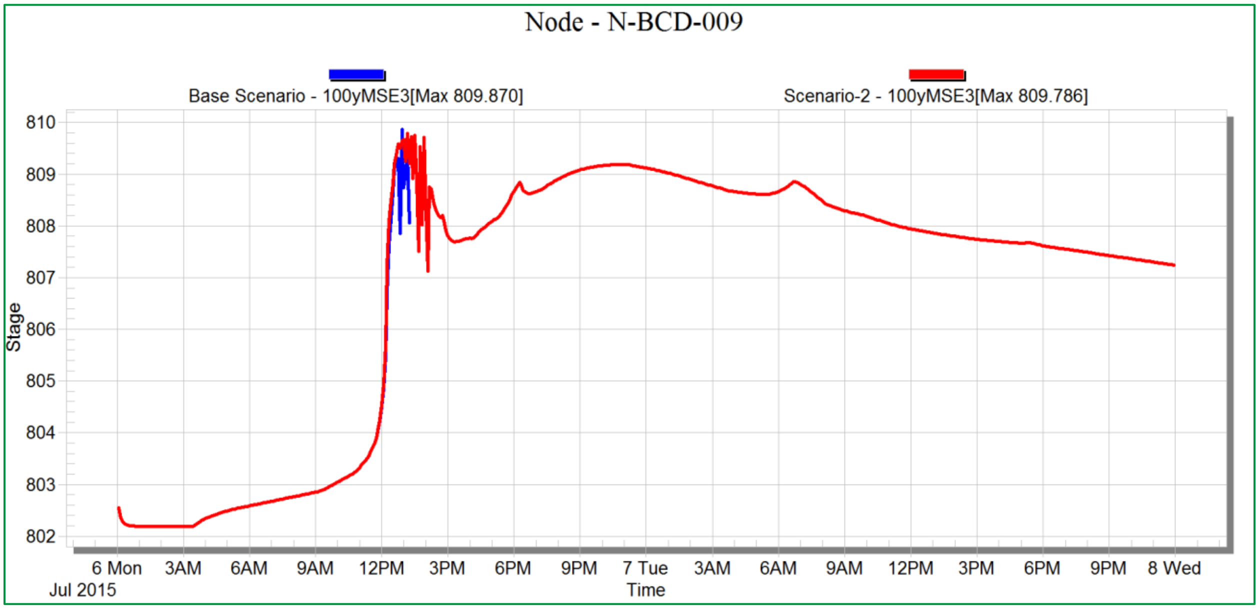

Figure 3: Scenario 2 & Base Scenario (Existing Conditions) Hydrograph

Scenario 3:

Design Details as related to XP-SWMM model (Table 3):

- Combination of Scenario 1 & 2 designs: surface storage has footprint of 8 acres (up to 3-foot depth), underground system is 3.6 acres (5.75-foot depth)
- Surface storage directed to underground storage to reduce disruption to park.

See Figure 4 for the comparison between existing flood elevation and proposed flood elevation at Irving Ave.

Table 3: Changes to Existing Model for Scenario 3

Object	Change	Reason
BCD-048A	Storage Curve	Removed storage from 4.84 and 6.84 depth to reflect raising fields in Bryn Mawr.
L-BCD-153	Redirected flow from BCD-048A to Bryn Mawr node	Storm sewer downstream of this node at inverts below bottom of proposed storage system
Bryn Mawr	Added	Reflects underground and surface storage system. Approx. 44 AF.
Links to BCD-048A	Redirected to Bryn Mawr	Redirected overland flow to surface storage system

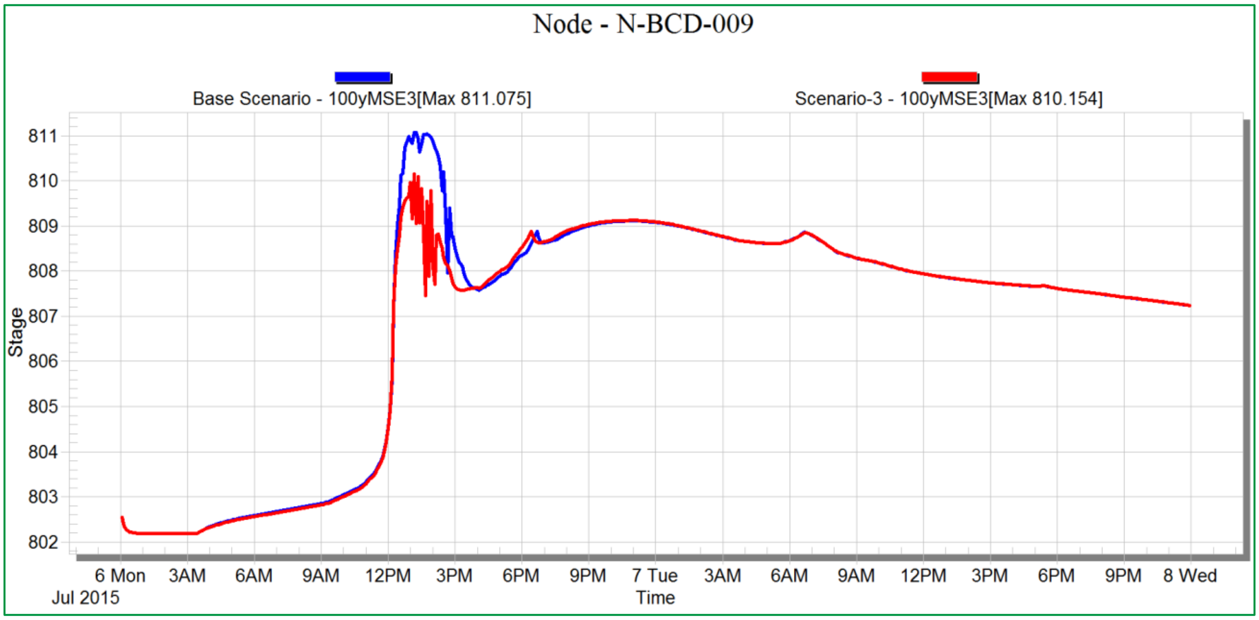

Figure 4: Scenario 3 & Base Scenario (Existing Conditions) Hydrograph

Scenario 4:

Design Details as related to XP-SWMM model (Table 4):
The cross section of Bassett Creek between Cedar Lake Rd and Van White Blvd was manipulated to provide a volume of approximately 34 acre-feet (AF). Updated cross section in model could be manipulated to fit within design requirements as long as same volume is provided and storage is accessible during 100-year storm event.

The proposed model did not change creek channel bottom elevations from existing conditions. Modified overbanks would need to be graded to match existing grade and still provide necessary freeboard from channel high water level. Proposed model has higher flow than exiting conditions (1650 cfs v 1388 cfs) but a lower velocity (3.5 fps v 6.1 fps); values provided are between Irving Ave and Van White Blvd. These changes in flow and velocity in the model area contained within the Development Area. These potential impacts should be taken into account when further refining the design or rerunning the model with a different time step to reduce oscillations. See Figure 5 for the comparison between existing flood elevation and proposed flood elevation at Irving Ave.

Table 4: Changes to Existing Model for Scenario 4

Object	Change	Reason
L-BCD-010	Natural channel to New XL- XS (top width of 150-feet)	Regrade with tiered cross section
L-BCD-010	Natural channel to New XL- XS (top width of 150-feet)	Regrade with tiered cross section
L-BCD-009	Natural channel to New XL- XS (top width of 150-feet)	Regrade with tiered cross section

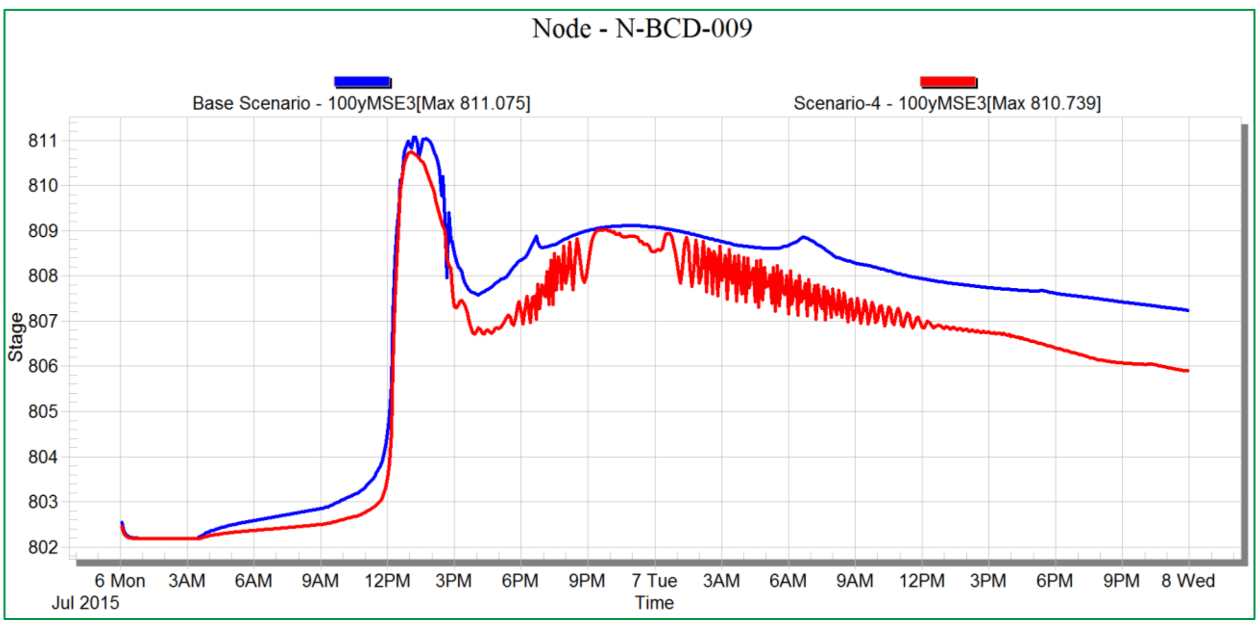

Figure 5: Scenario 4 & Base Scenario (Existing Conditions) Hydrograph

Scenario 5:

Design Details as related to XP-SWMM model (Table 5):
The cross section of Bassett Creek between Cedar Lake Rd and Van White Blvd was manipulated to provide a volume of approximately 48 acre-feet (AF). Updated cross section in model could be manipulated to fit within design requirements as long as same volume is provided and storage is accessible during 100-year storm event.

The proposed model did not change creek channel bottom elevations from existing conditions. Modified overbanks would need to be graded to match existing grade and still provide necessary freeboard from channel high water level. New cross section between Cedar Lake Blvd and Irving Ave is smaller than the cross section from Irving Ave to Van White Blvd to avoid impacts to land south of Bassett Creek. Proposed model has higher flow than exiting conditions (1624 cfs v 1388 cfs) but a lower velocity (1.8 fps v 6.1 fps); values provided are between Irving Ave and Van White Blvd. These changes in flow and velocity in the model area contained within the Development Area. These potential impacts should be taken into account when further refining the design or rerunning the model with a different time step to reduce oscillations. See Figure 6 for the comparison between existing flood elevation and proposed flood elevation at Irving Ave.

Table 5: Changes to Existing Model for Scenario 5

Object	Change	Reason
L-BCD-011	Natural channel to New XL- XS (top width of 150-feet)	Regrade with tiered cross section
L-BCD-010	Natural channel to New XXL- XS (top width of 235-feet)	Regrade with tiered cross section
L-BCD-009	Natural channel to New XXL- XS (top width of 235-feet)	Regrade with tiered cross section

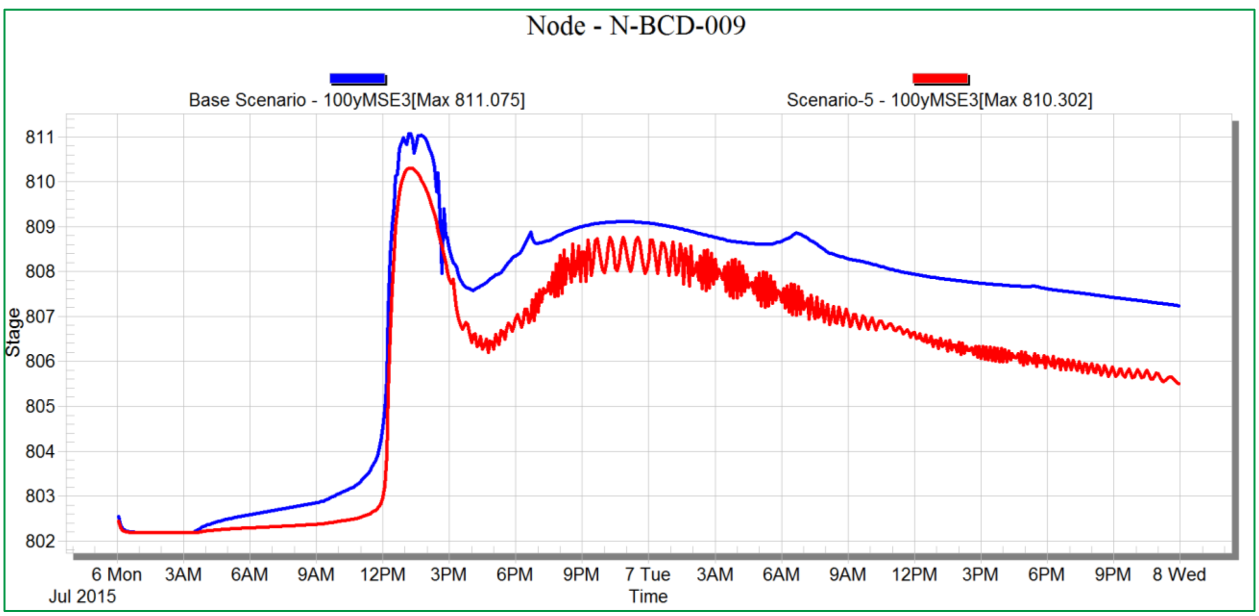

Figure 6: Scenario 5 & Base Scenario (Existing Conditions) Hydrograph

Scenario 6:

Design Details as related to XP-SWMM model (Table 6):
The cross section of Bassett Creek between Cedar Lake Rd and Van White Blvd was manipulated to provide a volume of approximately 62 acre-feet (AF). Updated cross section in model could be manipulated to fit within design requirements as long as same volume is provided and storage is accessible during 100-year storm event.

The proposed model did not change creek channel bottom elevations from existing conditions. Modified overbanks would need to be graded to match existing grade and still provide necessary freeboard from channel high water level. New cross section between Cedar Lake Blvd and Irving is smaller than the cross section from Irving Ave to Van White to avoid impacts to land south of Bassett Creek. Proposed model has higher flow than exiting conditions (1962 cfs v 1388 cfs) but a lower velocity (1.9 fps v 6.1 fps). These changes in flow and velocity in the model area contained within the Development Area. These potential impacts should be taken into account when further refining the design or rerunning the model with a different time step to reduce oscillations. See Figure 7 for the comparison between existing flood elevation and proposed flood elevation at Irving Ave.

Table 6: Changes to Existing Model for Scenario 6

Object	**Change**	**Reason**
L-BCD-011	Natural channel to New XL- XS (top width of 150-feet)	Regrade with tiered cross section
L-BCD-010	Natural channel to New XXXL- XS (top width of 280-feet)	Regrade with tiered cross section
L-BCD-009	Natural channel to New XXXL- XS (top width of 280-feet)	Regrade with tiered cross section

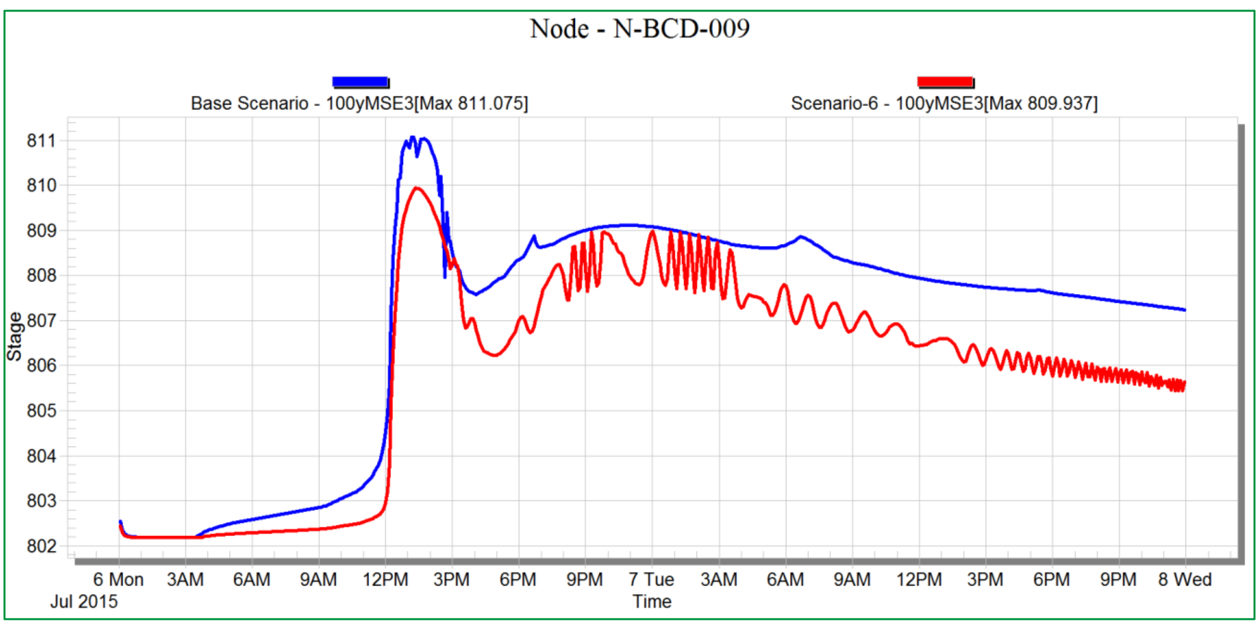

Figure 7: Scenario 6 & Base Scenario (Existing Conditions) Hydrograph

Scenario 7:

Design Details as related to XP-SWMM model (Table 7):

- Combination of Scenario 2 and 6.
- See Table XX for changes to model

The proposed model did not change creek channel bottom elevations from existing conditions. Modified overbanks would need to be graded to match existing grade and still provide necessary freeboard from channel high water level. New cross section between Cedar Lake Blvd and Irving Ave is smaller than the cross section from Irving Ave to Van White Blvd to avoid impacts to land south of Bassett Creek. Proposed model has higher flow than exiting conditions (1822 cfs v 1388 cfs) but a lower velocity (1.9 fps v 6.1 fps). These changes in flow and velocity in the model area contained within the Development Area. These changes should be taken into account when further refining the design. See Figure 8 for the comparison between existing flood elevation and proposed flood elevation at Irving Ave.

Table 7: Changes to Existing Model for Scenario 7

Object	**Change**	**Reason**
L-BCD-011	Natural channel to New XL- XS (top width of 150-feet)	Regrade with tiered cross section
L-BCD-010	Natural channel to New XXXL- XS (top width of 280-feet)	Regrade with tiered cross section
L-BCD-009	Natural channel to New XXXL- XS (top width of 280-feet)	Regrade with tiered cross section
BCD-048A	Storage Curve	Removed storage from 4.84 and 6.84 depth to reflect raising fields in Bryn Mawr
L-BCD-153	Redirected flow from BCD-048A to Bryn Mawr node	Storm sewer downstream of this node at inverts below bottom of proposed storage system
Bryn Mawr	Added	Reflects surface storage system. Approx. 42 AF.
Links to BCD-048A	Redirected to Bryn Mawr	Redirected overland flow to surface storage system

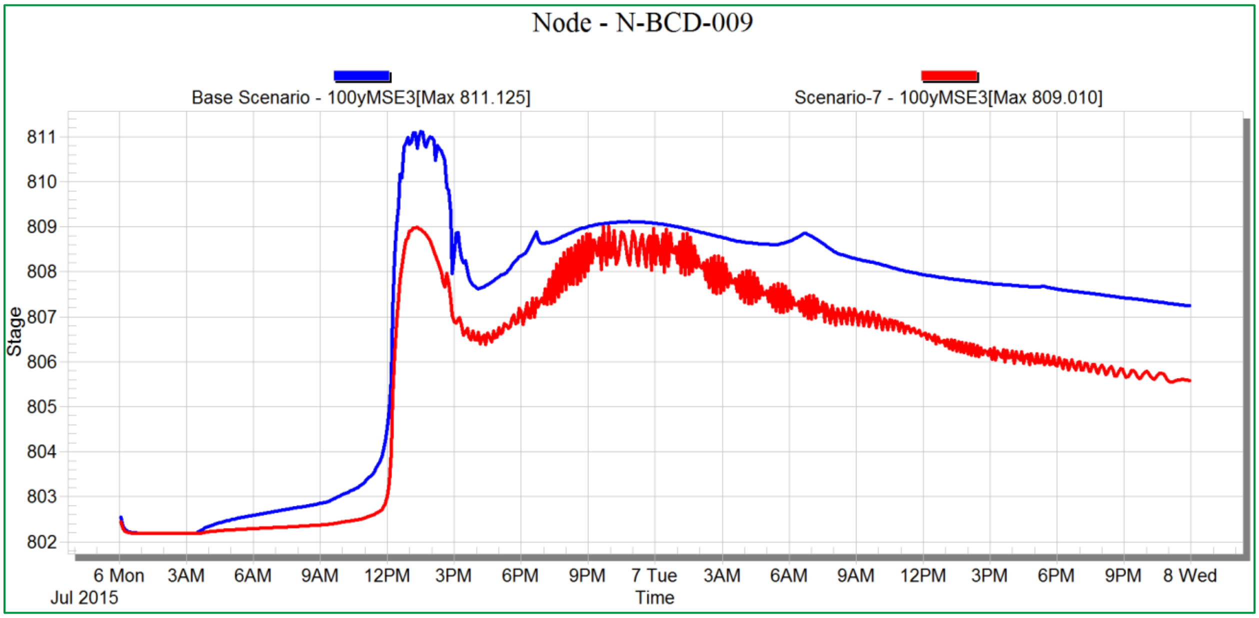

Figure 8: Scenario 7 & Base Scenario (Existing Conditions) Hydrograph

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