

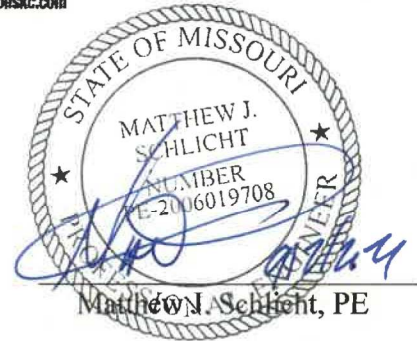
MACRO STORM WATER DRAINAGE STUDY

COLBERN ROAD INVESTMENTS COMMERCIAL DEVELOPMENT NE QUADRANT COLBERN & RICE ROADS

Site Acreage: 23.93 Acres

Lee's Summit, MO

PREPARED BY:



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Matthew J. Schlicht, PE

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3. GENERAL INFORMATION

This storm study has been prepared to evaluate potential hydrologic impacts related to the proposed commercial development at the NE quadrant of Colbern and Rice Roads at ultimate buildout and recommend improvements if required to mitigate any anticipated negative impacts. The proposed project will be constructed in phases. The study will address ultimate buildout conditions for the entire development. It is anticipated that the Development will consist of 5 commercial lots with one common 7.01 acre detention tract. There are currently no known commercial users. The study will use a neighborhood commercial curve number of 94 which equates to a proposed land usage of 85% impervious to allow a variety of uses. The existing property currently consists of mainly prairie land with a large pond located in the northeast corner of the property. The Development will utilize enclosed storm sewer to convey runoff to the existing pond. The existing pond will be utilized to detain and attenuate excess storm water runoff. See Exhibit A for an aerial image of the proposed project site along with an aerial image of the surrounding area. The Development consists of approximately 23.93 acres.

3.1 FEMA FLOODPLAIN DETERMINATION

The property is located in an Area of Minimal Flood Hazard, Zone X, according to FEMA Firm Map Number 29095C0430G, dated January 20, 2017.

See Exhibit B for a FIRMette which includes the proposed project site.

3.2 NRCS SOIL CLASSIFICATION

Soil classifications published by the United States Department of Agriculture/National Resources Conservation Service (USDA/NRCS) website for Jackson County, Missouri, Version 22, May 29, 2020. The existing site contains five major soil types:

10000	Arisburg Silt Loam, 1 to 5 Percent Slopes Hydrologic Soils Group (HSG): Type C
10117	Sampsel Silty Clay Loam, 5 to 9 Percent Slopes HSG: Type C/D
10120	Sharpsburg Silt Loam, 2 to 5 Percent Slopes HSG: Type C
10128	Sharpsburg-Urban Land Complex, 2 to 5 Percent Slopes HSG: Type D
30080	Greenton Silty Clay Loam, 5 to 9 Percent Slopes HSG: Type C/D

See Exhibit C for a detailed soils report of the proposed project site.

4. METHODOLOGY

The study utilized existing city contours to create the Existing Drainage Area Map. The study conforms to the requirements of the City of Lee's Summit, Missouri "Design and Construction Manual" and all applicable codes and criteria referred to therein, unless stated otherwise.

Using the above criteria, the proposed site was evaluated using the Soil Conservation Service, SCS TR-55 method to calculate storm runoff volumes, peak rates of discharge, pre and post developed hydrographs and required storage volumes for detention facilities. TR-55 was first introduced in 1975 by the SCS particularly for small urbanizing watersheds. The analysis contains results for the 2, 10 and 100-year design storms.

Hydraflow Hydrographs Extension for AutoCAD Civil 3D was utilized to model the various SCS TR-55 stormwater rainfall runoff events. The following SCS TR-55 Unit Hydrograph variables were utilized;

- AMC II Soil Moisture Conditions
- 24-Hour SCS Type II Rainfall Distribution (Shape Factor 484)
- SCS Runoff Curve Numbers per SCS TR-55 (Tables 2-2a to 2-2c)

Time of Concentration has been calculated using the following formulas:

- Sheet Flow (Max. 100 LF): APWA 5602.5 Time Inlet, $T_1 = 1.8 * (1.1-C) * L^{1/2} / S^{1/3}$
- Shallow Concentrated Flow: SCS TR-55 Appendix F:

Unpaved	$V=16.1345(S)^{0.5}$
Paved	$V=20.3282(S)^{0.5}$

Shallow Concentrated Travel Time (min): SCS TR-55 Eq-3-1, $T_t = L / V * 60$

- Channel Flow Improved: Manning's Equation (Full Flow)
- Channel Flow Unimproved: APWA 5602.7.A. Travel Time, Table 5602-6

<u>Avg. Channel Slope (%)</u>	<u>Velocity (fps)</u>
< 2	7
2 to 5	10
>5	15

5. EXISTING CONDITIONS ANALYSIS

The existing site consists of mainly prairie land with a few trees lining the north property boundary. The site contains three sub-basins referred to as the West Sub-basin, South Sub-basin and East Sub-basin for the purposes of this report. Each Sub-basin drains to a Point of Interest which corresponds to its given sub-basin drainage area, i.e., West Sub-basin drains to Point of Interest (POI) West. The Existing Drainage Area Map is located in Exhibit D. Following is a brief description of each sub-basin.

West Sub-basin is generally located on the western portion of the property adjacent to Rice Road, south of the Post Office. Runoff drains to the west via sheet and shallow concentrated flow. The runoff is intercepted by a road side ditch running along Rice Road for further conveyance downstream to the north. The sub-basin consists of 2.31 acres all of which are onsite. The West POI is located in the Rice Road drainage ditch.

South Sub-basin is generally located on the southern portion of the property adjacent to Colbern Road, just west of the Public Library. Runoff drains to the south via sheet flow. Runoff is intercepted by Colbern Road and conveyed to the east via an enclosed storm sewer system. The South POI will consist of the south property line adjacent to Colbern Road in lieu of a specific point discharge due to the geometry of the sub-basin and nature of the drainage. The sub-basin consists of 0.47 acres.

East Sub-basin is the last and largest sub-basin making up the remainder of the site. Runoff drains to the northeast via sheet and shallow concentrated flow to the existing pond located in the northeast corner of the property. Runoff leaves the site via the pond spillway located in the northeast corner of the pond and property. Runoff is conveyed downstream via a natural channel on the adjacent property to the north. The East POI will be located at the existing pond spillway. The sub-basin contains 14.73 acres. The pond tract contains 7.01 acres and is not included in the East Sub-basin. The pond tract will remain undeveloped and therefore will not be accounted for in any hydraulic calculations.

The following tables summarize the results of the Existing Conditions analysis. A complete breakdown of TR-55 unit hydrographs may be found in Exhibit E.

Table 5-1 Existing Conditions Sub-basin Data

Sub-basin	Area (ac.)	CN	Tc (min.)
West	2.31	74	11.7
South	0.47	74	5
East	14.73	74	10.5

Table 5-2 Existing Conditions Sub-basin/Point of Interest Peak Discharge Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
West	4.31	8.91	16.32
South	1.08	2.20	3.98
East	27.49	56.82	104.05

Per APWA 5608.4 and City of Lee's Summit criteria, post development peak discharge rates from the site shall not exceed those indicated below:

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

Allowable release rates were calculated at each point of interest. Due to the geography of the site there are no offsite areas draining through the developable areas of the site. The 7.01 acre detention tract will not be developed therefore this area was not accounted. The use of the area-discharge ratio method to account for offsite tributaries was not required.

Allowable Release Example Calculations:

$$\text{West Sub-basin (2-Yr): } (2.31 \times 0.5) = \underline{1.16 \text{ cfs}}$$

Table 5-3 Existing Conditions Sub-basin/Point of Interest Allowable Peak Discharge Release Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
West	1.16	4.62	6.93
South	0.24	0.94	1.41
East	7.37	29.46	44.19

6. PROPOSED CONDITIONS ANALYSIS

The Development will consist of various commercial land usages. The runoff coefficient used for the entire site will be 94 which equates to 85% impervious land. The proposed site will continue to consist of three distinct sub-basins referred to as the West Sub-basin, South Sub-basin and East Sub-basin for the purposes of this report. Each sub-basin peak runoff rate will be calculated at a given Point of Interest which corresponds to its given sub-basin drainage area, i.e., West Sub-basin drains to Point of Interest (POI) West. The Proposed Drainage Area Map is located in Exhibit F. Following is a brief description of each sub-basin.

West Sub-basin will be reduced considerably due to the proposed development. The sub-basin will contain 0.25 acres of peripheral undeveloped area along Rice Road.

South Sub-basin will be reduced by more than half of its existing condition. The sub-basin will contain 0.21 acres of peripheral undeveloped area along Colbern Road.

East Sub-basin will increase in land area due to the proposed development. The area lost by the west and south sub-basins will contribute to the east. The East Sub-basin will contain 17.05 acres of commercial development. An enclosed storm sewer system will be installed in the development conveying storm water runoff to the retention pond located in the northeast corner of the property. The existing pond will be modified with a new outlet control device in the northeast corner and a new emergency spillway along the north berm to meet the City's current storm water design standards. These improvements will be detailed further as the project proceeds past the preliminary stages.

The following tables summarize the results of the Proposed Conditions analysis for all three sub-basins.

Table 6-1 Proposed Conditions Sub-basin Data

Sub-basin	Area (ac.)	Composite CN	Tc (min.)
West	0.25	74	8.2
South	0.21	74	5
East	17.05	94	13.1

Table 6-2 Proposed Conditions Sub-basin/Point of Interest Peak Discharge Rates

Sub-basin	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
West	0.52	1.06	1.92
South	0.48	0.98	1.78
East	64.14	99.07	149.77

As shown above in Table 6-2 the East Sub-basin will require attenuation measures to meet allowable peak discharge rates as shown in Table 5-3. The South Sub-basin is a minor peripheral area that will continue to free release sheet flow to the Colbern Road enclosed storm sewer system. The proposed runoff is less than half of the existing condition for all storm events. A formal waiver will be requested for the South Sub-basin once the final report has been accepted. The West and South Sub-basins will not be improved and are minor peripheral areas that will not be discussed any further in this report.

6.1 RETENTION

The existing pond located in the northeast corner of the property will be modified to allow attenuation of the proposed increase in storm water runoff from the proposed Development. Following are a list of preliminary design parameters for the retention system.

Designation: East Retention Basin

Type: Earthen Basin

Side Slopes: 5:1 TBD

Bottom Slope: N/A

Basin Bottom Elevation: TBD

Basin Top Berm Elevation: 950.00 (Verify)

Basin Volume: TBD

Pond Surface Area: 5.20 acres @ 947.00 (Verify)

Outlet Pipe: 24" HDPE, FL (In) = 945.00, FL (Out) = 944.00, L=70', S=1.43%

Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=948.00, Crest Length=500.00'

Consecutive 100-YR Q=149.77 cfs Emergency Spillway HGL=948.24, Freeboard=1.76'

The Retention Basin Plan is located in Exhibit G. See Table 6-4 for a summary of retention basin data.

Table 6-4 Proposed Conditions Detention Basin Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin C1						
2-Year	64.14	721	1.89	883	945.57	121,729
10-Year	99.07	721	4.15	817	945.87	186,193
100-Year	149.77	721	8.33	785	946.29	279,329

As shown in the table above all proposed peak flowrates have been attenuated. See Table 6-5 below for a summary of proposed peak discharge rates at the East POI. Hydrographs tributary to each point of interest have been combined to determine subsequent peak discharge rates.

Table 6-5 Proposed Conditions Post Detention Point of Interest Peak Discharge Rates

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
East	1.89	4.15	8.33

As can be seen in the above table all peak discharge rates attributable to the Development have been attenuated below allowable release rates outlined in Table 5-3.

Table 6-6 below provides a comparison of runoff data between Proposed, Existing and Allowable Release Rates at each Point of Interest.

Table 6-6 Point of Interest Peak Discharge Comparison

POI	Condition	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
East	Proposed	1.89	4.15	8.33
	Existing	27.49	56.82	104.05
	Difference	-26.6	-52.67	-95.72
	Allowable	7.37	29.46	44.19
	Difference	-5.48	-25.31	-35.86

Peak discharge rates at the East POI will be reduced below allowable for all design storms analyzed.

7. 40 HOUR EXTENDED DETENTION/INFILTRATION BMP

In addition to mitigation of peak flow rates, APWA Section 5608.4 also requires 40 hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). The proposed detention facility will release the water quality event over a period of 40-72 hours. In the hydrograph report the 1-year storm event has been assigned the water quality rainfall runoff value of 1.37 inches. The 1-year hydrograph for the East Sub-basin will drain within 40-72 hours as proposed.

8. CONCLUSIONS & RECOMMENDATIONS

This macro storm water drainage study reveals that the proposed development will not generate any negative downstream hydraulic impacts. The existing pond will be modified to provide required attenuation of the East Sub-basin as outlined in the body of this report. As more information is received about the existing pond through field survey and visit options like a principal spillway will be investigated in lieu of an outlet pipe.

In conclusion, proposed peak discharge rates for each point of interest are below allowable release rates for all regulatory design storms with the exception of the South Sub-basin. A formal waiver will be requested after the acceptance of the proposed project. The study is in conformance with all applicable City of Lee's Summit standards and criteria therefore Engineering Solutions recommends approval of this macro storm water drainage study.