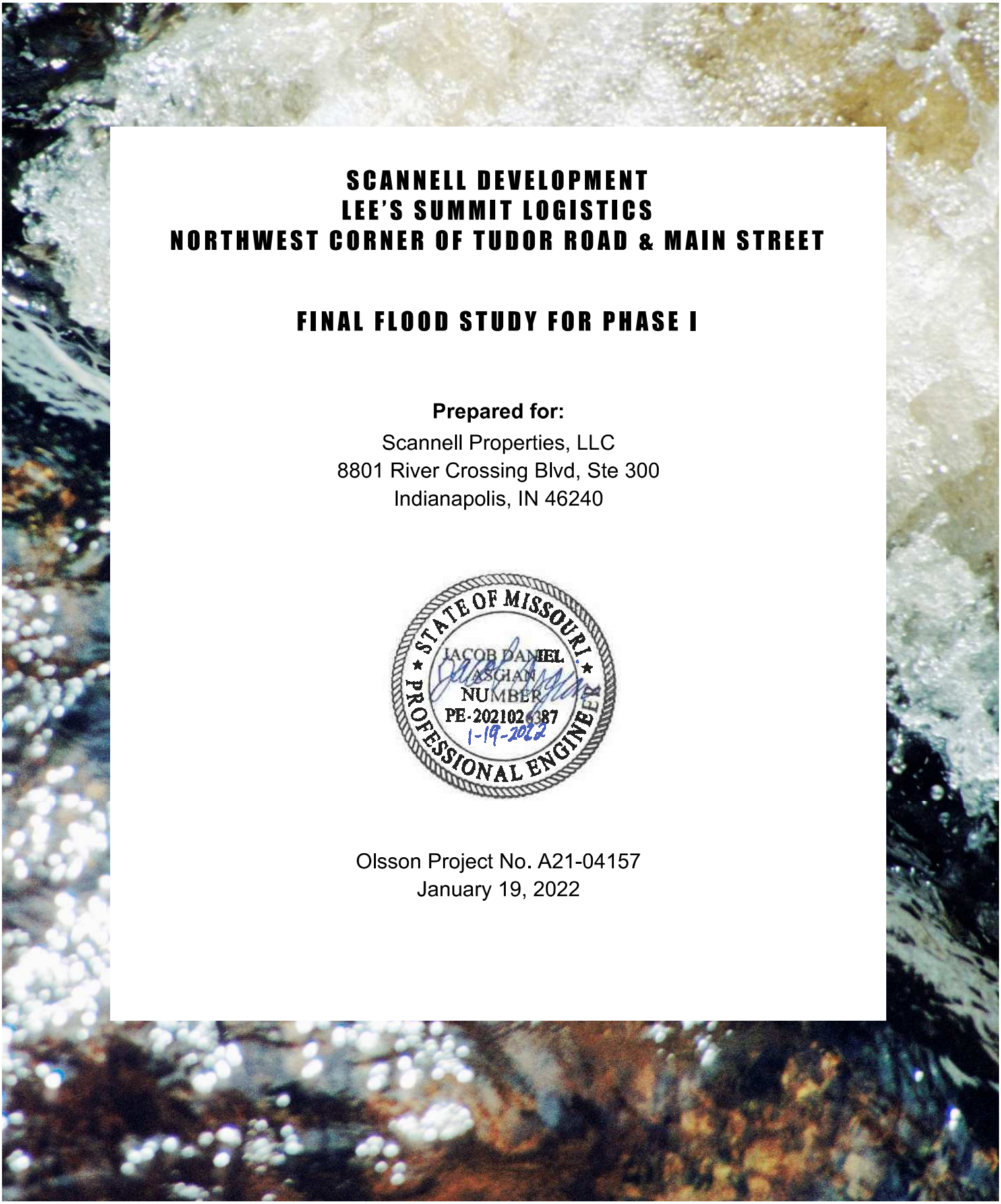

# SCANNELL DEVELOPMENT
# LEE'S SUMMIT LOGISTICS
# NORTHWEST CORNER OF TUDOR ROAD & MAIN STREET

## FINAL FLOOD STUDY FOR PHASE I

**Prepared for:**

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Olsson Project No. A21-04157
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olsson

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# APPENDICES

Appendix A Site Maps
Appendix B HEC-RAS Model Results

# 1. INTRODUCTION

This flood study is an update to the previous approved preliminary flood study (dated July 8, 2021) and presents the impacts to the floodplain generated by construction of Phase I of the project. This document builds on the preliminary study and new text that has been added or previous text that has been modified to describe the Phase I improvements is included in green text. Phase I includes the southernmost of the three proposed buildings (Building A) from the preliminary flood study, and its appurtenances. The attached Exhibits 1-3 in Appendix A show the overall improvements and the limits of Phase I improvements within the overall project boundary.

Scannell Properties, LLC has retained Olsson to complete a flood study for the Scannell Development project (the project), generally located northwest of the intersection of NW Tudor Road and NW Sloan Street. The project is a proposed industrial development on approximately 83 acres, including warehouses, loading docks, parking lots, stormwater detention basins, and open space. The project is located within the Cedar Creek watershed and is located adjacent to two existing streams: Little Cedar Creek generally flows from east to west through the project boundary and an unnamed tributary to Little Cedar Creek generally flows from south to north along the west side of the project boundary. Figure 1 shows the location and approximate boundary of the project.

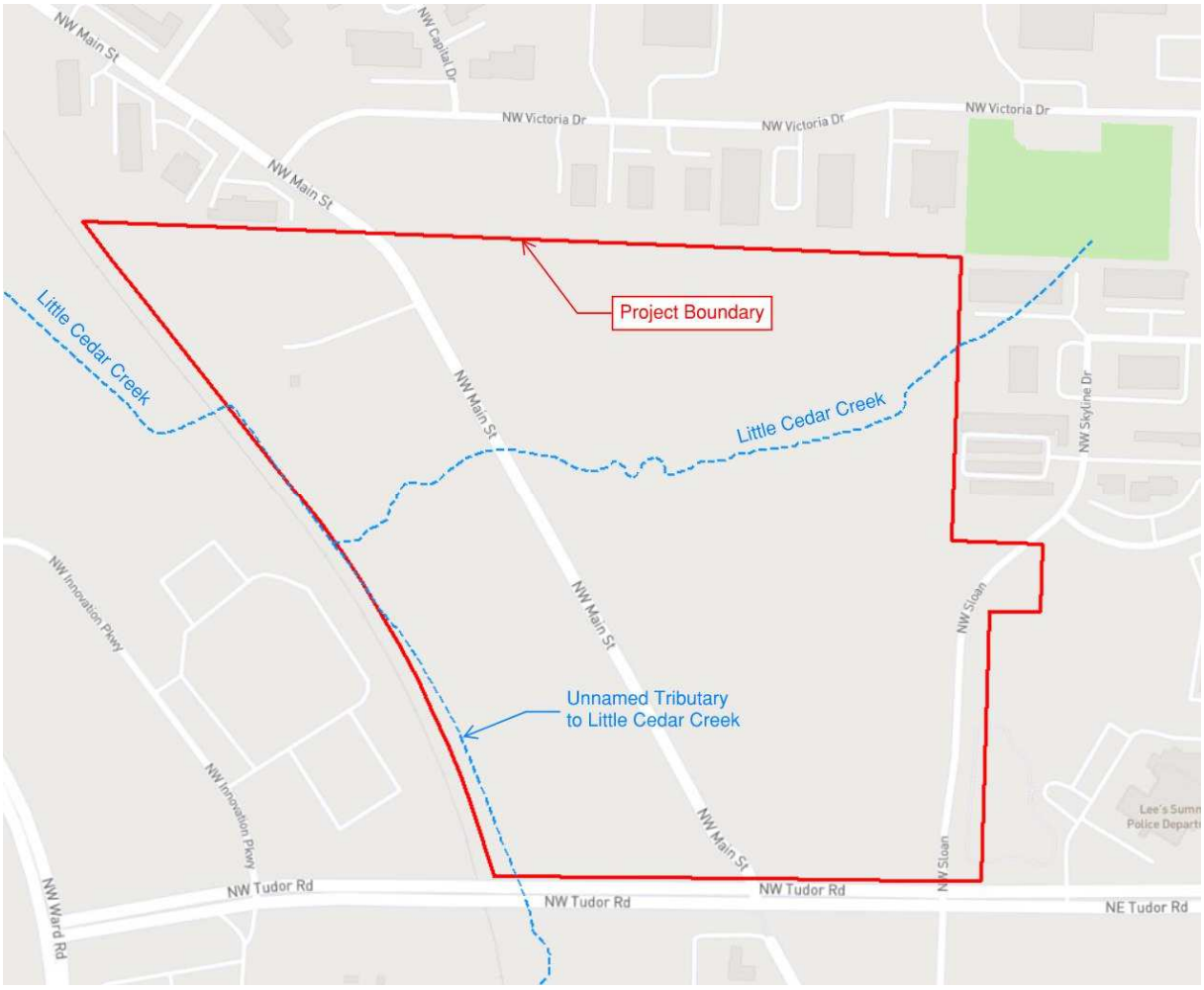


**Figure 1. Location Map.**

The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel Number 29095C0417G classifies portions of the project to be within the special flood hazard area (SFHA) for Little Cedar Creek and the unnamed tributary to Little Cedar Creek. SFHA's located within the project boundary include:

- Zone AE – Areas that are determined through detailed analyses to be subject to inundation from the 100-year (1-percent-annual chance) flood and for which base flood elevations (BFE's) have been determined.
- Zone A – Areas that are determined through approximate analyses to be subject to inundation from the 100-year (1-percent annual chance) flood and for which BFE's have not been determined.
- Zone X – Areas that are determined to be moderate flood hazards areas and can be any of the following: areas of the 500-year (0.2-percent-annual-chance) flood; areas of average depths of less than one foot or with drainage areas less than one square mile; areas protected by levees from the 1% annual chance flood.

This flood study will examine the impacts to SFHA's caused by the project. See Exhibit 1 in Appendix A for the location SFHA boundaries in relation to the project boundary.

# 2. MODEL DEVELOPMENT

No major changes have been made to the methodology of the overall model development since the preliminary flood study.

Hydrologic and hydraulic analyses were performed using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) version 4.7.1 and River Analysis System (HEC-RAS) version 6.1.0, respectively. Hydrologic flow data derived from HEC-HMS was incorporated into the updated HEC-RAS model for the 2-percent-annual-chance (50-year) and 1-percent-annual-chance (100-year) storm events. These peak flows were used in conjunction with the HEC-RAS model to compare water surface elevations (WSE's) between existing conditions and proposed conditions and ensure conformance with City of Lee's Summit design criteria. The hydrologic and hydraulic models for Little Cedar Creek and its tributaries at the project location were requested from FEMA, the City of Lee's Summit, and other sources. Usable hydrologic and hydraulic models were not available for the project area. A copy of the effective hydraulic model for Cedar Creek downstream of the project site was obtained from a FEMA data request, which was used to set starting WSE's of the hydraulic model that was developed for this project.

## 2.1. Hydrologic Model Development

Points of interest and drainage areas remain the same as in the preliminary flood study. No changes have been made to the existing conditions hydrologic model since the preliminary flood study.

Olsson created a hydrologic model for the project using HEC-HMS to determine the peak flows used in this flood study and the corresponding stormwater drainage study. Drainage areas and points of interest for the project are summarized below. See Exhibit 2 in Appendix A for a map indicating the location of these items.

- **Point 1** is located just downstream of the crossing of Little Cedar Creek at the Union Pacific Railroad Little Cedar Creek and the unnamed tributary to Little Cedar Creek both drain to this common point-of-interest. Point 1 is located at the upstream limit of FEMA's mapped floodway for Little Cedar Creek at cross-section AF.
- **Drainage Area A** discharges to Little Cedar Creek and is located upstream of Point 1.
- **Point 2** is located at the confluence of Little Cedar Creek and the unnamed tributary to Little Cedar Creek. This point is used as an intermediate point for calculation purposes.
- **Drainage Area B** discharges to Little Cedar Creek and is located upstream of Point 2.
- **Drainage Area C** discharges to the unnamed tributary to Little Cedar Creek and is located upstream of Point 2.

Hydrologic inputs from the existing conditions HEC-HMS model are summarized in Table 1. Existing conditions peak flow rates were used for purposes of this flood study as on-site detention will be provided that will mitigate increases in peak flow rates. Refer to the stormwater drainage study for a detailed explanation of how inputs were determined.

**Table 1. Hydrologic Inputs Summary.**

| Hydrologic Element | Total Area (acres) | $T_C$ (hour) | Weighted CN | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) |
|---|---|---|---|---|---|
| Area A | 20.3 | 0.197 | 86 | 146 | 169 |
| Area B | 150.9 | 0.355 | 86 | 866 | 1,006 |
| Area C | 269.3 | 0.404 | 87 | 1,476 | 1,711 |
| Point 1 | - | - | - | 2,416 | 2,802 |
| Point 2 | - | - | - | 2,335 | 2,709 |

*Tc = time of concentration, *CN = curve number, *Q = flow rate, *cfs = cubic feet per second

The Flood Insurance Study (FIS) identifier for this area is 29095C, which has 8 total volumes. It should be noted that the peak flow rates calculated from this model are higher than FEMA peak flow rates from this FIS, which was last revised in January 2017. Although this revision was fairly recent, peak flows along Little Cedar Creek and the unnamed tributary to Little Cedar Creek were not updated with this revision. Peak flow rates for Little Cedar Creek are listed in the summary of discharges table of FIS 29095CV001B. The nearest flooding source location listed in this table is located at approximately 153 feet upstream of I-470, which has a peak flow rate of 1,952 cubic feet per second (cfs) for the 50-year storm and a peak flow rate of 2,254 cfs for the 100-year storm. This location is downstream of Point 1 and listed peak flow rates are lower than the calculated flow rates for Point 1. Therefore, the calculated peak flow rates are conservative and should be acceptable for the modeling purposes of this flood study.

The summary of discharges table from FIS 29095CV001B references the use of a frequency discharge-drainage area curve for determination of peak flow rates for peak flow rates along Little Cedar Creek for points of interest located more than 153 feet upstream of I-470. This curve may be used for determining peak flow rates for the project; however, creation of a hydrologic model was needed for the stormwater drainage study.

## 2.2. Hydraulic Model Development

No changes have been made to the methodology of the overall hydraulic model development since the preliminary flood study.

Olsson created a hydraulic model for the project using HEC-RAS for determination of peak WSE's. Existing conditions and proposed conditions hydraulic models were created in order to provide a comparison of peak WSE's prior to and after development of the project. All hydraulic models used in the analysis of the project are referenced to the North American Vertical Datum of 1988 (NAVD88). Refer to Figure 3 in Appendix A for a map showing the locations of hydraulic model cross-sections and centerlines.

### 2.2.1. Hydraulic Model Development - Existing Conditions

The existing conditions geometric data was sourced from a combination of topographic survey, and drone LiDAR survey. Where the cross-section data extended outside of the surveyed area, the overbank geometry data was used from available 2012 County LiDAR data. Cross-sections were placed intermittently and at appropriate locations along Little Cedar Creek. Station-elevation data was then cut for each cross-section using the geometric data mentioned above. Blocked

obstructions and ineffective flow areas were set appropriately using engineering judgement and guidance from the HEC-RAS hydraulic reference manual. Manning's "n" values for the cross-sections were determined using recent aerial imagery. Manning's "n" values used in the hydraulic study are summarized in Table 2.

**Table 2. Hydraulic Model Manning's "n" values.**

| Land Cover | Manning's "n" value |
|---|---|
| Natural Channel | 0.045 |
| Grass / Open Space | 0.040 |
| Wooded / Forested Areas | 0.100 |
| Railroad / Industrial | 0.180 |

Little Cedar Creek crosses NW Main Street and the Union Pacific Railroad in the hydraulic model. Elevations and sizes for these culverts were modeled based off of multiple topographic surveys and drone LiDAR. Additional information for the existing culverts has been gathered since the preliminary flood study. The size and configurations of the culvert crossings at NW Main Street and the Union Pacific Railroad have been updated since the preliminary flood study to reflect the existing culvert configuration more accurately. In addition, cross-section 3651 (previously 3635) has been shifted slightly upstream in both existing conditions and proposed conditions. Table 3 contains a summary of the culvert configurations in the existing conditions HEC-RAS model.

**Table 3. Hydraulic Model Culvert Configurations (Existing Conditions).**

| Location | Cross-Section | Size | Material |
|---|---|---|---|
| NW Main Street | 3540 | 6-foot by 6-foot Conspan Arch | corrugated metal |
| Union Pacific Railroad | 2232 | 6.1-foot by 9.3-foot elliptical | corrugated metal |

The downstream cross-section of the hydraulic model is located at the upstream limit of FEMA's detailed study for Little Cedar Creek at cross-section AF. The starting WSE for the 50-year and 100-year flow profiles of Little Cedar Creek were set equal to the corresponding WSE's at FEMA cross-section AF.

These same modeling procedures were repeated for creation of the hydraulic model for the unnamed tributary to Little Cedar Creek. The starting 100-year WSE for this model was set by first running the existing conditions model for Little Cedar Creek. The 100-year WSE at the confluence of Little Cedar Creek and the unnamed tributary to Little Cedar Creek was then calculated by interpolating between the determined WSE's for nearby cross-sections (2791 and 3207) of Little Cedar Creek. The calculated 100-year WSE for Little Cedar Creek at the confluence was used as the starting WSE for the unnamed tributary to Little Cedar Creek. This process was repeated for the 50-year flow profile.

Flow changes from the hydrologic model were incorporated into the hydraulic model. Table 4 contains a summary of these flow changes.

**Table 4. Hydraulic Model Flow Changes.**

| Hydrologic Element | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | Reach[1] | Cross-Section |
|---|---|---|---|---|
| Point 1 | 2,416 | 2,709 | Main Channel | 2791 |
| Area B | 866 | 1,066 | Main Channel | 5394 |
| Area C | 1,476 | 1,711 | Tributary | 1192 |

*Q = flow rate, *cfs = cubic feet per second
[1]Little Cedar Creek = Main Channel, Unnamed Tributary to Little Cedar Creek = Tributary

## 2.2.2.Hydraulic Model Development - Proposed Conditions

The proposed conditions hydraulic model was created by modifying the existing conditions hydraulic model to match the proposed site layout. Grading changes for Phase I of the development were incorporated into the topographic information used to cut cross-sections. Proposed grading affects the overbank geometries of multiple cross-sections; however, the channelized portions of both streams remain largely unaffected by the project. For this reason, the locations of most cross-sections are the same in both existing and proposed conditions. Cross-sections 3488 and 3591 were removed in the proposed conditions hydraulic model to reflect the proposed re-alignment and widening of NW Main Street.

Manning's n-values and other items were updated appropriately to match the proposed site layout. Peak flow rates remain the same as in existing conditions as detention will be provided for the site to limit peak flow rates for proposed conditions to at or below peak flow rates in existing conditions. Locations of flow changes also remain the same as in existing conditions.

The culvert crossing located under NW Main St was updated to meet City of Lee's Summit design criteria. Per the City of Lee's Summit's Thoroughfare Master Plan, NW Main Street is classified as commercial/industrial collector. City of Lee's Summit's Design criteria states that the minimum design storm capacity for collector streets 50-year design storm. The City of Lee's Summit has also adopted the design criteria of the Kansas City Metropolitan Chapter of the American Public Works Association's (KC-APWA) 2011 design guidance document "Section 5600 Storm Drainage Systems & Facilities". KC-APWA 5600 requires that overflow depths at low points in roadways be limited to 7-inches or less during the 100-year design storms. The proposed culvert configuration was sized in order to meet the design criteria stated above and match the proposed reinforced concrete box (RCB) configuration in the public street plans. Cross-sections 3488 and 3591 were removed in the proposed conditions model due to the increase in length of the proposed RCB. The culvert located under the Union Pacific Railroad remains the same as in existing conditions as it is located outside of the project limits.

# 3. RESULTS

The following sections summarize the results of hydraulic analysis. The results of the hydrologic analysis have been summarized in Section 2.1 of this study.

## 3.1. Hydraulic Results

The hydraulic impact of the project along Little Cedar Creek and the unnamed Tributary to Little Cedar Creek can be analyzed by examining water surface elevations of the nearby HEC-RAS cross-sections. The 100-year storm WSE's are shown below in Table 5 at representative cross-sections throughout the site for existing conditions and proposed conditions. A summary of outputs from HEC-RAS model can be found in Appendix B. There are minor changes in elevations shown in Table 5 from the preliminary stormwater study, as noted below.

**Table 5. 100-Year Water Surface Elevations.**

| Reach[1] | Cross-Section | Existing Conditions (feet) | Proposed Conditions (feet) | Δ WSE (feet) |
|---|---|---|---|---|
| Main Channel | 5394 | 980.39 | 980.33 | -0.06 |
| Main Channel | 5209 | 974.91 | 974.91 | 0.00 |
| Main Channel | 5015 | 971.18 | 971.13 | -0.05 |
| Main Channel | 4787 | 968.81 | 968.84 | 0.03 |
| Main Channel | 4506 | 965.60 | 965.79 | 0.19 |
| Main Channel | 4225 | 963.06 | 962.99 | -0.07 |
| Main Channel | 3909 | 960.07 | 959.05 | -1.02 |
| Main Channel | 3651 | 960.05 | 958.99 | -1.06 |
| Main Channel | 3591 | 959.89 | - | - |
| Main Channel | 3540 (Culvert) | - | - | - |
| Main Channel | 3488 | 949.34 | - | - |
| Main Channel | 3411 | 948.32 | 948.28 | -0.04 |
| Main Channel | 3207 | 947.56 | 947.61 | +0.05 |
| Main Channel | 2791 | 947.50 | 947.50 | 0.00 |
| Main Channel | 2598 | 947.45 | 947.44 | -0.01 |
| Main Channel | 2272 | 947.44 | 947.44 | 0.00 |
| Main Channel | 2232 (Culvert) | - | - | - |
| Main Channel | 2191 | 940.11 | 940.11 | 0.00 |
| Main Channel | 2146 | 934.88 | 934.88 | 0.00 |
| Tributary | 1192 | 961.52 | 961.52 | 0.00 |
| Tributary | 1076 | 960.3 | 960.03 | 0.00 |

| Reach[1] | Cross-Section | Existing Conditions (feet) | Proposed Conditions (feet) | Δ WSE (feet) |
|---|---|---|---|---|
| Tributary | 886 | 956.71 | 956.71 | 0.00 |
| Tributary | 784 | 954.65 | 954.49 | -0.16 |
| Tributary | 612 | 951.58 | 951.73 | +0.15 |
| Tributary | 488 | 949.94 | 949.87 | -0.07 |
| Tributary | 300 | 947.52 | 947.52 | 0.00 |
| Tributary | 188 | 947.40 | 947.39 | -0.01 |
| Tributary | 100 | 947.32 | 947.32 | 0.00 |

*WSE = water surface elevation, *Δ = difference in value

[1]Little Cedar Creek = Main Channel, Unnamed Tributary to Little Cedar Creek = Tributary

The results of the HEC-RAS model indicate that there are minor impacts to 100-year water surface elevations from existing conditions to Phase I proposed conditions along a majority of the cross sections along Little Cedar Creek and the unnamed tributary to Little Cedar Creek. There is a significant decrease in water surface elevations upstream of NW Main Street due to the increase in size from the proposed RCB. Three cross-sections along Little Cedar Creek (4787, 4506, and 3207) and one along the Tributary (612) indicate a rise in water surface elevations from existing conditions. These increases are due to proposed grading and fill within the overbanks of the channel. Preliminary grading for future phases (buildings B and C) shows fill within the overbanks of the right overbank of Little Cedar Creek. In these future phases it will be evaluated if fill placement withing the floodplain can be minimized in order to mitigate the rise in water surface elevations that are currently shown.

The configuration for the culvert crossing at NW main street was updated to meet City of Lee's Summit design criteria as described in Section 2.2.2. The configuration for the culvert crossing at the Union Pacific Railroad remains the same as in existing conditions. Culvert configurations for proposed conditions are summarized in Table 6.

**Table 6. Hydraulic Model Culvert Configurations (Proposed Conditions).**

| Location | Cross-Section | Size | Material |
|---|---|---|---|
| NW Main Street | 3540 | 12-foot by 8-foot box | reinforced concrete |
| Union Pacific Railroad | 2232 | 6.1-foot by 9.3-foot elliptical | corrugated metal |

## 3.2. Low Adjacent Grade Determination

Per the City of Lee's Summit Unified Development Ordinance (Article 5. – Overlay Districts, Division II. – Floodplain Overlay District, Sec. 5.170) non-residential structures must be elevated to two feet above the BFE. Proposed conditions 100-year WSE's were used to determine the minimum low adjacent grade (LAG) elevations for the proposed buildings. These values were calculated by taking the corresponding proposed 100-year WSE at the most upstream corner of the building and adding two feet. Table 7 contains a comparison of the proposed LAG elevations to the minimum required LAG elevations. Proposed LAG's correspond to the side of the building

adjacent to the stream corridor. Refer to Exhibit 3 in Appendix A for locations of proposed buildings.

As noted in Section 2.1, there is some discrepancy between the FEMA peak flows and Olsson's calculated peak flows in the project area. The calculated peak flows are higher and generally yield higher water surface elevations. FEMA 100-Year water surface elevations have been added to Table 7 for reference. The Minimum LAG elevations shown in the table are based off of the higher of the two water surface elevations.

**Table 7. Low Adjacent Grade Comparison.**

| Lot | Building | 100-Year WSE[1] (feet) | FEMA 100-Year WSE[2] (feet) | Minimum LAG (feet) | Proposed LAG (feet) | Δ LAG (feet) |
|---|---|---|---|---|---|---|
| 1 | A (SW Corner) | 954.5 | 956.4 | 958.4 | 991.5 | +33.1 |
| 1 | A (NE Corner) | 968.8 | 966.0 | 970.8 | 991.5 | +20.7 |
| 2 | B | 948.3 | 948.9 | 950.9 | 962.0 | +11.1 |
| 3 | C | 971.2 | 967.0[3] | 973.2 | 972.0 | -1.2 |

*LAG = low adjacent grade, *Δ = difference in value, *WSE = water surface elevation
[1]From proposed conditions HEC-RAS model, [2]Effective base flood elevation from flood insurance study, [3]Most upstream point of building located in Zone A (no established BFE). Elevation shown corresponds to closest known BFE from FEMA FIS Profile.

The calculated LAG's for buildings A and B exceed the City of Lee's Summit's requirements for minimum elevation above the floodplain. Proposed LAG's for buildings B and C remain the same as in the preliminary study. Building C as currently shown in the preliminary plans does not meet these requirements. The proposed grading around building C will be modified in final design so that the building is elevated a minimum of two feet above the corresponding 100-year WSE.

## 3.3. Floodplain Impacts

As described in Section 3.1, the proposed conditions floodplain elevations are lower than the existing conditions except at four cross-sections (Little Cedar Creek - 4787, 4506, and 3207; Tributary – 612), where minor increases occur. These rises take place primarily on the developer's property, and do not affect adjacent properties. There is increase in water surface elevation (0.15 feet) at cross-section 612 (Tributary), which is in close proximity to the property line of the adjacent Union Pacific Railroad but does cause any major impact to the floodplain in this area.

Floodplain widths will be affected as a result of this project as well. An exhibit displaying cross-section locations, the regulatory floodplain, the existing conditions floodplain, and the proposed conditions floodplain can be found in Exhibit 3 of Appendix A. As seen on the exhibit, the proposed buildings are located outside of the limits of the proposed 100-year floodplain.

Submittals to the City of Lee's Summit and FEMA will be required due to changes occurring from the existing conditions floodplain to the proposed conditions floodplain. Permit submittals for the Phase I improvements are summarized below:

- Conditional Letter of Map Revision Based on Fill (CLOMR-F) and Letter of Map Revision Based on Fill (LOMR-F) – CLOMR-F and LOMR-F's can be submitted to FEMA to remove a structure from the floodplain that has been elevated by fill. A CLOMR-F is submitted prior to construction to ensure compliance with regulations and a LOMR-F is submitted post-construction to receive official determination of removal from the floodplain. The CLOMR-F and LOMR-F process could be used to remove Building A (Phase I) from the regulatory floodplain as needed should the City of Lee's Summit elect not to require a CLOMR or LOMR for this project.
- Floodplain Development Permit – A floodplain development permit is required from the City of Lee's Summit for all work within the regulatory floodplain.

The LOMR-F process is recommended for the Phase I improvements to remove Building A from the floodplain after construction is completed. A CLOMR-F is not required by FEMA, but the city may opt to require this submittal (prior to construction) as a precaution in order to verify that the proposed improvements will meet FEMA requirements. The CLOMR and LOMR process is not required by FEMA for these improvements as:

- The project does not affect a regulatory floodway
- The project is located within the special flood hazard area where base flood elevations have been established (Zone AE) and causes increases in water surface elevation less than one foot.

A CLOMR-F application and floodplain development permit application have been prepared and are included with this submittal. The current proposed layouts for Buildings B and C are outside of the limits of the current effective Zone AE floodplain and should not require submittals to FEMA, which will be verified with the final flood studies for these phases. A floodplain development permit with the city will be required for these future phases.

# 4. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This flood study study was prepared to evaluate the floodplain impacts generated by the Scannell Development Phase I project and achieve compliance with current design criteria in effect for the City of Lee's Summit, Missouri. The project is a proposed industrial development on approximately 83 acres, including warehouses, stormwater detention basins, and open space.

The results of the hydrologic and hydraulic analysis show that the project will have little impact on floodplain elevations along Little Cedar Creek and the unnamed tributary to Little Cedar Creek. Proposed conditions 100-year water surface elevations are at or below the existing conditions 100-year water surface elevations except as noted in sections 3.1 and 3.2. Altering the future phases grading plans in addition to the construction of detention basins as part of the project will help mitigate increases in water surface elevations and/or reduce peak flows to points of interest as summarized in this study and discussed in detail in the stormwater study. Applications for additional permits through the City of Lee's Summit and FEMA have been included with this submittal and are outlined in Section 3.3.

The results of the analysis demonstrate that the flood study for the project achieves compliance with design criteria. We therefore request approval of this Scannell Development Final Flood Study for Phase I. This approval is conditional and should be substantiated with each plat / future phase of the project.

# 5. REFERENCES

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