



**UNIVERSITY BOULEVARD FLOOD  
MITIGATION PLAN**

University Boulevard Flood Mitigation Plan for  
the City of Clive

May 2022

Prepared for:  
City of Clive

Prepared by:  
Stantec Consulting Services Inc.

Project Number: 193708720  
Flood Mitigation Assessment

**University Boulevard Flood Mitigation Plan – May 2022**

| <b>Revision</b> | <b>Description</b> | <b>Author</b> | <b>Date</b> | <b>Quality Check</b> | <b>Date</b> | <b>Independent Review</b> | <b>Date</b> |
|-----------------|--------------------|---------------|-------------|----------------------|-------------|---------------------------|-------------|
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## University Boulevard Flood Mitigation Plan – May 2022

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## Executive Summary

The University Boulevard Flood Mitigation Plan for the City of Clive (the City) aims to reduce the risk of riverine flooding for the City within an area that has experienced historic flooding. This area lies northwest of the confluence between Walnut Creek and North Walnut Creek. The flood risk in the University Boulevard area is a real and growing threat with three (3) major flood events in the last 12 years. The goal of this study is to build a strategy to reduce the flood risk and break the cycle of “flood-rebuild-repeat,” supporting the City’s strategic plan for the next 10 years.

This study assessed flood risk for the University Boulevard area, an area of particular concern due to a history of frequent flooding. The City had previously identified a target area for flood mitigation including property buyout due to previous studies and historical flood events. This area is outlined in the figure below and is referred to as the Focus Area. Though the central focus of this study is to mitigate risk in the Focus Area, a total of 411 structures in the surrounding neighborhood along Walnut Creek were selected as part of this study to assess the prioritization of these properties in the Focus Area and to consider more widespread effects of flood mitigation options. The Focus Area and full study area (study area) are indicated in Figure 1 below.

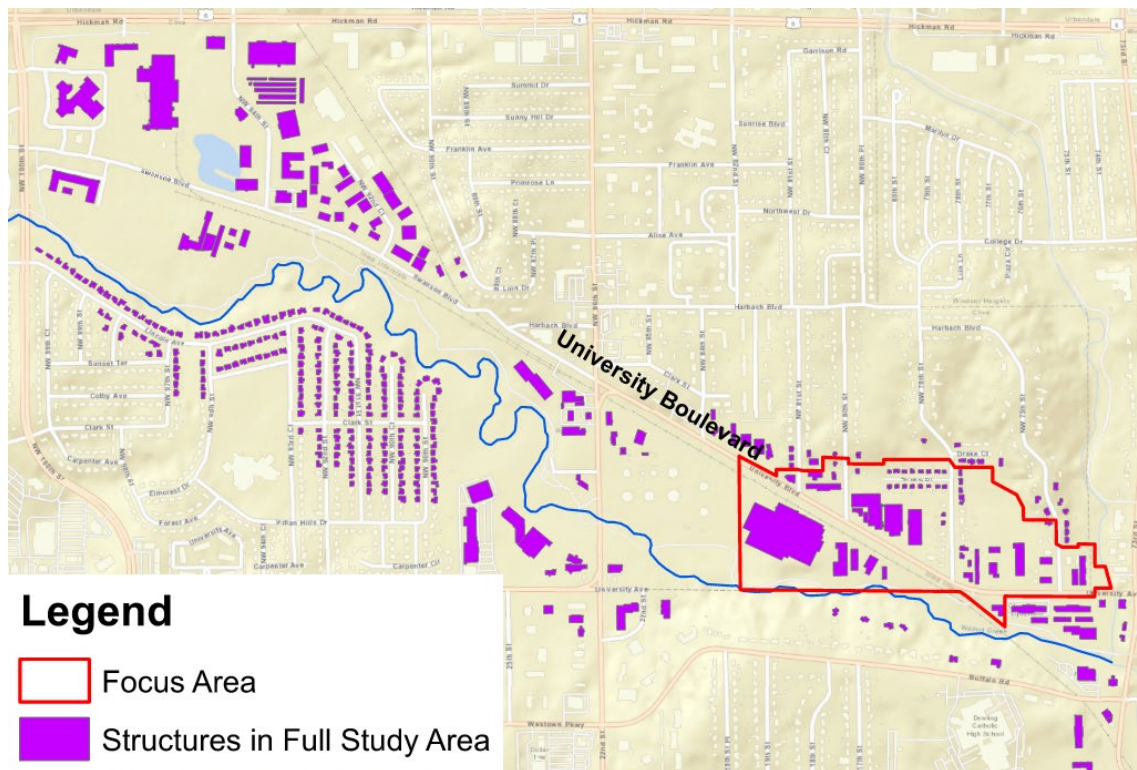


Figure 1: Focus Area and full study area extents



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This study started by leveraging the existing Hydrologic and Hydraulic (H&H) analysis developed in the Windsor Heights Flood Reduction and Resiliency Plan dated February 2022. Stantec leveraged this H&H study and updated the 2D HEC-RAS (hydraulic) model to incorporate significant buildings and two berms within the study area.

From there, various flood mitigation alternatives were conceptualized and run through this model to ultimately calculate a flood mitigation benefit-cost ratio (BCR) and strategize a path forward in the community. BCR's were calculated using the FEMA benefit-cost analysis methodologies and BCA Toolkit Version 6.0 to provide the City of Clive with data and deliverables that can be used to apply for federal grant money.

Five alternative flood mitigation strategies were considered in this project, listed below:

- Alternative 1 – Walnut Creek Railroad Bridge Improvements
- Alternative 2 – Levee and Floodwall Construction
- Alternative 3 – Individual Floodproofing of Structures
- Alternative 4 – Acquisition and Demolition of Structures
- Alternative 5 – Stream Re-Meandering and Conveyance Improvements

Analysis of the feasibility and BCR of each alternative allowed Stantec to collaborate with the City of Clive to provide a set of flood mitigation recommendations for the University Boulevard area, including an overall funding strategy. These benefit-cost analyses also helped inform public engagement efforts, which were essential in determining a path forward for flood mitigation.

The recommendations included in this report were presented to City Council in May of 2022 to gauge support in the path forward to broader flood mitigation.



## Acronyms / Abbreviations

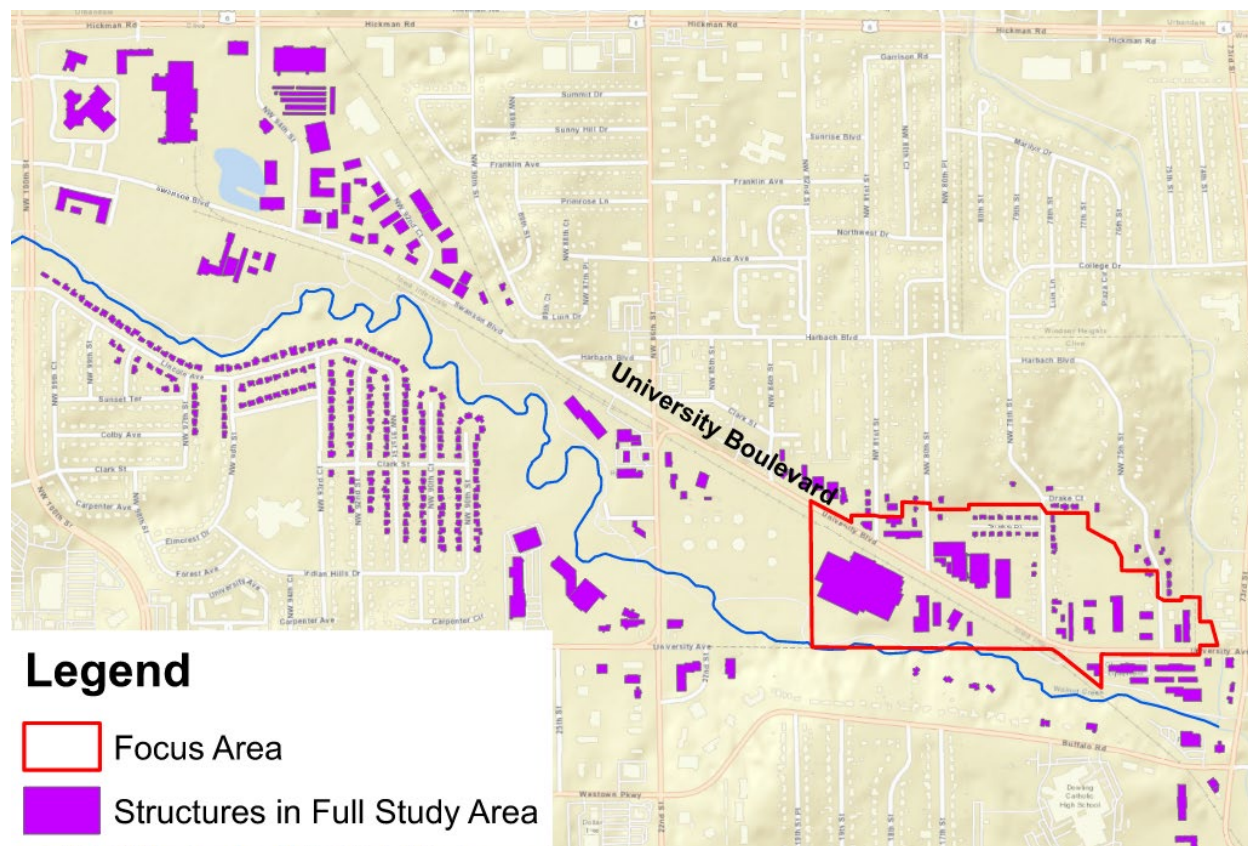
|       |   |
|-------|---|
| BCA   | Benefit-Cost Analysis                             |
| BCR   | Benefit-Cost Ratio                                |
| BRIC  | Building Resilient Infrastructure and Communities |
| DDF   | Depth Damage Function                             |
| DEM   | Digital Elevation Model                           |
| FEMA  | Federal Emergency Management Agency               |
| FMA   | Flood Mitigation Assistance                       |
| HMGP  | Hazard Mitigation Grant Program                   |
| H&H   | Hydraulic and Hydrologic Analysis                 |
| IDALS | Iowa Department of Agriculture & Land Stewardship |
| LFE   | Lowest Floor Elevation                            |
| MBE   | Mitigation Benefits Estimator                     |
| NFIP  | National Flood Insurance Program                  |
| USACE | United States Army Corps of Engineers             |
| USGS  | United States Geological Survey                   |
| WSE   | Water Surface Elevation                           |



# 1 Background

## 1.1 Project Overview and Objective

This project aims to build upon existing flood risk assessments to strategize and further flood mitigation efforts for the University Boulevard area of Clive, Iowa, as depicted in the Figure 2 below.



**Figure 2: Project scope diagram**

The University Boulevard Flood Mitigation Plan’s primary purposes are to:

- Determine feasibility and cost-effectiveness for various flood mitigation alternatives
- Gain community feedback and factor preferences into the next steps for the City
- Develop a preferred alternative to present to Clive City Council
- Recommend funding and implementation strategies for preferred flood mitigation alternative

This report provides a summary of existing hydraulic modeling and previous studies which were used as leveraged data to capture the existing conditions for the area, including existing flood mitigation measures. Further refinement of the existing hydraulic model allowed for a more accurate representation of the hydrologic and hydraulic (H&H) conditions to a scale that is useful for the objectives of the study.



Alternatives to alleviate the flooding problems in the neighborhood included modifications to a railroad bridge, construction of a levee and floodwall, floodproofing of individual buildings, acquisition and demolition of structures at risk, and a stream re-meander. A FEMA benefit-cost analysis (BCA) was performed for each of these alternatives.

An important component of this project was to engage with the University Boulevard community to learn more about their priorities and to communicate the preliminary results of this study. A brief discussion of this process and the knowledge gained is provided in this report.

The final steps for this study were to determine the most cost effective and feasible path forward for the City of Clive, utilizing any funding alternatives that may be available. Ultimately what this report will provide is a recommended mitigation path forward that can be implemented by the City upon approval from City Council.

## 1.2 Previous Studies Included in Project

Previous studies conducted in the area indicate that the City of Clive has severe flood risk. Within the University Boulevard neighborhood specifically, in recent decades, flooding occurs about every four (4) years on average, and the City is frustrated by the current cycle of “flood-rebuild-repeat.”

Stantec became familiar with the flood risk in the University Boulevard Neighborhood when conducting the Walnut Creek Watershed Mitigation Benefits Estimator (MBE) study, which led to the development of structure-specific flood risk and mitigation profiles for the neighborhood and surrounding areas.

The MBE study, along with other studies and reports, such as JEO’s Windsor Heights Flood Reduction Resiliency Plan and HDR’s Stream Re-Meandering Concept, were used as the launching point for this study. This effort expanded upon the most promising solutions in the University Boulevard neighborhood and assessed their feasibility and likelihood of success.

Additional reports, such as Clive’s Flood-Prone Property Buyout Program, Clive’s Draft District 1 Neighborhood Plan, and Clive’s Draft Water Resources Master Plan, were also reviewed for background information and to learn more about the City of Clive’s goals and priorities in conducting this study.



## 2 Methodology

Several alternative types of flood mitigation activities were selected for analysis based on collaboration with the City and from the previous reports mentioned above. Each of these alternatives was explored using the standardized FEMA benefit-cost analysis methodologies to analyze project cost-effectiveness and to support future grant funding requests. Within the FEMA Benefit-Cost Analysis toolkit (BCA Toolkit), the professional expected damages module was used as a comparison tool for all alternatives since several mitigation options could not be accommodated with the preferred riverine modeled damages (ie. floodproofing and levee options). However, for funding considerations, it is recommended that the City uses the riverine modeled damages module results from the BCA Toolkit if it is compatible with the mitigation action selected. Attached to this report are the BCA Toolkit files for each alternative under the professional expected damages module (Attachment A), as well as the BCA Toolkit files and report for the selected alternative under the riverine modeled damages module (Attachment B).

Project feasibility and community opinions towards each alternative were considered in the analysis and selection of alternatives. Two community meetings throughout the process allowed the opportunity for iterative feedback from property owners, and frequent meetings with the City’s Community Development Director helped shape the direction of the analysis based on City priorities and constraints.

The H&H model used for this analysis was leveraged from an existing 2D HEC-RAS model developed by the City of Windsor Heights and delivered to Stantec in December 2021. Stantec updated the geometry from this model to include two berms and some buildings within the Focus Area that significantly impacted hydraulics. More details are provided in the full report entitled *University Boulevard Flood Mitigation Plan* provided in Appendix E.1.

### 2.1 Data and Sources

Stantec reviewed existing reports and modeling efforts to leverage existing data in meeting project objectives. The data sources presented in Table 1 below were used directly for this analysis.

**Table 1: Data and sources**

| Data Source   | Use of Data  |
|---|--|
| 2D HEC-RAS Model of Walnut Creek from Windsor Heights Project                     | Used as the starting point for the 2D HEC-RAS models used to model water surface elevation and discharge under each flood mitigation alternative |
| Building Footprints Assessor Data from the City of Clive and County Assessor Data | Used to create building-specific inputs for the benefit-cost analysis  |



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|   |  |
|---|--|
| Ground Elevation DEM – 2014 LiDAR data used in previous Walnut Creek Study  | Used in the 2D HEC-RAS model and to estimate lowest floor elevations (LFE) for the benefit-cost analysis |
| Existing City and Local Plans (such as the Walnut Creek Watershed Master Plan, Clive's Draft District 1 Neighborhood Plan, and Clive's Draft Water Resources Master Plan) | Used for context and background information on flood risk and City priorities                            |
| USACE 1992 feasibility study  | Provided the alignment for the proposed levee and floodwall alternative                                  |

## 2.2 Mitigation Action Alternatives

### 2.2.1 INFRASTRUCTURE ALTERNATIVES

#### 2.2.1.1 Alternative 1 – Railroad Bridge Improvements

The first mitigation action considered was to make hydraulic improvements to an active railroad bridge along Walnut Creek. The existing bridge, as depicted in Figures 3 and 4 below, is about 180 feet long, as measured from Google Earth, and has a truss span of about 100 feet. The existing bridge and bridge opening restricts the river flow during the 500-year flood event, worsening flooding in the surrounding area.

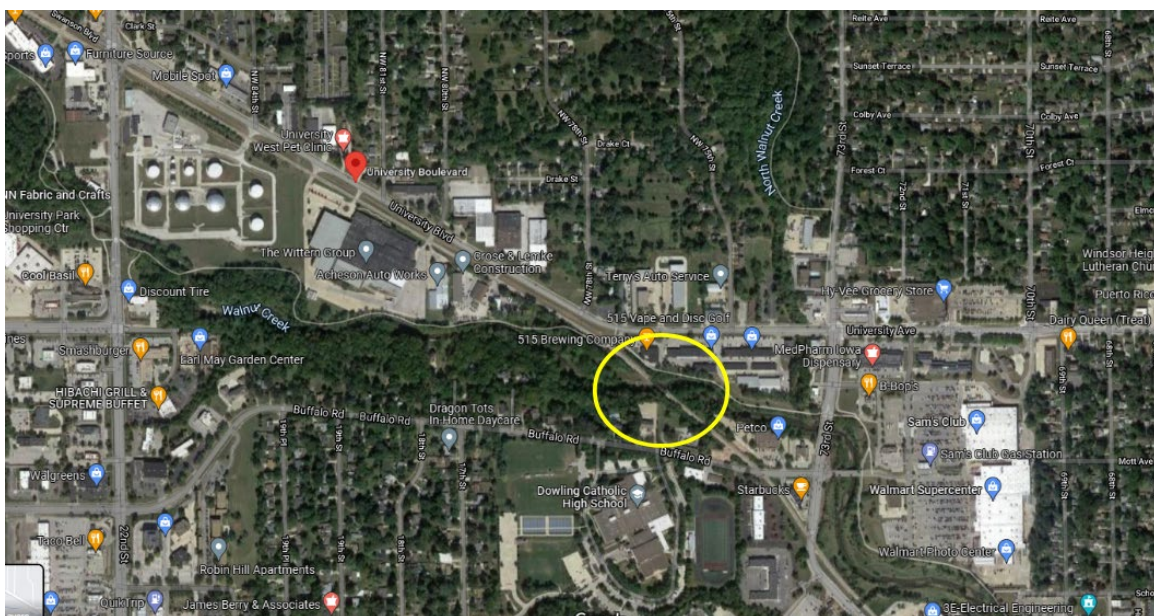


Figure 3: Existing railroad bridge location





**Figure 4: Photo of existing railroad bridge**

To increase channel capacity and lessen flooding impacts due to restricted flow, the existing track would need to be raised, and the bridge span would need to be increased to at least 150-feet. A main span of 150-feet would require a total length of 250-feet, considering the 50-foot approach spans on either side on new abutments. Based on pricing estimates for similar bridges, these improvements would cost approximately \$30,000 per linear foot, plus a 30% contingency given the conceptual nature of these estimates. This puts the opinion of probable cost at \$9.75 million. The costs are broken out as displayed in Table 2 below, and more details are provided in Attachment C.1. This cost also does not include improvements to the approach track, which would need to be included in final considerations if this option were to be selected.

**Table 2: High-level cost estimate for railroad bridge removal**

| Item                           | Minimum Cost Estimate | Maximum Cost Estimate |
|--------------------------------|-----------------------|-----------------------|
| Mobilization/Demobilization    | \$975,000             | \$1,267,000           |
| Site Preparation               | \$1,000,000           | \$1,300,000           |
| Earthwork                      | \$815,000             | \$1,059,000           |
| New Track on Bridge and Tie-in | \$750,000             | \$975,000             |
| Substructure                   | \$800,000             | \$1,340,000           |
| Superstructure                 | \$2,910,000           | \$3,483,000           |
| Remove Existing Bridge         | \$250,000             | \$326,000             |
| <b>Total Cost</b>              | <b>\$7,500,000</b>    | <b>\$9,750,000</b>    |

Considering this option qualitatively, significant coordination would be required with the railroad company that owns this bridge. A project of this nature is also likely to take at least several years to design and implement. As will be discussed in Section 3 showing the results of the benefit-cost, these changes will result in a relatively minor change in water surface elevations (WSEs) during flooding events for a high

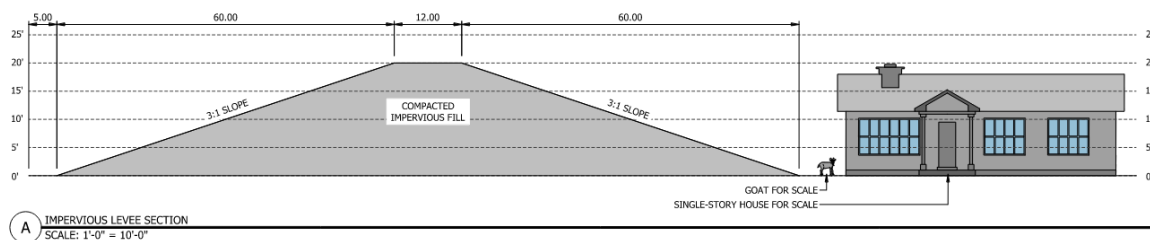


cost and significant logistical considerations. Additionally, the H&H modeling assessed an optimistic scenario where the bridge was fully removed where this alternative would likely still have some hydraulic impacts.

### 2.2.1.2 Alternative 2 – Levee and Floodwall Construction

The second flood mitigation alternative considered for the area was a levee and floodwall based on the alignment from a USACE 1992 feasibility study, including 4,200-feet of earthen levee and 4,180-feet of floodwall. The levee and floodwall height required to protect against the 1% annual chance flood event (100-year flood event) was calculated based on the H&H model adapted for this project, as discussed in Section 2.3.1 of this report.

From this analysis, it was determined that the levee and floodwall would need to be as much as 20 feet tall in some areas, as demonstrated in Figure 5 below.

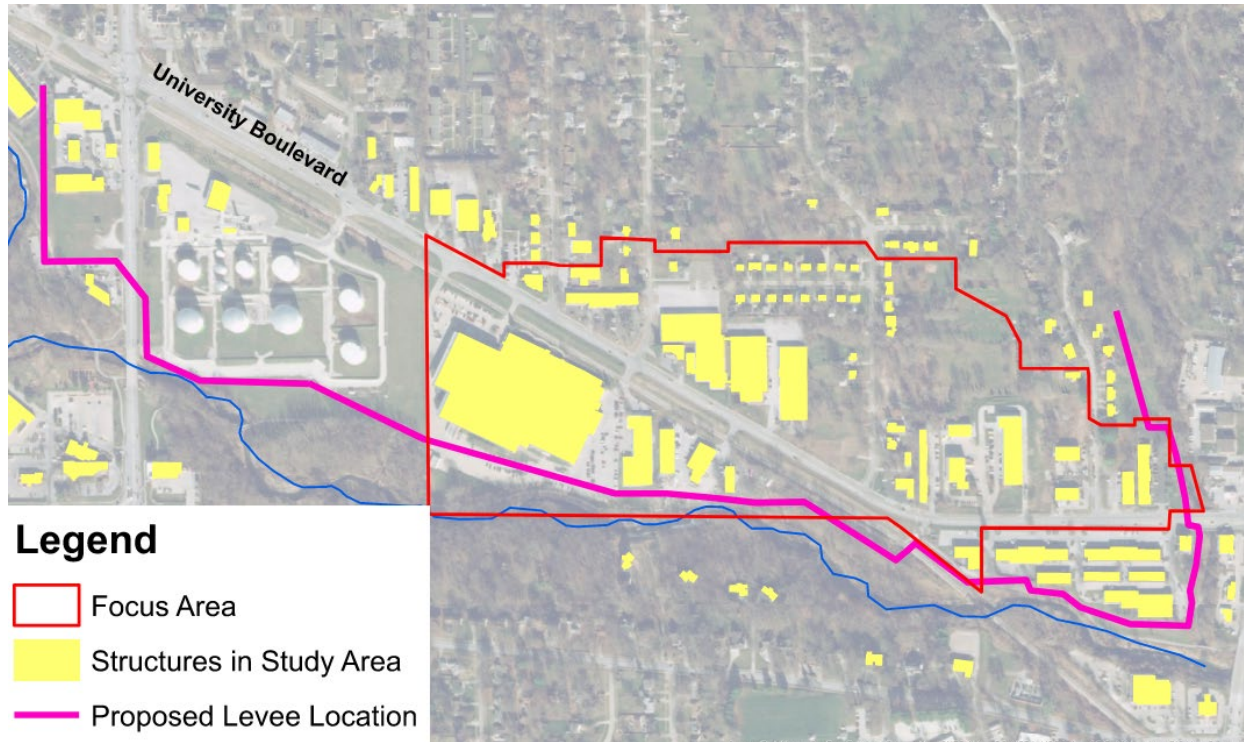


**Figure 5: Levee and floodwall approximate dimensions for scale**

The total opinion of probable cost for such a levee is \$68.9 million dollars. The assumptions and considerations included in this cost estimate can be found in Attachment C.2. This cost estimate was based on the general assumption that the levee is 20-feet tall at its maximum height and that a sheet pile wall would be placed underneath the floodwall. The cost estimate includes earthwork, sewers and drains, structures for sanitary and storm sewers, traffic control, site work and landscaping, and engineering and permitting. Note that no geotechnical analyses were performed in this conceptual assessment.

Implementing a levee to protect the University Boulevard area from the 100-year flood event would come at a significant cost and would also likely be disruptive for the community considering how tall it would need to be and the disruption to the local Greenbelt trails. A project of this scale and scope would also require significant permitting efforts through FEMA and USACE. Figure 6 below shows the proposed alignment of the levee and floodwall.





**Figure 6: Proposed alignment of levee and floodwall in relation to Focus Area**

As demonstrated in Figure 7 below, adding a levee and floodwall to the project area will also cause flood depths to increase in some areas. A water surface elevation increase in the 100-year flood event is indicated in red and orange in the figure below. If this alternative were to be considered further, the impacts of this flooding increase would need to be considered and managed.

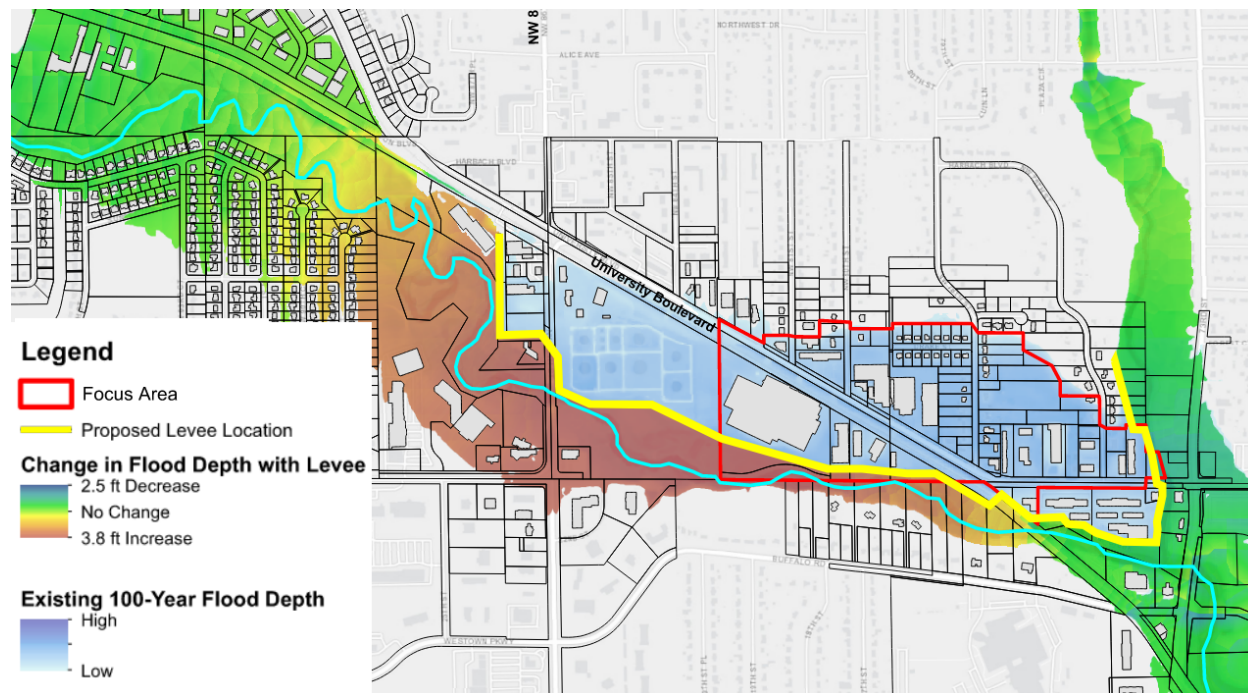


Figure 7: Change in flood depth after implementation of proposed levee

## 2.2.2 BUILDING-SPECIFIC ALTERNATIVES

Flood mitigation action alternatives that consider each building or structure individually were also analyzed. These include both floodproofing and property acquisition and demolition.

### 2.2.2.1 Alternative 3 - Individual Floodproofing

According to the FEMA National Flood Insurance Program (NFIP) Technical Bulletin 3 (2021), wet floodproofing is defined as the following:

*“The use of flood damage-resistant materials and construction techniques that intentionally allow floodwater to enter and flow through a structure without causing damage that requires more than cosmetic repairs.”*

Dry floodproofing is defined as follows:

*“A combination of measures that make a building and attendant utilities and equipment watertight and substantially impermeable to floodwater, with structural components having the capacity to resist flood loads.”*

Dry floodproofing, though more resilient than wet floodproofing, is not easily obtainable for each structure in this scope given cost and building constraints. For this analysis, Stantec optimistically accounted for



the costs and benefits of dry floodproofing to simplify the benefit-cost analysis, though it is worth noting that a wet floodproofing level of protection is more likely. This dry floodproofing assumption includes water-tight sealing, opening barriers, and structural reinforcements in some cases, as shown in Figure 8 below.



**Figure 8: Floodproofing conceptual design**

For conceptual design considerations, the height of floodproofing matches the minimum requirement of Clive, Iowa regulations that specify floodproofing to be one (1) foot above the Base Flood Elevation<sup>1</sup>. Note that without additional freeboard, building materials and components do still have flood risk since flood waters could still overtop the floodproofing elevation. It is also worth noting that this type of floodproofing is not fundable for residential buildings through FEMA hazard mitigation funding. According to National Flood Insurance Program (NFIP) regulations, residential buildings would have to have their lowest floor elevated to or above the BFE as a floodproofing measure, which was not considered for this analysis<sup>2</sup> due to local preferences. For more information on floodproofing guidelines in Iowa, see Attachment D.1.

The floodproofing conceptual cost estimate conducted in this analysis does not include design and permitting costs. A cost estimate of about \$11 per square foot of building area for every foot of vertical flood protection was considered. For example, if a 5,000 sf commercial building with a masonry exterior needed two (2) feet of vertical protection,  $5,000\text{-sf} \times 2 \text{ vertical feet} \times \$11 / \text{sf/vertical foot} = \$110,000$ . The estimated flood proofing cost of \$110,000 can be expected for floodproofing on that example building.

Stantec analyzed the conceptual cost of this floodproofing for non-residential properties within the Focus Area. These calculations can be found in Attachment C.3. Considering the high flood depths in the area, floodproofing would need to be eight (8) or nine (9) vertical feet for some structures to meet Clive regulations, which is not only unlikely to provide adequate flood protection from such an event, but it is also unrealistic considering the building's design. The building would need to be designed to handle hydrostatic forces at such a height, which is not likely. Floodproofing can only realistically reach three (3)

<sup>1</sup> Clive does have a certified floodproof basement exemption that would be allowed if the buildings were raised, but this would not be a practical solution.

<sup>2</sup> [https://www.fema.gov/floodplain-management/manage-risk/residential-buildings-basements#:~:text=Since%201971%2C%20the%20National%20Flood,the%20Base%20Flood%20Elevation%20\(BFE\)](https://www.fema.gov/floodplain-management/manage-risk/residential-buildings-basements#:~:text=Since%201971%2C%20the%20National%20Flood,the%20Base%20Flood%20Elevation%20(BFE))

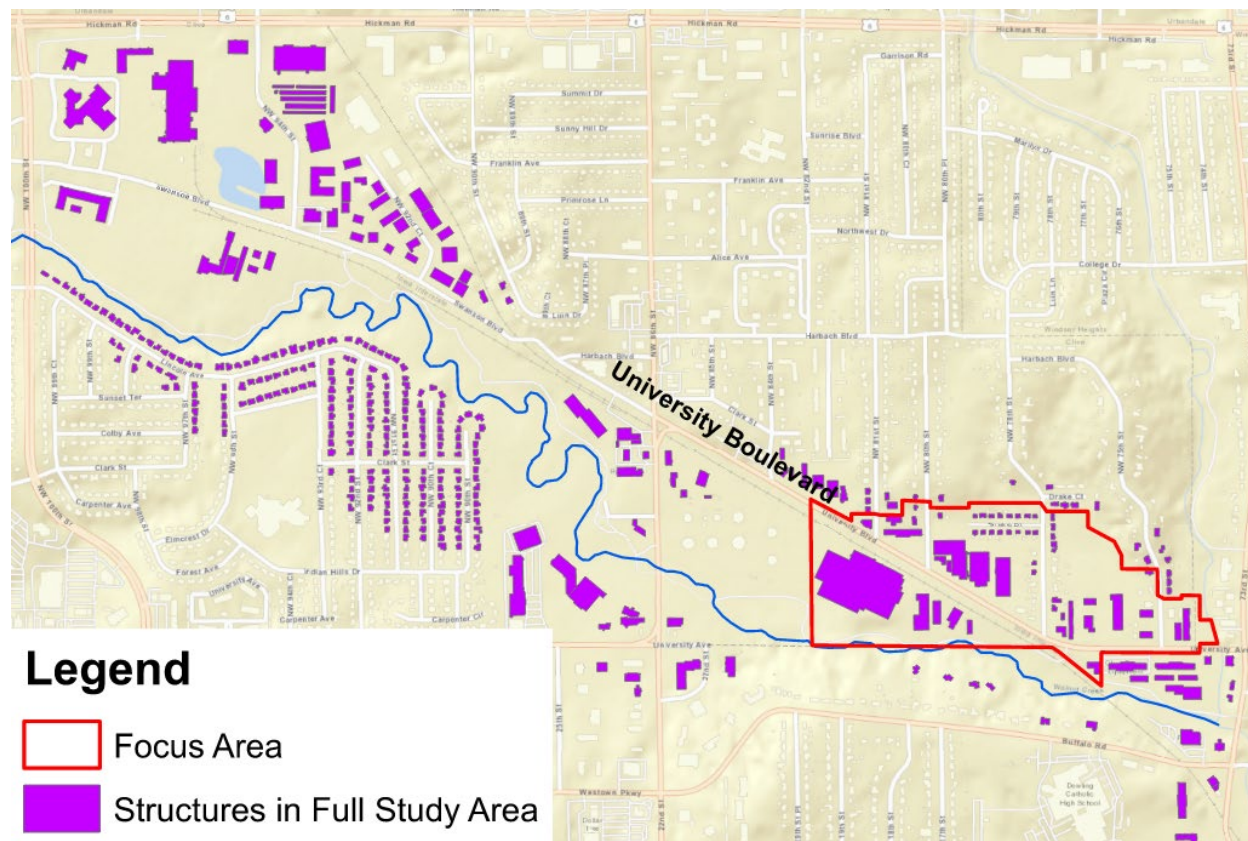


to four (4) feet, which eliminates many buildings in the Focus Area from consideration for dry floodproofing.

This mitigation strategy would only be recommended for properties on the fringe of the floodplain where about one (1) or two (2) vertical feet of floodproofing would be required, or in situations where other mitigation strategies, such as property acquisition, are less feasible.

### 2.2.2.2 Alternative 4 - Individual Acquisition and Demolition

The fourth mitigation action alternative considered is acquisition and demolition. Each property was analyzed individually to determine the potential flood reduction benefits associated with buying out the property and preventing further development. This strategy was part of the City's initial plan when the Focus Area depicted in Figure 9 was developed following the June 2018 flood. This destructive event prompted the City's call to action in eliminating the cycle of flood, rebuild, repeat that the City continues to experience. Acquisition is the only true permanent solution with no residual risk but needs to be voluntary based on individual property owner decisions.



**Figure 9: Project area**

Though the properties in the original Focus Area were in center focus for this analysis, all 411 structures in the study area were analyzed to assess the need to adjust buyout priorities, as depicted above in



Figure 9. The benefit of analyzing buyout cost-effectiveness with each property individually is that it allows for easy grouping of different structures to consider buyout phases.

If properties are to be acquired in groups, the City may be able to consider potential community features, additional land uses, or other benefits for large plots of newly acquired land. Acquisition and demolition is the only strategy to fully eliminate flood risk on a property.

The cost of acquisition and demolition for each property was estimated based on county assessor data for each property. Properties are to be acquired at fair market value, which was assumed to be a 20% markup from county assessor data valuation as coordinated with the City. From there, an allowance for the cost of appraisal, closing and legal fees, asbestos removal, and demolition and site grading were considered as well. After acquisition and demolition, the land will need to be landscaped and maintained periodically. Table 3 below shows the variables considered in the acquisition and demolition cost estimate for each structure.

**Table 3: Costs associated with property acquisition and demolition**

|                                   |                         |
|-----------------------------------|-------------------------|
| Markup from Valuation             | 20%                     |
| Property Appraisal                | \$1,000 per structure   |
| Closing Costs and Legal Fees      | \$4,000 per structure   |
| Asbestos Removal without Basement | \$2.00 per square foot  |
| Asbestos Removal with Basement    | \$3.85 per square foot  |
| Demolition and Site Grading       | \$15.03 per square foot |
| Landscaping Maintenance           | \$300 per acre per year |

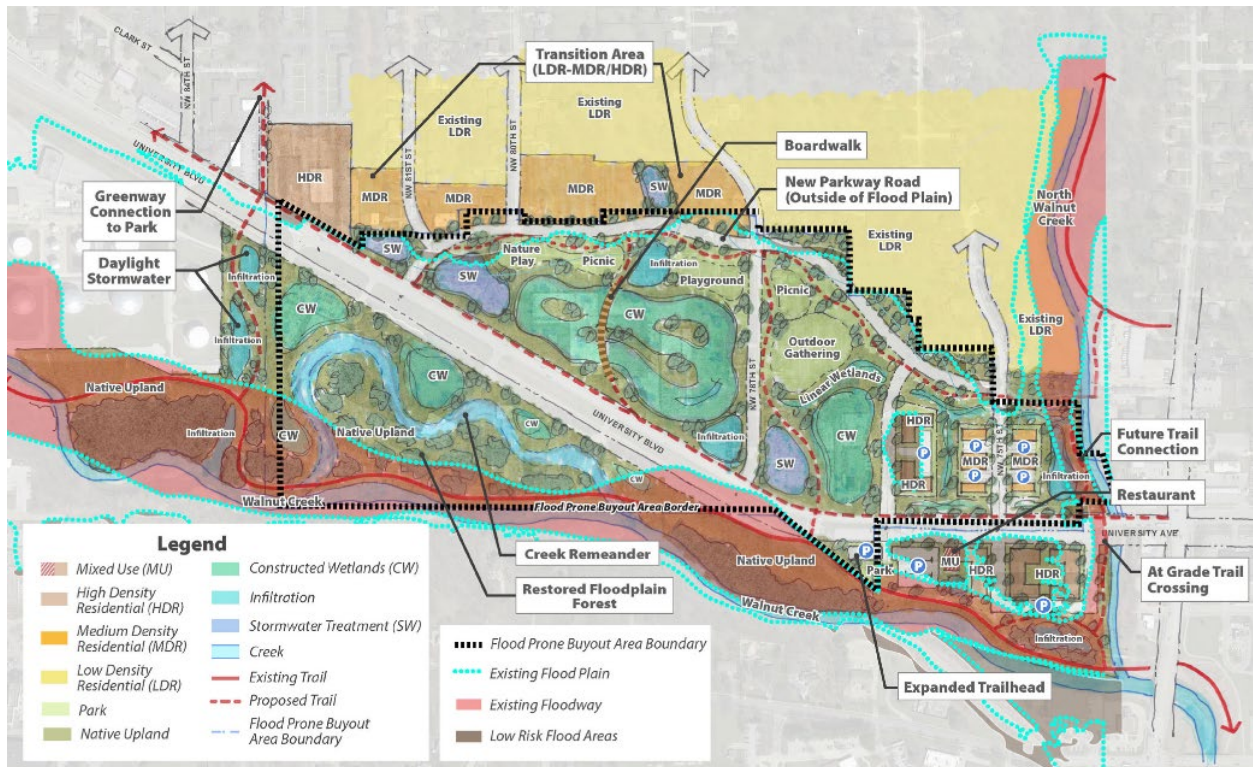
## **2.2.3 ADDITIONAL ALTERNATIVE**

### **2.2.3.1 Alternative 5 – Stream Re-Meander and Conveyance Improvements**

The final mitigation action considered stream re-meandering and conveyance improvements, which could potentially be paired with acquisition and demolition. The Walnut Creek re-meander concept was developed as an alternative to evaluate the potential benefits of floodplain restoration and channel re-meandering to the known flooding issues in the surrounding areas. The historic Walnut Creek floodplain, within the project area, has experienced significant encroachment and fill due to adjacent urban development, and Walnut Creek had been previously straightened. This has resulted in channel incision, reduced flood flow conveyance capacity and hydraulic floodplain access, which has contributed to repeat flood events in the University Boulevard neighborhood. This alternative review is intended to serve as a high-level assessment to factor into the BCA and to potentially expand funding opportunities for flood mitigation in the area.



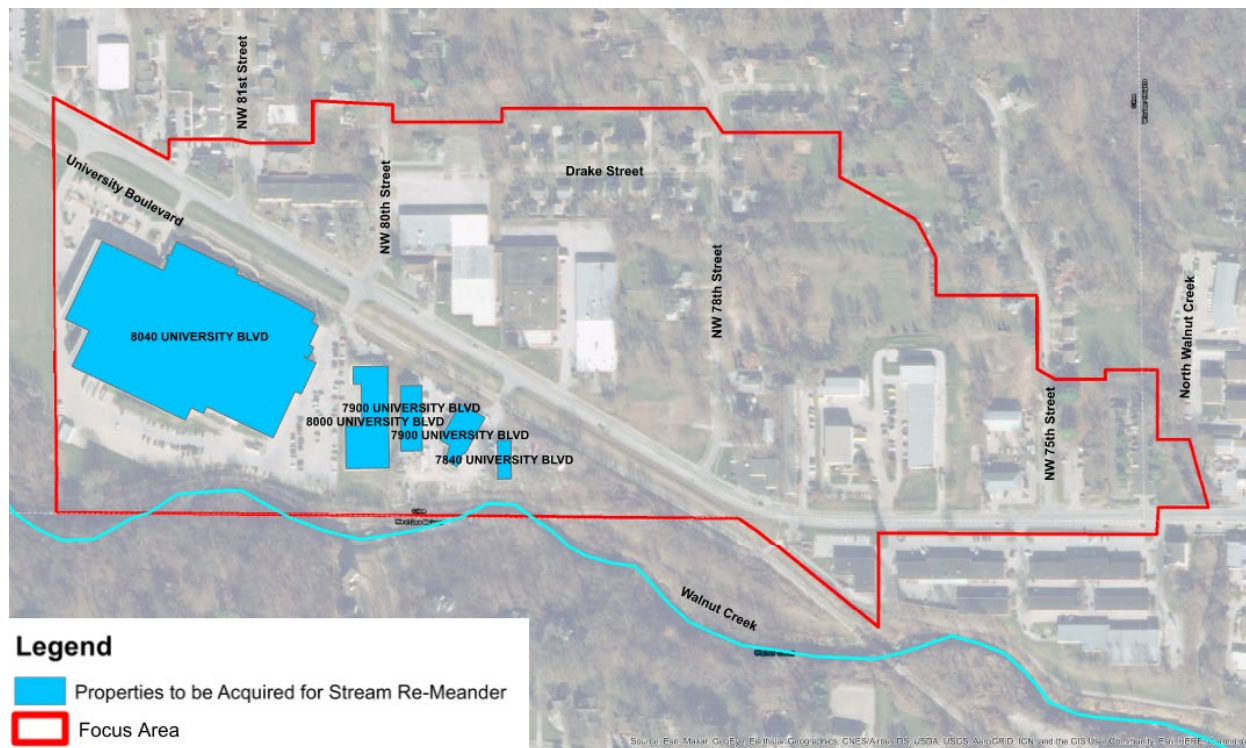
## University Boulevard Flood Mitigation Plan – May 2022



**Figure 10: Stream re-meander conceptual design (by the Hoisington Koegler Group Inc. 86<sup>th</sup> Street Neighborhood Plan)**

The conceptual design, depicted in Figure 10 above, would combine a new meandering channel with extensive earthwork in the floodplain. The existing straightened and incised river channel would be replaced with a meandering (and longer) channel form, and portions of the floodplain would be excavated to create a floodplain accessible in smaller, more frequent flood events. This conceptual design would require acquisition and demolition of the five high-risk properties south of University Boulevard at the addresses depicted in Figure 11 below.





**Figure 11: Properties to be acquired to enable a stream re-meander and conveyance improvements project**

By removing the encroachments that have confined the valley, the area will be more resilient to flood events and reduce flooding risks for both adjacent and upstream areas. Allowing flood flows to slow down and spread out across a well-connected floodplain improves flood storage and groundwater recharge, encourages deposition of fine sediments, promotes natural recruitment of volunteer vegetation, recharges shallow groundwater, and reduces erosion forces. Increasing channel, riparian, wetland, and terrestrial complexity will provide an ecological uplift in an area that has historically been impacted by urban development. Existing stormwater drainage systems could be configured to drain to the new floodplain, and wetlands could be provided to capture pollutants, thus improving downstream water quality. This type of project could also possibly be used to generate bank mitigation credits to offset impacts that occur elsewhere in the watershed, though it is worth noting that federal funds cannot be used to create bank mitigation credits that would be used on a federal permit. Figures 12 and 13 below show the difference between the existing and proposed alignment for Walnut Creek under this stream re-meander alternative.



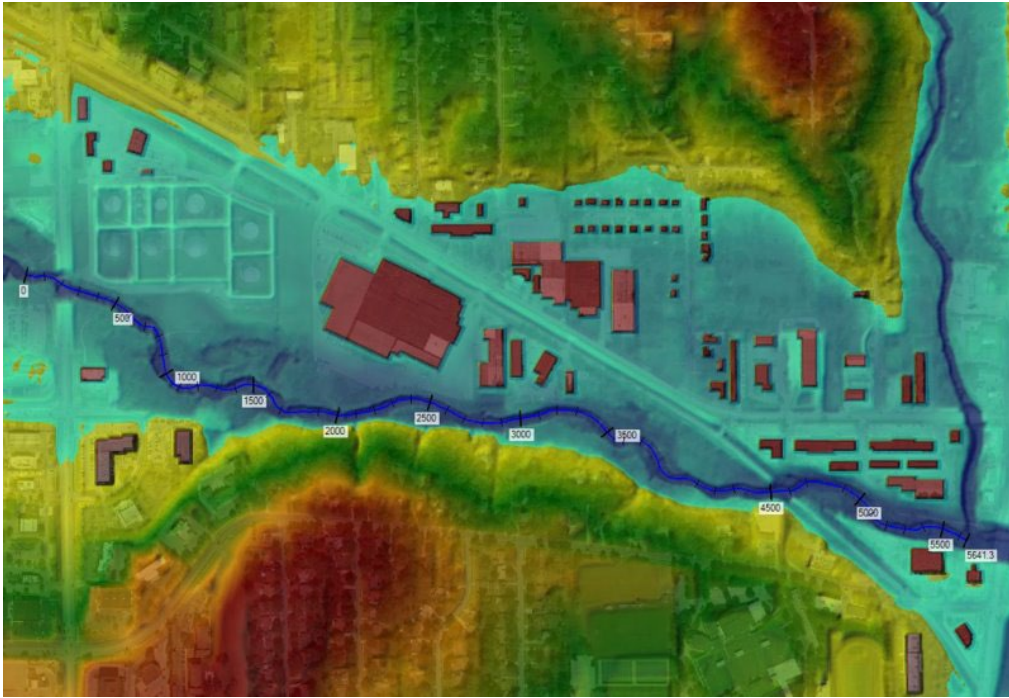


Figure 12: Existing Walnut Creek alignment

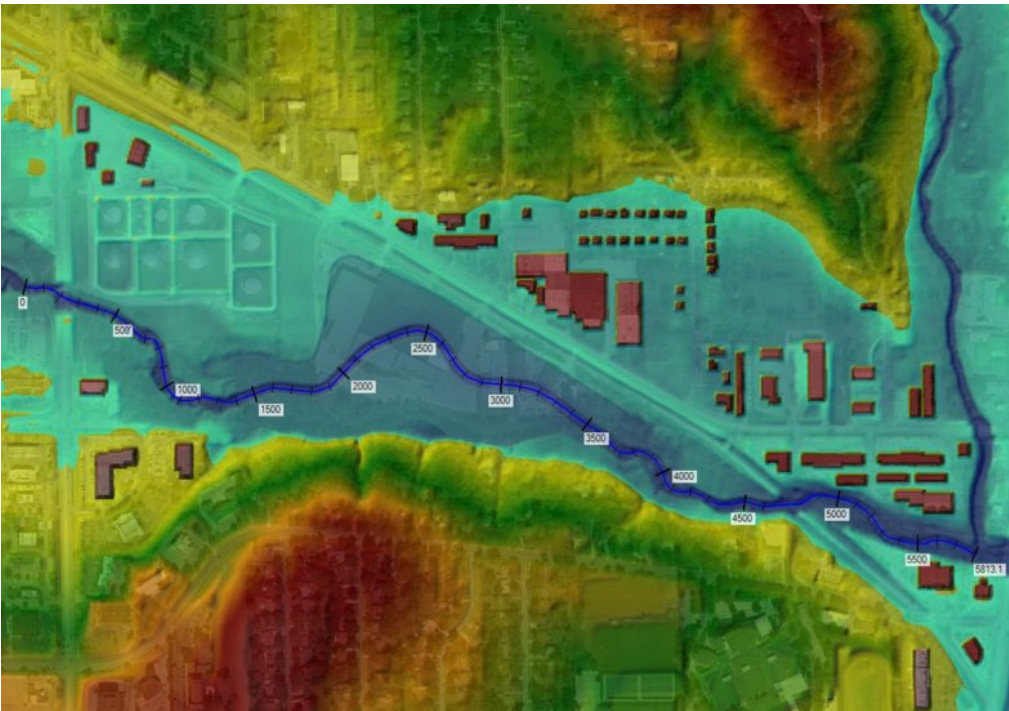


Figure 13: Proposed Walnut Creek alignment under stream re-meander and conveyance improvements project



2.2.3.1.1 Stream Re-Meander Methods

The evaluated project area is located between the 86<sup>th</sup> street and 73<sup>rd</sup> street bridges. The channel and floodplain area become constricted by the 86<sup>th</sup> street roadway embankment and remain so through the project reach. The channel corridor was previously channelized and pushed up against the right valley wall throughout this entire stretch, while the left side of the valley has been filled with berms and development pads that are more than 6+ feet above the historic floodplain elevations. The combination of channelization and encroachment has contributed to channel degradation and incision and an increase in flood water surface elevations.

The proposed channel dimensions and corridor were developed based on natural channel design principles to create a resilient and long-term sustainable solution. A key metric for determining proper channel configurations is estimating bankfull discharge. Bankfull discharge is defined as the flow at which water levels access the adjacent floodplain, and in urban watersheds typically have a recurrence interval between 1-1.5 years. This is typically determined by field measurements and accompanying stage discharge calculations or flow frequency analysis at a USGS Gage. For this concept, a flow frequency analysis was conducted on USGS Gage 05484800, located about 1.5 miles downstream of the site. The gage has fifty (50) years of record and drainage area of 78.4 square miles. The estimated 1.25-year discharge at the Gage was scaled proportionally to the contributing drainage area at the project site (60-square miles or ~77% of the drainage area at the gage). A summary of the conceptual channel dimensions and planform are provided in Table 4 below.

**Table 4: Morphological characteristics for stream re-meander design**

| Morphological Characteristics                         | Design |
|---|--------|
| Stream Type (Rosgen)                                  | C      |
| Drainage Area, square miles (DA)                      | 60     |
| Flow, CFS (Q <sub>bkf</sub> )                         | 1,126  |
| Water Surface Slope, Ft/ft (S)                        | 0.25%  |
| Bankfull Width, ft (W <sub>bkf</sub> )                | 66.3   |
| Width/Depth Ratio (W/D)                               | 18     |
| Maximum Depth (d <sub>max</sub> )                     | 5.16   |
| Mean, Depth, ft (d <sub>bkf</sub> )                   | 3.7    |
| Cross-Sectional Area, square feet (A <sub>bkf</sub> ) | 245    |
| Pool-to-Pool Spacing (ft)                             | 5-7    |
| Sinuosity   | 1.2    |

The concept plan includes bioengineered bank stabilization methods that would utilize wood debris and logs salvaged on-site to protect against erosional processes, while providing a medium to support revegetation. Successful revegetation will help to improve resilience to flood events that are expected to become stronger (more likely) over time. The plan also calls for reestablishing a bedform complexity in



the form of riffles and pools. Imported mixtures of rock, combined with locally salvaged woody debris is used to provide vertical stability and prevent upstream migration of headcuts.

This stream-re-meander design would require test pit digging, clearing and grubbing, channel excavation, boulder cross vanes, mobilization/demobilization, and other line items, as fully described in Attachment C.5.

With a 20% contingency and construction observation included, the total project budget is expected to be about \$8.16 million for stream re-meander and conveyance improvements, not including the acquisition of the five properties necessary for the project to take place.

## 2.3 Inputs and Assumptions

Assessing the benefits of flood mitigation strategies for the University Boulevard neighborhood required that an H&H study be performed, and that the appropriate building data and assumptions were used to accurately estimate flood damage. The following sub-sections describe the inputs and assumptions that went into the estimation of benefit-cost analysis using the riverine modeled damages module for the acquisition and demolition alternative, though many of these assumptions apply to the other alternatives analyzed.

Figure 14 below shows the general process flow for incorporating each of these inputs and determining a benefit-cost ratio. Water surface elevations are compared to building features, including lowest floor elevation, to assess flood depth at each property. Depth-damage functions built into the BCA Toolkit are then used to calculate monetary damage anticipated from flood events, which is converted to annualized loss and compared to project costs to produce a benefit-cost ratio.

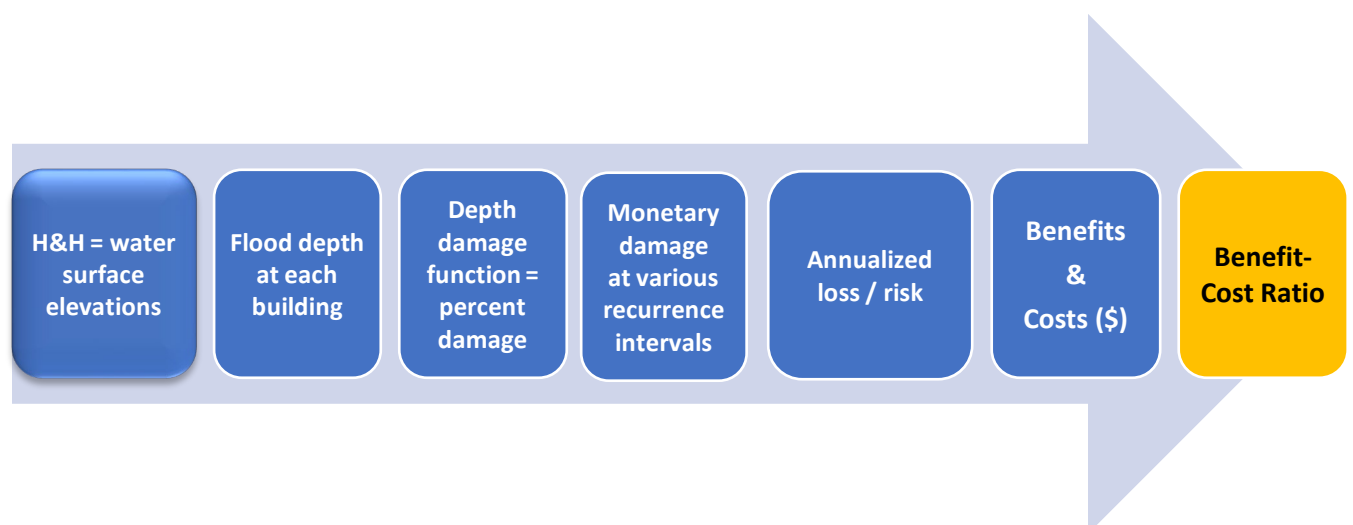


Figure 14: Process flow for calculating flood risk, for use in the benefit-cost ratio calculation



Water surface elevation and discharge data for each flood recurrence interval (10-, 50-, 100-, and 500-year) were obtained from the HEC-RAS 2D model developed for this study. Section 2.3.1 summarizes the input and assumptions that were made during the modeling exercise. Section 2.3.2 will describe the inputs and assumptions that were included in the BCA. Some useful definitions for terms referred to are listed below for awareness:

*Risk Assessment* – An investigation into consequence versus likelihood of a particular hazard

*Mitigation Benefit* – Difference between baseline ‘risk assessment’ and post mitigation ‘risk assessment’

*Mitigation Cost* – The capital and lifecycle cost of implementing a mitigation measure. Operation and maintenance costs are an example of a mitigation cost.

*Benefit-Cost Ratio* – Ratio of benefit to cost that represents the cost effectiveness. For example, a ratio of 1.0 or higher would imply that the benefit cost outweighs the overall cost.

### 2.3.1 HYDROLOGIC & HYDRAULIC ASSUMPTIONS

The existing H&H analysis developed by the City of Windsor Heights in December 2021 was leveraged for this project. Stantec used this model, created using HEC-HMS Version 4.8, and updated the geometry in HEC-RAS Version 6.0 to incorporate buildings and two significant berms within the study area. Details on this process and the assumptions made are included in the full report *University Boulevard Flood Mitigation Plan* provided in Appendix E.1.

From this analysis, water surface elevation (WSE), streambed elevation, and discharge data were extracted for each project alternative and under each storm recurrence interval (10-, 50-, 100-, and 500-year). Discharge values were consistent throughout the study area, but WSE and streambed elevation values were assigned to each property individually.

WSE grids and Walnut Creek cross-sections with corresponding water surface elevation rasters were exported from HEC-RAS to ArcMap. Within ArcMap, these WSE rasters were intersected with the county-provided building footprint shapefile, and the WSE value nearest to each building footprint was taken as the corresponding WSE. This process involved converting the WSE grids to a set of points using the Raster to Point tool and subsequently finding the closest match between these points and the building footprint using the Spatial Join tool.

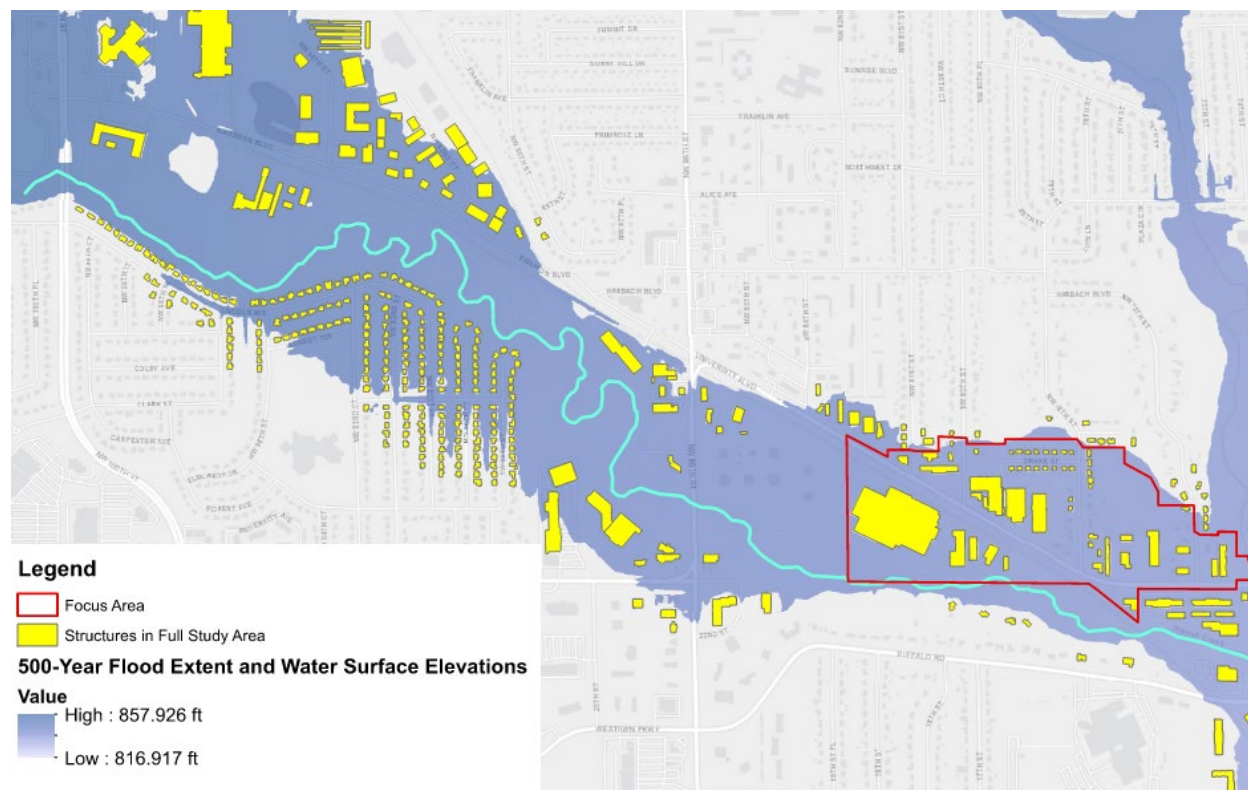
Streambed elevations corresponding to each building footprint were calculated by interpolating between the streambed elevations corresponding to each Walnut Creek cross-section by creating a raster from the cross-sections using the Topo to Raster tool. This raster was intersected with each building footprint shapefile, taking the mean streambed elevation value from the intersection as the structure’s streambed elevation.



## 2.3.2 BENEFIT-COST ANALYSIS (BCA) ASSUMPTIONS

### 2.3.2.1 Analysis Scope and Overview

The benefit-cost analysis conducted for the University Boulevard neighborhood includes 411 properties with a particular emphasis placed on the properties in the Focus Area, as depicted in Figure 15 below. These structures include a mix of residential and non-residential properties, with the study area extending to reach all properties with parcels touched by the 500-year flood plain.



**Figure 15: Structures included in the analysis, overlaid with 500-year floodplain**

This BCA was conducted using the Federal Emergency Management Agency (FEMA) BCA Toolkit V.6.0 Benefit-Cost Calculator (BCA Toolkit). This calculator requires input data to inform estimates of project costs and benefits, ultimately calculating a ratio of cost-effectiveness with 1.0 or higher indicating a cost-effective project. In general, the 10-, 50-, 100-, and 500- year storm events were considered. The time value of money adjustments (7% discount rate) were made within the toolkit using a project useful life of 100 years for the acquisition and demolition of the properties per FEMA BCA<sup>3</sup> and Office of Management

<sup>3</sup> [https://www.fema.gov/sites/default/files/2020-04/fema\\_bca\\_reference-guide.pdf](https://www.fema.gov/sites/default/files/2020-04/fema_bca_reference-guide.pdf)



and Budget (OMB)<sup>4</sup> standards. Useful life values for other alternatives include 50 years for railroad bridge adjustments, levee and flood wall construction, and stream re-meander, and 30 years for floodproofing.

The BCA Toolkit was used to predict the cost-effectiveness for each project alternative mentioned in the previous section. Because a few of these alternatives could only be analyzed using the BCA Toolkit’s professionally expected damages module, all alternatives were initially compared using this module for direct comparison. These results will be discussed in Section 3 of this report. Once these alternatives were compared and the property acquisition alternative was determined to be preferable, the acquisition alternative was assessed using the riverine modeled damages module for the damage frequency relationship, as this module will likely be used for future grant applications. The professionally expected damages module results are conservative (lower damage/benefit values) in comparison to the riverine module results. The following assumptions were used as inputs in both types of module runs.

**2.3.2.2 Inputs and Assumptions**

Building parameters such as square footage, number of stories, occupancy type, and presence of a basement were obtained from assessor data provided by the City in the form of a consolidated shapefile with unique parcel identifiers. Elevation certificates were provided by the City for some of the properties as well to inform lowest floor elevation inputs.

**Building Type, Number of Floors, and Presence of a Basement**

The number of floors and presence of a basement for each property was used to inform the depth damage function used in the analysis. Secondary structures, such as sheds and garages, were not considered as separate structures in this analysis but were used in building replacement value estimates.

The complete assessor data shapefile provided by the City and county assessor data was accompanied by two supplementary data sets with additional data matching to each parcel identifier. These two supplementary data sets correspond to residential and non-residential structures. This building footprints shapefile is provided in the attached geodatabase (Attachment F.1.1).

Within the residential data set, the “residence\_type” field informed the number of stories. Table 5 below explains the assumptions made for residential building types, in relation to number of floors.

**Table 5: Building type assumptions for residential structures**

| <b>Assessor Data Description</b>                   | <b>Assumed Building Type (Residential) for BCA Toolkit</b> |
|--|--|
| 2 Stories  | Two or More Stories  |
| 1 Story, 1 Story with Finished Attic, 1.5 Stories, | One Story  |
| Split Foyer, Split Level                           | Split Level  |

<sup>4</sup> <https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A94/a094.pdf>



The assessor field for square footage of finished residential basement was used to inform the BCA toolkit designation related to the presence of a basement. If the square footage of finished residential basement was greater than zero, the residential structure was considered to contain a basement. For residential properties, the USACE Generic damage curves were used, as informed by the number of stories and presence of a basement.

Selection of the damage curve for non-residential properties was also informed by the supplementary assessor data provided by the City with the assessor building data shapefile. This data provides an occupancy description which was used, in combination with Google Street View imagery, to assign the most appropriate damage curve on a case-by-case basis. For example, if the occupancy type in the assessor data was listed as “Office” and appeared to be one story from Google Street View, the “Office One-Story (Default)” Damage Curve was assigned.

### **Lowest Floor Elevation of the Property**

Each building's lowest floor elevation was assigned based on information presented in the assessor data. This assessor data included fields for building elevation, elevation datum, elevation source, and indication of presence of a basement for each of the buildings in the study area. For those buildings with the elevation source being labeled as “Elevation Certificate,” “Site Plan,” or “Clive EC Database,” the elevation provided in the assessor data was used.

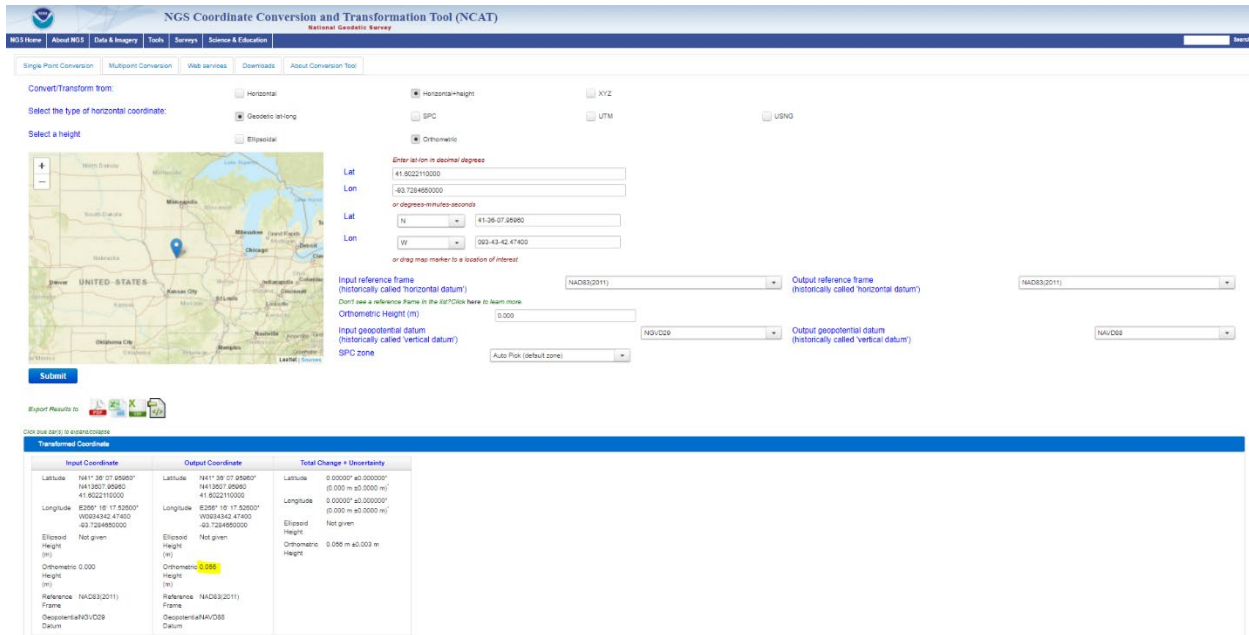
From there, the elevation datum and presence of a basement would need to be taken into consideration. If a property was known to have a finished basement, as presented in the county-provided assessor data, the building elevation provided was lowered by an eight-foot offset to reflect the elevation of the finished basement. For consistency and proper input into the BCA toolkit, datum NAVD-88 was used for final elevation inputs. In cases where the county-provided assessor data presented information in NGVD-29, an adjustment was made to offset this data, increasing the elevation by 0.18 feet. This 0.18 foot offset was determined using the National Geodetic Survey's Coordinate Conversion and Transformation Tool (NCAT)<sup>5</sup>, which shows that converting from NGVD-29 to NAVD88 requires an offset of 0.056 meters, equivalent to 0.18 feet, as depicted in Figure 16 below.

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<sup>5</sup> [NGS Coordinate Conversion and Transformation Tool \(NCAT\) \(noaa.gov\)](https://www.ngs.noaa.gov/NCAT/)



# University Boulevard Flood Mitigation Plan – May 2022



**Figure 16: Coordinate conversion transformation tool results**

For those properties without county elevation certificate data available, lowest floor elevations were estimated. Approximately 242 of the 411 total properties in the study area required lowest floor elevation estimates. The 2014 DEM data provided by the county and presented in NAVD-88, was used to estimate the ground elevation at a unique reference point along the front face of the building. This elevation was not necessarily the lowest adjacent grade but rather a reference point with a known DEM elevation. From there, Google Street View was used to estimate appropriate offsets from that ground elevation point to the lowest floor elevation. Figure 17 below shows the reference point locations along with the DEM data from which ground elevations were extracted. Figure 18 shows an example of a home's Google Street View from which elevation offsets to lowest floor were assumed. Attachment F.3 contains screenshots from Google Street View for each property, labeled by its building identification number.



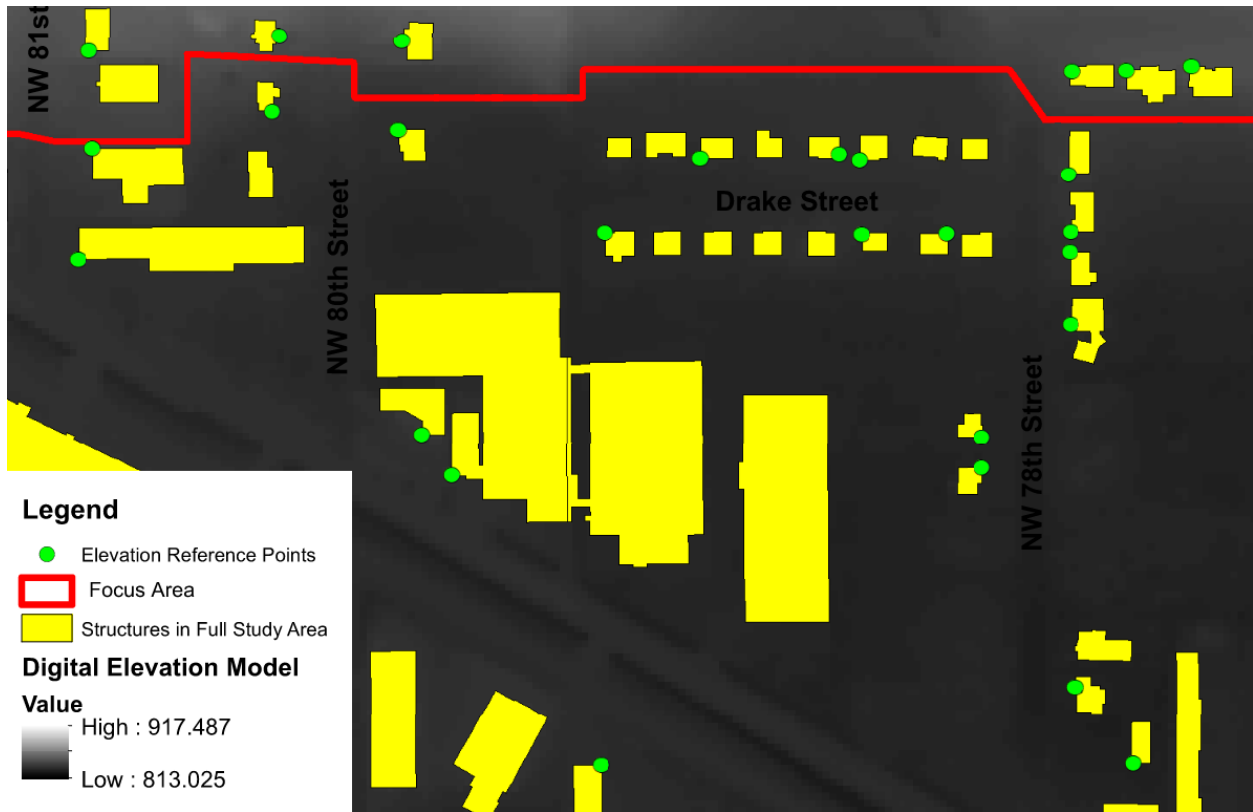


Figure 17: Elevation reference points and digital elevation model used for lowest floor elevation estimates

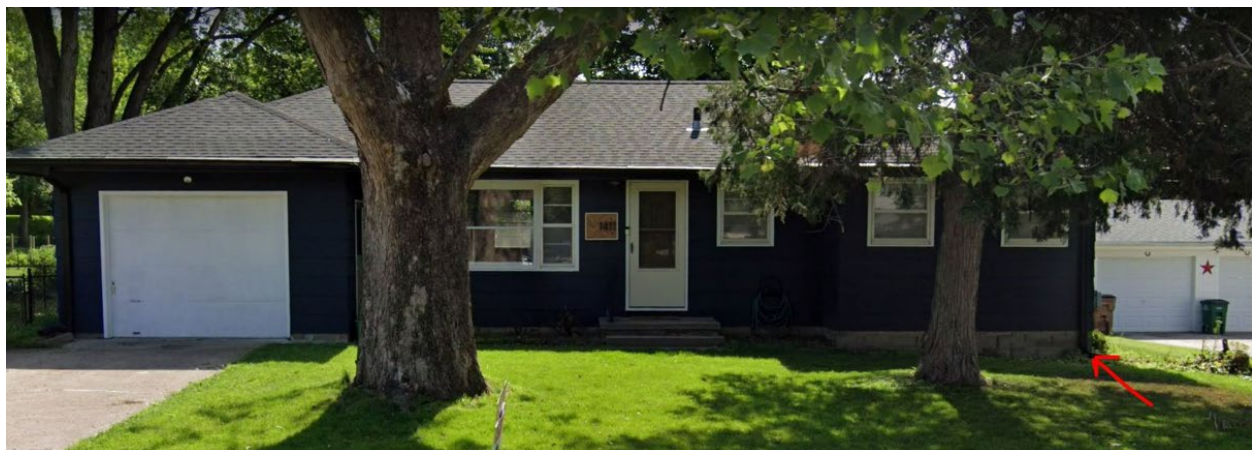


Figure 18: Google Street View example image with reference point indicated



Using these Google Street View images, the offset from the ground reference point to the top of the lowest floor varied somewhat significantly. Therefore, the number of steps leading from the ground to the lowest floor was counted, and each step was estimated to be about 7.5 inches, or 0.625 feet. From there, the number of steps was multiplied by its assumed height and added to the ground elevation at the reference point to obtain an estimate for lowest floor elevation to be used in the BCA. This approach aligns with guidance from the 2011 Supplement to the Benefit-Cost Analysis Reference Guide<sup>6</sup>. For example, in Figure 19 below, this property would be considered to have one step, with a total offset of 7.5 inches from the elevation found in the DEM at the reference point selected.



**Figure 19: Example of property with a one-step designation for lowest floor elevation estimate**

With the presence of basements, elevation datum, and the availability of elevation certificate data taken into consideration, the lowest floor elevation of each property within the study area was presented in NAVD-88.

### **Building Replacement Value and Content**

The 2020 Craftsman National Building Cost Manual (Attachment D.2) was used to estimate each home's replacement value on a per square foot basis. Estimating the building replacement value (BRV) required that assumptions be made about the classification and quality of each property.

Based on county assessor data provided, particularly the occupancy description and building type, it was determined that each of the properties in the study area could be considered to fall into one of four categories: residential (home), residential (apartment), commercial, or industrial. Though buildings within each of these categories varied slightly in quality and size, a representative quality and square footage for each category was selected, based on average values. Figures 20-23 below show the typical quality of

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<sup>6</sup> [https://www.fema.gov/sites/default/files/2020-08/fema\\_bca\\_guide-supplement.pdf](https://www.fema.gov/sites/default/files/2020-08/fema_bca_guide-supplement.pdf)



## University Boulevard Flood Mitigation Plan – May 2022

buildings within each of these categories, based on Google Street View and Zillow images accessed in December 2021.



Figure 20: Residential (home) typical quality

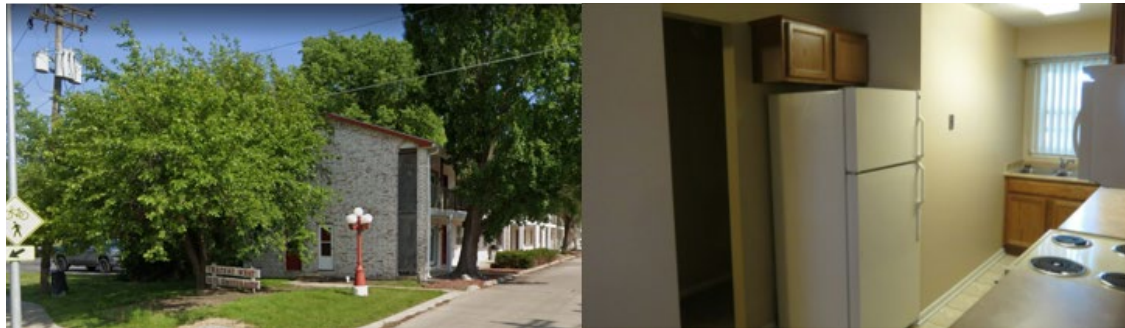


Figure 21: Residential (apartment) typical quality



Figure 22: Commercial typical quality





**Figure 23: Industrial Typical Quality**

The 2020 Craftsman Building Cost Manual provides a national average building replacement value for buildings of different types and sizes. Area modification factors on Page 8 of the manual depict the increase in BRV from the national average that can be expected regionally. The Des Moines region has a 5% area modification factor, so national average BRV's were increased by 5% in this analysis. Table 6 below depicts the BRV that results from this manual when the following building type, representative square footage, and quality class are assumed. Building Type and quality class were selected subjectively based on images from Google Street View and Zillow, as depicted above.

**Table 6: Building replacement values assumed based on 2020 Craftsman Building Cost Manual**

| Occupancy Type         | BRV/sf (National Average) | BRV/sf with (5% Des Moines Factor) | Page Reference in Manual | Representative Square Feet | Building Type  | Quality Class          |
|------------------------|---------------------------|------------------------------------|--------------------------|----------------------------|--|------------------------|
| Residential            | \$273.03                  | \$286.68                           | 12                       | 1,200                      | Single-Family Residential, 4 Corners                 | 2, Semi-Luxury         |
| Commercial             | \$120.04                  | \$126.04                           | 93                       | 20,000                     | Suburban Stores, Masonry, Concrete                   | 2, Good-Quality        |
| Industrial             | \$70.27                   | \$73.78                            | 225                      | 30,000                     | Light Industrial                                     | 2, Good-Quality        |
| Residential, Apartment | \$86.41                   | \$90.73                            | 22                       | 700                        | Multi-Family Residences, Apartment, 10 or more units | 4, Low Average Quality |
| Garages                | \$46.31                   | \$48.63                            | 29                       | 480                        | Detached Garages for Single Family Dwellings         | 4, Good Standard       |



Square footage was also taken into consideration in determining the full building replacement value for each structure. Usable square footage was included in the county-provided data. For commercial, industrial, and residential (apartment) structures, “building\_full” square footage was taken as the usable square footage. For residential (home) structures, both total livable area was provided, as well as the square footage associated with secondary structures, particularly detached garages. For those structures with detached garages, the BRV per square foot was taken as the weighted average of the BRV values for residential properties and garages, considering their respective square footage. These BRV estimates are expected to be conservative since building costs have increased since 2020.

Content value is assumed to be 50% of the building replacement value for all residential structures and 100% of building replacement value for all commercial and industrial structures, considering the value of equipment and materials that are likely to be found in industrial and commercial spaces in the region.

**Additional Benefits and Other Considerations**

For conservatism, the environmental benefits of property acquisition were not considered in the professional expected damages module. They were considered in the riverine modeled damages module, however, given that the benefits of added green open space in this area is anticipated to be significant. The acquisition riverine damages module, both with and without environmental benefits included, is included in Attachment B.2.1 and B.2.2, respectively.

These environmental benefits may be made even more significant with the addition of the stream re-meander concept to the project plan. Allowing for stream re-meander and restoration has the potential to enhance the existing Greenbelt trail and provide greater land area for green open space, wetlands, and riparian area.

**Mitigation Project Costs**

Project costs for the acquisition of properties within the buyout area start with the building valuation of each property from assessor data. From there, the following adjustments were made on a property-by-property basis to estimate the total project cost for property acquisition and demolition.

**Table 7: Constants and Assumptions for Initial Project Costs**

|  |   |
|--|---|
| Markup from Valuation  | Add 20% to Valuation from Assessor Data |
| Property Appraisal Per Structure                                 | \$1,000                                 |
| Closing Cost and Legal Fees Per Structure                        | \$4,000                                 |
| Asbestos Abatement and Removal for Properties Without a Basement | \$2.00 per square foot                  |
| Asbestos Abatement and Removal for Properties With a Basement    | \$3.85 per square foot                  |
| Demolition and Site Grading                                      | \$15.03 per square foot                 |

For properties that undergo acquisition and demolition, it is also assumed that there will be annual mitigation costs in the form of landscaping maintenance. Landscaping mitigation costs are assumed to be



about \$300 per acre per year. Each property's parcel area was therefore converted to acres and multiplied by \$300 to estimate the total annual project maintenance cost.

These values for initial mitigation project cost and annual maintenance cost were input directly into the BCA Toolkit, which then factored in the costs over the project lifetime, assumed to be 100-years, with time value of money considerations. The BCA Toolkit uses a discount rate of 7% per OMB Circular A-94 Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs<sup>7</sup>.

### 3 BCA Results

#### 3.1 Professional-Expected Damages BCA Results

Flood mitigation alternatives were compared using the professional expected damages module of the BCA Toolkit. The corresponding toolkits, reports, and results for this module are included in Attachment A. This module was used for comparison to maintain consistency, as the riverine modeled damages module was not compatible with all alternatives considered. The professional expected damages method involved estimation of damages at each recurrence interval (10-,50-,100-, and 500-year) before and after mitigation based on flood depth. These damages were calculated manually using the USACE Generic depth damage function for residential structures, or the Fast Food (Default), Grocery (Default), Medical Office (Default), Non-Fast Food (Default), Office One-Story (Default), Retail-Clothing (Default), Retail-Electronics (Default), Retail-Furniture (Default), Service Station (Default), or Warehouse, Non-Refrigerated (Default) depth damage function for commercial properties, depending on the most fitting classification for each structure.

Changes in water surface elevation (WSE) were the basis for calculating the benefits of railroad bridge improvements, levee and floodwall construction, and stream re-meander. Table 8 below shows the water surface elevation associated with each of these alternatives at select points on the upstream, middle, and downstream ends of the focus area for the 100-year event, as depicted in Figure 24.

**Table 8: 100-year WSE associated with project alternatives**

|  | <b>WSE Upstream End of Focus Area (ft) (Point 1)</b> | <b>WSE Middle of Focus Area (ft) (Point 2)</b> | <b>WSE Downstream End of Focus Area (ft) (Point 3)</b> |
|--|--|--|--|
| Existing Conditions                          | 839.45   | 836.99   | 835.24   |
| Alternative 1 – Railroad Bridge Improvements | 839.40   | 836.86   | 835.25   |
| Alternative 2 – Levee and Floodwall          | 842.81   | 839.48   | 835.56   |

<sup>7</sup> [https://www.whitehouse.gov/wp-content/uploads/legacy\\_drupal\\_files/omb/circulars/A94/a094.pdf](https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A94/a094.pdf)



|   |        |        |        |
|---|--------|--------|--------|
| Alternative 5 – Stream re-meander and conveyance improvements | 837.79 | 837.02 | 835.25 |
|---|--------|--------|--------|

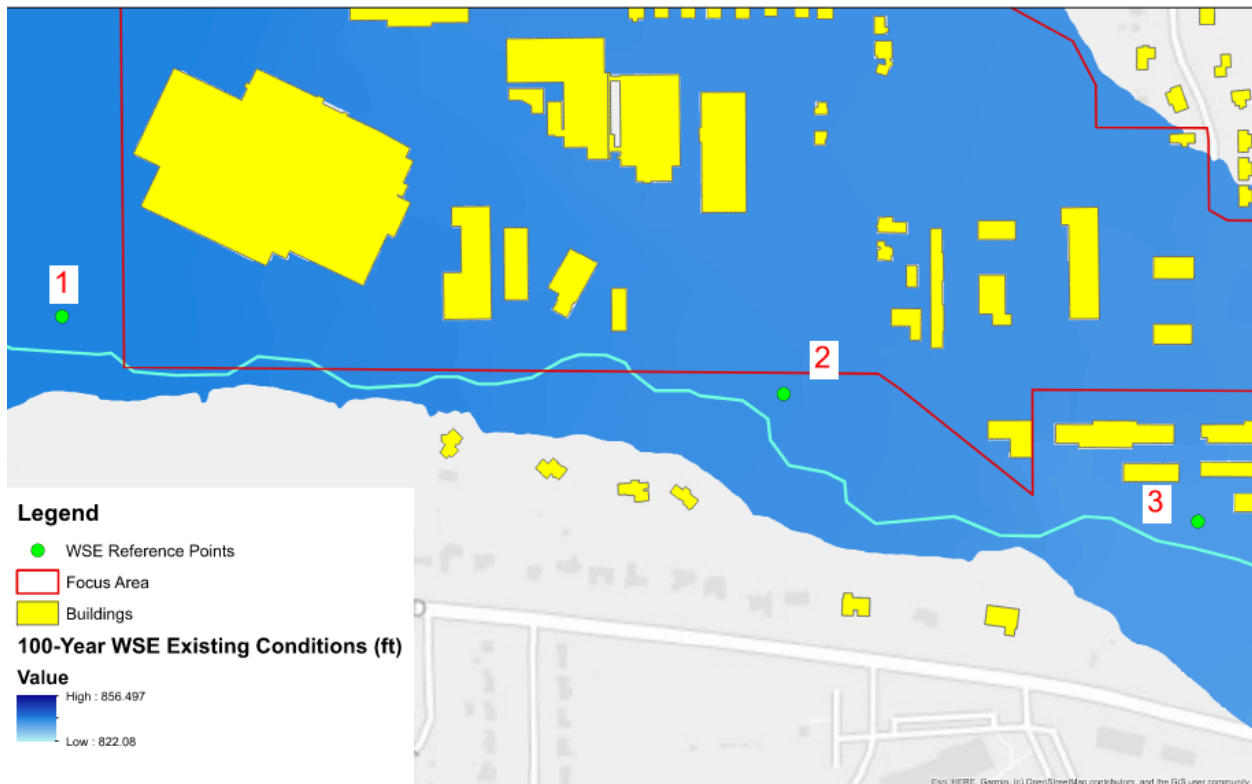
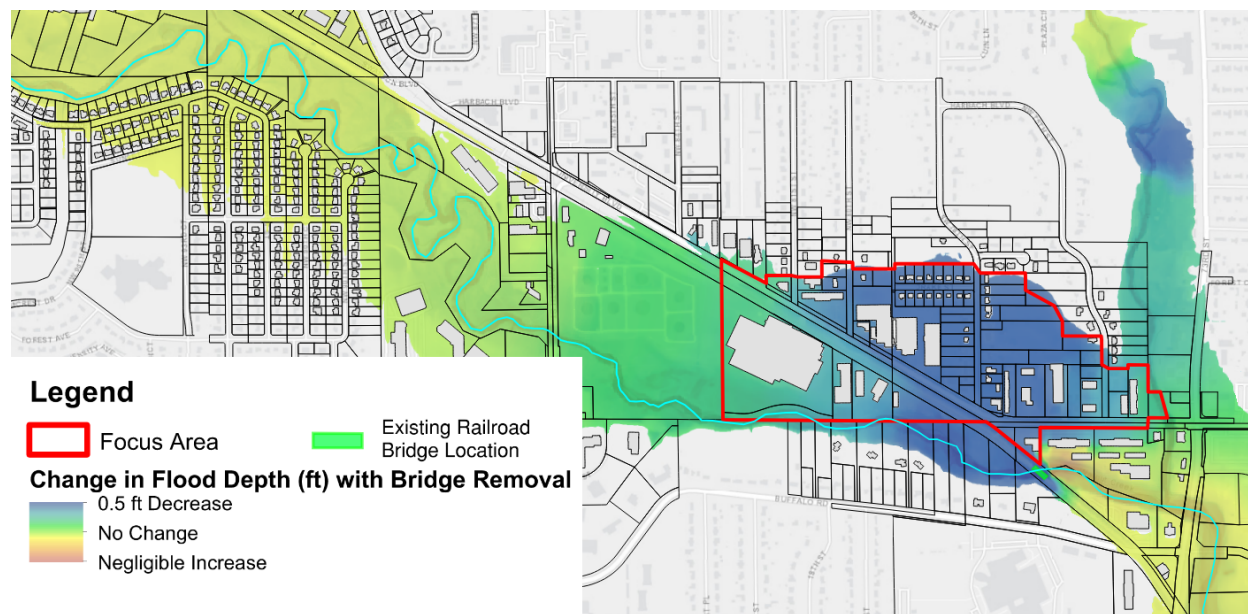


Figure 24: WSE reference points corresponding to Table 8

### 3.1.1 ALTERNATIVE 1 – RAILROAD BRIDGE IMPROVEMENTS

Removing and replacing the railroad bridge just south of University Boulevard is anticipated to reduce flood depths within the Focus Area but will result in negligible change in flooding for other properties in the University Boulevard neighborhood. According to the updated H&H model, where flood depths are anticipated to decrease, this decrease will be minimal, with a maximum decrease of 0.5 feet during the 100-year storm. A 0.5-foot decrease is relatively insignificant considering the 100-year flood depths of 4 to 12 feet in this area. Figure 25 below shows the change in flood depth anticipated with these railroad bridge improvements for the 100-year storm.





**Figure 25: Change in 100-year Flood Depth Anticipated with Railroad Bridge Improvements**

Whether the entire study area of 411 properties is considered, or if looking only at properties within the Focus Area, the considered railroad bridge improvement project is not cost-effective, as demonstrated in Table 9 below. Considering the high cost and significant logistical barriers, such as coordination with the railroad company, involved in this alternative, railroad bridge improvements are not a recommended flood mitigation strategy for the University Boulevard Neighborhood.

It is possible that additional railroad bridge and embankment configurations could provide additional hydraulic relief, but these were not explored under this study given the initial assessment of railroad bridge feasibility and BCA results.

**Table 9: BCA Results for Railroad Bridge Improvements**

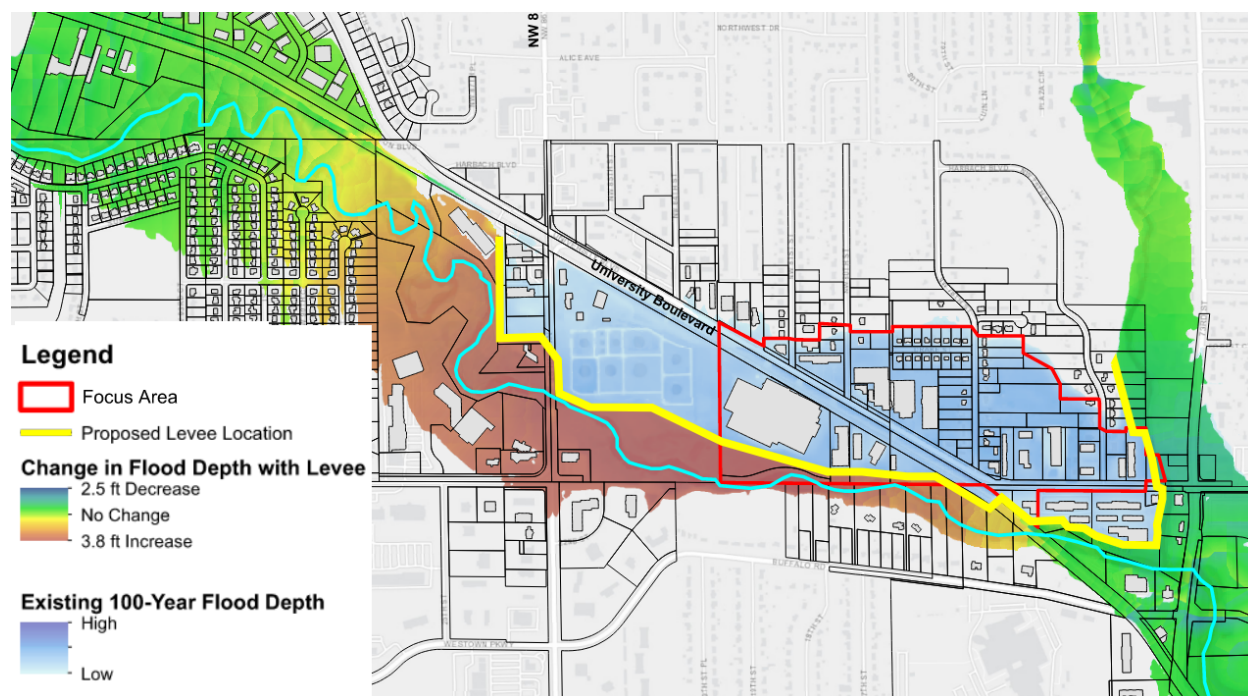
| Study Area                       | Benefits    | Costs       | BCR  |
|----------------------------------|-------------|-------------|------|
| Full Study Area (411 Properties) | \$2,470,000 | \$9,750,000 | 0.25 |
| Focus Area                       | \$1,980,000 | \$9,750,000 | 0.20 |

### 3.1.2 ALTERNATIVE 2 – LEVEE AND FLOODWALL CONSTRUCTION

Modeling for the proposed levee and floodwall alternative demonstrates that a levee with the capability of providing protection against the 100-year storm would require 4,200 feet of earthen levee, 4,180 feet of floodwall, and a maximum height of 20 feet.



While this levee would provide protection for the University Boulevard Neighborhood, it would potentially increase flooding in other parts of the neighborhood south of University Boulevard, such as the eastern portion of the Indian Hills neighborhood. Figure 26 below demonstrates the changes in flood depth anticipated during the 100-year storm. Note that green is indicative of no change in flood depth but that yellow, orange, and red indicate increases in flood depth during the 100-year storm.



**Figure 26: Change in flood depth during the 100-year storm with levee and floodwall construction**

Considering that the Focus Area will be protected up to the 100-year flood event, the greatest project benefits would be seen in this area specifically. The decrease in flood protection seen elsewhere in the full study area help explain how the anticipated project benefits within the Focus Area itself are much higher than they are in the total study area of 411 structures. The decrease in benefits for the full study area when compared to the Focus Area indicates that the levee would likely increase flood risk in areas outside the Focus Area without other efforts to counteract this. The project is not cost-effective in either the focus area or the full study area, as demonstrated in Table 10 below.

The cost of constructing a levee and floodwall so tall and covering so much area is anticipated to be substantial and would also involve a lengthy FEMA/USACE permitting process. The construction footprint for such a project is likely to be highly disruptive to the surrounding area and may affect the Clive Greenbelt, a key community feature and recreational staple. Significant velocities along Walnut Creek also present erosion concerns for the levee and floodwall. Given the cost ineffectiveness and logistical concerns, levee and floodwall construction is not recommended to mitigate flooding in the University Boulevard Neighborhood.

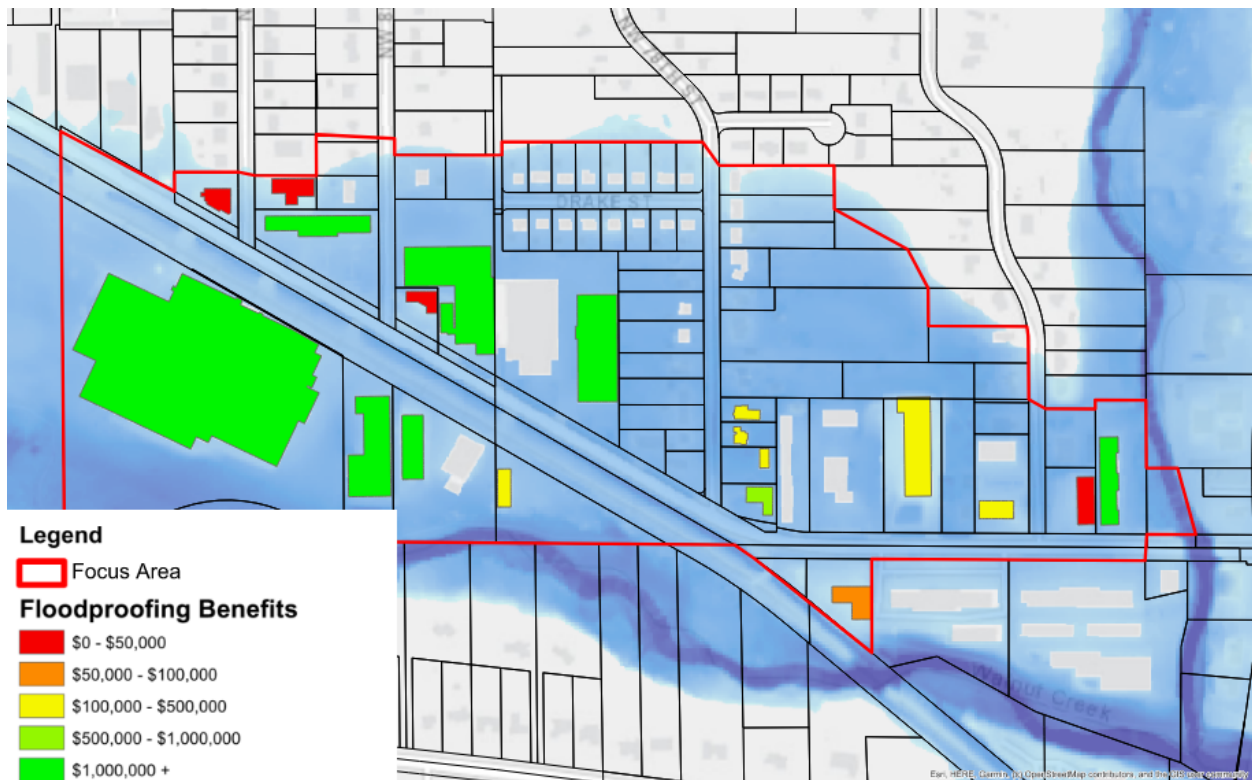


**Table 10: BCA Results for Levee and Floodwall Construction**

| Study Area                       | Benefits     | Costs        | BCR  |
|----------------------------------|--------------|--------------|------|
| Full Study Area (411 Properties) | \$21,210,000 | \$68,920,000 | 0.31 |
| Focus Area                       | \$32,500,000 | \$68,920,000 | 0.47 |

### 3.1.3 ALTERNATIVE 3 – INDIVIDUAL FLOODPROOFING

Individual floodproofing costs and benefits were estimated for nineteen (19) properties in the Focus Area to consider potential effectiveness. These properties selected for conceptual estimates can be seen in Figure 27 below. It was assumed that these properties were dry floodproofed up to one (1) foot above the BFE, though it is worth noting that this level of protection is not realistic in some cases, such as when this requires five (5) to nine (9) vertical feet of floodproofing. Figure 27 below shows the anticipated benefits of floodproofing based on the optimistic assumptions made in this analysis.



**Figure 27: Proposed benefits of floodproofing for select properties in the Focus Area**

Table 11 below summarizes the total benefits and costs of dry floodproofing for the nineteen (19) properties considered in this analysis. The average property sees a benefit of \$1,076,000 and a cost of



\$2,084,154. This analysis represents an optimistic modeling scenario, as dry floodproofing is difficult to achieve and maintain, requires prior notice of flooding, and still leaves significant residual risk. Despite being an optimistic modeling scenario, this alternative is not cost-effective on its own for the properties analyzed. Floodproofing may be a reasonable consideration for properties on the fringe of floodplain or as an interim protection while developing a longer-term flood mitigation strategy. However, floodproofing is not recommended as the primary flood mitigation strategy for the University Boulevard neighborhood.

**Table 11: BCA Results for Floodproofing**

| Study Area                                      | Benefits     | Costs        | BCR  |
|---|--------------|--------------|------|
| Nineteen (19) Selected Properties in Focus Area | \$20,441,552 | \$29,589,925 | 0.52 |

### 3.1.4 ALTERNATIVE 4 – INDIVIDUAL ACQUISITION AND DEMOLITION

Individually acquiring and demolishing properties with high flood risk offers the most cost-effective strategy based on the analysis and assumptions documented in this report. The results of this section pertain to the professionally expected damages module, though acquisition and demolition was also analyzed using the riverine modeled damages module, as explained in Section 3.2 *Riverine Modeled Damages BCA Results*. The benefits of property acquisition were the highest in properties within the Focus Area, as demonstrated in Figure 28 below, but acquisition may show to be a cost-effective option for properties elsewhere in the University Boulevard neighborhood, as demonstrated in Figure 29.



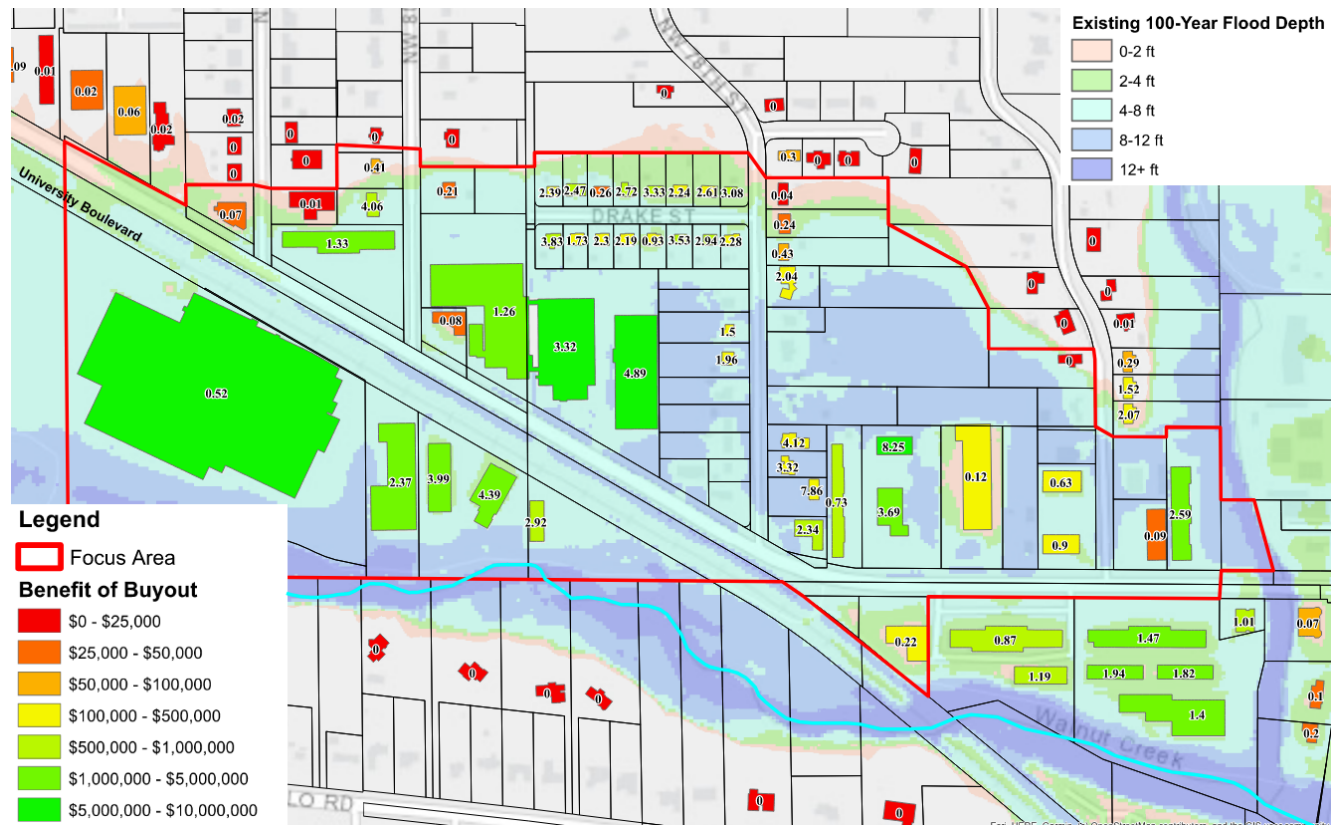
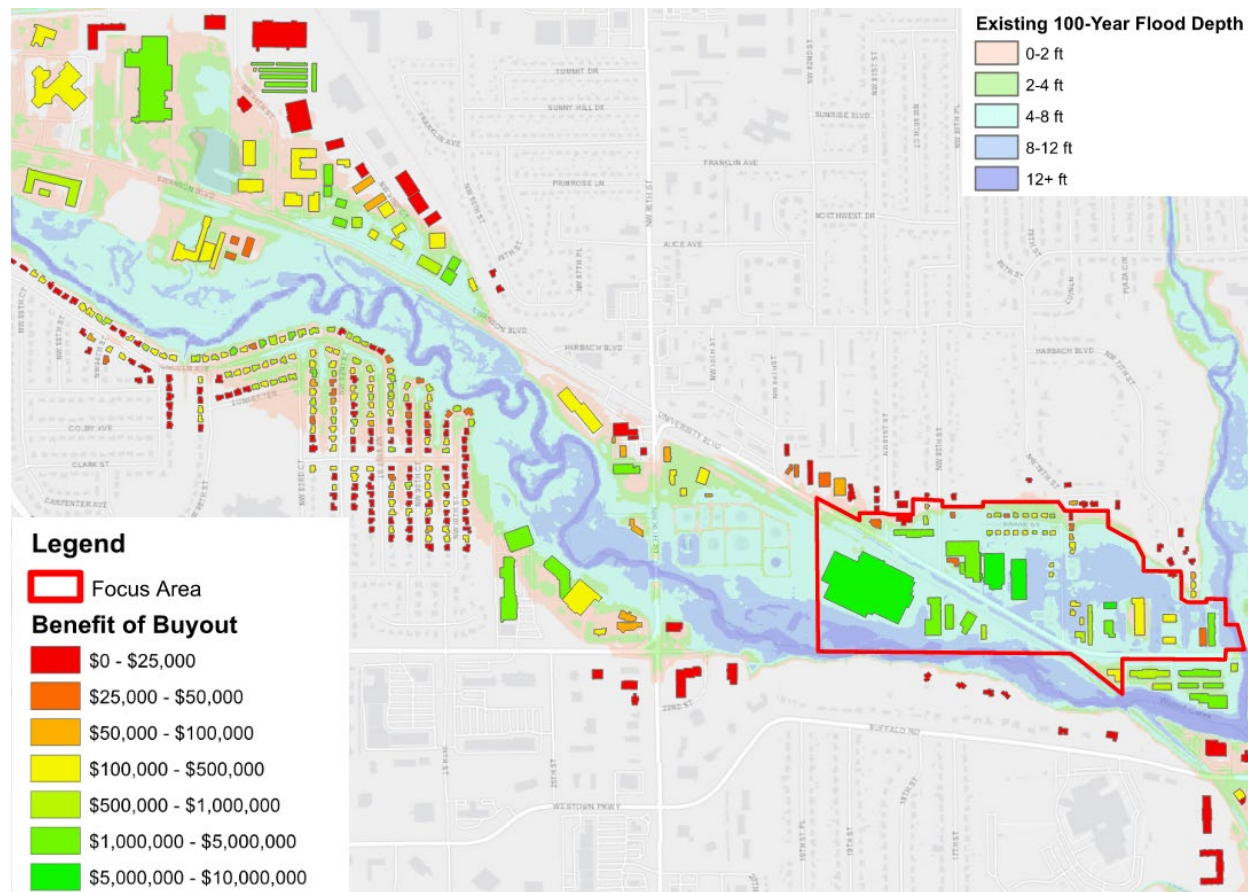


Figure 28: Benefits of property acquisition and demolition in the Focus Area





**Figure 29: Benefits of property acquisition and demolition in the full study area**

Acquisition, demolition, and deed restriction is the only flood mitigation strategy that eliminates residual risk and offers the potential for green space or other land use with recreational and environmental benefit. Considering that properties within the Focus Area run adjacent to the existing Clive Greenbelt, there is great potential to expand existing recreational community features as well. With consideration for housing market volatility, this option is flexible and may be done in phases. Table 12 below shows property acquisition and demolition to be an effective flood mitigation strategy within the focus area. This strategy is therefore the recommended alternative for flood mitigation within the University Boulevard neighborhood.

**Table 12: BCA Results for Property Acquisition, Demolition, and Deed Restriction**

| Study Area                       | Benefits      | Costs         | BCR  |
|----------------------------------|---------------|---------------|------|
| Full Study Area (411 Properties) | \$180,960,000 | \$230,650,000 | 0.78 |
| Focus Area                       | \$63,365,000  | \$38,200,000  | 1.66 |



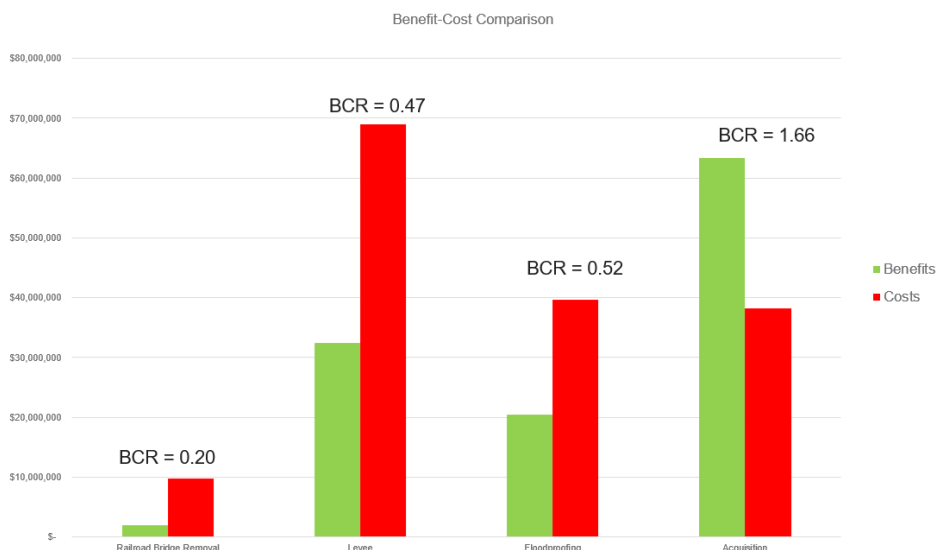
### 3.1.5 COMPARISON OF PRIMARY ALTERNATIVES

Of the four alternatives initially analyzed, and in communication with City representatives, the acquisition and demolition alternative is favorable for the University Boulevard Focus Area. Table 13 below compares the final benefits, costs, and BCRs for each alternative within the Focus Area.

**Table 13: BCR summary for primary alternatives**

| Alternative                      | Benefit      | Cost         | BCR  |
|----------------------------------|--------------|--------------|------|
| Railroad Bridge Improvements     | \$1,980,000  | \$9,750,000  | 0.20 |
| Levee and Floodwall Construction | \$32,500,000 | \$69,000,000 | 0.47 |
| Individual Floodproofing         | \$20,441,552 | \$29,589,925 | 0.52 |
| Acquisition and Demolition       | \$63,365,000 | \$38,200,000 | 1.66 |

Figure 30 below emphasizes the advantage that the property acquisition and demolition alternative has over the other alternatives considered. While the costs of property acquisition are high, the potential benefits greatly outweigh the costs. Railroad bridge removal represents a relatively low-cost option, but the benefits are even lower. Levee and floodwall construction show a significant cost with a relatively low level of benefit in comparison. Floodproofing costs are similar to the cost of acquisition in many cases but leave a significant amount of residual risk and therefore a much lower benefit.



**Figure 30: Summary of benefit-cost ratios for flood mitigation alternatives within the Focus Area**

While the benefit and cost numbers show acquisition and demolition to be the only cost-effective alternative, qualitative considerations discussed between Stantec and the City of Clive also favor



acquisition and demolition. The decision matrix presented in Table 14 below compares these four primary alternatives based on qualitative considerations. For each qualitative category, the alternatives are ranked with **green** meaning that the alternative offers advantages in that category, **yellow** being neutral or limited, and **red** meaning that the alternative offers negative consequences for that category. The acquisition and demolition alternative offers advantages in four categories, which is more than any other alternative. Individual floodproofing also shows a high number of advantages, but it is worth keeping in mind that floodproofing is not realistic for many structures in the Focus Area, particularly residential structures or those that have more than 3-4 feet of flooding in the 100-year storm. The levee and floodwall alternative ranks particularly poorly for qualitative considerations. Construction of a 20-foot tall levee would disrupt the University Boulevard neighborhood significantly and would also reduce access to the Clive Greenbelt trail, a key community feature and major hub for recreation in the area.

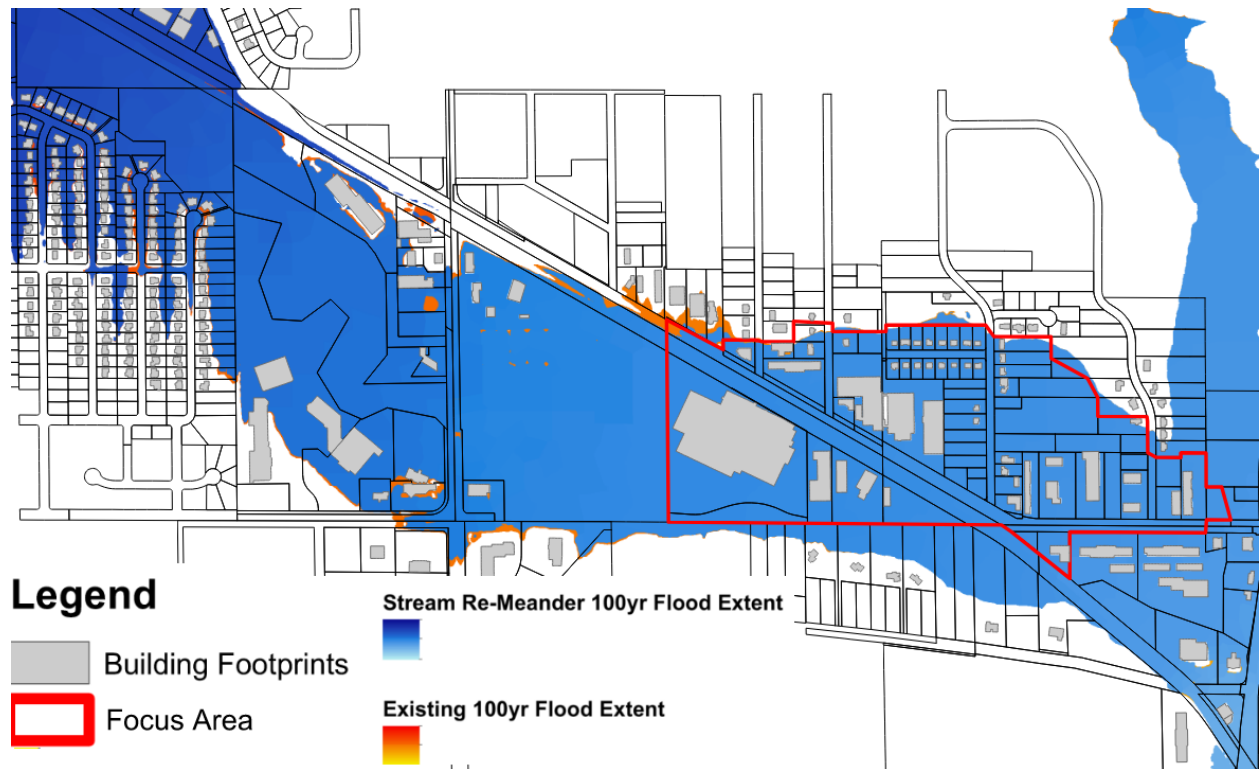
**Table 14: Qualitative ranking of primary alternatives**

|                                 | Railroad Bridge Improvements | Levee and Floodwall | Individual Floodproofing | Acquisition and Demolition |
|---------------------------------|------------------------------|---------------------|--------------------------|----------------------------|
| Implementation Feasibility      | Yellow                       | Red                 | Red                      | Green                      |
| Project Footprint               | Green                        | Red                 | Green                    | Yellow                     |
| Permitting Requirements         | Red                          | Red                 | Green                    | Green                      |
| Community Disruption            | Green                        | Red                 | Green                    | Yellow                     |
| Flood / Residual Risk Reduction | Red                          | Yellow              | Yellow                   | Green                      |
| Environmental Benefit           | Yellow                       | Red                 | Yellow                   | Green                      |

### 3.1.6 ALTERNATIVE 5 – STREAM RE-MEANDER AND CONVEYANCE IMPROVEMENTS

The proposed stream re-meander and conveyance improvements project is considered as an ancillary alternative to potentially pair with property acquisition and demolition. The stream re-meander and conveyance improvements concept requires acquisition of the five (5) properties within the Focus Area south of University Boulevard, though the costs presented in this benefit-cost analysis show the costs of the stream re-meander itself without the costs of these acquisitions. Figure 31 below shows how the stream re-meander and conveyance improvements project alternative is anticipated to change the 100-year flood extent. This change in flood extent may be particularly valuable to properties on the fringe of the floodplain, such as those just north of the Focus Area.

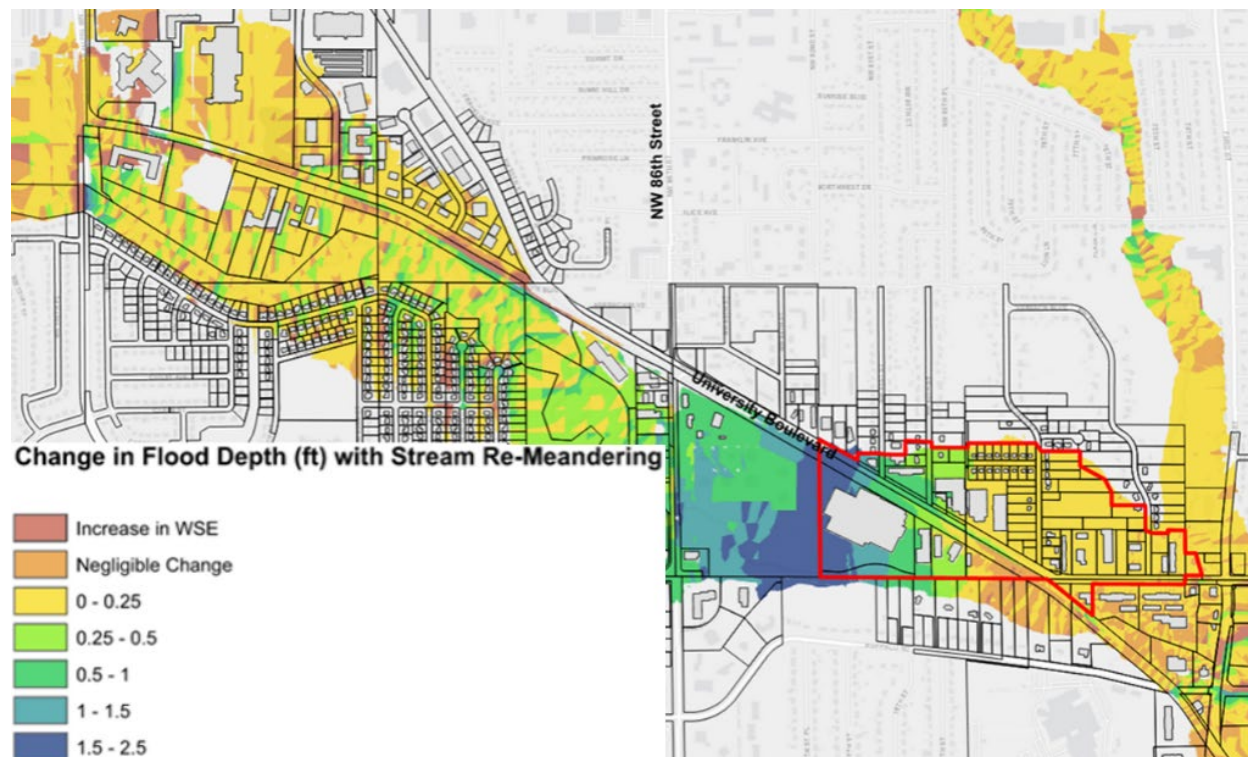




**Figure 31: Changes to the 100-year flood extent due to stream re-meander**

Figure 32 below gives additional context to this change in flood extent by showing the change in flood depth during the 100-year flood event anticipated with stream re-meander and conveyance improvements. Note that the greatest decrease in flood depth is about 2.5 feet, near the western end of the Focus Area, though moderate flood depth reduction is seen throughout the Focus Area. As indicated in red, stream re-meandering and conveyance improvements are anticipated to increase the flood depth in some locations, though these increases are negligible in the model and would be worked out in subsequent modeling efforts.





**Figure 32: Changes to the 100-year flood depth as a result of stream re-meander**

The benefits of stream re-meander and conveyance improvements for each property are depicted in Figure 33 below. Note that these benefits represent the structural benefits that result from a decrease in water surface elevation with the proposed project, though environmental benefits due to an increase in Riparian Area are anticipated as well. If the five properties within the Focus Area south of University Boulevard are to be acquired to implement the stream re-meander and conveyance improvements project, the increase in Riparian Area will amount to \$1,914,063 in environmental benefit based on the default benefit value for Riparian area in the BCA Toolkit. The change in water surface elevation expected with the stream re-meander and conveyance improvements project will provide an additional \$8,152,550 of benefits within the Focus Area and \$16,410,295 of benefits within the full study area, due to lower flood depths and lower property damage. Table 15 below summarizes these results and the corresponding Benefit-Cost Ratios. Please note that these benefits are related to the structures that remain and that the benefit of stream re-meander specifically would decrease if more properties were to be acquired.



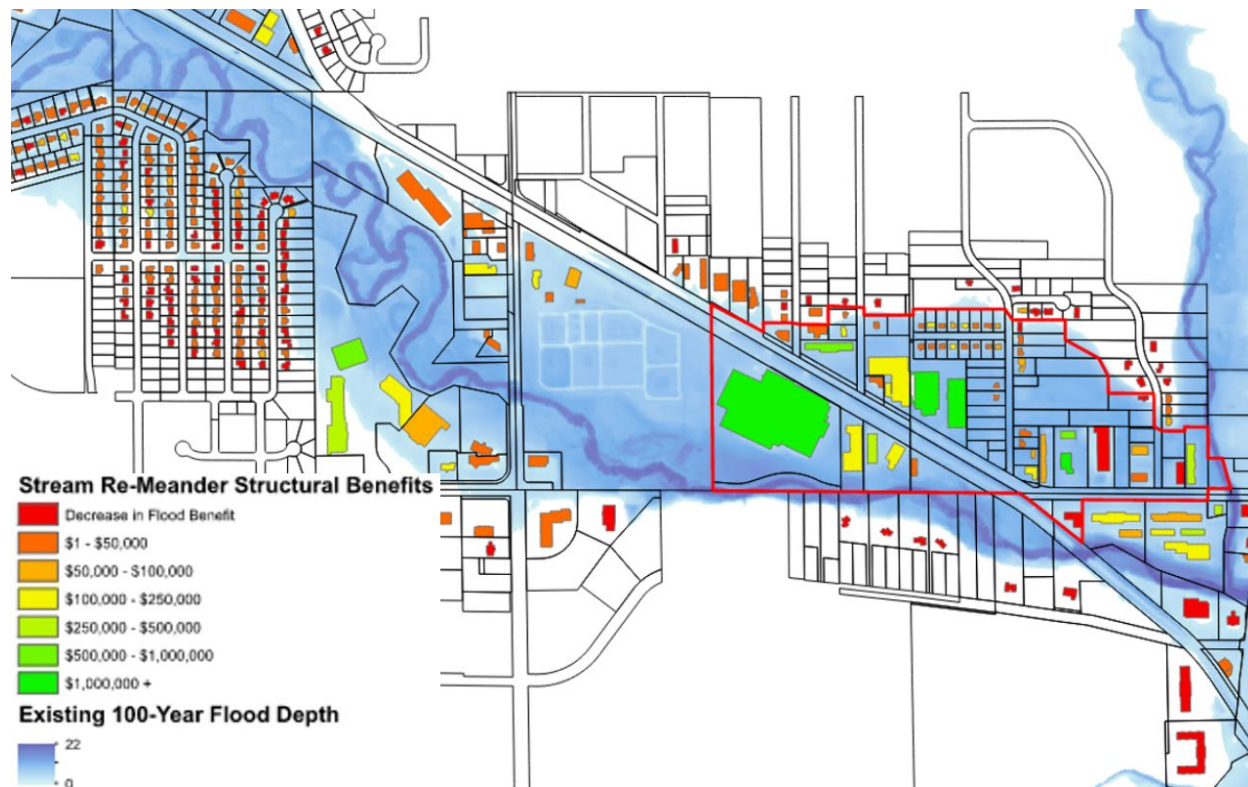


Figure 33: Structural benefits associated with stream re-meander and conveyance improvements

Table 15: BCA Results for Property Acquisition, Demolition, and Deed Restriction

| Study Area                                    | Benefits                                   | Costs        | BCR  |
|---|--|--------------|------|
| Full Study Area <sup>8</sup> (411 Properties) | \$1,914,063+\$16,410,063<br>= \$18,324,358 | \$13,794,085 | 1.33 |
| Focus Area                                    | \$1,914,063+\$8,152,550<br>= \$10,066,613  | \$13,794,085 | 0.73 |

The stream re-meander and conveyance improvements project offers the potential to be paired with a phased property buyout strategy to provide additional environmental and flood reduction benefit with land that is made available by acquisition and demolition. Such benefits may also make future University Boulevard flood mitigation projects more attractive for certain funding programs, such as FEMA’s Building Resilient Infrastructure and Communities (BRIC) program, which emphasizes innovation, nature-based and infrastructure solutions.

<sup>8</sup> Benefits reported are limited to the study area. The stream re-meander and conveyance improvements project may produce additional benefit further upstream or downstream, but additional study would be needed to verify any benefits outside the study area.

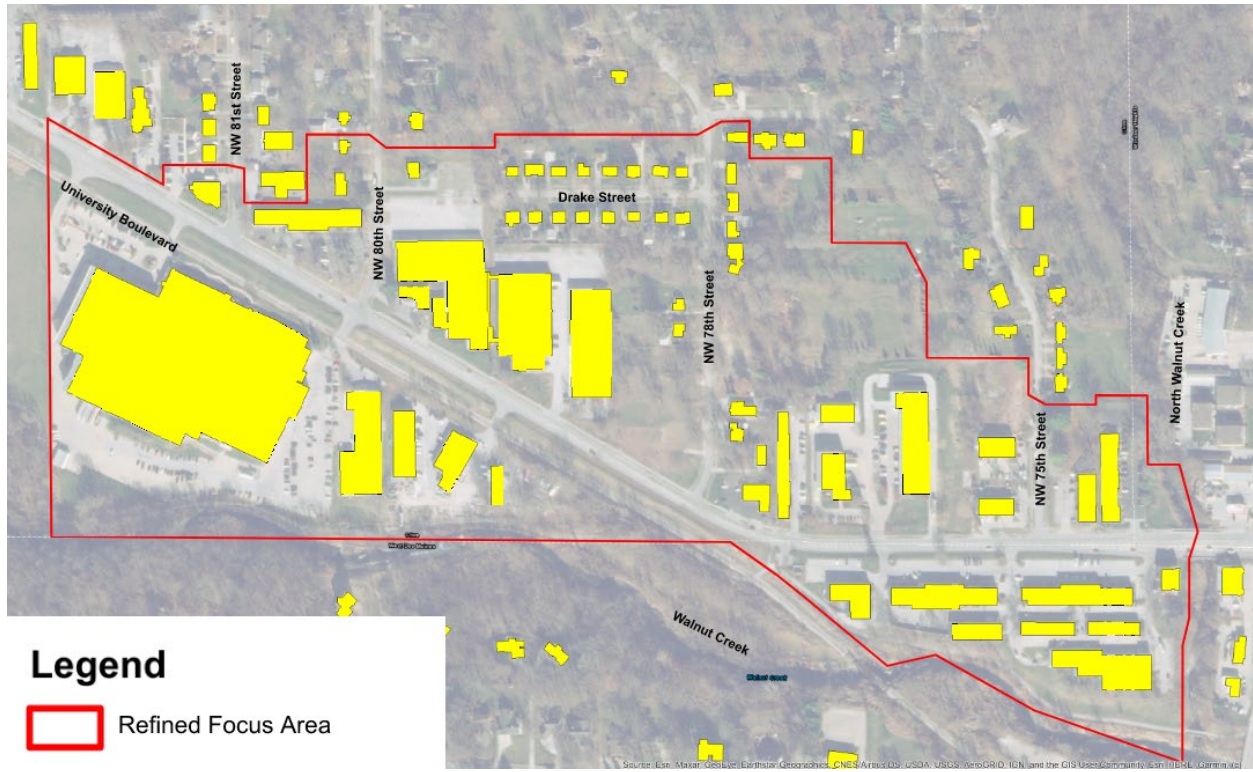


The stream re-meander and conveyance improvements concept considered under this study was limited in its scope and footprint. Given previous studies and results from this study, it has been noted that stream re-meander and other floodplain storage, conveyance improvements, and stormwater features could provide additional benefit for areas further upstream and downstream of this study area. Additional analysis and modeling would be needed to determine exact impacts and potential for additional stream work to qualify for federal funding programs.

### 3.2 Riverine Modeled Damages BCA Results

Because property acquisition and demolition was selected as the preferred flood mitigation strategy for the University Boulevard neighborhood, this alternative was assessed using the BCA Toolkit's riverine modeled damages module to obtain a more comprehensive understanding of flood mitigation benefits with consideration for water surface elevation, discharge, streambed elevation, and the environmental benefits of increased greenspace area. The BCA files and reports associated with this module are included in Attachment B, showing the scenario that includes environmental benefits and the scenario that does not include environmental benefits, respectively. The inputs detailed in Sections 2.3.1 *Hydrologic & Hydraulic Assumptions* and 2.3.2 *Benefit-Cost Analysis (BCA) Assumptions* were used as inputs to the riverine modeled damages module. Within this refined analysis, the study area was reduced to a modified focus area based on initial results, referred to as the Refined Focus Area. Figure 34 below shows the extents of this Refined Focus Area. These extents were delineated based on both current property owner willingness for buyout and proposed cost-effectiveness.





**Figure 34: Refined Focus Area for analysis**

The 57 structures within the Refined Focus Area show significant benefit for acquisition and demolition. The individual benefit results and benefit-cost ratios for each structure can be seen in Figure 35 below.





**Figure 35: BCR and benefit values by structure in the Refined Focus Area**

The summary of benefits and costs within the entire Refined Focus Area is detailed in Table 16 below. Note the breakdown of standard, environmental, and social benefits within the total benefit calculation as well.

**Table 16: Benefit-cost summary for Refined Focus Area**

|   |                      |
|---|----------------------|
| Standard Benefits   | \$172,166,555        |
| Environmental Benefits  | \$10,534,180         |
| Social Benefits   | \$385,560            |
| <b>TOTAL BENEFIT</b>  | <b>\$182,906,295</b> |
| Mitigation Project Cost   | \$44,152,656         |
| Annual Maintenance Cost   | \$25,996             |
| Total Maintenance Cost (Over 100-year assumed project lifetime) | \$370,944            |
| <b>TOTAL COST (Over 100-year assumed project lifetime)</b>      | <b>\$44,523,600</b>  |
| <b>TOTAL BCR</b>  | <b>4.11</b>          |



## 4 Public Engagement

Public engagement plays a large part in formulating a path forward for flood mitigation following this analysis. Flood mitigation alternatives – particularly property acquisition – require collaboration and willingness from property owners, and the City of Clive prioritizes the needs of its community members.

Two public meetings were held throughout the development of this flood mitigation alternatives analysis to present ideas to the community members of the University Boulevard neighborhood and receive feedback iteratively. The first public meeting focused on detailing the four primary alternatives considered in the analysis and presenting the initial results comparing cost-effectiveness. The second public meeting provided updates related to the stream re-meander concept and next steps in developing a flood mitigation strategy. Public feedback was limited during these meetings themselves, but a survey distributed during the first meeting helped spur conversation, and subsequent one-on-one conversations between the City's Community Development Director and property owners helped inform future planning considerations.

The following list details lessons learned from public engagement, particularly related to property owner preferences in relation to property acquisition.

- Most of the residential property owners in the Focus Area carry flood insurance, although most don't understand the limitation of the coverage since most have basements or split levels. Timing variability will need to be taken into consideration for residential properties, potentially buying them out as they are sold at will.
- Residential property owners on Drake Street North do not tend to have specific interest in selling since they generally have not seen direct flood impacts recently and are largely on the fringe of the floodplain. Flexibility is encouraged in this area.
- Residential property owners on Drake Street South tend to have a more immediate interest in acquisition since flood risk is more apparent. Some of the property owners in this area are new to the area and are now dealing with the decision whether to move and reinvest now that they are aware of their risk.
- Several residential property owners on NW 78<sup>th</sup> street have indicated interest in selling their properties, but additional variables are also taken into consideration.
- Property owners at NW 80<sup>th</sup> street have expressed little interest in selling at this time.
- Several commercial property owners along University Avenue and University Boulevard have expressed interest in selling.
- Managing the business operation transition will be an important factor. In some cases, a phased buyout over several years may be necessary to meet business needs.



## 5 Discussion and Path to Mitigation

Approaching an effective strategy for flood mitigation in the University Boulevard Neighborhood requires flexibility and diversification. Various state and federal funding programs will be considered to support property acquisition and explore larger projects that include a stream re-meandering component. The City of Clive has expressed the desire to mitigate flooding concerns in the University Boulevard neighborhood within the next ten years. The City also recognizes that timelines will be contingent on community and property owner readiness as well as funding program restrictions.

### 5.1 Grant Funding Options

Federal, state, and local funding may be considered in developing a flood mitigation strategy. Through collaboration with the City of Clive, Stantec recommends that federal funding sources, particularly through FEMA grant programs, be prioritized, leveraging state and local monies as matching funds. In addition, other federal and state funding programs have been identified to either pair with FEMA funding sources or to be used in separate property acquisitions.

#### 5.1.1 FEMA FUNDING PROGRAMS

The Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance program presents three different grant programs to aid in the reduction of risk from natural hazards, such as flooding. Table 17 below details the funding programs available, along with the local and state match requirements anticipated. In addition to the funds listed below, FEMA also has an Advance Assistance opportunity to provide early funding to accelerate the identification and implementation of mitigation activities. This would likely be feasible to support the engineering, modeling, and design for a stream re-meandering project, but it could not be used directly for acquisition of properties.

In general, FEMA grant programs provide 75% federal funding then require the remaining 25% be covered by non-federal sources such as state or local funding allocations. In coordination with the Iowa Department of Homeland Security and Emergency Management, Iowa is expected to be able to provide 10% of project funds through state funding sources, leaving the remaining 15% to be covered by local or other funding sources.



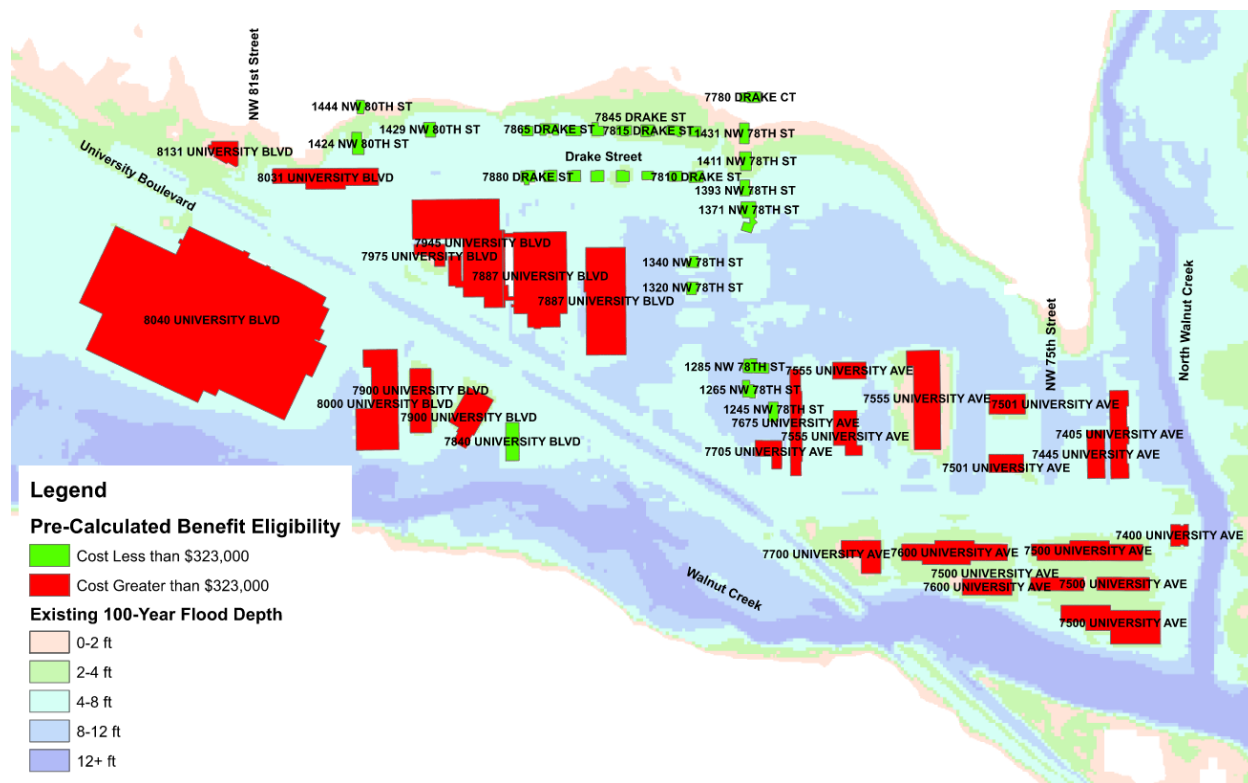
**Table 17: Details of FEMA Hazard Mitigation Assistance programs**

| Name of Program  | Description   | State Match                                       | Local Match   | Additional Considerations  |
|--|---|---|---|--|
| Flood Mitigation Assistance (FMA)                        | Emphasizes the reduction of risk of repetitive flood damage to buildings insured by the National Flood Insurance Program. | 10% (or 0% if property is Severe Repetitive Loss) | 0% if property is Repetitive Loss or Severe Repetitive Loss | This program should be used for properties deemed as Repetitive Loss or Severe Repetitive Loss Properties as defined by FEMA. This is a nationally competitive program.  |
| Hazard Mitigation Grant Program (HMGP)                   | Funding available within a state after a presidentially declared disaster.  | 10%   | 15%   | There are currently two disaster declarations for 2022 in Iowa (see more details below). Iowa has seen 22 declarations since 2011. Additional declarations are anticipated in future years.  |
| Building Resilient Infrastructure and Communities (BRIC) | Competitive program emphasizing innovative, nature-based, infrastructure projects, etc.                                   | 10%   | 15%   | BRIC is a nationally competitive program geared towards infrastructure projects (i.e., only acquisitions would not qualify). This is where the stream re-meander project could potentially be pursued if designed to align with BRIC criteria. |

FEMA funding programs typically require that a benefit-cost analysis and corresponding documentation be provided with the application to demonstrate cost-effectiveness. The goal of this report and subsequent attachments is to give the City of Clive enough information to inform/produce a benefit-cost analysis and report for each application. For some properties, however, a benefit-cost ratio may not be necessary. As mentioned in the FEMA Memorandum in Attachment D.3, for properties in the Special Flood Hazard Area (SFHA), or 100-year floodplain, if the total project cost for acquiring a structure is \$323,000 or less, FEMA considers the project to be cost-effective without the need to present a BCR. Figure 34 below shows the 100-year floodplain and indicates the structures that would cost less than \$323,000 to acquire. This can also be done on an aggregate basis, meaning if the average acquisition cost of multiple acquisitions are less than \$323,000 then the grant application would not require a BCA.



## University Boulevard Flood Mitigation Plan – May 2022



**Figure 36: Indicators of pre-calculated benefit eligibility based on estimated project costs**

It is also worth noting that FEMA grants for acquisitions will require property appraisals, which currently take about 30 days in the City of Clive and will be valid for 6-8 months. Environmental and Historical site assessment will also be required before applying, which present both upfront cost and timing considerations.

As mentioned in Table 17 above, there are currently two disaster declarations in the State of Iowa allowing the potential for HMGP funding. DR 4483 has \$1-2 million available as of March 31, 2022 according to correspondence with Iowa State Hazard Mitigation Officer, Dusty Pogones. This funding closes in June 2022 but is currently pending a 90-day extension period. According to the same correspondence, DR 4642 has \$1.4 million available and is due to the state in December 2022. It is also worth noting that a FEMA-approved Natural Hazard Mitigation Plan is required to receiving HMGP funding. The plan identifies hazards, assesses community needs, and describes a community-wide strategy for reducing risks associated with natural disasters. The City of Clive currently has a Hazard Mitigation Plan<sup>9</sup> on file, noting Clive’s flood risk, due to expire in July 2024.

<sup>9</sup> <https://www.polkcountyiowa.gov/emergency-management/our-plans/multi-jurisdictional-hazard-mitigation-plan/>



### 5.1.2 OTHER FEDERAL FINANCING PROGRAMS

Due to the broad funding available for hazard mitigation through FEMA and the BCA approach taken in this analysis, Stantec recommends that applying for FEMA grants be prioritized. However, Table 18 below details some other federal financing programs to consider. Stantec recommends that the City of Clive consider the US Army Corps of Engineers (USACE) for the Small Flood Risk Management Project and the US Fish and Wildlife for the North American Wetlands Conservation Act Grant program. These programs have earlier deadlines and more overall time is involved. Please see the Funding Assistance Letter in Attachment D.4 for more details on Federal and State financing programs. Congressional earmarks may be another way to secure funding for wide-spread flood mitigation in the area. This strategy would allow Congress to direct a specific amount of money to an agency’s budget for a particular project.

**Table 18: Other federal financing programs to consider**

| Name   | Description  | Funding Available   | Deadline                           | Required Match   |
|--|--|---|------------------------------------|--|
| USACE Section 205 – Small Flood Risk Management Projects                                   | Typical flood risk management projects may include levees, floodwalls, impoundments, pumping stations, and channel modifications as well as non-structural measures. Non-structural measures reduce flood damages by changing the use of floodplains or by accommodating existing uses to the flood hazard. Examples include flood proofing, relocation of structures, and flood warning and preparedness systems. | Up to \$100,000 for initial study. Construction grant depends on project. | Rolling deadline after April 2022. | Initial study has 0% match requirement. Subsequent project requires 35% match. |
| US Fish and Wildlife North American Wetlands Conservation Act US Standard and Small Grants | This program provides a source of funds to conserve wetlands and wetland-dependent fish and wildlife through acquisition (including easements and land title donations), restoration, enhancement, and/or wetland establishment.   | Up to \$1 million.  | July 2022.                         | Requires a 50% match.  |
| National Park Service Land and Water   | This program provides a source of funds for land acquisition for parks and trails; construction of   | \$300,000 to \$1 million (Iowa has a                                      | Due in March Annually.             | Requires a 50% match.  |



|                      |   |  |  |  |
|----------------------|---|--|--|--|
| Conservation Program | trails/biking/hiking paths, riverfront park amenities, and wildlife/nature observation. | max of \$125,000 based on population). |  |  |
|----------------------|---|--|--|--|

### 5.1.3 STATE FINANCING PROGRAMS

State and private financing programs may be considered as well, detailed in Table 19 below. Similarly, please see the Funding Assistance Letter attached for more details on these potential funding sources. Stantec recommends that the City of Clive consider applying for a non-federal grant program, such as the Five Star and Urban Waters Restoration Grant Program, to complement federal flood mitigation grants. Applying to the Iowa Clean Water State Revolving Fund program may also help close any funding gaps.

**Table 19: State and Private financing programs to consider**

| Name   | Description  | Funding Available   | Deadline  | Required Match         |
|--|--|---|---|------------------------|
| Iowa Department of Natural Resources Clean Water State Revolving Funds (CWSRF) | Provides low-interest loans for projects that result in the protection or restoration of surface water. Funding is available for property acquisition.   | Loans vary.   | Rolling application.  | Loan program.          |
| National Fish and Wildlife Foundation Five Star and Urban Waters Restoration   | This program provides funds for wetland, riparian, in-stream and/or coastal habitat restoration. To have a competitive application, the grant application must include an educational component and a community partnership. | \$20,000 to \$50,000.   | Annual solicitation. Most recent deadline was January 25, 2022. | Requires a 50% match.  |
| Iowa DNR Recreational Enhancement and Protection (REAP)                        | Program that invests in the enhancement and protection of the state's natural and cultural resources. Property would need to be deed restricted to open space/recreational use only.   | Maximum of \$125,000 per award. No match is required, though it is advantageous in the competitive scoring process. | Annual solicitation.  | Contact: 515-281-7043. |



|   |  |                              |  |                              |
|---|--|------------------------------|--|------------------------------|
| Water Infrastructure Fund/Conservation Infrastructure Project – Iowa Finance Authority        | Makes investments to support innovative projects across the state, primarily related to water quality improvement, but eligible projects may include those that reduce flood risk as well.       | See details when open again. | Due February 16, 2022. May return in future years. | See details when open again. |
| Iowa Department of Agriculture & Land Stewardship (IDALS) Conservation Infrastructure Project | This fund supports non-point source conservation projects in priority watersheds. Ancillary benefits to improved water quality, habitat, recreation, and carbon sequestration are also supported | \$25,000,000                 | Contact 515-281-5851                               | Contact 515-281-5851         |

## **5.2 Existing City Funds**

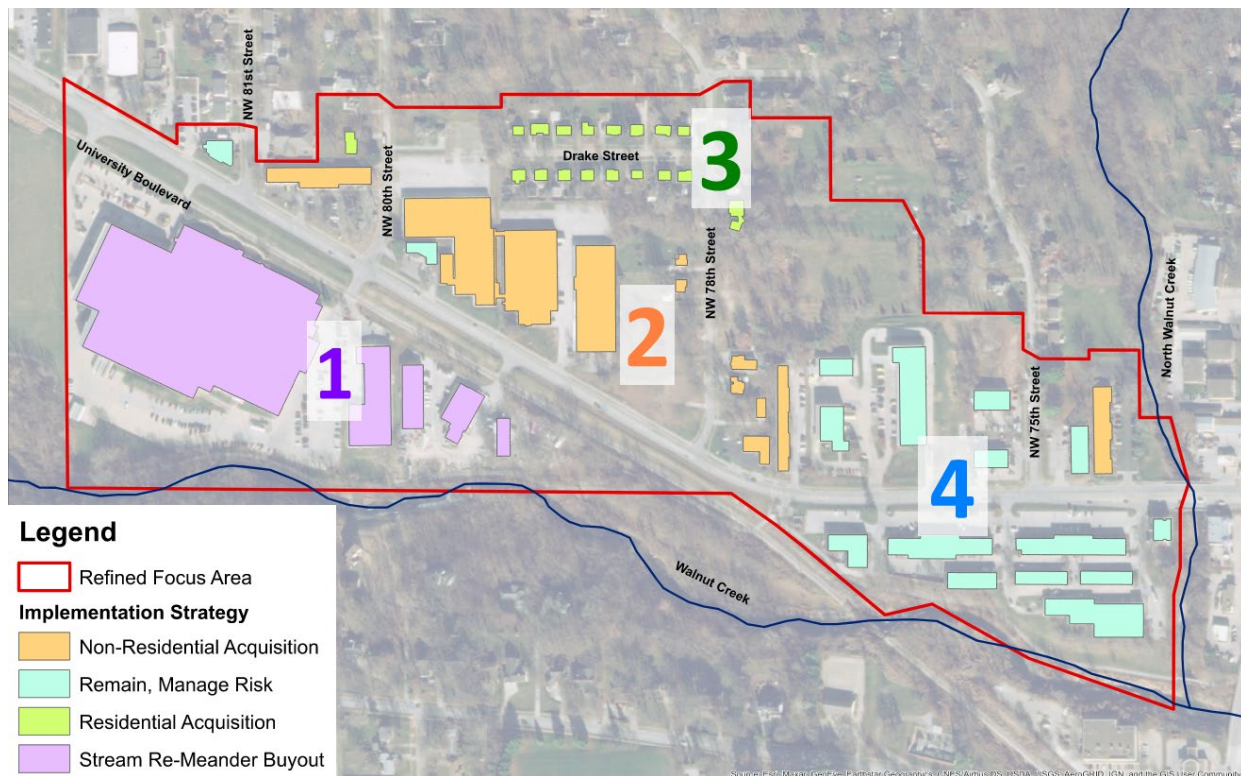
The City of Clive currently has about \$4-4.5 million available to either use as match funding for some of these programs or to use as acquisition support. About \$500,000 of this is the remaining funding from the city’s Phase 3 buyout program, \$1.3 million is from the funds allocated by the American Rescue Plan Act, with \$1.3 million more anticipated from the same program by the end of May 2022. Funds from the American Rescue Plan Act must be expended by 2026. Approximately \$850,000 comes from the Flood Mitigation Planning Capital Fund, and \$500,000 is allocated per year from the Capital Improvement Plan.

## **5.3 Mitigation Timeline and Approach**

### **5.3.1 BUYOUT AREA GROUPINGS**

Within the Refined Focus Area, property acquisitions are anticipated to occur in phases, depending on property owner readiness and funding availability. To begin sorting through acquisition priorities and categorizing groups of structures, a few major groups have been created, as demonstrated in Figure 37 below.





**Figure 37: Refined Focus Area project grouping**

Group One, shown in purple in Figure 37, includes properties south of University Boulevard that are at significant risk of flood damage and would need to be acquired to implement a stream re-meander project. Within Group One is the Acheson property at 8000 University Boulevard, which has experienced repetitive flooding events.

Group Two, shown in orange in Figure 37, includes non-residential properties in the buyout area that would be advantageous to acquire within the next few years to potentially accommodate stormwater management or similar projects. Within Group Two is the Briggs property at 7975/7945/7887 University Boulevard, which has experienced repetitive flooding events.

Group Three, shown in green in Figure 37, represents residential properties within the Refined Focus Area that should be acquired as funding is available or as sellers are ready to leave their homes. Residential properties just south of Drake Street have seen greater flooding damage than those just north of Drake Street and tend to be more willing to sell.

Group Four, shown in blue in Figure 37, represents properties that either show less flood risk than other properties in the Refined Focus Area or have expressed an unwillingness to sell. These properties are recommended to remain and manage risk either with floodproofing, flood insurance, redevelopment, or incremental flood mitigation considerations. These properties may be considered in future efforts or may be brought into more timely plans if a strong desire to sell is expressed.



### 5.3.2 NEXT STEPS

Given that the State of Iowa currently has two disaster declarations offering HMGP funding applications due this year, it is recommended that the City of Clive start the flood mitigation process by applying to the HMGP DR 4642 by December 2022 and/or the HMGP DR 4483 by September 2022 if the deadline is extended. Five (5) to 10 properties may be submitted between these two applications (as funding and property owner willingness allows), making a good start for the overall buyout strategy. From there, Stantec recommends that the City continue to focus on other FEMA funding programs, including FMA and potentially BRIC, as well as submitting applications to HMGP in future years. In the interim, other federal and state funds could be considered as well. Table 20 below outlines estimates as to how FEMA funding may be approached and what it would cost the City of Clive.

**Table 20: FEMA funding details and timeline**

| Program                             | No. Properties                         | Total Cost   | Federal Share | State Share | Clive Local Share |
|-------------------------------------|--|--------------|---------------|-------------|-------------------|
| HMGP (This Year)                    | 5-10 (as funding / willingness allows) | \$3,000,000  | \$2,250,000   | \$300,000   | \$450,000         |
| FMA                                 | 3-5 (prioritize RL and SRL properties) | \$2,000,000  | \$1,800,000   | \$200,000   | \$0               |
| Advanced Assistance / BRIC Planning | Stream Re-Meander Modeling and Design  | \$200,000    | \$150,000     | \$20,000    | \$30,000          |
| BRIC or other                       | 4-5 Properties and Stream Re-Meander   | \$28,700,000 | \$21,525,000  | \$2,870,000 | \$4,305,000       |
| HMGP (Future Years)                 | Remaining                              | \$3,000,000  | \$2,250,000   | \$300,000   | \$450,000         |

## 6 Conclusions and Recommendation

With this report and the attachments included, Stantec hopes that the City of Clive has the resources necessary to advance applications for federal and state flood mitigation programs and begin prioritizing next steps for flood mitigation.

Given that flood mitigation in the University Boulevard Neighborhood is anticipated to span about ten years, it is important to consider flood protection for properties with significant flood risk in the interim. Stantec recommends that the City of Clive continue their flood protection and hazard mitigation efforts and that floodproofing for high-risk structures also be considered.



## 7 Attachments

### A – BCA Professional Expected Damages Module

#### A.1 – Batch Toolkits

- A.1.1\_Clive\_Univ\_Blvd\_Alt1\_RR\_Bridge\_Batch
- A.1.2\_Clive\_Univ\_Blvd\_Alt2\_Levee\_Batch
- A.1.3\_Clive\_Univ\_Blvd\_Alt3\_Floodproofing\_Batch
- A.1.4\_Clive\_Univ\_Blvd\_Alt4\_Acquisition\_Batch
- A.1.5\_Clive\_Univ\_Blvd\_Alt5\_Stream\_Batch

#### A.2 – BCA Toolkit Files

- A.2.1\_Clive\_Univ\_Blvd\_Alt1\_RR\_Bridge\_Toolkit
- A.2.2\_Clive\_Univ\_Blvd\_Alt2\_Levee\_Toolkit
- A.2.3\_Clive\_Univ\_Blvd\_Alt3\_Floodproofing\_Toolkit
- A.2.4\_Clive\_Univ\_Blvd\_Alt4\_Acquisition\_Toolkit
- A.2.5\_Clive\_Univ\_Blvd\_Alt5\_Stream\_Toolkit

### B – BCA Riverine Modeled Damages Module

#### B.1 – Batch Toolkits

- B.1.1\_Clive\_Univ\_Blvd\_Acquisition\_No\_Env\_Batch
- B.1.2\_Clive\_Univ\_Blvd\_Acquisition\_Env\_Batch

#### B.2 – BCA Toolkit Files

- B.2.1\_Clive\_Univ\_Blvd\_Acquisition\_No\_Env\_Toolkit
- B.2.2\_Clive\_Univ\_Blvd\_Acquisition\_Env\_Toolkit

#### B.3 - BCA Reports

- B.3.1\_Clive\_Univ\_Blvd\_Acquisition\_No\_Env\_Report
- B.3.2\_Clive\_Univ\_Blvd\_Acquisition\_Env\_Report

### C – Cost Estimates

- C.1\_Cost\_Estimate\_Alt1\_RR\_Bridge
- C.2\_Cost\_Estimate\_Alt2\_Levee
- C.3\_Cost\_Estimate\_Alt3\_Floodproofing
- C.5\_Cost\_Estimate\_Alt5\_Stream\_Remeander

### D – Guidelines and References

- D.1\_Iowa\_Floodproofing\_Guidelines
- D.2\_2020\_Craftsman\_National\_Building\_Cost\_Manual
- D.3\_FEMA\_Memo\_Pre-Calculated\_Benefits
- D.4\_Stantec\_Funding\_Assistance\_Letter

### E- Hydraulic and Hydrologic Model

- E.1\_University\_Boulevard\_H&H\_Report



E.2\_University Boulevard\_H&H\_Model

**F- BCA Supporting Evidence**

F.1 – Geodatabase files with BCA Input and Output Data

F.1.1\_Clive\_Univ\_Blvd\_BCA\_Inputs.gdb

- Bldg\_Footprints
- Bldg\_Point\_Elevation
- Parcels
- DEM
- Focus\_Area
- Refined\_Focus\_Area
- Existing Conditions WSEs
  - WSE\_Existing\_XXyr (10-,50-,100-,500-)

F.1.2 – Post-Mitigation Water Surface Elevations

F.1.2.1\_Clive\_Univ\_Blvd\_Alt1\_Railroad\_Bridge\_Removal.gdb

- WSE\_Alt1\_XXyr (10-,50-,100-,500-)

F.1.2.2\_Clive\_Univ\_Blvd\_Alt2\_Levee.gdb

- WSE\_Alt2\_XXyr (10-,50-,100-,500-)

F.1.2.3\_Clive\_Univ\_Blvd\_Alt5\_Stream\_Remeander.gdb

- WSE\_Alt5\_XXyr (10-,50-,100-,500-)

F.1.3\_Clive\_Univ\_Blvd\_BCA\_Prof\_Dmgs\_Results.gdb

- Footprint\_File\_to\_Join\_Results
- Alt1\_Railroad\_Bridge\_Removal\_Results
- Alt2\_Levee\_Results
- Alt3\_Individual\_Floodproofing\_Results
- Alt4\_Individual\_Acquisition\_Results
- Alt5\_Stream\_Remeander\_Structural\_Results

F.1.4\_Clive\_Univ\_Blvd\_Acq\_Riverine\_Module\_Results.gdb

- Footprint\_File\_to\_Join\_Results
- Focus\_Area\_Results

F.2\_Supplemental\_Building\_Data

F.3\_Screenshots\_Google\_Street\_View\_Step\_Count



## 8 Disclaimer

The conclusions in the Report are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

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