# Cherry Bayou Drainage Master Plan

Volume I – Executive Summary

TETRA TECH

**Project # 200-25929-18001**

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# 1.0 INTRODUCTION

The City of Memphis (City) selected Tetra Tech to perform a Drainage Master Plan for the Cherry Bayou Study Area as part of the citywide Stormwater Master Planning Program. The main goals of the project are to:

- Collect data on the existing stormwater drainage systems and develop a comprehensive geographic information system (GIS) dataset for future City planning and maintenance efforts.
- Develop a model to identify flooding within the area.
- Identify areas that lack hydraulic conveyance capacity and the corresponding extents of flooding.
- Evaluate and recommend improvements to alleviate flooding in the stormwater drainage system.

The Cherry Bayou Study Area (study area) is located northeast of the center portion of the City within Council Districts 4 and 5. The study area consists of approximately 3,168 acres situated between the Black Bayou to the west, the Nonconnah Creek to the south, Route 57 to the north, and South White Station Road to the east. The study area is predominantly single-family residential with some commercial land use in the northeast portion of the study area.

The study area consists of two distinct watersheds or drainage basins, as shown in Figure 1.1:

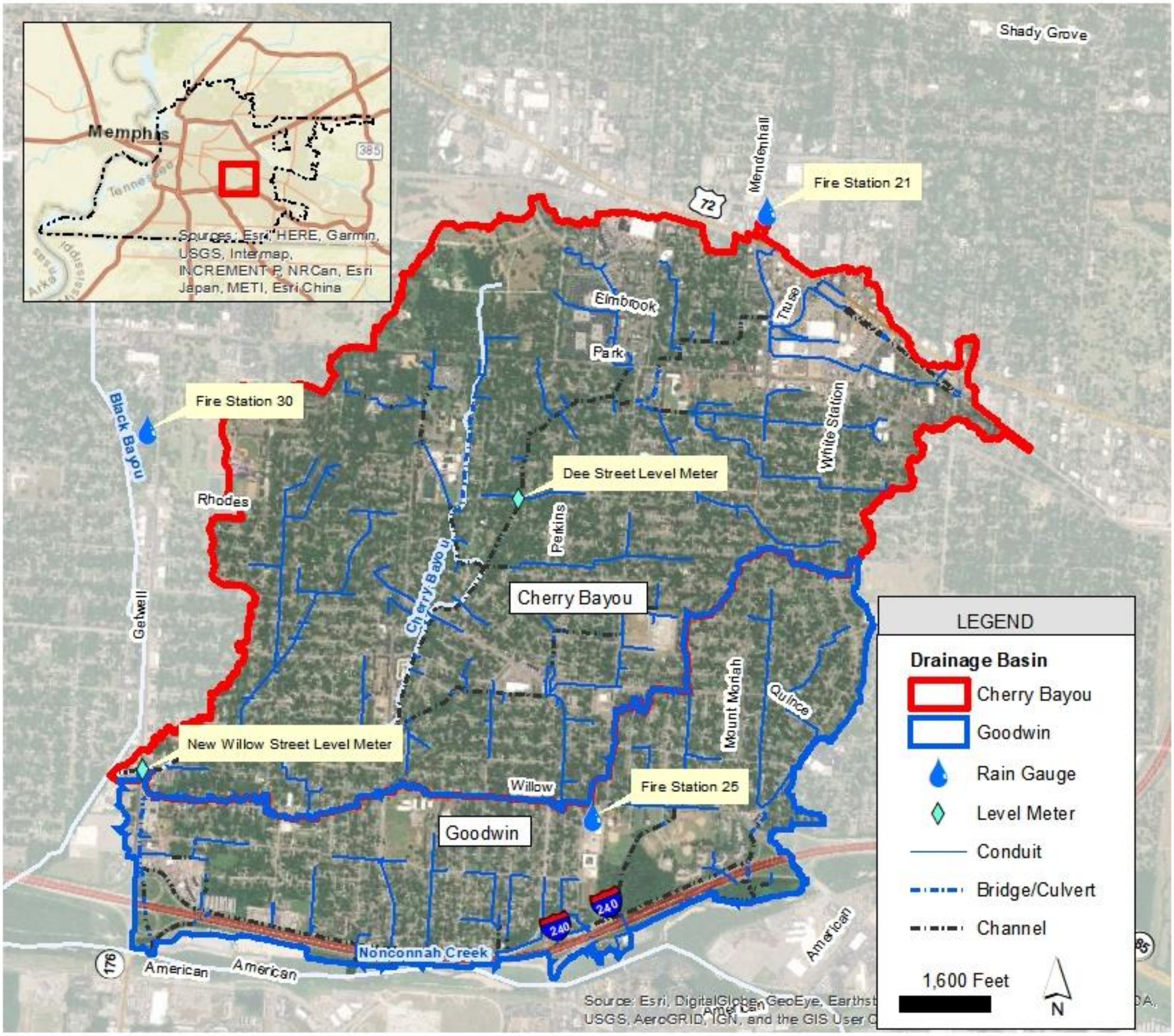
- Cherry Bayou: This 2,190-acre basin is drained by Cherry Bayou, which flows to the Black Bayou and then on to Nonconnah Creek.
- Goodwin: This 978-acre basin is drained by small drainage branches all independently draining into Nonconnah Creek.

For the initial public outreach effort, the Tetra Tech team coordinated with key stakeholders such as school representatives, church leaders, and other community groups. The Tetra Tech team conducted a public meeting within the study area on March 29, 2018 at White Station Church of Christ Community Life Center. Feedback from local citizens improved the evaluation, identification, and prioritization of project opportunities during the study. The City also provided a GIS database for flooding-related service requests received from November 2003 through May 2019, including location and type of flooding (e.g., home, street, yard, or general flooding).

Prior to the model development stage, the Tetra Tech team performed an extensive data collection effort in order to develop an accurate GIS database of the existing storm drainage system. The field surveying inventory included 474 drainage structures (typically for 24-inch diameter or larger pipe), 9 road crossings (bridges or culverts), 20 cross-sections of open channel, 70 finished floor elevations, and geo-referenced photos at open-to-closed flow transitions.

The City also engaged the University of Memphis Ground Water Institute (GWI) to install and maintain two stream level (flow depth) meters and three rain gauges within the study area in order to support the model validation and calibration process. The level meters were located near the Dee Street bridge and at New Willow Road at Getwell Road. The rain gauges were located at Fire Stations 21, 25, and 30. The GWI collected stream level and precipitation data from November 2017 through May 2018.

**Figure 1.1: Cherry Bayou Study Area Drainage Basins**



# 2.0 EXISTING CONDITIONS MODELING SUMMARY

The existing drainage system in the study area consists of a variety of natural channels, concrete-lined channels, bridges, box culverts, pipe culverts, and storm sewer systems with inlets, manholes, junctions, and connecting pipes or other closed conduits. Detailed descriptions of the existing drainage systems and modeling process can be found in Volume II of the Final Report.

The City determined that InfoSWMM® would be the modeling platform used to provide a basis for analyzing the existing storm drainage system, identify hydraulic contraction locations and capacity limitations, and ultimately identify improvement opportunities to reduce flooding at or near homes and businesses in the study area.

The survey-based GIS database was used as the starting point for the hydraulic model network. The hydraulic model includes a total of 46,062 lineal feet of open channel, 127,148 lineal feet of storm sewer drainage components, and 81 road crossings (culverts or bridges). The model includes 120,291 lineal feet of overland flow paths to convey flooded water from under-capacity sections to downstream locations where adequate capacity exists. The model also includes 11 outfalls representing the downstream boundary or terminal node of each drainage system. The Cherry Bayou watershed is the largest portion of the overall study area with over 68 percent of the stormwater conveyance network and the Goodwin watershed containing 32 percent of the modeled drainage system.

For open channels, the field survey effort focused on collecting data within the channel banks. The field surveyed cross-sections were merged with Shelby County LIDAR data to produce a single three-dimensional (3D) surface model of the entire study area including channels and floodplain areas. Cross-sections for modeling were cut from the 3D surface at each open channel section. This 3D surface was also used to delineate floodplain limits for design storm simulations of existing and proposed conditions.

The model was calibrated and validated using data collected from the two level metering locations. The time-series level data was converted to flow rate with a depth vs. flow rating curve. The model developed meets current industry criteria, and based on meetings and discussions with the City and program management team, is considered well-calibrated based on available data.

After the modeling validation and calibration was accepted by the City, the 2-, 5-, 10-, 25-, 50-, and 100-year, 24-hour design storms were used to evaluate the system's hydraulic capacity and potential for flooding. Floodplain inundation maps were developed to illustrate the extent of flooding from the 10-year and 100-year, 24-hour design storm events. The inundation maps are color coded based on depth of flooding. See Figure 2.1 and Figure 2.2 for examples of the 10-year and 100-year maps.

The floodplains are presented with three color-coded depth classifications to help identify the severity of the flooding. The three classifications are:

- Green - Zero to one foot in depth
- Yellow - One to two feet in depth
- Red - Greater than two feet in depth.

The full set of inundation maps may be viewed in Volume II.

The following tables (Table 2.1 and Table 2.2) provide the number of structures within each depth classification in each watershed for the existing 10-year and 100-year, 24-hour design events. For this study, a structure is the main dwelling of each parcel. Secondary structures such as garages, sheds, and trailers were not included in the analysis.

**Table 2.1: Cherry Bayou Flooded Structures**

| Flooding Depth (feet) | Existing 10-year, 24-hour Floodplain | Existing 100-year, 24-hour Floodplain |
|---|---|---|
| 0 – 1 | 398 | 579 |
| 1 - 2 | 122 | 204 |
| > 2 | 17 | 39 |
| Total | 537 | 783 |
| Total > 1 | 139 | 243 |

**Table 2.2: Goodwin Flooded Structures**

| Flooding Depth (feet) | Existing 10-year, 24-hour Floodplain | Existing 100-year, 24-hour Floodplain |
|---|---|---|
| 0 – 1 | 125 | 166 |
| 1 - 2 | 20 | 46 |
| > 2 | 21 | 37 |
| Total | 166 | 249 |
| Total > 1 | 41 | 83 |

**Figure 2.1: Example 10-Year Existing Floodplain Inundation Map**

**Figure 2.2: Example 100-Year Existing Floodplain Inundation Map**

# 3.0 ALTERNATIVES DEVELOPMENT SUMMARY

## 3.1 APPROACH AND PRELIMINARY ALTERNATIVES DEVELOPMENT

An evaluation of alternatives was performed to identify and evaluate opportunities to improve system performance and reduce the frequency or severity of flooding. Ideally, the existing drainage systems would be upgraded to increase hydraulic capacity to handle at least the 10-year, 24-hour design event without surcharging. After completing the assessment of the existing system, it became apparent that such a capacity level would not be feasible throughout the entire study area. A more practical objective was to eliminate as many primary residential/commercial structures as possible from the 10-year, 24-hour design event floodplain. Secondary structures such garages, sheds, and trailers were not included in the analysis; nor were basements in primary structures considered.

The two types of improvement alternatives considered were (1) increased detention storage to attenuate peak flows, and (2) increased conveyance to remove isolated hydraulic contractions (“bottlenecks”) and lower system hydraulic grade line (HGL) profiles.

Potential storage (detention) facilities were first identified and evaluated. However, storage sites alone were not sufficient to reduce significant flooding in the model simulation. This is partly due to the significant number of bottlenecks in the system. Therefore, additional conveyance improvements, such as upsizing channels, pipes and box culverts, were identified and analyzed.

A meeting was held on February 7, 2020 with representatives from the City to review the status of model development activities and potential alternatives that could be evaluated to reduce flooding. No system capacity alternatives were eliminated during this meeting. However, out of seven potential storage sites reviewed, only four were chosen to be viable options based on the location and current property ownership and were included in the alternatives to be further evaluated:

- **Harding Academy** (Storage Site 1): This site is located on the west side of the Harding Academy property in the Cherry Bayou drainage basin.
- **Marquette Park** (Storage Site 2): This site is located at Marquette Park in the Cherry Bayou drainage basin.
- **FEMA Buyout Properties/Vacant Parcel** (Storage Site 3A/3B): These sites are located along Titus Road in the Goodwin drainage basin.
- **Board of Education** (Storage Site 3C): This site is located at South Park Elementary School in the Goodwin drainage basin.

Figure 3.1 features all of the areas evaluated for potential storage sites. Figures 3.2-3.6 display the four viable storage options.

**Figure 3.1: Areas Evaluated for Potential Storage Sites**

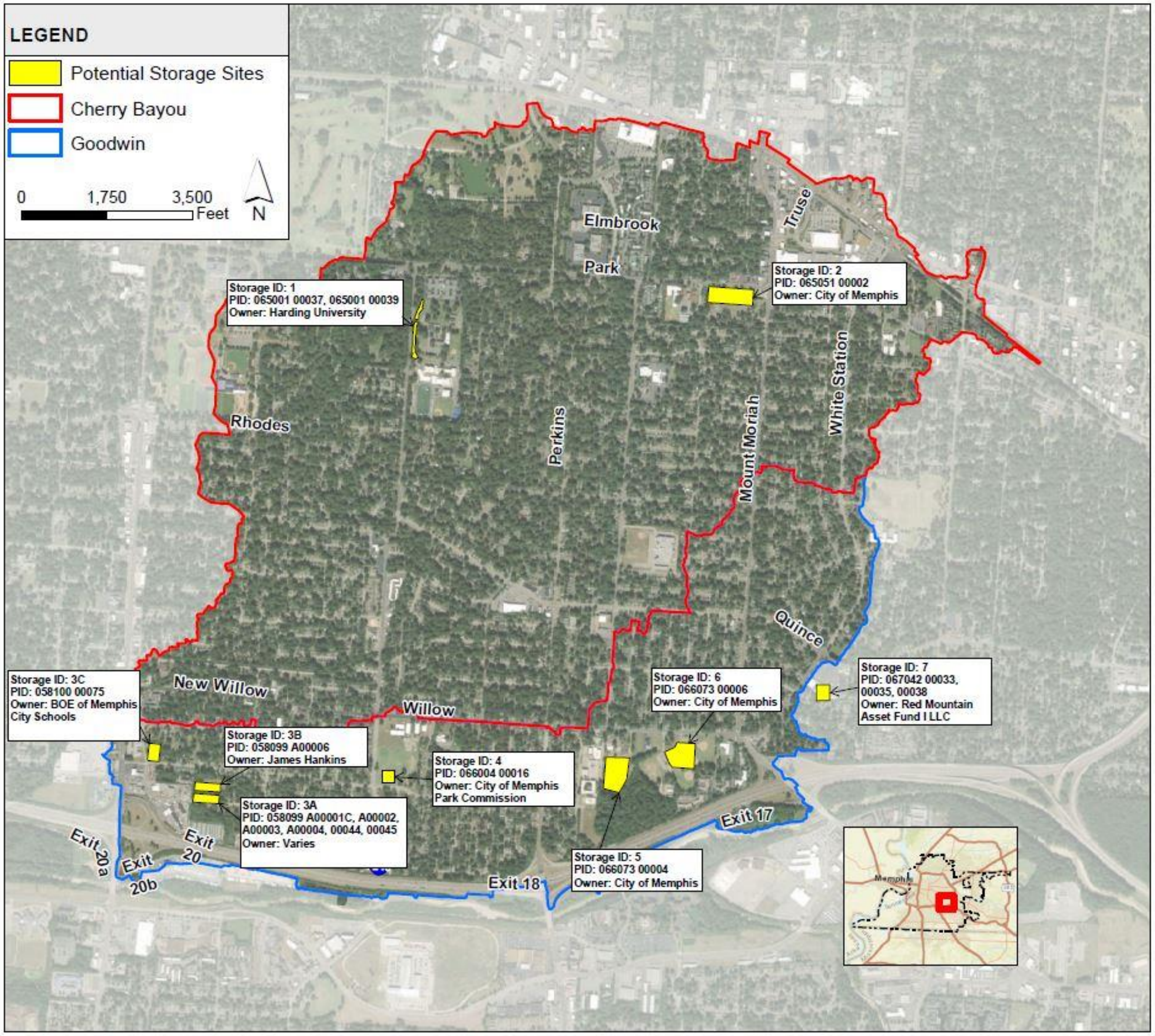


**Figure 3.2: Conceptual Harding Academy Storage Alternative**

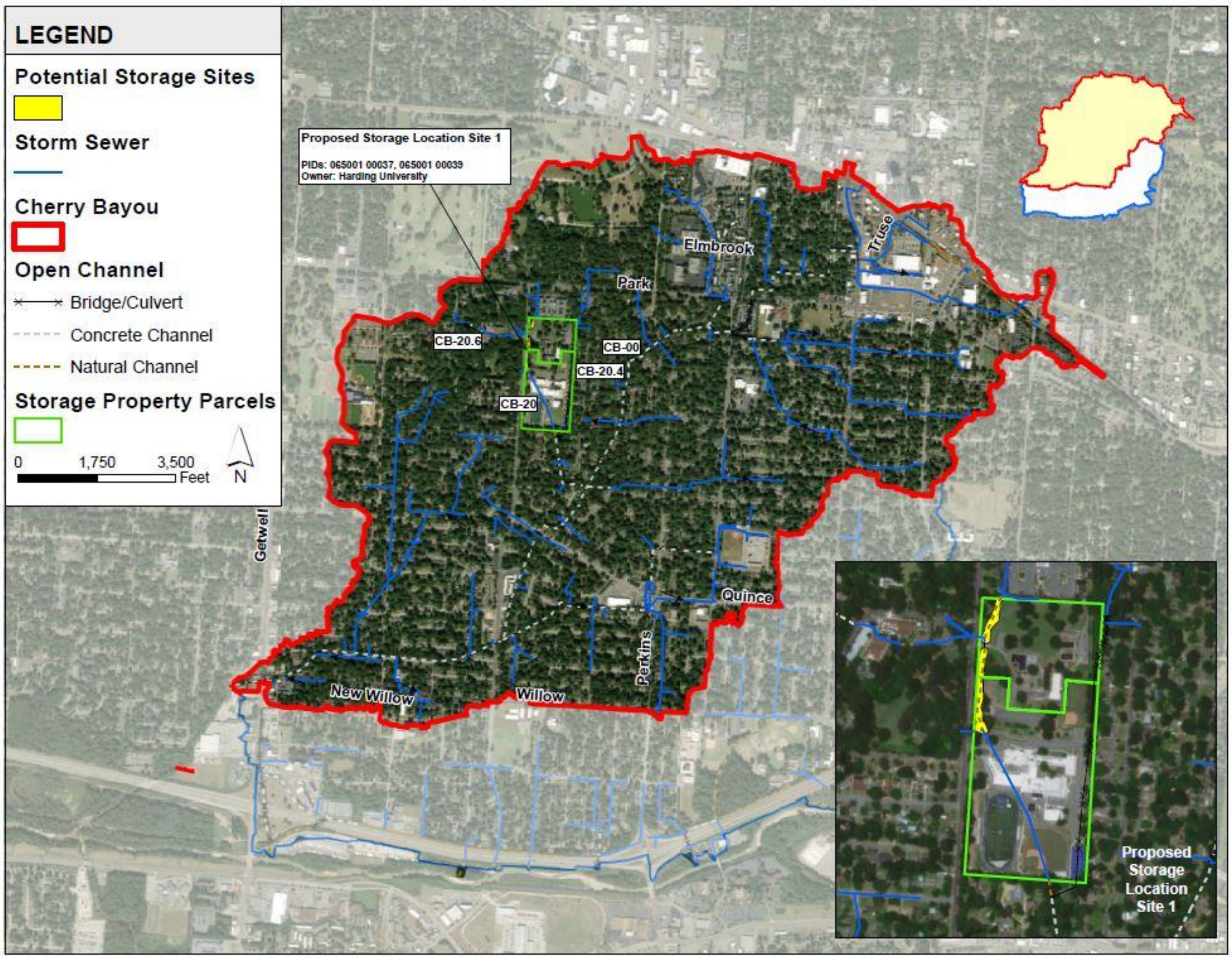


**Figure 3.3: Conceptual Harding Academy Storage Alternative**

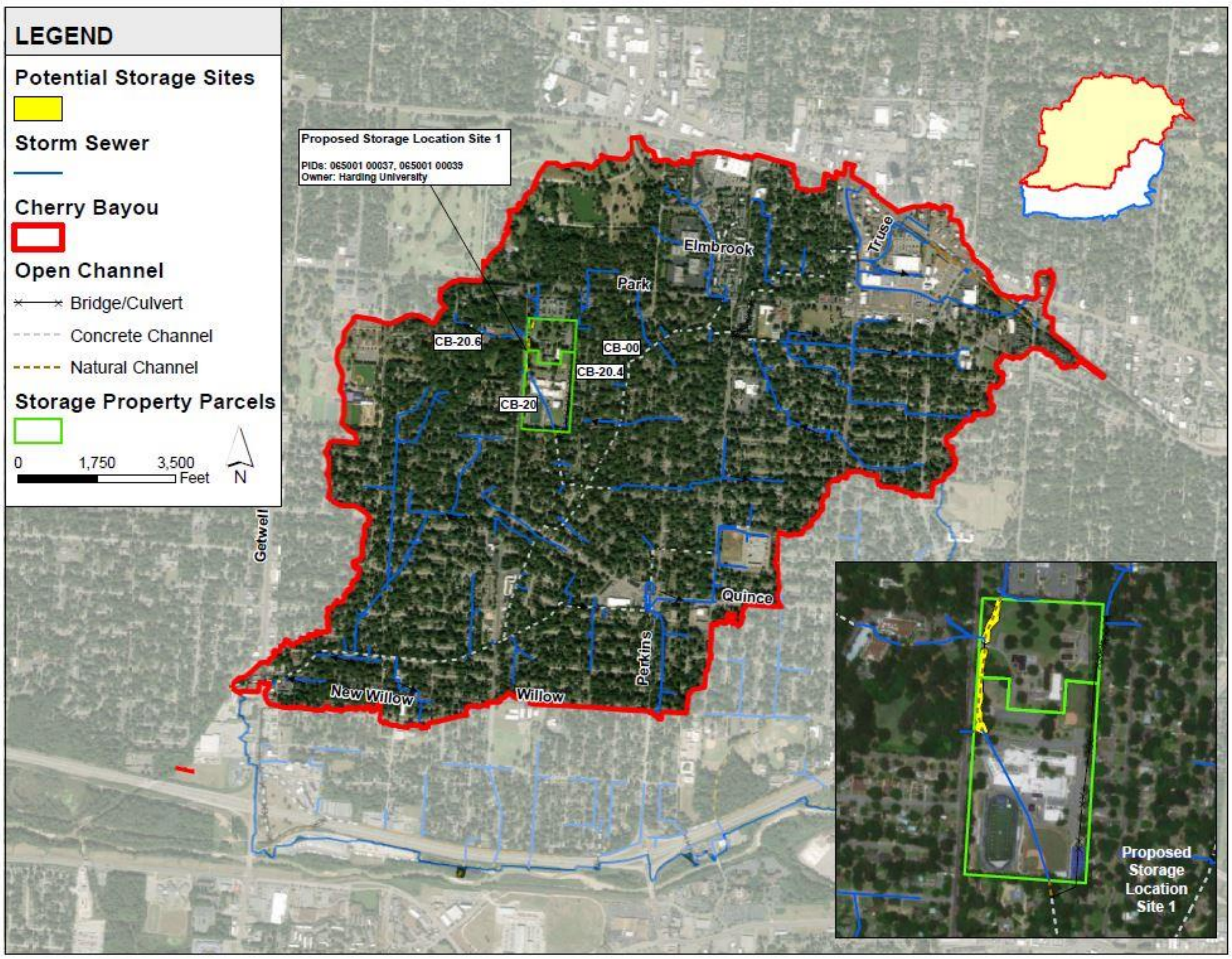


**Figure 3.4: Conceptual Memphis Board of Education Alternative 3A**

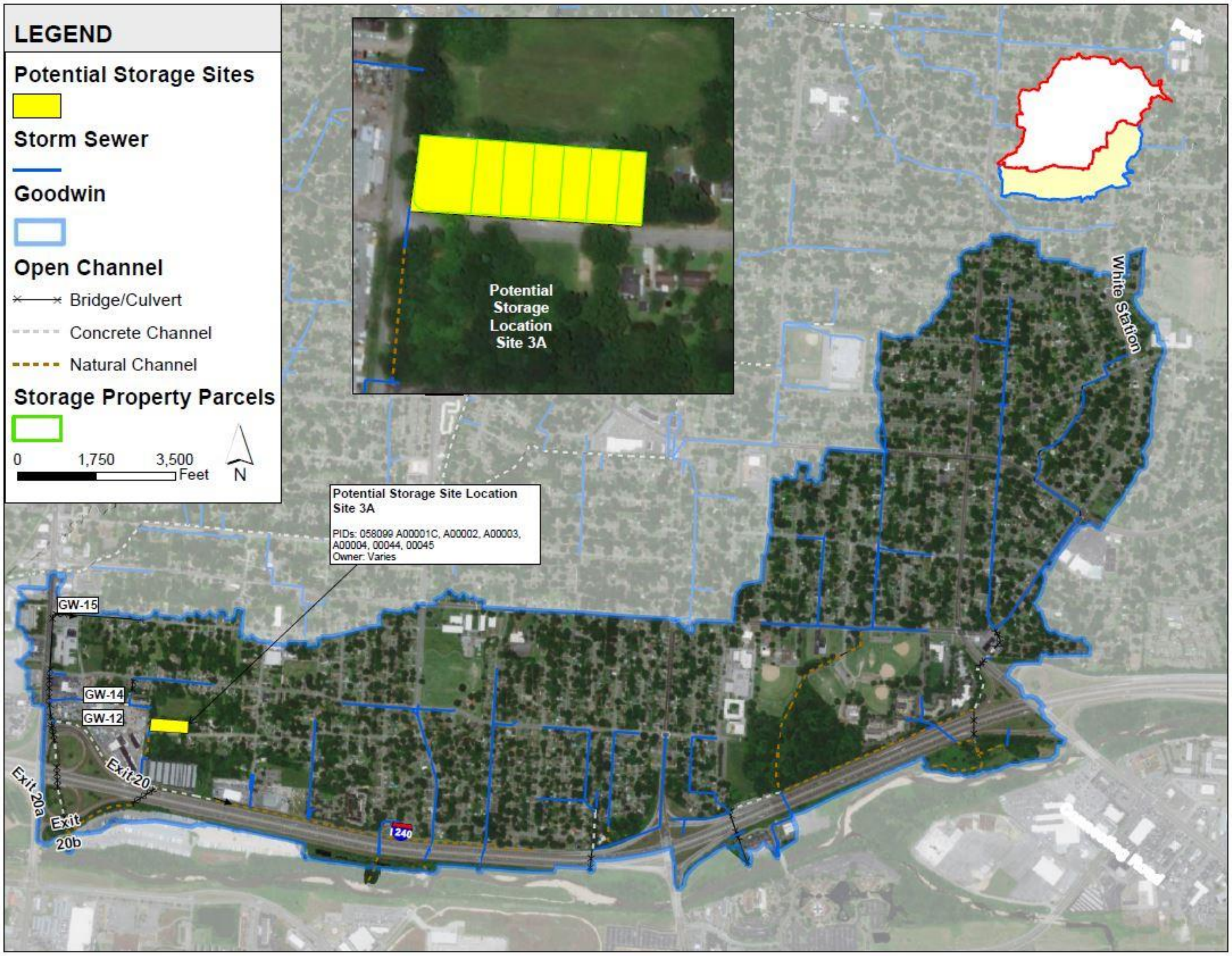


**Figure 3.5: Conceptual Memphis Board of Education Alternative 3B**

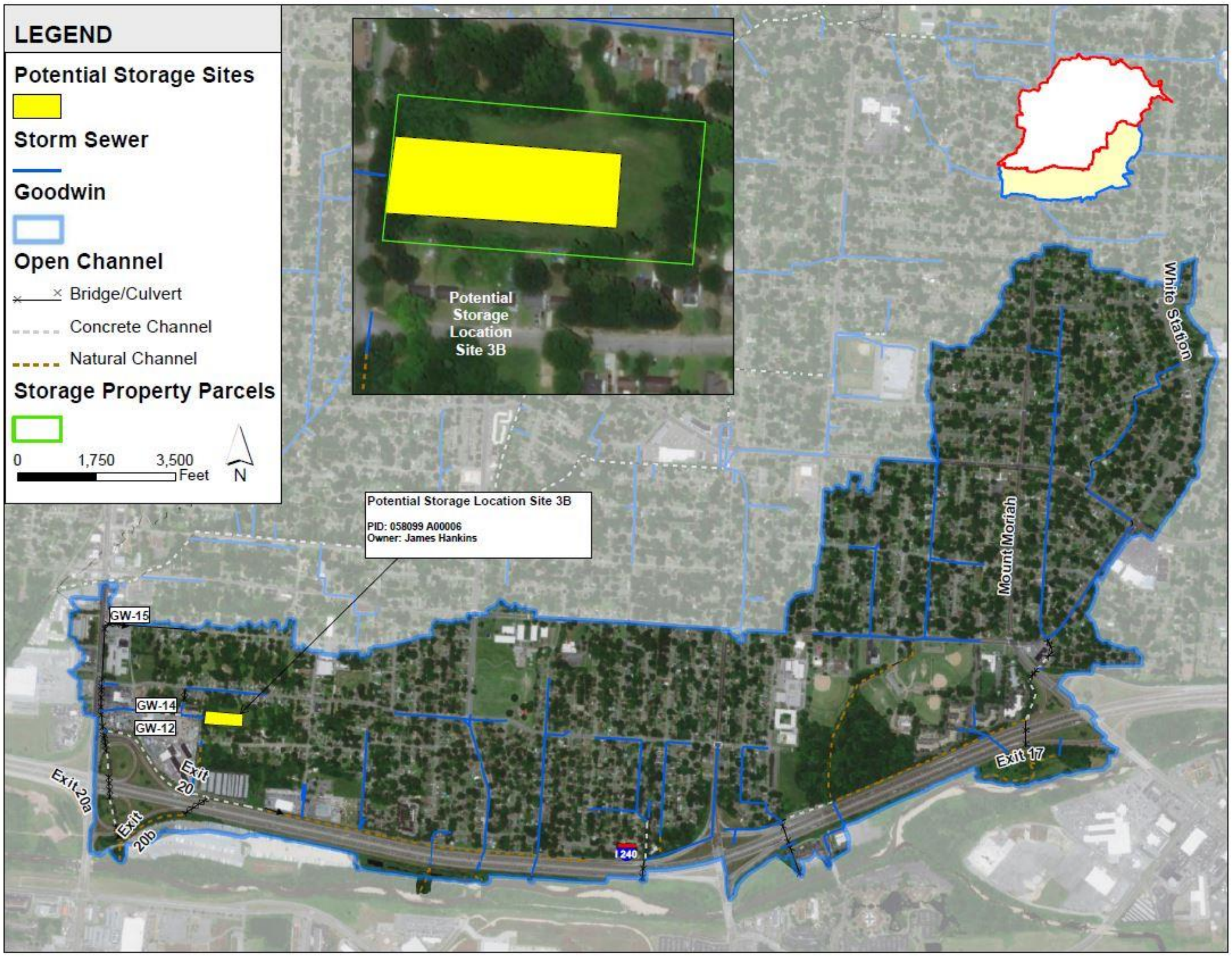
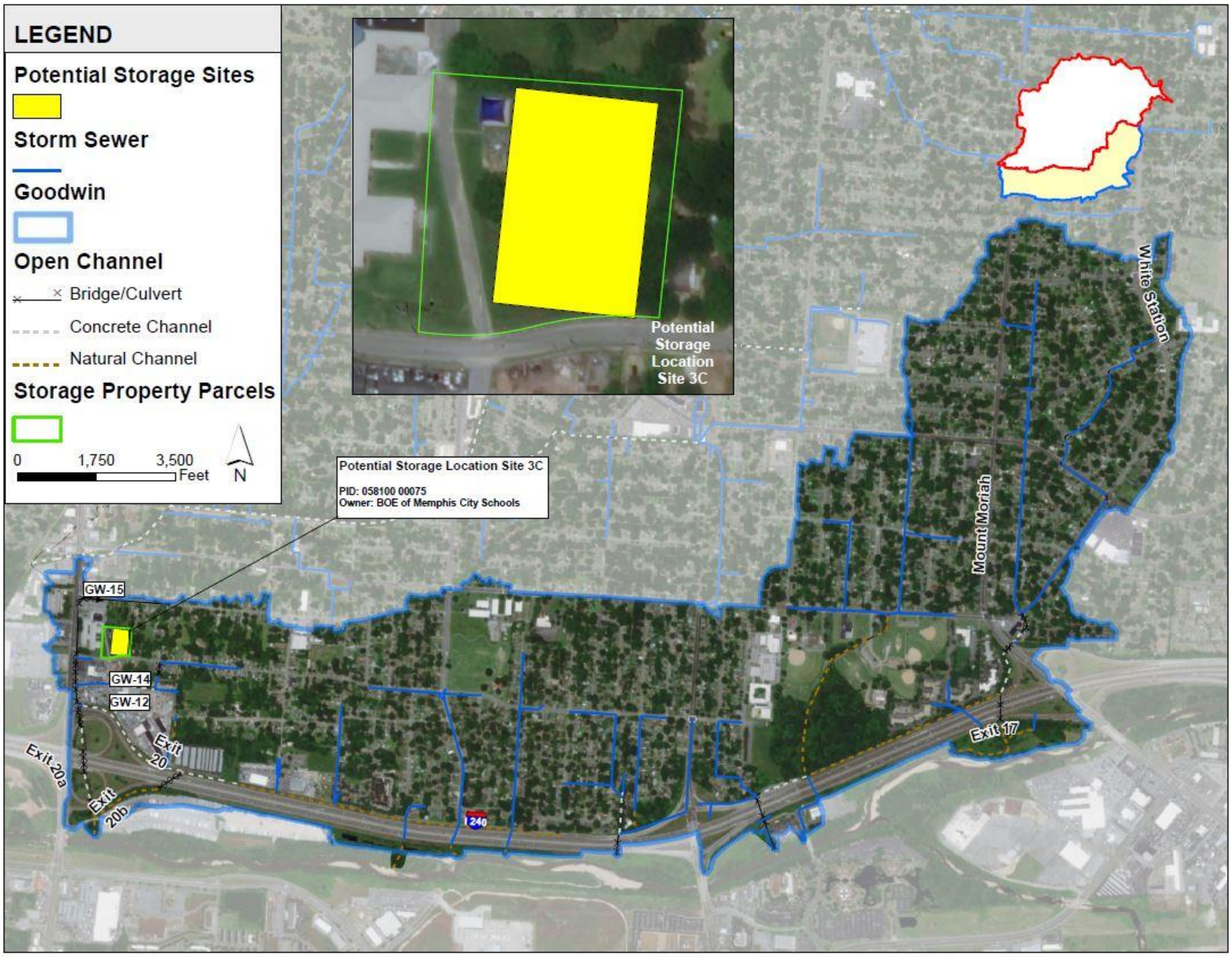


**Figure 3.6: Conceptual Memphis Board of Education Alternative 3C**



## 3.2 FINAL RECOMMENDED ALTERNATIVES

This section provides a listing of the evaluated alternatives that are recommended for the study area, with the general location of flooding intended to be alleviated (which is not necessarily the same as the location of the actual proposed improvement). All alternatives are system capacity alternatives, unless otherwise indicated.

A total of fourteen (14) alternatives were evaluated for the Final Report, including ten (10) system capacity alternatives and four (4) combined storage and system capacity alternatives. Location maps and detailed descriptions of the recommended alternatives, including planning-level cost opinions for each project, can be found in Volume II of the Final Report. Floodplain delineation maps and hydraulic profiles (along main branches) for the proposed alternatives based on the 10-year and 100-year design storms can also be found in Volume II.

### Cherry Bayou Basin

- **CB-02 Alternative:** Goal is to reduce flooding along New Willow Avenue.
- **CB-03 Alternative:** Goal is to reduce flooding along Willowview Avenue.
- **CB-05 & CB-05.04 Alternative:** Goal is to reduce flooding that begins at Dunn Road and continues upstream to Audubon Drive. Severe flooding areas include properties along Rebecca Street, Fredericks Avenue, Fizer Road, Meadow Drive, Briarwood Road, Oakridge Drive, Broadmoor Street, Wedgewood Street, Carolyn Drive, Cherrydale Road, Cherrydale Cove, Rhodes Avenue, Woodcrest Drive, and Amber Lane.
- **CB-07 Alternative:** Goal is to reduce flooding near the intersection of New Willow Avenue and South Goodlett Street.
- **CB-12 & CB-12.8 Alternative:** Goal is to reduce flooding along Sea Isle Drive, Marcia Road, and Verne Drive.
- **CB-20, CB-20.04, & CB-23 Capacity/Storage Alternative:** Goal is to reduce flooding at Harding Academy via capacity and storage improvements.
- **CB-21 Alternative:** Goal is to reduce flooding along Dearing Avenue, South Perkins Road, Mockingbird Lane, Hummingbird Lane, Colonial Lane, and Flamingo Road.
- **CB-28 Alternative:** Goal is to reduce flooding along Towering Oaks Drive, Colonial Street, and Colonial Road.
- **CB-30, CB-30.1, CB-30.2, & CB-00 Capacity/Storage Alternatives:** Goal is to reduce flooding along Alrose Avenue, Kaye Avenue, Welchshire Avenue, Hampshire Avenue, Edenshire Avenue, and Ivy Road via capacity improvements or a combination of capacity and storage improvements dependent upon selected option.
- **CB-43 Alternative:** Goal is to reduce flooding along Leatherwood Road.

### Goodwin Basin

- **GW-11 Alternative:** Goal is to reduce flooding along East Mallory Road and Titus Road.
- **GW-14 & GW-15 Capacity/Storage Alternatives:** Goal is to reduce flooding along South Goodlett Street and Bar Avenue via capacity and storage improvements.

Table 3.1 and Table 3.2 show the number of structures within each depth classification for the proposed 10-year and 100-year design storm events per drainage area if the above improvements are completed. Floodplain inundation maps for the proposed design storm events were also developed. See Figure 3.7 and Figure 3.8 for examples of the 10-year and 100-year proposed design storm event floodplain inundation maps. The full set of inundation maps may be viewed in Volume II.

| Table 3.1: Cherry Bayou Flooded Structures with Recommended[1] Improvements | | |
|---|---|---|
| **Flooding Depth (feet)** | **Proposed 10-year, 24-hour Floodplain** | **Proposed 100-year, 24-hour Floodplain** |
| 0 – 1 | 120 | 303 |
| 1 - 2 | 2 | 32 |
| > 2 | 2 | 2 |
| Total | 124 | 337 |
| Total > 1 | 4 | 34 |

| Table 3.2: Goodwin Flooded Structures with Recommended[1] Improvements | | |
|---|---|---|
| **Flooding Depth (feet)** | **Proposed 10-year, 24-hour Floodplain** | **Proposed 100-year, 24-hour Floodplain** |
| 0 – 1 | 89 | 164 |
| 1 - 2 | 0 | 21 |
| > 2 | 0 | 1 |
| Total | 89 | 186 |
| Total > 1 | 0 | 22 |

Footnotes:

1 – Structure counts included for the recommended project when more than one alternative is provided.

**Figure 3.7: Example 10-Year Proposed Floodplain Inundation Map**

**Figure 3.8: Example 100-Year Proposed Floodplain Inundation Map**

## 3.3 CONCLUSION

The sizing and effectiveness of improvements assumes that all of the projects in a particular watershed are implemented. For example, if an upstream capacity upgrade project is completed prior to recommended downstream improvements, the downstream system may not have sufficient capacity which could lead to adverse impacts in those areas. Implementation of individual projects, or subsets of projects would need to be further evaluated on a case-by-case basis.

The recommended improvements were prioritized based on constructability and the effectiveness of reducing residential flooding. Projects were prioritized as follows: storage improvements first, followed by conveyance improvements in a downstream to upstream manner. Projects located upstream of the main branches were prioritized based on the effectiveness of removing homes from the predicted 10-year and 100-year floodplain.

Table 3.3 below summarizes the total approximate costs by priority level, and the anticipated total number of homes removed from the 10-year and 100-year floodplains, if all of the projects in each priority grouping are implemented. Table 6.2 in the Final Report (Volume II) summarizes the recommended improvements for each project including type of improvement, priority level, approximate project cost, number of homes in the existing 10-year and 100-year floodplain, and anticipated number of homes removed from the 10-year and 100-year floodplains if the project is implemented.

The Priority 1 improvements provide the most benefit and would remove approximately 128 total primary structures from the 10-year floodplain at a cost of approximately $29.1M (or $228,000 per structure removed). These projects are in areas with significant predicted flooding and structure or land flooding complaints. The Priority 2 projects category contains projects with street or maintenance complaints. Priority 3 projects are projects in areas with no reported flooding complaints and a significantly higher cost benefit ratio, which is the primary reason for their lower priority ranking.

The cumulative anticipated project cost for Priority 1, 2 and 3 improvements is $36.2M. To optimize the City's capital expenditure for the greatest positive impact, we recommend a phased implementation approach. We recommend implementing the Priority 1 improvements and then evaluating the remaining system to determine if isolated flooding continues to persist. If isolated flooding does continue to occur, the City can implement specific Priority 2 or 3 projects as needed to address specific issues.

| | Table 3.3: Summary of Improvement by Priority | | | |
|---|---|---|---|---|
| **Priority Level** | **Project IDs** | **Total Cost Opinion, $[1]** | **Primary Structures[2] Removed from 10-Year Floodplain** | **Primary Structures[2] Removed from 100-Year Floodplain** |
| 1 | CB-05 & CB-05.04, CB-20, CB-20.04, & CB-23, CB-30, CB-30.1, CB-30.2, & CB-00 (Option B), GW-14 & GW-15 (Option A) | $29,060,000 | 128 | 199 |
| 2 | CB-03, CB-12.6 & CB-12.8, CB-21, CB-28, GW-11 | $4,520,000 | 41 | 59 |
| 3 | CB-02, CB-07, CB-43 | $2,870,000 | 7 | 11 |

Footnotes:

1 – See Appendix B in Volume II for breakdown of cost opinions for each project with explanatory notes.

2 – Primary structures do not include out-buildings, garages, or sheds.

**END OF VOLUME I**