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

FINAL STORMWATER DRAINAGE STUDY FOR PHASE II

Prepared for:

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Olsson Project No. B21-04157
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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) and final stormwater study for Phase I (dated October 15, 2021). This study presents the hydrologic impact generated by construction of Phase II of the project and builds on the preliminary study for the overall development and final study for Phase I. Phase II includes the westernmost of the three proposed buildings (Building B) from the preliminary stormwater drainage study, and its appurtenances. The attached exhibits 1-6 in Appendix A show the limits of the Phase II 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 are minor changes to the on-site area and allowable release rates outlined in Tables 2 and 3 due to refinements to the grading boundary.

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 I ➔ Phase II)	-0.7	-1.0	-0.3%

[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 I ➔ Phase II)	+2	+2	+3

*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 for the on-site areas.

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 Phase I and Phase II improvements, 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	13.2	0.0	13.2	0.100	95
B-3	2.1	0.0	2.1	0.100	85

Drainage Area	On-site Area (acres)	Off-site Area (acres)	Total Area (acres)	T_c[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 II improvements. Updates have been made to the hydrologic parameters and detention facilities for the Phase III improvements from the preliminary stormwater study based on updated grading. These updates were made in order to obtain more accurate results, but have not been outlined in this study in order to avoid confusion. A final stormwater study will be completed in conjunction with the Phase III improvements to confirm results.

Table 5. Outlet Structures Summary (Phase II).

Detention Facility	Basin Top Elevation (feet)	Basin Bottom Elevation (feet)	Primary Outlet Diameter (inches)	Structure Length (feet)	Structure Width (feet)	Approx. Height (feet)
A-1	961	942	15	4	4	9.0
B-1[1]	948	942	24	-	-	-

[1]Detention facility B-1 does not have an outlet structure, only an outlet pipe

Table 6 summarizes the water quality device configurations for each of the proposed detention facilities for Phase II of the project, respectively. Detention facility B-1 is small and very limited in size due to constraints from nearby roadways and stream buffers, limiting storage volume in the basin and its ability to provide extended detention; therefore, B-1 will not be equipped with a perforated riser or water quality outlet structure, and the outlet will just be a circular pipe. To compensate for this, detention facility A-1 has been designed to provide extended detention of the cumulative water quality volume for both basin A-1 and B-1. Detention facility A-1 is much larger in size and storage volume than B-1 and is able to accommodate for the increased volume.

The multi-stage outlet structure for B-1 has 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. 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 6. Water Quality Devices Summary (Phase II).

Detention Facility	Perforation Diameter (inches)	Number of Columns	Number of Rows[1]
A-1[2]	0.7	1	17

[1]4-inch vertical spacing between perforations, center to center
[2]Detention facility A-1 is designed to handle water quality volume for A-1 and B-1

Detention facilities will also be equipped with an independent broad-crested weir graded into the berm of the basin to function as the emergency spillway. Table 7 summarizes minimum bottom lengths of the emergency spillways for each of the proposed detention facilities for Phase II of the project.

Table 7. Emergency Spillway Summary (Phase II).

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)
A-1	69	958.5	2.5	50	0.6	6.7	1.9
B-1	27	946.0	2.0	25	0.5	1.1	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)

4.4 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 8 shows peak discharge values at the point of interest. Table 9 compares these discharge values to existing and allowable discharge values. In Table 9, negative values indicate a reduction in peak flows, while positive values indicate an increase.

Table 8. Proposed Point of Interest Peak Flow Rates.

Point of Interest	Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
Point 1	981	1,647	2,601

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

Table 9. Proposed Conditions Point of Interest Peak Flows Comparison.

Point 1	ΔQ_2 (cfs)	ΔQ_{10} (cfs)	ΔQ_{100} (cfs)
Existing Conditions	-50	-100	-201
Allowable Release	+53	+10	-13

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

As shown in Table 9, 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 10 compares the percent change in proposed peak discharge values to existing and allowable discharge values.

Table 10. 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%	-5.7%	-7.2%
Allowable Release	+5.7%	+0.6%	-0.5%

*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 0.6 percent. Further consideration will be given to the remaining detention basin outlets during subsequent phases of the project to lower the proposed 2- and 10-year release rate as close to allowable as reasonably able.

4.5 Impacts to Stream Buffer

Impacts to the stream buffer for Phase II 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:

- Just upstream of Point 2, on the north side of the stream. The 60-foot stream buffer in this area will be encroached upon with construction of the detention facility for Drainage Area B-1. To account for this loss in stream buffer on the north side of the stream, additional width has been provided in this area on the south side. A waiver is requested for this area and has been included with this submittal in Appendix D.
- Just upstream of the stream's crossing with the Union Pacific Railroad. The proposed loading dock in encroaches on the 100-foot stream buffer in this area on the west side of the stream. The stream in this area has been previously impacted and straightened by the nearby railroad crossing. The existing stream is confined and has little potential for migration due to the proximity of the railroad culvert. 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 II improvements pertain to the westernmost building (Building B) 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 storm. Subsequent final drainage studies will be required with the submittal of future phases of this project.

The results of the analysis demonstrate that the future stormwater management plan for the project will achieve compliance with design criteria or the requested waiver. We therefore request approval of this Scannell Development Final Stormwater Drainage Study for Phase II 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 II
Lee's Summit, MO

NW Victoria Dr
Little Cedar Creek
Unnamed Tributary to Little Cedar Creek
NW Main St
NW Sloan
NW Ward Rd
NE Tudor Rd

- Project Boundary
- Phase II 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 II
Lee's Summit, MO

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

0 250 500 Feet

1 Inch = 250 Feet

N

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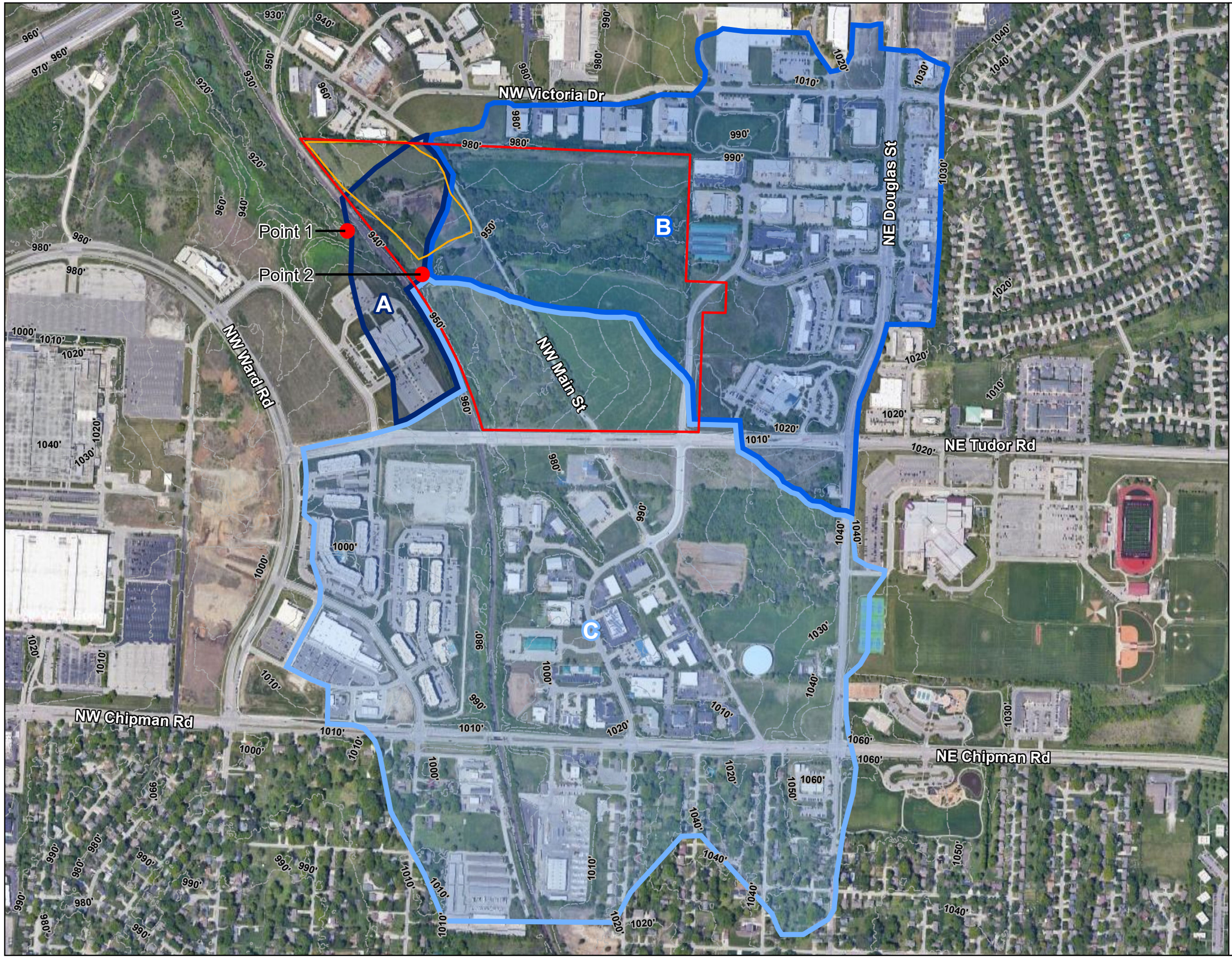

Exhibit 3.
Existing Conditions
Drainage Areas

Scannell Development
Phase II
Lee's Summit, MO

- Project Boundary
- Phase II Grading Boundary
- Drainage Area A
- Drainage Area B
- Drainage Area C
- Existing Contours

0 600 1,200 Feet

1 Inch = 600 Feet

N

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Exhibit 4.
On-Site Areas

Scannell Development Project
Phase II
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

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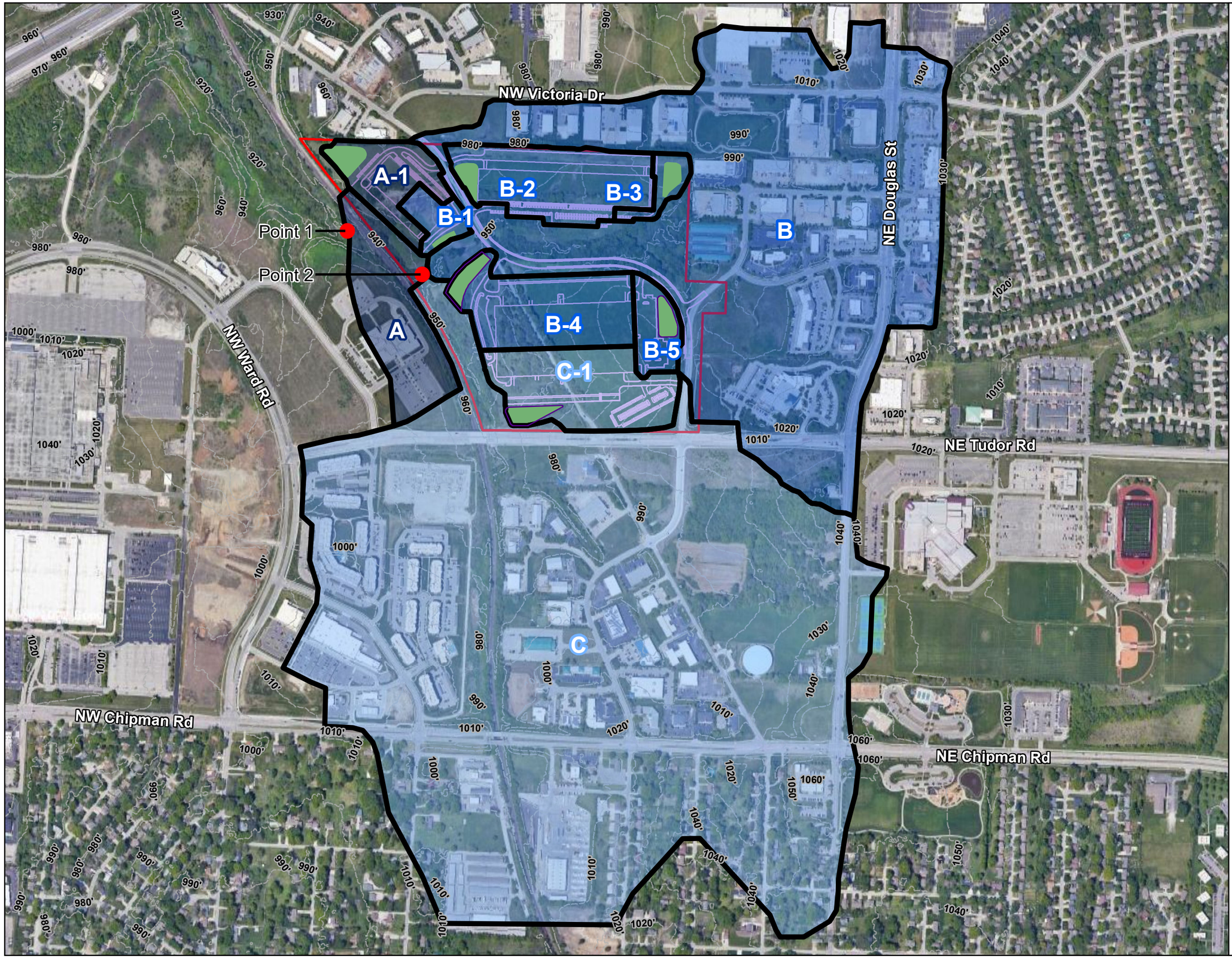
Exhibit 5.
Proposed Conditions
Drainage Areas

Scannell Development
Phase II
Lee's Summit, MO



Existing Contours

Site Layout

Proposed Drainage Area

Proposed Detention Basin

Project Boundary

0 600 1,200 Feet

1 Inch = 600 Feet

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Exhibit 6.
Stream Buffer Map

Scannell Development Project
Phase II
Lee's Summit, MO

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

0 250 500 Feet

1 Inch = 250 Feet

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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 Good Condition; Grass Cover > 75%	C	74	0.7
Open Space Areas Good Condition; Grass Cover > 75%	D	80	10.6
Impervious Areas 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 Commercial & Business	C	94	0.0
Urban Districts 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 Good Condition; Grass Cover > 75%	C	74	46.7
Open Space Areas Good Condition; Grass Cover > 75%	D	80	24.2
Impervious Areas 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 Commercial & Business	C	94	47.6
Urban Districts 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 Good Condition; Grass Cover > 75%	C	74	54.2
Open Space Areas Good Condition; Grass Cover > 75%	D	80	39.1
Impervious Areas 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 Commercial & Business	C	94	67.0
Urban Districts 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	13.2	2.5	80	10.7	98	95
B-3	2.1	1.5	80	0.6	98	85
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

APPENDIX C

Level of Service and Stormwater BMP Calculations

WORKSHEET 1: REQUIRED LEVEL OF SERVICE-UNDEVELOPED SITE

Project:	Scannell Development - Building B	By:	JDA
Location:	Lee's Summit, MO	Checked:	BPS
		Date:	8/4/2022

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

		Change in CN	LS
Predevelopment CN:	82	17+	8
		7 to 16	7
Postdevelopment CN:	88	4 to 6	6
		1 to 3	5
Difference:	6	0	4
		-7 to -1	3
LS Required (see scale at right):	6	-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:	8/4/2022
Project:	Scannell Development - Building B	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 - A1

Project:	Scannell Development - Building B	Date:	8/8/2022
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) =	9.59
Step 2:	Calculate WQ_V using methodology in Section 6	WQ_V (ac-ft) =	0.68
Step 3:	Add 20 percent to account for silt and sediment depositation in the basin	V_{DESIGN} (ac-ft) =	**0.81**

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) = 6.50

Step 2: Average head of water quality volume over invert of orifice, H_{WQ} (ft) — H_{WQ} (ft) = 3.25

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

Step 3: Average water quality outflow rate, Q_{WQ} (cfs) — Q_{WQ} (cfs) = 0.20

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

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) = 1.98

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

(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 B	Date:	8/8/2022
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) =	6.50
Step 2:	Recommended maximum outlet area per row, A_O (in^2) $A_O = WQ_V / (0.013 * Z_{WQ}^2 + 0.22 * Z_{WQ} - 0.10)$	A_O (in^2) =	0.36
Step 3:	Circular perforation diameter per row assuming a single column, D_I (in)	D_I (in) =	0.68
Step 4:	Numbers of columns, n_c	n_c =	1
Step 5:	Design circular perforation diameter, D_{Perf} (in)	D_{Perf} (in) =	0.68
Step 6:	Horizontal peforation column spacing when $n_c > 1$, center to center, S_c 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 =	20

IIc. Water Quality Outlet, V-Notch Weir

Step 1:	Depth of water quality volume above permanent pool, Z_{WQ} (ft)	Z_{WQ} (ft) =	6.50
Step 2:	Average head of water quality pool volume over invert of v-notch H_{WQ} (ft) $H_{WQ} = 0.5 * Z_{WQ}$	H_{WQ} (ft) =	3.25
Step 3:	Average water quality pool outflow rate, Q_{WQ} (cfs) $Q_{WQ} = (WQ_V * 43{,}560) / (40*3{,}600)$	Q_{WQ} (cfs) =	0.20
Step 4	V-notch weir coefficient, C_v (2.5 is typical)	C_v =	2.50
Step 5:	V-notch weir angle, q (deg) $\theta = 2 * (180/\pi) * \arctan(Q_{WQ} / (C_v * H_{WQ}^{5.2}))$ 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) $W_v = 2 * Z_{WQ} * TAN(\theta/2)$	W_v (ft) =	2.29
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 B	Date:	8/8/2022
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) = 15.71

Step 2: Required trash rack open area, A_t (in^2)

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

A_t (in^2) = 534.23

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 B	Date:	8/8/2022
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:

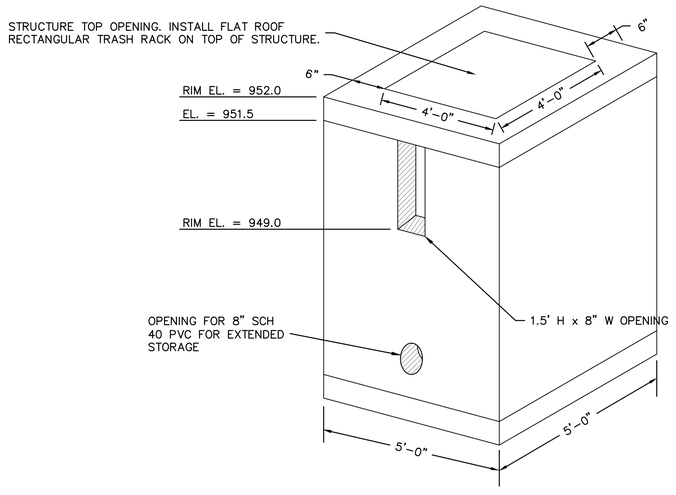
X. Inlet protection

Indicate method of inlet protection/energy dissipation at EDDB inlet

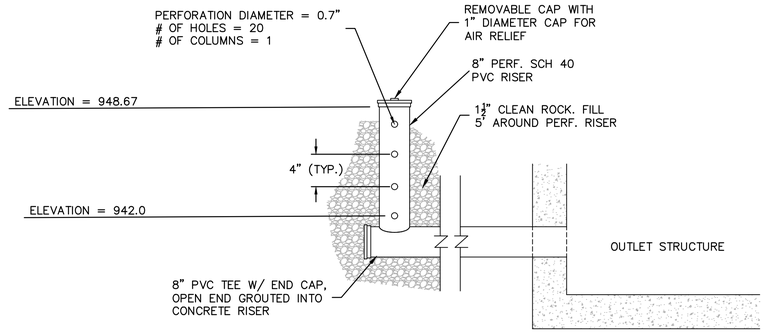
XI. Access

Indicate that access has been provided for maintenance vehicles

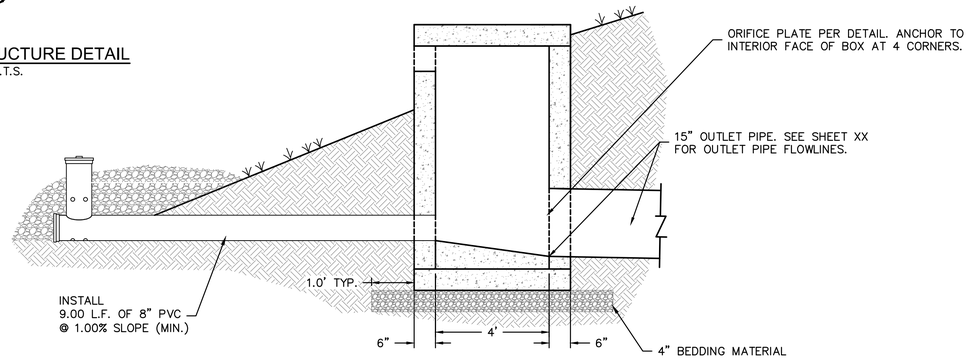
NOTES:
1. BOTTOM TO BE POURED IN PLACE.
2. PIPE TO BE ON GRADE BEFORE BOTTOM IS CONSTRUCTED.
3. RAM-NEK ALL JOINTS (OR EQUAL).
4. #4 BARS @ 10" C.C. VERT. & HOR. IN WALLS & BOTTOM.
5. REINFORCING BARS SHALL BE CUT OR BENT AT PIPE OPENINGS.
6. ALL PIPES SHALL FIT FLUSH WITH INSIDE FACE OF BOX.
7. BOTTOM 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.

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

EXHIBIT
NOT FOR CONSTRUCTION

REVISIONS

REV. NO.	DATE	REVISIONS DESCRIPTION	BY

WATER QUALITY OUTLET STRUCTURE
DETENTION FACILITY A-1

SCANNELL DEVELOPMENT - PHASE ii
LEE'S SUMMIT LOGISTICS

LEE'S SUMMIT, MO

2022

drawn by: JDA
checked by:
approved by:
QA/QC by: BPS
project no.: B21-04157
drawing no.:
date: 08.09.2022

SHEET
1 of 1

DWG: F:\2021\04001-04500\021-04157-B\40-Design\Calcs\WTRS\Stormwater Study\Extended Detention Calcs\Perforated_Riser_Detail.dwg USER: jasgian
DATE: Aug 09, 2022 12:55pm XREFS:

APPENDIX D

Waiver Requests

LEE'S SUMMIT
MISSOURI

DESIGN AND CONSTRUCTION MANUAL DESIGN MODIFICATION REQUEST

PROJECT NAME: Scannell Development - Phase II

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 II have been designed to minimize increases in release rates at the point of interest as much as reasonable able.

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

LEE'S SUMMIT
MISSOURI

DESIGN AND CONSTRUCTION MANUAL DESIGN MODIFICATION REQUEST

PROJECT NAME: Scannell Development - Phase II

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 and the Unnamed Tributary to Little Cedar Creek, as outlined in Section 4.5 of the final stormwater drainage study for Phase II. A proposed detention facility encroaches on the north stream buffer for Little Cedar Creek. Additional buffer has been provided on the south side to account for this loss. The proposed loading dock area on the west side of Building B encroaches on the buffer for Little Cedar Creek. The stream in this area has been previously impacted and straightened by the railroad to the west and has little potential for significant migration to the east (towards the road/building).

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