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

## FINAL STORMWATER DRAINAGE STUDY FOR PHASE III

**Prepared for:**

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# APPENDICES

# 1. GENERAL INFORMATION

This drainage study is an update to the previously approved preliminary stormwater drainage study (dated July 8, 2021), final stormwater study for Phase I (dated October 15, 2021), and final stormwater drainage study for Phase II (dated August 9, 2022). This study presents the hydrologic impact generated by construction of Phase III of the project and builds on the preliminary study for the overall development and final studies for Phases I and II. Phase III includes the northeast of the three proposed buildings (Building C) from the preliminary stormwater drainage study, and its appurtenances. The attached exhibits 1-6 in Appendix A show the limits of the Phase III improvements within the overall project boundary.

## 1.1 FEMA Floodplain Classifications

No changes have occurred to the FEMA floodplain since the approval of the preliminary stormwater drainage study. Refer to Exhibit 1 in Appendix A for locations of floodplain on-site and in vicinity of the project.

## 1.2 Soil Classifications

No changes have occurred to the soil classifications since the approval of the preliminary stormwater drainage study. Refer to Exhibit 2 in Appendix A for locations on on-site soils.

# 2. METHODOLOGY

No changes have occurred to the overall methodology from the preliminary stormwater drainage study.

# 3. EXISTING CONDITIONS

Points of interest and drainage boundaries in existing conditions remain the same as in the preliminary stormwater drainage study. Exhibit 3 in Appendix A displays the locations of drainage areas and points of interest in existing conditions.

## 3.1 Hydrologic Analysis (Existing Conditions)

No changes have been made to the existing conditions hydrologic analysis from the preliminary stormwater drainage study. Table 1, below, displays the peak flow rates in existing conditions at Point 1.

**Table 1. Existing Conditions Point of Interest Peak Flow Rates.**

| Point of Interest | $Q_2$ (cfs) | $Q_{10}$ (cfs) | $Q_{100}$ (cfs) |
|---|---|---|---|
| Point 1 | 1,031 | 1,747 | 2,802 |

*Q = flow rate, *cfs = cubic feet per second

## 3.2 Detention Requirements

Methodology for determining detention requirements remains the same as in the preliminary stormwater drainage study. Allowable release rates were calculated for the points of interest, allowing that discharges from off-site area and undeveloped portions of on-site area would be permitted to bypass the detention. Bypass peak flow rates were calculated as the percentage of the existing conditions, relating to the percentage of off-site/undeveloped on-site area flowing to each point. The development release rates for the project were calculated based on City of Lee's Summit detention criteria. The development release rates were added to the bypass peak flow rates to calculate an allowable peak flow rate for each point of interest. Refer to the equation below:

*Allowable Release Rate = (percent off-site area * existing peak flow) + (on-site area * allowable cfs per site acre)*

- *50 percent storm peak rate less than or equal to 0.5 cfs per site acre*
- *10 percent storm peak rate less than or equal to 2.0 cfs per site acre*
- *1 percent storm peak rate less than or equal to 3.0 cfs per site acre*

Tables 2 and 3 summarize on-site area and the allowable discharges for each storm event. There were minor shifts in on-site area and allowable release rates between Phases I and II due to grading refinements. On-site areas and allowable release rates outlined in Tables 2 and 3 for Phase III remain the same as in the Phase II study.

**Table 2. Point of Interest On-site Area.**

| Point of Interest (Point 1) | Total Area[1] (acres) | On-site Area[1] (acres) | Percent On-site |
|---|---|---|---|
| Phase I Study | 443.3 | 57.4 | 13.0% |
| Phase II Study | 442.6 | 56.4 | 12.7% |
| Phase III Study | 442.6 | 56.4 | 12.7% |

[1]Total area draining to basins A-1, B-1, B-2, B-3, B-4, B-5, and C-1 in proposed conditions

**Table 3. Allowable Peak Flow Rates.**

| Point of Interest (Point 1) | Allowable 2-Year (cfs) | Allowable 10-Year Q (cfs) | Allowable 100-Year Q (cfs) |
|---|---|---|---|
| Phase I Study | 926 | 1,635 | 2,611 |
| Phase II Study | 928 | 1,637 | 2,614 |
| Phase III Study | 928 | 1,637 | 2,614 |

*Q = flow rate, *cfs = cubic feet per second

For the purposed of this analysis, the proposed grading boundary for the project (all phases) has been considered as on-site area when determining allowable release rates to Point 1. There are portions of land within the project boundary that will remain undisturbed and are not included in as site area for this analysis. The proposed re-routing of NW Main Street has not been considered as on-site area as this work eventually become new city-maintained right-of-way. The allowable release rates from this private site do not include the roadway improvements, however, curve number calculations for the off-site drainage areas have been updated to account for the increase in impervious area caused by the roadway improvements. Refer to Exhibit 4 in Appendix A.

## 3.3 Stream Buffer

No changes to the existing stream buffers have occurred since the approval of the preliminary stormwater drainage study.

## 3.4 Required Level of Service and Stormwater BMP's

Post-development curve number calculations have been updated from the preliminary stormwater drainage study due to refinement of the impervious areas during Phase II. The required level of service for the project of 6 was determined by calculating the pre-development (82) and post-development (88) curve numbers. Refer to Appendix C for level of service calculations and worksheets.

# 4. PROPOSED CONDITIONS

The methodology for the proposed conditions section remains the same as in the preliminary stormwater drainage study. Updates have been made to the proposed hydrologic parameters and detention facilities to account for improvements from Phases I-III, as outlined in this section.

## 4.1 Effects of Development

Proposed conditions drainage patterns remain the same as in the preliminary stormwater drainage study, with minor changes to acreage for individual drainage areas. Due to proposed grading activities, not all of the on-site area is able to be captured by proposed drainage areas. This also causes area that is not being developed (considered off-site for the purposes of this study) to drain to the proposed detention basins. For these reasons, the on-site area listed in Table 2 may not match up exactly with the total of the proposed conditions drainage areas.

## 4.2 Hydrologic Analysis (Proposed Conditions)

Table 4 summarizes the proposed conditions drainage area data for all phases of the project. Refer to Appendix B for proposed conditions curve number calculations. An electronic copy of the HEC-HMS model used for the hydrologic analysis has been provided.

**Table 4. Proposed Conditions Drainage Area Data (All Phases).**

| Drainage Area | On-site Area (acres) | Off-site Area (acres) | Total Area (acres) | $T_C$[1] (hour) | Weighted CN |
|---|---|---|---|---|---|
| A | 0.0 | 13.5 | 13.5 | 0.197 | 89 |
| B | 0.0 | 126.4 | 126.4 | 0.355 | 88 |
| C | 0.0 | 247.1 | 247.1 | 0.404 | 88 |
| A-1 | 6.9 | 0.0 | 6.9 | 0.100 | 91 |
| B-1 | 2.7 | 0.0 | 2.7 | 0.100 | 91 |
| B-2 | 12.0 | 0.0 | 12.0 | 0.100 | 94 |
| B-3 | 3.3 | 0.0 | 3.3 | 0.100 | 90 |

| Drainage Area | On-site Area (acres) | Off-site Area (acres) | Total Area (acres) | Tc[1] (hour) | Weighted CN |
|---|---|---|---|---|---|
| B-4 | 13.2 | 0.0 | 13.2 | 0.100 | 89 |
| B-5 | 3.9 | 0.0 | 3.9 | 0.100 | 90 |
| C-1 | 13.5 | 0.0 | 13.5 | 0.197 | 89 |

*Tc = time of concentration, *CN = curve number
[1]Hydrologic model elements are referenced by lag time, minimum time of concentration of 6 minutes (0.100 hours) per SCS TR-55

## 4.3 Proposed Detention Facilities

Table 5 summarizes the outlet structure configurations for the Phase III improvements.

**Table 5. Outlet Structures Summary (Phase III).**

| Detention Facility | Basin Top Elevation (feet) | Basin Bottom Elevation (feet) | Primary Outlet Diameter (inches) | Structure Length (feet) | Structure Width (feet) | Approx. Height (feet) |
|---|---|---|---|---|---|---|
| B-2 | 952 | 965 | 18 | 4 | 4 | 4.0 |
| B-3 | 965 | 973 | 15 | 4 | 4 | 4.0 |

Detention facility B-2 is relatively small in size compared to its contributing drainage area due to constraints from the nearby building and roadways, limiting storage volume in the basin and its ability to provide extended detention. In contrast, detention facility B-3 has a relatively small contributing drainage area and has additional storage volume available. A cumulative water quality volume was determined based on the tributary area to both basins. Detention facility B-2 is designed to provide extended detention for 40-percent of this cumulative water quality volume, and detention facility B-3 is designed to provided extended detention for the remaining 60-percent. Table 6 summarizes the tributary areas and impervious areas used for determining water quality volumes for the proposed detention facilities.

**Table 6. Water Quality Volume Determination (Phase III).**

| Detention Facility | Tributary Area (acres) | Impervious Area (acres) | Percent Impervious |
|---|---|---|---|
| B-2 | 12.0 | 9.5 | 79.3% |
| B-3 | 3.3 | 1.5 | 44.8% |
| **Cumulative** | **15.3** | **11.0** | **71.9%** |
| B-2 and B-3 Adjusted Values to Better Distribute the Cumulative Water Quality Volume | | | |
| B-2 Adjusted (40-percent of Total) | 6.1 | 4.4 | 71.9% |
| B-3 Adjusted (60-percent of Total) | 9.2 | 6.6 | 71.9% |

The multi-stage outlet structures for each facility have been designed to provide extended detention for the water quality storm and also provide overflow for high intensity rainfall events, while still attenuating peak flows. Table 7 summarizes the water quality device configurations for each of the proposed detention facilities for Phase III of the project. Trash racks will be installed on top of each outlet structure to prevent debris from clogging the primary outlet pipes. Refer to Appendix C for water quality calculations and a detail of the outlet structure.

**Table 7. Water Quality Devices Summary (Phase III).**

| Detention Facility | Perforation Diameter (inches) | Number of Columns | Number of Rows[1] |
|---|---|---|---|
| B-2 | 0.8 | 1 | 12 |
| B-3 | 1.1 | 1 | 10 |

[1]4-inch vertical spacing between perforations, center to center

Detention facility B-3 will be equipped with an independent broad-crested weir graded into the berm of the basin to function as the emergency spillway. Table 8 summarizes minimum bottom lengths of the emergency spillway for detention facility B-3. Detention facility B-2 is unable to be equipped with emergency spillways due to site restrictions, as it is confined by adjacent parking lot, building, and road. The overflow path for this basin is directed away from proposed buildings and towards the NW Main Street, where overflow will be captured by curb inlets. Olsson has discussed the grading with city staff and the city has accepted that these basins do not meet emergency spillway design criteria per previous correspondence. Freeboard has been allocated to this basins to accommodate for the omission of the emergency spillways. The freeboard listed in the "Freeboard A" column of Table 8 correspond to the freeboard from the 100-year peak water surface elevation to the top of the basin for detention facility B-2.

**Table 8. Emergency Spillway Summary (Phase III).**

| Detention Facility[1] | 100-Year Peak Inflow (cfs) | Spillway Bottom Elevation (feet) | Spillway Depth (feet) | Spillway Length (feet) | 100-Year Depth through Spillway (feet) | Freeboard A[2] (feet) | Freeboard B[3] (feet) |
|---|---|---|---|---|---|---|---|
| B-2[4] | 123 | - | - | - | - | 1.7 | - |
| B-3 | 33 | 970.9 | 2.1 | 25 | 0.6 | 2.1 | 1.5 |

*cfs = cubic feet per second, *WSE = water surface elevation
[1]Each emergency spillway is trapezoidal in shape with 4:1 horizontal to vertical side slopes
[2]Distance from peak 100-year WSE in basin to spillway bottom (0.5 foot minimum)
[3]Distance from peak 100-year WSE through spillway to top of basin (1.0 foot minimum)
[4]Basin does not have emergency spillway. Freeboard A value pertains to total freeboard in basin.

## 4.4 Effects of Proposed Detention

The following tables compare the results of the proposed conditions analysis with the detention described above to the existing conditions from Section 3 at the points of interest. Table 9 shows peak discharge values at the point of interest. Table 10 compares these discharge values to existing and allowable discharge values. In Table 10, negative values indicate a reduction in peak flows, while positive values indicate an increase.

**Table 9. Proposed Point of Interest Peak Flow Rates.**

| Point of Interest | $Q_2$ (cfs) | $Q_{10}$ (cfs) | $Q_{100}$ (cfs) |
|---|---|---|---|
| Point 1 | 981 | 1,646 | 2,600 |

*Q = flow rate, *cfs = cubic feet per second

**Table 10. Proposed Conditions Point of Interest Peak Flows Comparison.**

| Point 1 | $\Delta Q_2$ (cfs) | $\Delta Q_{10}$ (cfs) | $\Delta Q_{100}$ (cfs) |
|---|---|---|---|
| Existing Conditions | -50 | -101 | -202 |
| Allowable Release | +53 | +9 | -14 |

*Q = flow rate, *cfs = cubic feet per second, *Δ = difference in value

As shown in Table 10, with the addition of detention facilities, peak discharges at Point 1 will be at or below the allowable release rates for the 100-year storm; however, the proposed conditions (with detention) peak flow rate for the 2- and 10-year storms are above the allowable release rate. Table 11 compares the percent change in proposed peak discharge values to existing and allowable discharge values.

**Table 11. Proposed Conditions Point of Interest Percent Change Comparison**

| Point 1 | Percent Change 2-Year | Percent Change 10-Year | Percent Change 100-Year |
|---|---|---|---|
| Existing Conditions | -4.8% | -5.8% | -7.2% |
| Allowable Release | +5.7% | +0.5% | -0.6% |

*Q = flow rate, *cfs = cubic feet per second

A waiver is requested for detention of the 2-year and 10-year events at the point of interest. In order to detain to the 2-year allowable release rate, the current proposed conditions (with detention) release rate at Point 1 must be lowered by 50 cfs. The sum of the outflows for the proposed conditions detention basins is approximately 39 cfs. Therefore, it is not possible to detain the 2-year event for the given point of interest with the current site configuration. This is due to the stringent restriction of allowing only 0.5 cfs per acre of on-site area for the 2-year event. The proposed 10-year release rate is barely above the allowable release rate, with a minor increase of only 0.5 percent. Proposed detention basins for Phase III have been designed to minimize increases in release rates at the point of interest as much as reasonable able while still meeting other design criteria.

## 4.5 Impacts to Stream Buffer

Impacts to the stream buffer for Phase III of the project have been outlined in this section. There are minor impacts to the stream buffer for Little Cedar Creek, which are displayed on Exhibit 6 in Appendix A. Impacts to the stream buffer areas are summarized below:

- On the east side of the proposed building. A proposed private road encroaches on the north stream buffer for Little Cedar Creek. This road serves as a connection between the loading dock and parking areas on the east side of the building and is required for fire protection purposes so that there is a full loop around the building. Additional buffer has been provided on the south side to account for this loss. A waiver is requested for this area and has been included with this submittal in Appendix D.

Additional temporary encroachments on the stream buffers may also take place with proposed grading and construction activities. These areas will be replanted with native grasses to restore the vegetation as much as possible.

## 4.6 Provided Level of Service and Stormwater BMP's

As discussed in Section 3.4, the required LS for the project is 6 based on the pre-development and post-development curve numbers. The proposed stormwater BMP's for the project are to establish and preserve native vegetation, and snout systems to extended dry detention (treatment train), which remains consistent with the preliminary stormwater study. Snout systems will be placed in junction structures to treat on-site stormwater prior to entering the extended dry detention basins. Approximately 12 acres of native vegetation will be established / preserved in order to meet the required level of service and will be located primarily around the perimeters of each lot. Portions of the site will be untreated due to grading restrictions preventing some areas from being able to drain to proposed detention basins or other treatment facilities. The provided level of service for the project was calculated to be approximately 6.05, which is above the required level of service of 6. Refer to Appendix C for stormwater BMP calculations and worksheets.

# 5. SUMMARY

This stormwater drainage study was prepared to evaluate the hydrologic impact generated by the Scannell Development project and to provide recommendations for a comprehensive stormwater management plan. The project is a proposed industrial development on approximately 83 acres, including warehouses, stormwater detention basins, and open space and vegetation along the existing streams that flow through the site. The Phase III improvements pertain to the westernmost building (Building C) and it's appurtenances.

Increases in peak flow rates for the 2-, 10- and 100-year storms caused by the development will be mitigated for all points of interest through the site through a combination of detention facilities and drainage area changes. A waiver is requested for meeting the allowable release rates for the 2- and 10-year storms at the point of interest. The detention facilities will also serve as water quality basins and provide detention of the 90-percent mean annual event.

Stream buffers were designated based on watershed size, per KC-APWA standards. A waiver is requested for encroachments on the stream buffers as noted in Section 4.5. Where encroachments are necessary, the impacts will be mitigated with preservation of adjacent native vegetation and establishment of new native vegetation elsewhere on-site as able.

# 6. CONCLUSIONS AND RECOMMENDATIONS

This proposed stormwater management plan was designed to achieve compliance with current design criteria in effect for the City of Lee's Summit, Missouri; however, a waiver is requested for encroachments to stream buffers at several locations and for meeting the allowable release rates for the 2- and 10-year design storm events.

The results of the analysis demonstrate that the stormwater management plan for the project achieves compliance with design criteria or the requested waiver. We therefore request approval of this Scannell Development Final Stormwater Drainage Study for Phase III of the project. This approval is conditional and should be substantiated with each phase of the project.

# 7. REFERENCES

City of Lee’s Summit. (2020). “Section 5600 – Storm Drainage Systems & Facilities, City of Lee’s Summit, Missouri, Design Criteria”

FEMA (Federal Emergency Management Agency). (2021). “FEMA Flood Map Service Center”. <https://msc.fema.gov/portal/home> (Jun. 23, 2021).

KC-APWA (American Public Works Association, Kansas City Metropolitan Chapter). (2011). “Division V Section 5600 Storm Drainage Systems & Facilities”.

NRCS (Natural Resources Conservation Service). (2021). “Web Soil Survey” <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx> (Jun. 23, 2021).

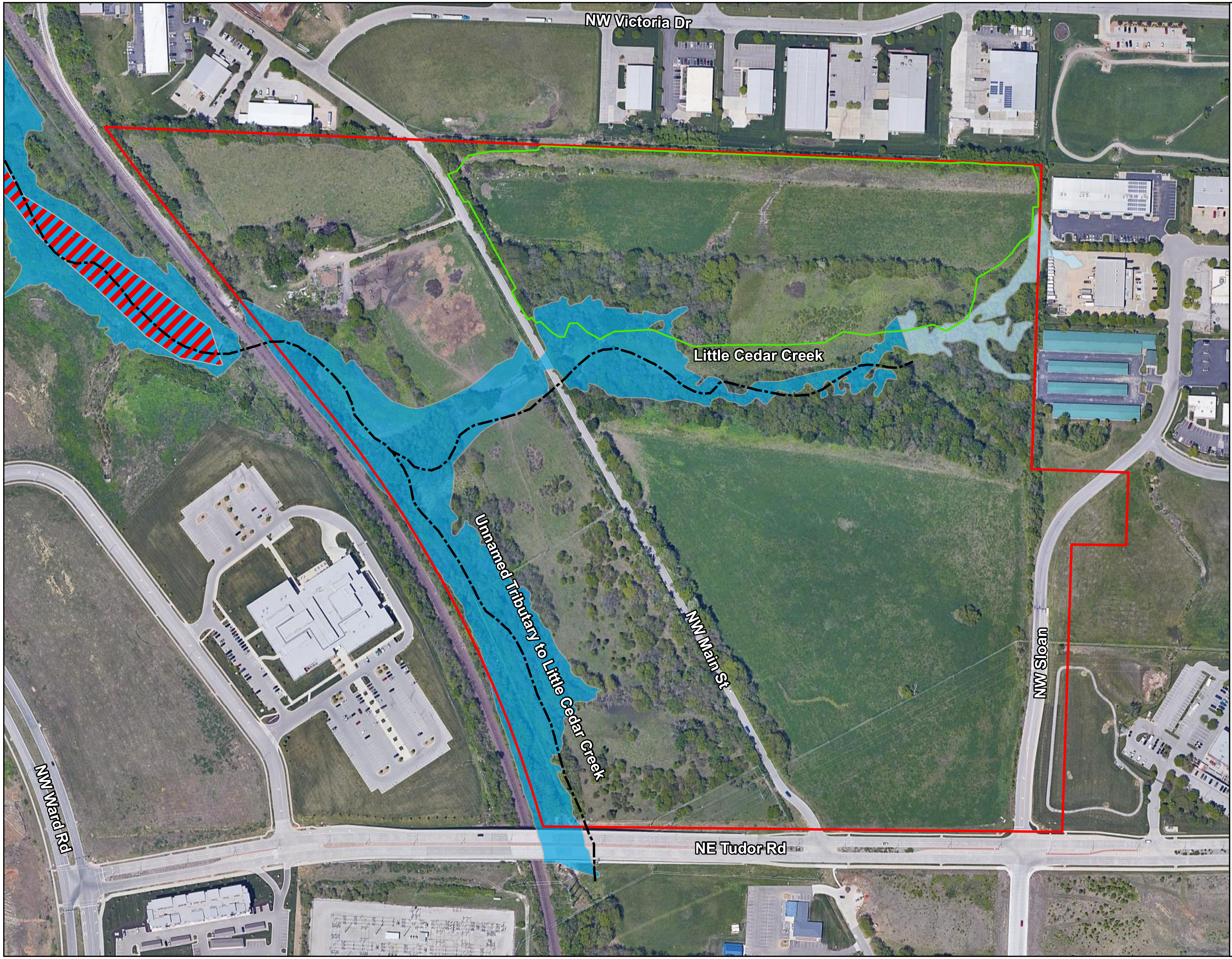
United States Weather Bureau. “Technical Paper No. 40 Rainfall Frequency Atlas of the United States”. (1961). Department of Commerce, Washington, D.C.

# APPENDIX A

Site Maps

# Exhibit 1.
# Floodplain Map

Scannell Development Project
Phase III
Lee's Summit, MO




- Project Boundary
- Phase III Grading Boundary
- FEMA Stream Centerline
- FEMA Floodway
- FEMA Zone AE
- FEMA Zone A

0 250 500
Feet

1 Inch = 250 Feet

N

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# Exhibit 2.
# Soils Map

Scannell Development Project
Phase III
Lee's Summit, MO


Phase III Grading Boundary
Project Boundary
Group C
Groups C/D
Group D

0 250 500 Feet

1 Inch = 250 Feet

N

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**Exhibit 3.**
**Existing Conditions**
**Drainage Areas**

Scannell Development
Phase III
Lee's Summit, MO

Phase III Grading Boundary
Project Boundary
Drainage Area A
Drainage Area B
Drainage Area C
Existing Contours

0 600 1,200
Feet

1 Inch = 600 Feet

N

**Exhibit 4.**
**On-Site Areas**

Scannell Development Project
Phase III
Lee's Summit, MO


Site Layout
Phase I Grading Boundary
Phase II Grading Boundary
Phase III Grading Boundary
Project Boundary

0 250 500
Feet

1 Inch = 250 Feet

N

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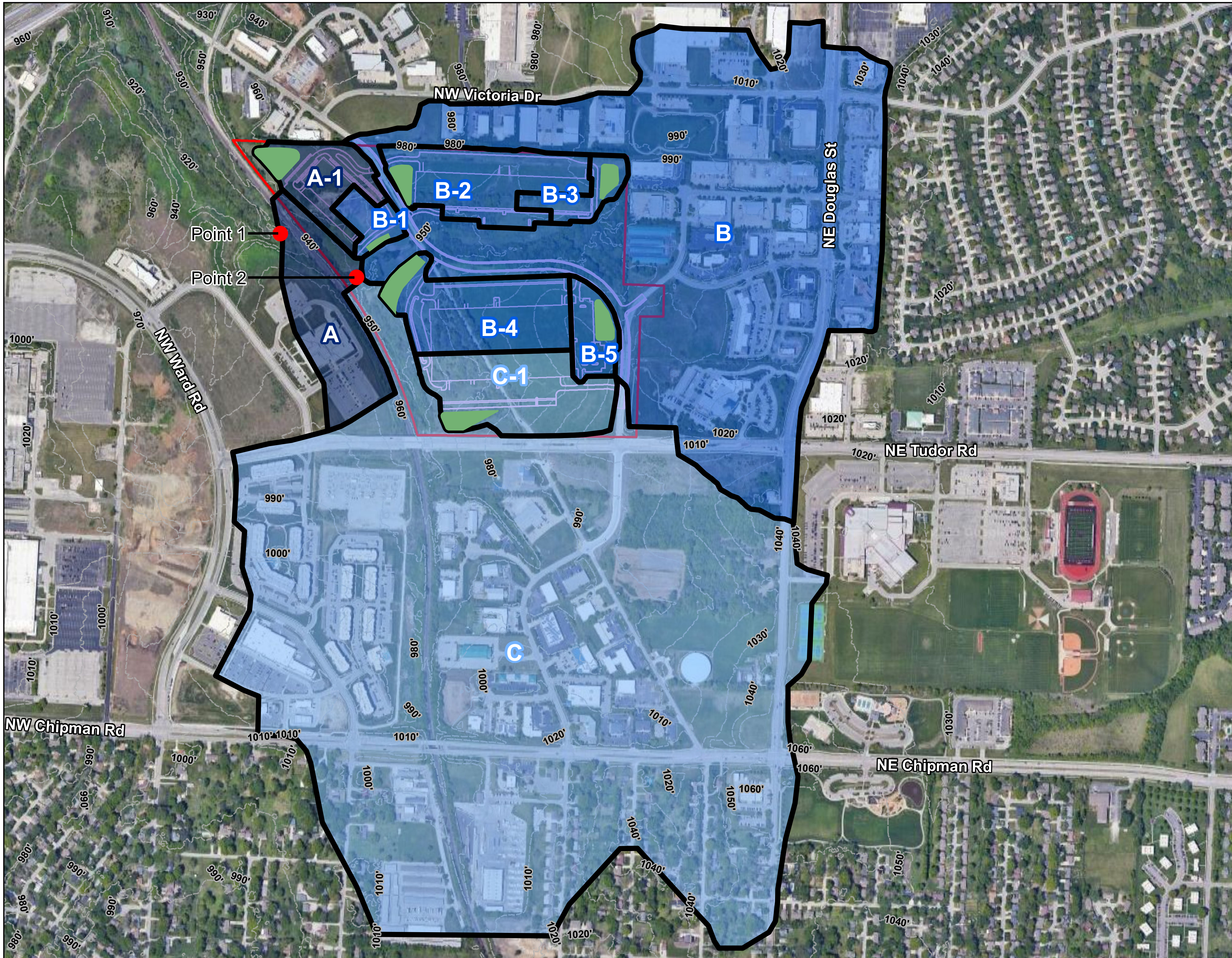


**Exhibit 5.**
**Proposed Conditions**
**Drainage Areas**

Scannell Development
Phase III
Lee's Summit, MO

Existing Contours
Site Layout
2022-08-16_DA_Boundaries
Proposed Detention Basin
Project Boundary

0 600 1,200
Feet

1 Inch = 600 Feet

N

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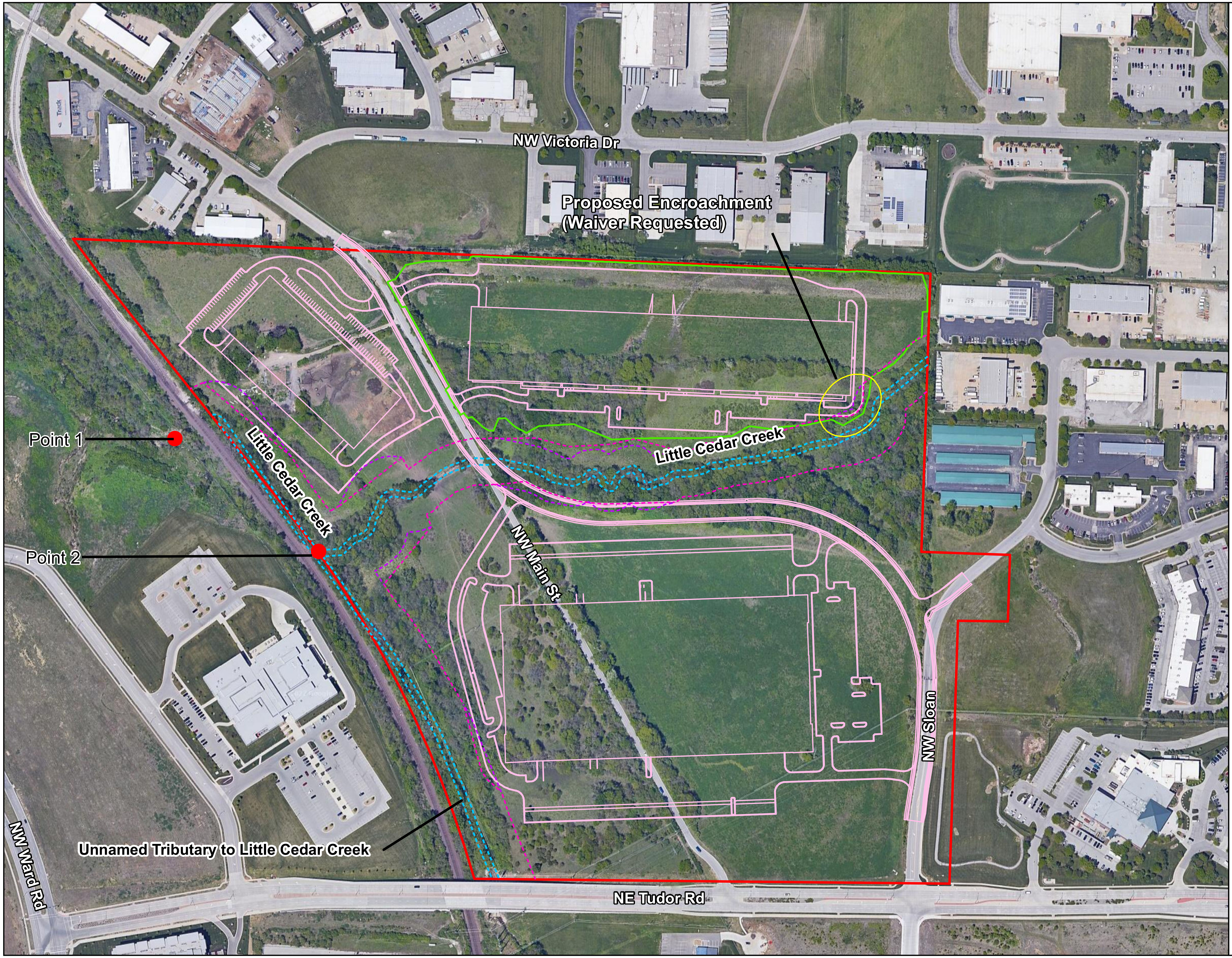
# Exhibit 6.
# Stream Buffer Map

Scannell Development Project
Phase III
Lee's Summit, MO




Ordinary High-water Mark
Proposed Stream Buffer
Required Stream Buffer
Site Layout
Phase III Grading Boundary
Project Boundary

0 275 550 Feet

1 Inch = 273 Feet

N

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# APPENDIX B

Curve Number & Time of Concentration Calcs

**Existing Curve Number – Drainage Area A, Curve Number = 86**

| Land Use | HSG | CN | Area (Acres) |
|---|---|---|---|
| Open Space Areas<br>Good Condition; Grass Cover > 75% | C | 74 | 0.7 |
| Open Space Areas<br>Good Condition; Grass Cover > 75% | D | 80 | 10.6 |
| Impervious Areas<br>Paved parking lots, roofs, driveways | C/D | 98 | 9.1 |
| Residential Districts (1/4 acre) | C | 83 | 0.0 |
| Residential Districts (1/4 acre) | D | 87 | 0.0 |
| Urban Districts<br>Commercial & Business | C | 94 | 0.0 |
| Urban Districts<br>Commercial & Business | D | 95 | 0.0 |

*HSG = Hydrologic Soil Group, *CN = Curve Number

**Existing Curve Number – Drainage Area B, Curve Number = 86**

| Land Use | HSG | CN | Area (Acres) |
|---|---|---|---|
| Open Space Areas<br>Good Condition; Grass Cover > 75% | C | 74 | 46.7 |
| Open Space Areas<br>Good Condition; Grass Cover > 75% | D | 80 | 24.2 |
| Impervious Areas<br>Paved parking lots, roofs, driveways | C/D | 98 | 8.2 |
| Residential Districts (1/4 acre) | C | 83 | 0.0 |
| Residential Districts (1/4 acre) | D | 87 | 0.0 |
| Urban Districts<br>Commercial & Business | C | 94 | 47.6 |
| Urban Districts<br>Commercial & Business | D | 95 | 21.6 |

*HSG = Hydrologic Soil Group, *CN = Curve Number

**Existing Curve Number – Drainage Area C, Curve Number = 87**

| Land Use | HSG | CN | Area (Acres) |
|---|---|---|---|
| Open Space Areas<br>Good Condition; Grass Cover > 75% | C | 74 | 54.2 |
| Open Space Areas<br>Good Condition; Grass Cover > 75% | D | 80 | 39.1 |
| Impervious Areas<br>Paved parking lots, roofs, driveways | C/D | 98 | 34.7 |
| Residential Districts (1/4 acre) | C | 83 | 20.8 |
| Residential Districts (1/4 acre) | D | 87 | 17.7 |

| Land Use | HSG | CN | Area (Acres) |
|---|---|---|---|
| Urban Districts<br>Commercial & Business | C | 94 | 67.0 |
| Urban Districts<br>Commercial & Business | D | 95 | 35.8 |

*HSG = Hydrologic Soil Group, *CN = Curve Number

**Existing Time of Concentration – Area A**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour) |
|---|---|---|---|---|---|
| Sheet | 100 | 0.027 | Grass-Range, Short (0.15) | | 0.134 |
| Shallow Concentrated | 219 | 0.024 | Unpaved | | 0.024 |
| Channel | 1,415 | | | 10 | 0.039 |
| Total | 1,734 | | | | 0.197 |

**Existing Time of Concentration – Area B**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour) |
|---|---|---|---|---|---|
| Sheet | 100 | 0.020 | Grass-Range, Short (0.15) | | 0.152 |
| Shallow Concentrated | 520 | 0.050 | Unpaved | | 0.040 |
| Channel | 4,118 | | | 7 | 0.163 |
| Total | 4,738 | | | | 0.355 |

**Existing Time of Concentration – Area C**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour) |
|---|---|---|---|---|---|
| Sheet | 100 | 0.020 | Grass-Range, Short (0.15) | | 0.152 |
| Shallow Concentrated | 297 | 0.021 | Unpaved | | 0.035 |
| Channel | 5,471 | | | 7 | 0.217 |
| Total | 5,898 | | | | 0.404 |

**Proposed Curve Numbers - Subareas**

| Drainage Area[1] | Total Area | Pervious Area | Pervious CN | Impervious Area | Impervious CN | Weighted CN |
|---|---|---|---|---|---|---|
| A-1 | 6.9 | 2.5 | 80 | 4.4 | 98 | 91 |
| B-1 | 2.7 | 1.0 | 80 | 1.7 | 98 | 91 |
| B-2 | 12.0 | 2.5 | 80 | 9.5 | 98 | 94 |
| B-3 | 3.3 | 1.5 | 80 | 1.8 | 98 | 90 |
| B-4 | 13.2 | 7.0 | 80 | 6.2 | 98 | 89 |
| B-5 | 3.9 | 1.8 | 80 | 2.1 | 98 | 90 |
| C-1 | 13.5 | 6.8 | 80 | 6.7 | 98 | 89 |

*CN = Curve Number, [1]All areas shown in this table are in acres

**Existing Curve Numbers to Proposed Curve Number Adjustments Part 1**

| Drainage Area[1] | Existing Area | Existing CN | Proposed Area | Area Change | Area Change CN | Weighted CN |
|---|---|---|---|---|---|---|
| A | 20.3 | 86 | 13.5 | 6.8 | 80 | 89 |
| B | 150.9 | 86 | 126.4 | 24.5 | 80 | 87 |
| C | 269.3 | 87 | 247.1 | 22.2 | 80 | 88 |

*CN = Curve Number, [1]All areas shown in this table are in acres
Note: These calculations account for shifting in drainage boundaries due to proposed grading activities

**Existing Curve Numbers to Proposed Curve Number Adjustments Part 2**

| Drainage Area[1] | Proposed Area | Area Change | Area Change CN | Weighted CN 2 |
|---|---|---|---|---|
| A | 13.5 | 0.0 | 95 | 89 |
| B | 123.4 | 7.9 | 95 | 88 |
| C | 247.1 | 0.3 | 95 | 88 |

*CN = Curve Number, [1]All areas shown in this table are in acres
Note: These calculations account for construction of the NW Main Street Improvements

**Proposed Time of Concentration – Area B4**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour)[1] |
|---|---|---|---|---|---|
| Sheet | 60 | 0.0639 | Smooth Surface (0.011) | | 0.008 |
| Shallow Concentrated | 50 | 0.0190 | Paved | | 0.005 |
| Channel | 1,265 | | | 10 | 0.032 |
| Total | 1,375 | | | | 0.045 |

[1]Minimum time of concentration of 6 minutes used per SCS TR-55 methodology

**Proposed Time of Concentration – Area B5**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour)[1] |
|---|---|---|---|---|---|
| Sheet | 60 | 0.020 | Grass-Range, Short (0.15) | | 0.152 |
| Shallow Concentrated | | | | | |
| Channel | 515 | | | 10 | 0.014 |
| Total | 575 | | | | 0.087 |

[1]Minimum time of concentration of 6 minutes used per SCS TR-55 methodology

**Proposed Time of Concentration – Area C1**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour) |
|---|---|---|---|---|---|
| Sheet | 100 | 0.0504 | Grass-Range, Dense (0.24) | | 0.157 |
| Shallow Concentrated | 277 | 0.0740 | Unpaved | | 0.018 |
| Channel | 807 | | | 10 | 0.022 |
| Total | 1,184 | | | | 0.197 |

**Proposed Time of Concentration – Area A1**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour)[1] |
|---|---|---|---|---|---|
| Sheet | 100 | 0.0147 | Smooth Surface (0.011) | | 0.022 |
| Shallow Concentrated | 80 | 0.0105 | Paved | | 0.011 |
| Channel | 620 | | | 7 | 0.025 |
| Total | 800 | | | | 0.058 |

[1]Minimum time of concentration of 6 minutes used per SCS TR-55 methodology

**Proposed Time of Concentration – Area B1**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour)[1] |
|---|---|---|---|---|---|
| Sheet | 100 | 0.0146 | Smooth Surface (0.011) | | 0.022 |
| Shallow Concentrated | 46 | 0.0141 | Paved | | 0.005 |
| Channel | 490 | | | 7 | 0.019 |
| Total | 636 | | | | 0.046 |

[1]Minimum time of concentration of 6 minutes used per SCS TR-55 methodology

**Proposed Time of Concentration – Area B2**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour)[1] |
|---|---|---|---|---|---|
| Sheet | 100 | 0.0121 | Smooth Surface (0.011) | | 0.024 |
| Shallow Concentrated | 110 | 0.0085 | Paved | | 0.016 |
| Channel | 1,240 | | | 7 | 0.049 |
| Total | 1,450 | | | | 0.089 |

[1]Minimum time of concentration of 6 minutes used per SCS TR-55 methodology

**Proposed Time of Concentration – Area B3**

| Flow Type | Length (feet) | Slope (feet/feet) | Surface (Manning's n) | Velocity (feet per second) | Time (hour)[1] |
|---|---|---|---|---|---|
| Sheet | 100 | 0.0177 | Smooth Surface (0.011) | | 0.022 |
| Shallow Concentrated | 55 | 0.0031 | Paved | | 0.013 |
| Channel | 420 | | | 7 | 0.017 |
| Total | 575 | | | | 0.050 |

[1]Minimum time of concentration of 6 minutes used per SCS TR-55 methodology

# APPENDIX C

Level of Service and Stormwater BMP Calculations

**WORKSHEET 1: REQUIRED LEVEL OF SERVICE-UNDEVELOPED SITE**

| | | | |
|---|---|---|---|
| Project: | Scannell Development - Building C | By: | JDA |
| Location: | Lee's Summit, MO | Checked: | BPS |
| | | Date: | 8/16/2022 |

**1. Runoff Curve Number**

**A. Predevelopment CN**

| Cover Description | Soil HSG | CN | Area (ac) | Product of CN x Area |
|---|---|---|---|---|
| Impervious Area (Streets) | C/D | 98 | 2.3 | 225.4 |
| Pasture-Continuous (Fair) | C | 79 | 20.0 | 1580 |
| Pasture-Continuous (Fair) | D | 84 | 32.9 | 2763.6 |
| Woods-Grass (Fair) | C | 76 | 2.1 | 159.6 |
| Woods-Grass (Fair) | D | 82 | 23.4 | 1918.8 |
| Open Space - Turf (Good) | D | 80 | 1.9 | 152 |
| | | | | |
| | | Totals: | 82.6 | 6799.4 |

Area-Weighted CN=total product/total area= 82 (Round to integer)

**B. Postdevelopment CN**

| Cover Description | Soil HSG[1] | CN | Area (ac) | Product of CN x Area | (CHECK) |
|---|---|---|---|---|---|
| Impervious Areas (Buildings, Parking Lots, Roadways, etc.) | D | 98 | 40.1 | 3929.8 | |
| Open Space - Turf (Good) | D | 80 | 30.5 | 2440.0 | |
| Native Vegetation - Brush (Good) | D | 73 | 12.0 | 876.0 | |
| | | | | | |
| | | Totals: | 82.6 | 7245.8 | |

[1] Postdevelopment CN is one HSG higher for all cover types except perserved vegetation, absent documentation showing how postdevelopment soil structure will be preserved.

Area-Weighted CN=total product/total area= 88 (Round to integer)

**C. Level of Service (LS) Calculation**

| | |
|---|---|
| Predevelopment CN: | 82 |
| Postdevelopment CN: | 88 |
| Difference: | 6 |
| LS Required (see scale at right): | 6 |

| Change in CN | LS |
|---|---|
| 17+ | 8 |
| 7 to 16 | 7 |
| 4 to 6 | 6 |
| 1 to 3 | 5 |
| 0 | 4 |
| -7 to -1 | 3 |
| -8 to -17 | 2 |
| -18 to -21 | 1 |
| -22 - | 0 |

Source:

*U.S. Department of Agriculture, Natural Resource Conservation Service. Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55). 1986.*

*Mid American Regional Council. Stormwater Best Management Practices. 2012*

**WORKSHEET 2: DEVELOP MITIGATION PACKAGE(S) THAT MEET THE REQUIRED LS**

| | | | |
|---|---|---|---|
| | | Date: | 8/16/2022 |
| Project: | Scannell Development - Building C | By: | JDA |
| Location: | Lee's Summit, MO | Checked: | BPS |

**1. Required LS (from Table 1 or 1A or Worksheet 1 or 1A, as appropriate):** 6

Note: Various BMPs may alter CN of proposed development and LS; recalculate both if applicable.

**2. Proposed BMP Option Package No.:** 1

| Cover/BMP Description | Treatment Area (acres) | VR from Table 4.4 or Table 4.5[1] | Product of VR x Area |
|---|---|---|---|
| | | | |
| Snout System to Extended Dry Detention[3] | 55.5 | 7.00 | 388.50 |
| Establish/Preserve Native Vegetation | 12.0 | 9.25 | 111.00 |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Untreated | 15.1 | 0.00 | |
| **Total[2]:** | 82.60 | **Total:** | 499.50 |
| | | **Weighted VR:** | **6.05** |

[1] VR calculated for final BMP only in treatment train

[2] Total treatment area cannot exceed 100 percent of the actual site area.

[3] Treatment Train

**Meets required LS (Yes/No)?** **Yes** (If No, or if additional options are being tested, proceed below.)

**2. Proposed BMP Option Package No.:** 2

| Cover/BMP Description | Treatment Area (acres) | VR from Table 5 or Table 6[1] | Product of VR x Area |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Untreated | 0.00 | 0.00 | |
| **Total[2]:** | 0.00 | **Total:** | 0.00 |
| | | **Weighted VR:** | |

[1] VR calculated for final BMP only in treatment train

[2] Total treatment area cannot exceed 100 percent of the actual site area.

**Design Procedure Form: Extended Dry Detention Basin (EDDB)**
**Main Worksheet - B2**

| | | | |
|---|---|---|---|
| Project: | Scannell Development - Building C | Date: | 8/16/2022 |
| Location: | Lee's Summit, MO | Company: | Olsson |
| Designer: | JDA | Checked: | BPS |

## I. Basin Water Quality Volume

Step 1: Tributary area to EDDB, $A_T$ (ac.) — $A_T$ (ac) = 6.12

Step 2: Calculate $WQ_V$ using methodology in Section 6 — $WQ_V$ (ac-ft) = 0.49

Step 3: Add 20 percent to account for silt and sediment deposition in the basin — $V_{DESIGN}$ (ac-ft) = **0.58**

## IIa. Water Quality Outlet Type

Step 1: Set water quality outlet type: — Outlet Type = 2

Type 1 = Single Orifice
Type 2 = Perforated Riser or Plate
Type 3 = V-Notch Weir

Step 2: Proceed to part IIb, IIc, or IId based on water quality outlet type selected

## IIb. Water Quality Pool Outlet, Single Orifice

Step 1: Depth of water quality volume at outlet, $Z_{WQ}$ (ft) — $Z_{WQ}$ (ft) = 3.95

Step 2: Average head of water quality volume over invert of orifice, $H_{WQ}$ (ft) — $H_{WQ}$ (ft) = 1.98

$H_{WQ} = 0.5 * Z_{WQ}$

Step 3: Average water quality outflow rate, $Q_{WQ}$ (cfs) — $Q_{WQ}$ (cfs) = 0.15

$Q_{WQ} = (WQ_V * 43,560) / (40*3,600)$

Step 4: Set value of orifice discharge coefficient, $C_O$ — $C_O$ = 0.66

$C_O$ = 0.66 when thickness of riser/weir plate is = or < orifice diameter
$C_O$ = 0.80 when thickness of riser/weir plate is > orifice diameter

Step 5: Water quality outlet orifice diameter (minimum of 1/2 inch), $D_O$ (in) — $D_O$ (in) = 1.90

$D_O = 12 * 2 (Q_{WQ} / (C_O * p * (2 * g * H_{WQ})^{0.5}))^{0.5}$

(if orifice diameter < 4 inches use outlet type 2 or 3)

Step 6: To size outlet orifice for EDDB with an irregular stage-volume relationship use the Single Orifice Worksheet

**Design Procedure Form: Extended Dry Detention Basin (EDDB)**
**Main Worksheet**

| | | | |
|---|---|---|---|
| Project: | Scannell Development - Building C | Date: | 8/16/2022 |
| Location: | Lee's Summit, MO | Company: | Olsson |
| Designer: | JDA | Checked: | BPS |

## IIc. Water Quality Outlet, Peforated Riser (Continued)

| | | | |
|---|---|---|---|
| Step 1: | Depth of water quality volume at outlet, $Z_{WQ}$ (ft) | $Z_{WQ}$ (ft) = | 3.95 |
| Step 2: | Recommended maximum outlet area per row, $A_O$ ($in^2$)<br>$A_O = WQ_V / (0.013 * Z_{WQ}^2 + 0.22 * Z_{WQ} - 0.10)$ | $A_O$ ($in^2$) = | 0.50 |
| Step 3: | Circular perforation diameter per row assuming a single column, $D_I$ (in) | $D_I$ (in) = | 0.80 |
| Step 4: | Numbers of columns, $n_c$ | $n_c$ = | 1 |
| Step 5: | Design circular perforation diameter, $D_{Perf}$ (in) | $D_{Perf}$ (in) = | 0.80 |
| Step 6: | Horizontal peforation column spacing when $n_c > 1$, center to center, $S_c$<br>If $D_{Perf}$ is not > or = 1, $S_c = 4$ | $S_c$ = | NA |
| Step 7: | Number of rows, 4" vertical spacing between perforations, center to center, | $n_r$ = | 12 |

## IIc. Water Quality Outlet, V-Notch Weir

| | | | |
|---|---|---|---|
| Step 1: | Depth of water quality volume above permanent pool, $Z_{WQ}$ (ft) | $Z_{WQ}$ (ft) = | 3.95 |
| Step 2: | Average head of water quality pool volume over invert of v-notch $H_{WQ}$ (ft)<br>$H_{WQ} = 0.5 * Z_{WQ}$ | $H_{WQ}$ (ft) = | 1.98 |
| Step 3: | Average water quality pool outflow rate, $Q_{WQ}$ (cfs)<br>$Q_{WQ} = (WQ_V * 43{,}560) / (40*3{,}600)$ | $Q_{WQ}$ (cfs) = | 0.15 |
| Step 4 | V-notch weir coefficient, $C_v$ (2.5 is typical) | $C_v$ = | 2.50 |
| Step 5: | V-notch weir angle, q (deg)<br>$\theta = 2 * (180/\pi) * \arctan(Q_{WQ} / (C_v * H_{WQ}^{5.2}))$<br>V-notch angle should be at least 20 degrees. Set to 20 degrees if calculated angle is smaller. | θ (deg) = | 20.00 |
| Step 6: | V-notch weir top width, $W_v$ (ft)<br>$W_v = 2 * Z_{WQ} * TAN(\theta/2)$ | $W_v$ (ft) = | 1.39 |

Step 7: To calculate v-notch angle for EDW with an irregular stage-volume relationship, use th V-notch Weir Worksheet

**Design Procedure Form: Extended Dry Detention Basin (EDDB)**
**Main Worksheet**

| | | | |
|---|---|---|---|
| Project: | Scannell Development - Building C | Date: | 8/16/2022 |
| Location: | Lee's Summit, MO | Company: | Olsson |
| Designer: | JDA | Checked: | BPS |

## III. Flood Control

Refer to APWA Specifications Section 5608

## IV. Trash Racks

Step 1: Total outlet area, $A_{ot}$ ($in^2$) — $A_{ot}$ ($in^2$) = 9.42

Step 2: Required trash rack open area, $A_t$ ($in^2$) — $A_t$ ($in^2$) = 320.54

$A_t = A_{ot} * 77 * e^{(-0.124 *D)}$ for single orifice outlet

$A_t = (A_{ot} / 2) * 77 * e^{(-0.124*D)}$ for orifice plate or perforated riser outlet

$At = 4 * A_{ot}$ for v-notch weir outlet

## V. Basin Shape

Step 1: Length to width ratio should be at least 3:1 (L:W) wherever practicable — (L:W) =

Step 2: Low flow channel side lining
- Concrete:
- Soil/Riprap:
- No low flow channel:

Step 3: Top stage floor drainage slope (toward low flow channel), $S_{TS}$ (%) — $S_{TS}$ (%) =

Top stage depth, $D_{TS}$ (ft) — $D_{TS}$ (ft) =

Step 4: Bottom stage volume, $V_{BS}$ (ac-ft) — $V_{BS}$ (% of $WQ_V$) =

$V_{BS}$ (ac-ft) =

## VI. Forebay (Optional)

Step 1: Volume should be greater than 10% of $WQ_V$ — Min $Vol_{FB}$ (ac-ft) =

Step 2: Forebay depth, $Z_{FB}$ (ft) — $Z_{FB}$ (ft) =

Step 3: Forebay surface area, $A_{FB}$ (ac) — $A_{FB}$ (ac) =

Step 2: Paved/hard bottom and sides?

## Design Procedure Form: Extended Dry Detention Basin (EDDB)
## Main Worksheet

| | | | |
|---|---|---|---|
| Project: | Scannell Development - Building C | Date: | 8/16/2022 |
| Location: | Lee's Summit, MO | Company: | Olsson |
| Designer: | JDA | Checked: | BPS |

**VII. Basin side slopes**

Basin side slopes should be at least 4:1 (H:V) Side Slope (H:V) = ________

**VIII. Dam Embankment side slopes**

Dam Embankment side slops should be at least 3:1 (H:V) Dam Embankment (H:V) = ________

**IX. Vegetation**

Check the method of vegetation planted in the EWDB or describe "Other"

☐ Native Grass

☐ Irrigated Turf Grass

☐ Other: ________

**X. Inlet protection**

Indicate method of inlet protection/energy dissipation at EDDB inlet ________

**XI. Access**

Indicate that access has been provided for maintenance vehicles ________

**Design Procedure Form: Extended Dry Detention Basin (EDDB)**
**Main Worksheet - B3**

| | | | |
|---|---|---|---|
| Project: | Scannell Development - Building C | Date: | 8/16/2022 |
| Location: | Lee's Summit, MO | Company: | Olsson |
| Designer: | JDA | Checked: | BPS |

## I. Basin Water Quality Volume

Step 1: Tributary area to EDDB, $A_T$ (ac.) — $A_T$ (ac) = 9.17

Step 2: Calculate $WQ_V$ using methodology in Section 6 — $WQ_V$ (ac-ft) = 0.73

Step 3: Add 20 percent to account for silt and sediment deposition in the basin — $V_{DESIGN}$ (ac-ft) = **0.88**

## IIa. Water Quality Outlet Type

Step 1: Set water quality outlet type: — Outlet Type = 2

Type 1 = Single Orifice
Type 2 = Perforated Riser or Plate
Type 3 = V-Notch Weir

Step 2: Proceed to part IIb, IIc, or IId based on water quality outlet type selected

## IIb. Water Quality Pool Outlet, Single Orifice

Step 1: Depth of water quality volume at outlet, $Z_{WQ}$ (ft) — $Z_{WQ}$ (ft) = 3.38

Step 2: Average head of water quality volume over invert of orifice, $H_{WQ}$ (ft) — $H_{WQ}$ (ft) = 1.69

$H_{WQ} = 0.5 * Z_{WQ}$

Step 3: Average water quality outflow rate, $Q_{WQ}$ (cfs) — $Q_{WQ}$ (cfs) = 0.22

$Q_{WQ} = (WQ_V * 43{,}560) / (40*3{,}600)$

Step 4: Set value of orifice discharge coefficient, $C_O$ — $C_O$ = 0.66

$C_O$ = 0.66 when thickness of riser/weir plate is = or < orifice diameter
$C_O$ = 0.80 when thickness of riser/weir plate is > orifice diameter

Step 5: Water quality outlet orifice diameter (minimum of 1/2 inch), $D_O$ (in) — $D_O$ (in) = 2.42

$D_O = 12 * 2 (Q_{WQ} / (C_O * p * (2 * g * H_{WQ})^{0.5}))^{0.5}$

(if orifice diameter < 4 inches use outlet type 2 or 3)

Step 6: To size outlet orifice for EDDB with an irregular stage-volume relationship use the Single Orifice Worksheet

**Design Procedure Form: Extended Dry Detention Basin (EDDB)**
**Main Worksheet**

| | | | |
|---|---|---|---|
| Project: | Scannell Development - Building C | Date: | 8/16/2022 |
| Location: | Lee's Summit, MO | Company: | Olsson |
| Designer: | JDA | Checked: | BPS |

## IIc. Water Quality Outlet, Peforated Riser (Continued)

| | | | |
|---|---|---|---|
| Step 1: | Depth of water quality volume at outlet, $Z_{WQ}$ (ft) | $Z_{WQ}$ (ft) = | 3.38 |
| Step 2: | Recommended maximum outlet area per row, $A_O$ (in$^2$)<br>$A_O = WQ_V / (0.013 * Z_{WQ}^2 + 0.22 * Z_{WQ} - 0.10)$ | $A_O$ (in$^2$) = | 0.92 |
| Step 3: | Circular perforation diameter per row assuming a single column, $D_I$ (in) | $D_I$ (in) = | 1.08 |
| Step 4: | Numbers of columns, $n_c$ | $n_c$ = | 1 |
| Step 5: | Design circular perforation diameter, $D_{Perf}$ (in) | $D_{Perf}$ (in) = | 1.08 |
| Step 6: | Horizontal peforation column spacing when $n_c > 1$, center to center, $S_c$<br>If $D_{Perf}$ is not > or = 1, $S_c = 4$ | $S_c$ = | NA |
| Step 7: | Number of rows, 4" vertical spacing between perforations, center to center, | $n_r$ = | 10 |

## IIc. Water Quality Outlet, V-Notch Weir

| | | | |
|---|---|---|---|
| Step 1: | Depth of water quality volume above permanent pool, $Z_{WQ}$ (ft) | $Z_{WQ}$ (ft) = | 3.38 |
| Step 2: | Average head of water quality pool volume over invert of v-notch $H_{WQ}$ (ft)<br>$H_{WQ} = 0.5 * Z_{WQ}$ | $H_{WQ}$ (ft) = | 1.69 |
| Step 3: | Average water quality pool outflow rate, $Q_{WQ}$ (cfs)<br>$Q_{WQ} = (WQ_V * 43{,}560) / (40*3{,}600)$ | $Q_{WQ}$ (cfs) = | 0.22 |
| Step 4 | V-notch weir coefficient, $C_v$ (2.5 is typical) | $C_v$ = | 2.50 |
| Step 5: | V-notch weir angle, q (deg)<br>$\theta = 2 * (180/\pi) * \arctan(Q_{WQ} / (C_v * H_{WQ}^{5.2}))$<br>V-notch angle should be at least 20 degrees. Set to 20 degrees if calculated angle is smaller. | θ (deg) = | 20.00 |
| Step 6: | V-notch weir top width, $W_v$ (ft)<br>$W_v = 2 * Z_{WQ} * \tan(\theta/2)$ | $W_v$ (ft) = | 1.19 |
| Step 7: | To calculate v-notch angle for EDW with an irregular stage-volume relationship, use th V-notch Weir Worksheet | | |

**Design Procedure Form: Extended Dry Detention Basin (EDDB)**
**Main Worksheet**

| | | | |
|---|---|---|---|
| Project: | Scannell Development - Building C | Date: | 8/16/2022 |
| Location: | Lee's Summit, MO | Company: | Olsson |
| Designer: | JDA | Checked: | BPS |

## III. Flood Control

Refer to APWA Specifications Section 5608

## IV. Trash Racks

Step 1: Total outlet area, $A_{ot}$ ($in^2$) — $A_{ot}$ ($in^2$) = 7.85

Step 2: Required trash rack open area, $A_t$ ($in^2$) — $A_t$ ($in^2$) = 267.11

$A_t = A_{ot} * 77 * e^{(-0.124 *D)}$ for single orifice outlet

$A_t = (A_{ot} / 2) * 77 * e^{(-0.124*D)}$ for orifice plate or perforated riser outlet

$At = 4 * A_{ot}$ for v-notch weir outlet

## V. Basin Shape

Step 1: Length to width ratio should be at least 3:1 (L:W) wherever practicable — (L:W) =

Step 2: Low flow channel side lining — Concrete: 
Soil/Riprap: 
No low flow channel:

Step 3: Top stage floor drainage slope (toward low flow channel), $S_{TS}$ (%) — $S_{TS}$ (%) =
Top stage depth, $D_{TS}$ (ft) — $D_{TS}$ (ft) =

Step 4: Bottom stage volume, $V_{BS}$ (ac-ft) — $V_{BS}$ (% of $WQ_V$) =
$V_{BS}$ (ac-ft) =

## VI. Forebay (Optional)

Step 1: Volume should be greater than 10% of $WQ_V$ — Min $Vol_{FB}$ (ac-ft) =

Step 2: Forebay depth, $Z_{FB}$ (ft) — $Z_{FB}$ (ft) =

Step 3: Forebay surface area, $A_{FB}$ (ac) — $A_{FB}$ (ac) =

Step 2: Paved/hard bottom and sides?

**Design Procedure Form: Extended Dry Detention Basin (EDDB)**
**Main Worksheet**

| | | | |
|---|---|---|---|
| Project: | Scannell Development - Building C | Date: | 8/16/2022 |
| Location: | Lee's Summit, MO | Company: | Olsson |
| Designer: | JDA | Checked: | BPS |

### VII. Basin side slopes

Basin side slopes should be at least 4:1 (H:V) Side Slope (H:V) = ______

### VIII. Dam Embankment side slopes

Dam Embankment side slops should be at least 3:1 (H:V) Dam Embankment (H:V) = ______

### IX. Vegetation

Check the method of vegetation planted in the EWDB or describe "Other"

- ___ Native Grass
- ___ Irrigated Turf Grass
- ___ Other: ______

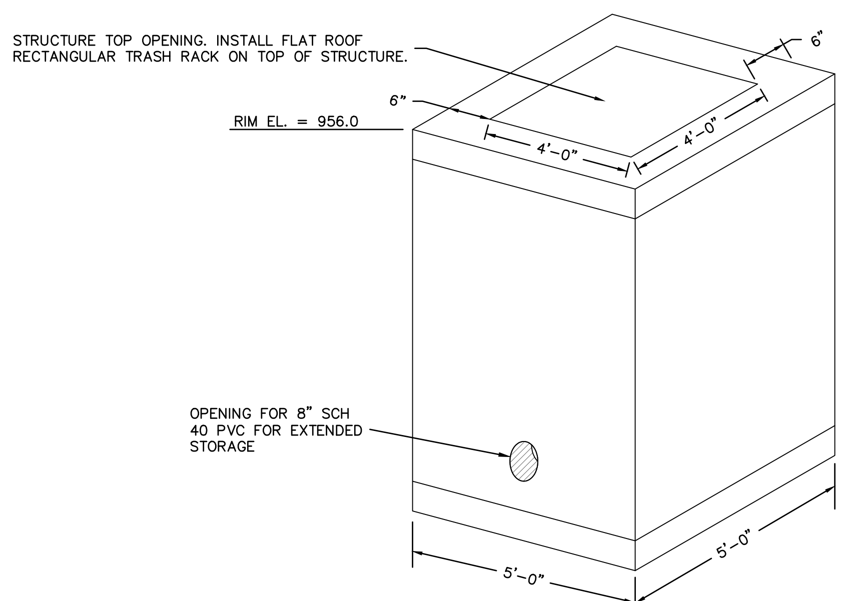
### X. Inlet protection

Indicate method of inlet protection/energy dissipation at EDDB inlet ______

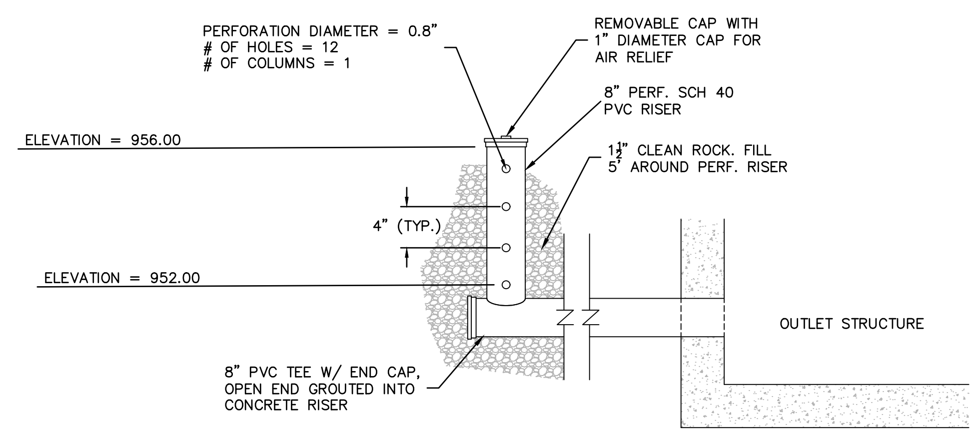
### XI. Access

Indicate that access has been provided for maintenance vehicles ______

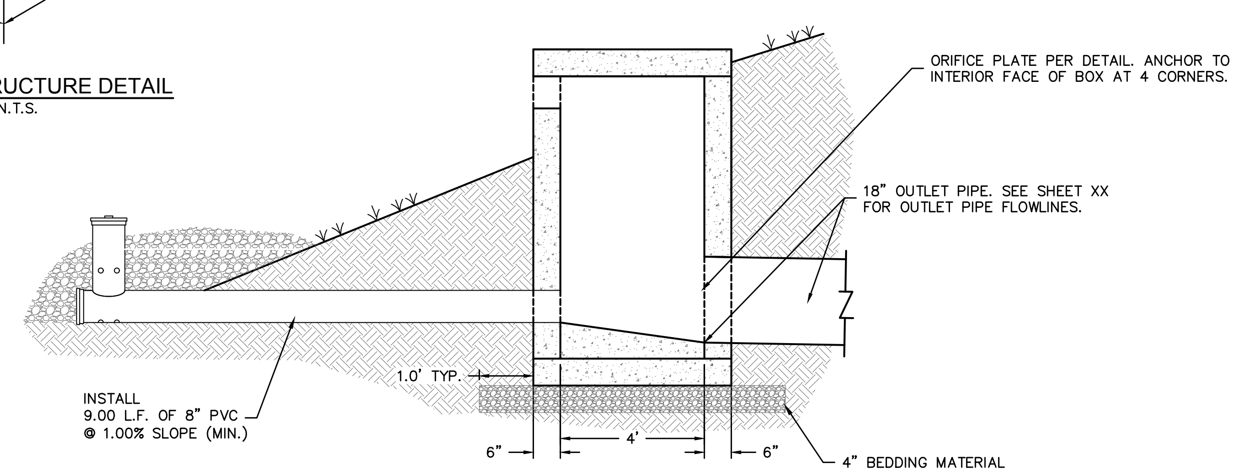
NOTES:
1. BOTTOM TO BE POURED IN PLACE.
2. PIPE TO BE ON GRADE BEFORE BOTTOM IS CONSTRUCTED.
3. RAM–NEK ALL JOINTS (OR EQUAL).
4. #4 BARS @ 10" C.C. VERT. & HOR. IN WALLS & BOTTOM.
5. REINFORCING BARS SHALL BE CUT OR BENT AT PIPE OPENINGS.
6. ALL PIPES SHALL FIT FLUSH WITH INSIDE FACE OF BOX.
7. BOTTOM OF BOX TO BE FILLED WITH CONCRETE TO 6" ABOVE INVERT OF PIPE FORMING CHANNELS TOWARD OUTLET PIPE FROM ALL INLET PIPES.
8. ALL CONCRETE SHALL HAVE 28 DAY COMPRESSIVE STRENGTH OF 4,000 PSI.
9. ALL REINFORCING BARS TO BE DEFORMED BARS AND MEET REQUIREMENTS OF 1966 ASTM STANDARDS NO. A–615–68 MIN. GRADE 40.
10. MUST MAINTAIN 6" CLEARANCE BETWEEN THE PIPE AND WALLS FOR PRECAST BOXES.




OUTLET STRUCTURE DETAIL
N.T.S.




PERFORATED RISER PIPE DETAIL
N.T.S.




SECTION THROUGH OUTLET STRUCTURE
N.T.S.

DWG: C:\Temp\AcPublish_13848\Perforated_Riser_Detail.dwg USER: jasgian
DATE: Aug 16, 2022 10:54am XREFS:

olsson
7301 West 133rd Street, Suite 200
Overland Park, KS 66213-4750
TEL 913.381.1170 www.olsson.com

EXHIBIT
NOT FOR CONSTRUCTION

| REV. NO. | DATE | REVISIONS DESCRIPTION | BY |
| --- | --- | --- | --- |

REVISIONS

WATER QUALITY OUTLET STRUCTURE
DETENTION FACILITY B-2

SCANNELL DEVELOPMENT - PHASE III
LEE'S SUMMIT LOGISTICS

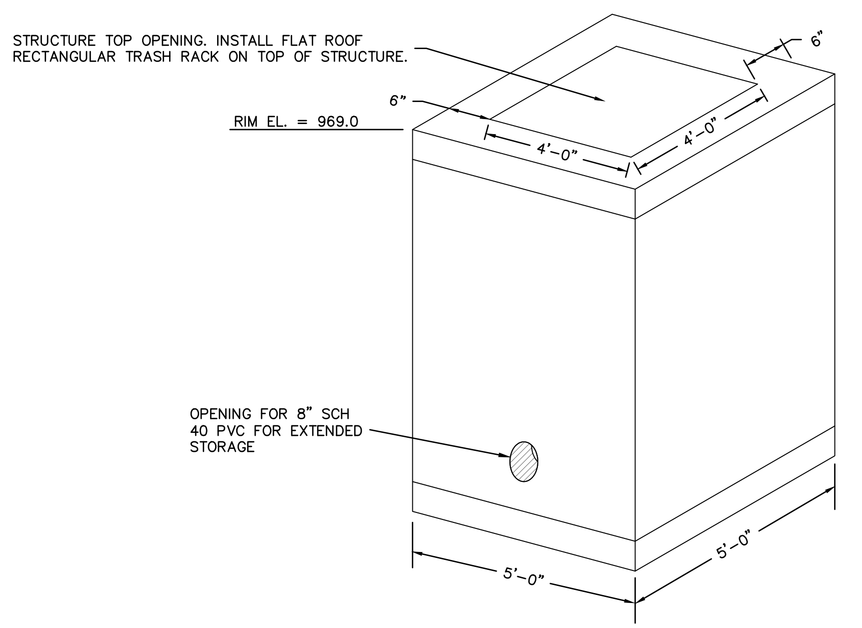
2022

LEE'S SUMMIT, MO

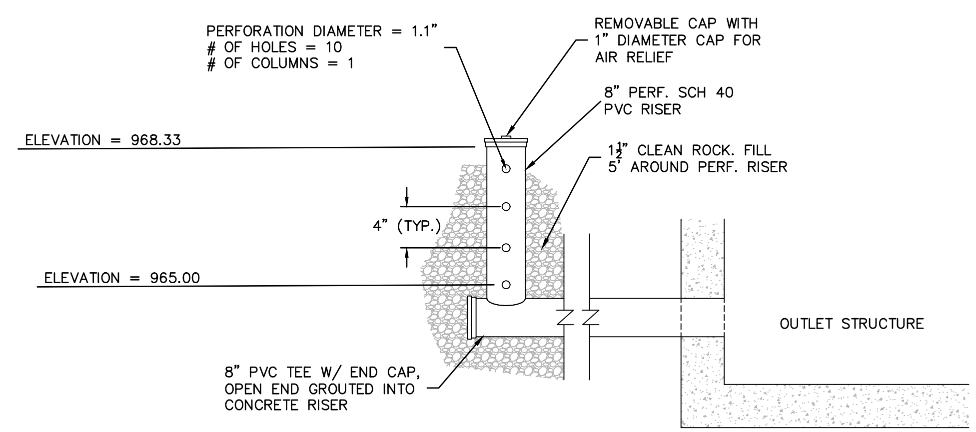
drawn by: JDA
checked by:
approved by:
QA/QC by: BPS
project no.: C21-04157
drawing no.:
date: 08.16.2022

SHEET
1 of 2

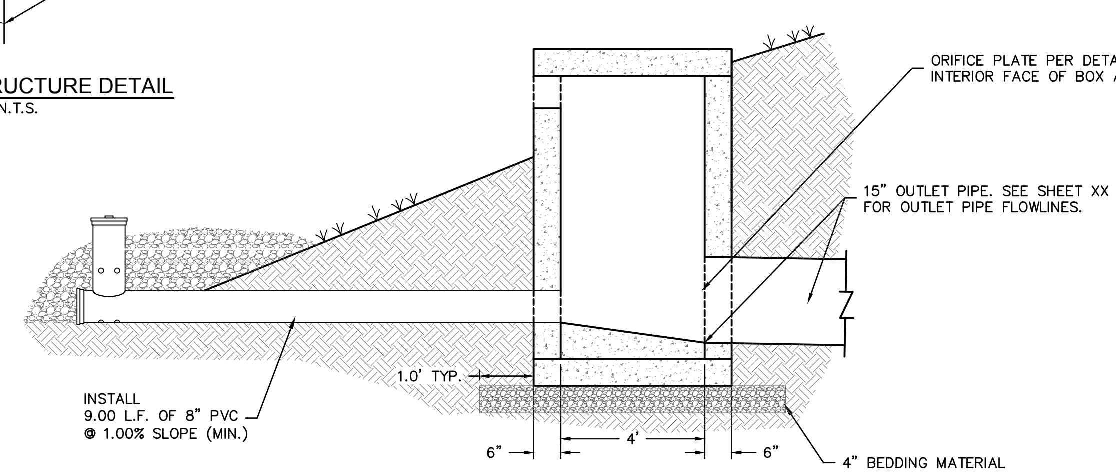
NOTES:
1. BOTTOM TO BE POURED IN PLACE.
2. PIPE TO BE ON GRADE BEFORE BOTTOM IS CONSTRUCTED.
3. RAM-NEK ALL JOINTS (OR EQUAL).
4. #4 BARS @ 10" C.C. VERT. & HOR. IN WALLS & BOTTOM.
5. REINFORCING BARS SHALL BE CUT OR BENT AT PIPE OPENINGS.
6. ALL PIPES SHALL FIT FLUSH WITH INSIDE FACE OF BOX.
7. BOTTOM OF BOX TO BE FILLED WITH CONCRETE TO 6" ABOVE INVERT OF PIPE FORMING CHANNELS TOWARD OUTLET PIPE FROM ALL INLET PIPES.
8. ALL CONCRETE SHALL HAVE 28 DAY COMPRESSIVE STRENGTH OF 4,000 PSI.
9. ALL REINFORCING BARS TO BE DEFORMED BARS AND MEET REQUIREMENTS OF 1966 ASTM STANDARDS NO. A-615-68 MIN. GRADE 40.
10. MUST MAINTAIN 6" CLEARANCE BETWEEN THE PIPE AND WALLS FOR PRECAST BOXES.




OUTLET STRUCTURE DETAIL
N.T.S.




PERFORATED RISER PIPE DETAIL
N.T.S.




SECTION THROUGH OUTLET STRUCTURE
N.T.S.


olsson
7301 West 133rd Street, Suite 200
Overland Park, KS 66213-4750
TEL 913.381.1170 www.olsson.com


EXHIBIT
NOT FOR CONSTRUCTION

| REV. NO. | DATE | REVISIONS DESCRIPTION | BY |
|---|---|---|---|

REVISIONS

WATER QUALITY OUTLET STRUCTURE
DETENTION FACILITY B-3

SCANNELL DEVELOPMENT - PHASE III
LEE'S SUMMIT LOGISTICS

LEE'S SUMMIT, MO

2022

| | |
|---|---|
| drawn by: | JDA |
| checked by: | |
| approved by: | |
| QA/QC by: | BPS |
| project no.: | C21-04157 |
| drawing no.: | |
| date: | 08.16.2022 |

SHEET
2 of 2

DWG: C:\Temp\AcPublish_13848\Perforated_Riser_Detail.dwg USER: jasgian
DATE: Aug 16, 2022 10:54am XREFS:

# APPENDIX D

Waiver Requests

# LEE'S SUMMIT
MISSOURI

# DESIGN AND CONSTRUCTION MANUAL DESIGN MODIFICATION REQUEST

PROJECT NAME: Scannell Development - Phase III

PREMISE ADDRESS: NW Corner of Tudor Road & Main Street

PERMIT NUMBER: ______________________________

OWNER'S NAME: Scannell Properties, LLC

TO: The City Engineer

In accordance with the Lee's Summit Design and Construction Manual (DCM) Section 1002.A, I wish to apply for a modification to one or more specification (s). The following articulates my request for your review and action. (NOTE: Cite specific code sections and engineering justification and drawings.)
A waiver is requested for detention of the 2-year and 10-year events at the site (outlined in Section 5608 of KC-APWA 5600). The allowable release rate at the point of interest for the 2-year event cannot be met with detention. If the proposed release rates for all detention basins were reduced to 0, the proposed peak flow rate at the point of interest would still be greater than the allowable release rate for the 2-year event. Proposed detention basins for Phase III have been designed to minimize increases in release rates at the point of interest as much as reasonable able while still meeting other design criteria.

SUBMITTED BY:
NAME: Jacob Asgian ( ) OWNER (x) OWNER'S AGENT
ADDRESS: 7301 West 133rd St, Suite 200 Tel.# (913) 381-1170
CITY, STATE, ZIP: Overland Park, KS 66213
Email: jasgian@olsson.com SIGNATURE: Jacob Asgian

FORWARDING MANAGER: ____________________ RECOMMENDATION ( ) APPROVAL ( ) DENIAL

SIGNATURE: ______________________ DATE: ______________________

GEORGE BINGER III, P.E. – CITY ENGINEER: ( ) APPROVED ( ) DENIED

SIGNATURE: ______________________ DATE: ______________________

COMMENTS ______________________________________________

**A COPY MUST BE ATTACHED TO THE APPROVED PLANS**

# DESIGN AND CONSTRUCTION MANUAL DESIGN MODIFICATION REQUEST

PROJECT NAME: Scannell Development - Phase III

PREMISE ADDRESS: NW Corner of Tudor Road & Main Street

PERMIT NUMBER: ______________________________

OWNER'S NAME: Scannell Properties, LLC

TO: The City Engineer

In accordance with the Lee's Summit Design and Construction Manual (DCM) Section 1002.A, I wish to apply for a modification to one or more specification (s). The following articulates my request for your review and action. (NOTE: Cite specific code sections and engineering justification and drawings.)
A waiver is requested for stream setback requirements for Little Cedar Creek as outlined in Section 4.5 of the final stormwater drainage study for Phase III. A proposed private road encroaches on the north stream buffer for Little Cedar Creek. This road serves as a connection between the loading dock and parking areas on the east side of the building and is required for fire protection purposes so that there is a full loop around the building. Additional buffer has been provided on the south side to account for this loss.

SUBMITTED BY:
NAME: Jacob Asgian ( ) OWNER (x) OWNER'S AGENT
ADDRESS: 7301 West 133rd St, Suite 200 Tel.# (913) 381-1170
CITY, STATE, ZIP: Overland Park, KS 66213
Email: jasgian@olsson.com SIGNATURE: Jacob Asgian

FORWARDING MANAGER: ____________ RECOMMENDATION ( ) APPROVAL ( ) DENIAL

SIGNATURE: ____________ DATE: ____________

GEORGE BINGER III, P.E. – CITY ENGINEER: ( ) APPROVED ( ) DENIED

SIGNATURE: ____________ DATE: ____________

COMMENTS ______________________________

**A COPY MUST BE ATTACHED TO THE APPROVED PLANS**