

MACRO STORM WATER DRAINAGE STUDY

WOODLAND OAKS
SW Corner Colbern & Blackwell

Site Acreage: 20.81 Acres

Lee's Summit, MO

PREPARED BY:



Submittal Date: March 3, 2020

Revision

Date	Comment	By
3-24-20	Revised Per City Comments	AEP
4-6-20	Revised Per City Comments Dated 3-31-20	AEP
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TABLE OF CONTENTS

- 1. REPORT COVER SHEET**
- 2. TABLE OF CONTENTS**
- 3. GENERAL INFORMATION**
 - 3.1 FEMA FLOODPLAIN DETERMINATION**
 - 3.2 NRCS SOIL CLASSIFICATION**
- 4. METHODOLOGY**
- 5. EXISTING CONDITIONS ANALYSIS**
- 6. PROPOSED CONDITIONS ANALYSIS**
 - 6.1 DETENTION**
- 7. 40 HOUR EXTENDED DETENTION**
- 8. CONCLUSIONS & RECOMMENDATIONS**
- 9. EXHIBITS**

3. GENERAL INFORMATION

This storm study has been prepared to evaluate potential impacts of the proposed single family residential subdivision, Woodland Oaks. The proposed development shall consist of 42 single family residential lots. The site is located at the southwest corner of Colbern Road and Blackwell Road. The site contains 20.81 acres. The existing site consists mainly of grass meadow with some wooded areas. There are currently no water bodies nor storm sewer systems on site. The property is bound by Colbern Road to the north, Blackwell Road to the east, Woodland Shores single family residential subdivision to the south and a large acre single family tract to the west. Woodland Oaks is tributary to Lake Jacomo which is located to the northwest just across Colbern Road. The site is a tract of land located in SE ¼ of Section 27, Township 48 North, and Range 31 West. See Exhibit A for an aerial view of the site along with the surrounding area.

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, effective January 20, 2017.

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

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 20, September 16, 2019. The existing site contains six major soil types:

10117	Sampsel Silty Clay Loam, 5 to 9 Percent Slopes Hydrologic Soils Group (HSG): Type C/D
10122	Sharpsburg Silt Loam, 5 to 9 Percent Slopes (HSG): Type C
10128	Sharpsburg-Urban Land Complex, 2 to 5 Percent Slopes (HSG): Type D
10141	Snead-Rock Outcrop Complex, 14 to 30 Percent Slopes (HSG): Type D
10179	Udarents-Urban Land Osaka-Complex, 5 to 9 Percent Slopes (HSG): Type D
60025	Urban Land Harvester-Complex, 2 to 9 Percent Slopes (HSG): Type C

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

4. METHODOLOGY

This Macro Storm Drainage Study has been prepared to evaluate potential hydrologic impacts from the proposed development and recommend improvements to eliminate potential negative impacts. The study utilized existing city contours to create the Pre-Development 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.

Using the above criteria, the proposed site was evaluated using SCS Methods to calculate storm runoff volumes, peak rates of discharge, pre and post developed hydrographs and required storage volumes for detention facilities. The analysis contains results for the 2, 10 and 100-year design storms.

5. EXISTING CONDITIONS ANALYSIS

The site has five (5) drainage subareas all consisting of meadow/wooded land that drain offsite along with two (2) offsite drainage subareas that drain through the site from Woodland Shores. Following are brief descriptions of each drainage subarea.

- Subarea A, 1.36 acres, consists primarily of Colbern Road right-of-way. The subarea drains to the Northwest along Colbern Road where it is collected by a curb inlet on Colbern. Subarea A will be evaluated at the curb inlet on Colbern, Point of Interest A
- Subarea B, 0.75 acres, is located along the north edge of the property and consists primarily of Colbern Road right-of-way. The subarea drains via sheet and gutter flow to a sump curb inlet for further conveyance north to Lake Jacomo.
- Subarea C, 1.10 acres, is located along the eastern edge of the property and consists primarily of Colbern and Blackwell Road right-of-way's. Runoff drains to the northeast where it is collected by an enclosed storm sewer system located at the intersection of Colbern and Blackwell Roads. Subarea C will be evaluated at the offsite curb inlet located on Colbern Road, Point of Interest C.
- Subarea D, 9.34 acres, is generally located on the west side of the property and drains to the west via sheet and shallow concentrated flow. Runoff is collected by two ponds on the neighbor's property. Excess flow from the downstream pond is conveyed to the north via a culvert under Colbern Road for eventual conveyance to Lake Jacomo. Subarea D will be evaluated at the west property line, Point of Interest D.
- Subarea E, 8.26 acres, is generally located on the east side of the property and drains to the north via sheet and shallow concentrated flow. Runoff is collected and conveyed by a culvert connected to an enclosed storm sewer system running along Colbern Road. Subarea E will be evaluated at the culvert entrance, Point of Interest, E.
- Offsite Undetained, 3.90 acres, is located adjacent to the southwest corner of the property and drains through the southwest corner of the property, Subarea D, via sheet and shallow concentrated flow. The subarea was evaluated at the south property line.
- Offsite Detained, 14.21 acres, is located adjacent to Subarea D just east of the Offsite Undetained Subarea. Runoff from this subarea is detained in an earthen reservoir where it is attenuated then released via a culvert to the southwest corner of Woodland Oaks. Both offsite subareas will be conveyed via a bypass channel around the proposed southwest detention basin, Basin D1. Woodland Shores 3rd Plat Offsite Detained Subarea data has been modeled in Hydraflow to determine peak discharge rates. Offsite Detained and Offsite Undetained Subarea data has been combined in Hydraflow as Offsite Bypass, to size the bypass channel. Storm sewer data from Woodland Shores 3rd Plat may be found in Exhibit D along with capacity calculations for the proposed bypass channel. Woodland Shores 3rd Plat detention system structures and piping have been field verified and shot. Elevations and data are in-line with recorded as-built information. Attenuation from offsite detention was not accounted for in the sizing of the bypass channel.

An Existing Drainage Map may be found in Exhibit E. Hydraflow Hydrograph software was utilized to calculate SCS Method peak discharge rates. A complete breakdown of Existing and Proposed hydrographs may be found in Exhibit F. The following tables summarize the results of the Existing Conditions analysis.

Table 5.1 Existing Conditions Subarea

Subarea	Area (ac.)	Curve Number	Tc (min)
A	1.36	82	9.5

B	0.75	82	7.5
C	1.10	82	6.0
D	9.34	74	11.6
E	8.26	74	11.6
Offsite Undetained	3.90	82	8.6
Offsite Detained	14.21	82	14.5

Table 5.2 Existing Conditions Runoff Data: Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	3.89	7.01	11.71
B	2.24	4.02	6.70
C	3.63	6.49	10.80
D	17.43	36.03	65.98
E	15.42	31.86	58.35
Ex B Combined	17.43	35.62	64.55
Offsite Bypass*	11.15	20.11	33.57

Ex B Combined = (B + E)

*The Offsite Bypass Subarea shows results for the Woodland Shores hydrograph detailed in the Hydraflow Report in Exhibit F representing the combination of Offsite Undetained and Offsite Detained Subareas. Attenuation of offsite runoff was not accounted for in an effort to be conservative in the sizing of the bypass channel. The “Ex B Combined” hydrograph will be used in Section 6.0 for comparative analysis.

Per APWA Section 5608.4 and City of Lee's Summit criteria, the performance criteria for detention is to provide detention to limit peak flow rates at downstream points of interest to maximum release rates:

- 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

Due to the nature of the drainage areas onsite and the surrounding infrastructure the onsite subarea limits were tied to the property boundaries.

Table 5.3 Existing Conditions APWA Allowable Peak Discharge Release Rates

Subarea	Onsite Area (ac.)	Offsite Area (ac.)	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	1.36	N/A	0.68	2.72	4.08
B	0.75	N/A	0.38	1.50	2.25
C	1.10	N/A	0.55	2.20	3.30
D	9.34	N/A	4.67	18.68	28.02
E	8.26	N/A	4.13	16.52	24.78

Subareas A, B and C are peripheral (free release) areas on the site consisting mainly of existing right-of-way. These areas are not being negatively impacted by the proposed improvements. Subareas D and E contain the majority of the area onsite along with the actual hard infrastructure improvements. Subareas D and E will be the focus of this report.

6. PROPOSED CONDITIONS ANALYSIS

The difference between Existing and Proposed Conditions is a direct result of the new single family residential development. Subareas A and C have been reduced significantly due to redirection of their tributary areas with proposed grading. Subarea B has increased slightly due to the creation of a detention basin to detain runoff from Subarea E. The additional land area will be turf lined and consist of the backside of the earthen dam. New detention systems shall be used to attenuate post development runoff from Subareas D1 and E. Subarea D shall continue to drain to the westerly neighbor via sheet and shallow concentrated flow. A Proposed Drainage Map may be found in Exhibit G.

Proposed Flow Rates

The proposed flow rates were calculated with the use of composite curve numbers as applicable. Subareas D, D1 and E utilize composite curve numbers due to the amount of turf area associated with proposed detention in each area. The curve numbers were determined based on APWA Table 5602-3 for residential lots. A curve of 82 was used for single family areas and a curve number of 74 was used for turf areas.

Table 6.1 Proposed Conditions Subarea Data

Subarea	Area (ac.)	Composite CN	Tc (min)
A	1.03	82	6.8
B	0.89	82	7.4
C	0.55	82	8.7
D	1.34	79	9.7
D1	6.00	82	9.6
E	11.00	81	11.8

Table 6.2 Proposed Conditions Runoff Data: Sub-Area Peak Discharge Rates

Subarea	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
A	3.07	5.52	9.20
B	2.65	4.77	7.95
C	1.57	2.84	4.73
D	3.37	6.36	10.96
D1	17.16	30.94	51.64
E	27.74	50.20	83.98

As shown in Table 6.2 above Subareas D and E will require detention to attenuate storm runoff at or below regulatory levels. Subarea B has increased slightly due to the geometry of the detention basin configuration however Subareas E and B are tributary to the same enclosed storm sewer system crossing Colbern. Peak discharge rates from these combined subareas will be below Allowable Release Rates as detailed in Table 5.3. Existing Subarea D has been divided into subareas D and D1. Subarea D will continue to free release to the west while subarea D1 will be captured and routed through the new southwest detention basin for attenuation.

6.1. DETENTION

A new single stage earthen detention basin E is being proposed in Sub-basin E to attenuate proposed peak discharge rates. Following are a list of design parameters for the detention system.

Designation: Detention Basin E

Type: Earthen Basin

Side Slopes: 3:1 Max.

Bottom Slope: 2% Min., Turf Lined

Basin Bottom Elevation: 934.6 @ Inlet Pipe

Basin Top Berm Elevation: 944.00

Basin Volume: 200,503 cf @ 944.00

Control Structure: 5'x5' Precast Concrete Box with Interior 6" Baffle/Weir Wall

Baffle Wall Orifices: (8) 1" Diameter on 4" Centers, FL=934.00 (Bottom Orifice)

(1) 15" Diameter, FL=937.50

Baffle Wall Crest Elevation: 942

Control Structure Top Elevation: 944.00

Control Structure Overflow Weir Openings: N/A – NO Field Inlet Openings

Control Structure Inlet Pipe: 30" HDPE, FL (In) = 934.60, FL (Out) = 934.20, L=51', S= 0.78%

Control Structure Effluent Pipe: 36" RCP, FL (In) = 932.78, FL (Out) = 924.42, L=47', S=17.64%

Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=942.00, Crest Length=160'

Consecutive 100-YR Q=83.98 cfs, Emergency Spillway HGL=942.34', Freeboard=1.66'

The Detention Basin Plan for the Development may be found in Exhibit H. Basin E emergency spillway calculations may be found in Exhibit I. See Table 6.3 for a summary of detention basin data.

Table 6.3 Proposed Conditions Detention Basin E Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin E						
2-Year	27.74	721	3.03	754	938.30	35,284
10-Year	50.20	721	7.99	738	939.66	63,060
100-Year	83.98	721	11.86	741	941.49	111,524

As shown in the table above all proposed peak discharge rates have been attenuated below both Existing and Allowable. See Table 6.4 below for a summary of proposed peak discharge rates at point of interest B which consists of combined subareas B and post detained E.

Table 6.4 Proposed Conditions Post Detention Point of Interest Peak Discharge Rates

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
B	3.26	8.99	16.53

As shown in the above table all peak discharge rates attributable to Proposed Subareas B & E have been attenuated below both Existing and Allowable Peak Discharge rates as outlined in Tables 5.2 and 5.3, respectively.

A new single stage earthen detention basin D1 is being proposed in Sub-basin D1 to attenuate proposed peak discharge rates. As discussed previously the goal shall be to attenuate post development peak discharge rates at or below pre development rates. Following are a list of design parameters for the proposed detention system.

Designation: Detention Basin D1

Type: Earthen Basin

Side Slopes: 3:1 Max.

Bottom Slope: 2% Min., Turf Lined

Basin Bottom Elevation: 908.40 @ Influent Pipe

Basin Top Berm Elevation: 918.00

Basin Volume: 114,055 cf @ 918.00

Control Structure: 5'x4' Precast Concrete Box with Interior 6" Baffle/Weir Wall

Baffle Wall Orifices: (6) 1" Diameter on 4" Centers, FL=908.20 (Bottom Orifice)
(1) 12" Diameter, FL=913.00

Baffle Wall Crest Elevation: N/A

Control Structure Top Elevation: 916.10

Control Structure Overflow Weir Openings: None

Control Structure Influent Pipe: 24" HDPE, FL (In) = 908.40, FL (Out) = 908.30, L=25.47', S= 0.39%

Control Structure Effluent Pipe: 24" HDPE, FL (In) = 908.10, FL (Out) = 908.00, L=25.47', S= 0.39%

Emergency Spillway: Earthen Broad Crested Weir, Crest Elevation=916.10, Crest Length=128'

Consecutive 100-YR Q=51.64 cfs, Emergency Spillway HGL=916.39, Freeboard=1.61'

Basin D1 emergency spillway calculations may also be found in Exhibit I. See Table 6.5 for a summary of detention basin data.

Table 6.5 Proposed Conditions Detention Basin D1 Data

	Peak Q In (cfs)	Tp In (min.)	Peak Q Out (cfs)	Tp Out (min)	Peak W.S.E.	Max. Storage Vol. (cf)
Basin D1						
2-Year	17.16	719	0.47	926	912.31	24,502
10-Year	30.94	719	1.35	811	913.89	43,577
100-Year	51.64	719	5.29	747	915.40	66,564

As shown in the table above all proposed peak flowrates have been attenuated below both Existing and Allowable. See Table 6.6 below for a summary of proposed peak discharge rates at point of interest D which consists of combined subareas D and routed Subarea D1.

Table 6.6 Proposed Conditions Post Detention Point of Interest Peak Discharge Rates

Point of Interest	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
D	3.62	6.83	13.59

As shown in the above table all peak discharge rates attributable to Proposed Subareas D and D1 have been attenuated below both Existing and Allowable Peak Discharge Rates as outlined in Table 5.2.

Table 6.7 below provides a comparison of runoff data between Proposed, Existing and Allowable Conditions for the Proposed Development.

Table 6.7 Point of Interest Discharge Comparison

		Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
Point A	Proposed	3.07	5.52	9.20
	Existing	3.89	7.01	11.71
	Difference	-0.82	-1.49	-2.51
	Allowable	0.68	2.72	4.08

	Difference	2.39	2.80	5.12
Combined Point B	Proposed	3.26	8.99	16.53
	Existing	17.43	35.62	64.55
	Difference	-14.17	-26.63	-48.02
	Allowable	4.51	18.02	27.03
	Difference	-1.25	-9.03	-10.50
Point C	Proposed	1.57	2.84	4.73
	Existing	3.63	6.49	10.80
	Difference	-2.06	-3.65	-6.07
	Allowable	0.55	2.20	3.30
	Difference	1.02	0.64	1.00
Combined Point D	Proposed	3.62	6.83	13.59
	Existing	17.43	36.03	65.98
	Difference	-13.81	-29.20	-52.39
	Allowable	4.67	18.68	28.02
	Difference	-1.05	-11.85	-14.43

Point A is a peripheral (free release) area made up primarily of right-of-way. No additional improvements are being proposed in this area. All proposed peak discharge rates will be below existing. Allowable release rates will not be met however the minimal area and associated runoff will not create adverse impacts to existing storm water infrastructure.

Combined Point B is a combination of Subarea B and post detained Subarea E. The runoff from this area utilizes the same storm sewer infrastructure to cross Colbern Road for further conveyance downstream to Lake Jacomo. This Subarea reduces peak discharge rates below both Existing and Allowable for all regulatory design storms.

Point C is a peripheral (free release) area made up primarily of right-of-way. No additional improvements are being proposed in this area. All proposed peak discharge rates will be below existing. Allowable release rates will not be met however the minimal area and associated runoff will not create adverse impacts to existing storm water infrastructure.

Combined Point D is a combination of Subarea D and D1. All subarea runoff will continue to be conveyed to a series of ponds located on the west neighbor. The proposed detention basin D1 will attenuate peak discharge rates below Existing and Allowable for all regulatory design storms.

7. 40 HOUR EXTENDED DETENTION

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 facilities will release the water quality event over a period of 40-72 hours. See Exhibit J for 40 hour extended detention calculations for each basin.

8. CONCLUSIONS & RECOMMENDATIONS

Runoff from the Development will be reduced below existing for all Subareas. A detention basin is being proposed in Subarea D1 to attenuate peak discharge rates. Detention Basin D1 will attenuate all proposed peak discharge rates below both Existing and Allowable. A detention basin will also be provided in Subarea E to attenuate peak discharge rates. Detention Basin E will attenuate all proposed peak discharge rates below both Existing and Allowable. No negative impacts are anticipated downstream of the Development. Subareas A, B, and C are peripheral areas of the Development and contain mainly established right-of-way. No improvements

are being proposed in these areas. Peak discharge rates from Subareas A, B and C will be reduced below Existing for all regulatory design storms. Allowable release rates which are peak discharge rate goals will not be met for the 2-yr storm for each subarea in addition to the 10-yr and 100-yr storms for Subareas A and C. See proposed Waivers for Allowable Peak Discharge Rates below. The study is in conformance with all applicable codes and regulations.

Waiver Requests:

Subarea A: Allowable (2-Yr), (10-Yr) & (100-Yr), Peripheral Area, Mainly Right-of-Way

Subarea B: Allowable (2-Yr), Peripheral Area, Mainly Right-of-Way

Subarea C: Allowable (2-Yr), (10-Yr) & (100-Yr), Peripheral Area, Mainly Right-of-Way

9. EXHIBITS

- **Exhibit A**
 - **Aerial View of Site**
 - **Aerial View of Site & Surrounding Area**
- **Exhibit B**
 - **FEMA FIRMette**
- **Exhibit C**
 - **NRCS Soils Report**
- **Exhibit D**
 - **Woodland Shores 3rd Plat – Storm Sewer Data**
 - **Proposed Bypass Channel Capacity Calculations**
- **Exhibit E**
 - **Existing Drainage Area Map**
- **Exhibit F**
 - **Hydraflow Hydrograph Report**
- **Exhibit G**
 - **Proposed Drainage Area Map**
- **Exhibit H**
 - **Detention Plan**
- **Exhibit I**
 - **Emergency Spillway Calculations**
- **Exhibit J**
 - **40 Hour Extended Detention Calculations**