BwR
DESIGN GROUP

February 3, 2021

City of Del City
3701 Se 15th Street
Del City, OK 73155
ATTN: Tom Leatherbee

RE: 3009 Epperly Drive ~ Site Grading Improvements

This letter has been prepared to address the existing drainage issues for the referenced property. It is our understanding that the existing building has flooded previously due to the ground elevation around the existing structure being too high and offsite runoff draining onto the subject property.

The existing property has been surveyed for the topographic land features, ground elevations and existing storm sewer system. Using the survey information and a site observation visit two drainage basins have been identified. Drainage Basin X-1 drains onto the property then flows to the east and Basin X-2 drains onto the property then flows to the west.

Table 1.0 details the drainage basin peak flow rates determined. These values were calculated using the ODOT Zone II IDF curve equations and the Rational Method.

Basin Name	Area (AC)	C	2 yr (cfs)	5 yr (cfs)	10 yr (cfs)	25 yr (cfs)	50 yr (cfs)	100 yr (cfs)
Existing X-1	0.30	0.92	1.56	1.76	2.01	2.53	2.88	3.20
Existing X-2	0.27	0.80	1.20	1.36	1.55	1.98	2.46	2.84

Table 1.0

Proposed Drainage Conditions
The proposed improvements will include re-grading the area on the east side of the building to have a more uniform slope and provide positive slopes to the east. In addition, the improvement will have two concrete drainage flumes constructed.

Both Flumes #1 and #2 will be a flat bottom, concrete lined, trapezoidal ditch. The depth will be 3", with 1:1 slide slopes and the width will vary between 3'-2" to 3'-8". Each flume has been designed to convey the Q100 storm flow rates. The flumes have been located along the south side of the existing building. It appears the runoff from the adjacent south neighbor may overtop their curb and discharge onto the subject property. The new flumes will aid in directing this south off-site basin runoff as well as the existing buildings roof downspouts.

PO Box 31732
Edmond, OK, 73003
www.bwrdg.com
405-761-5517

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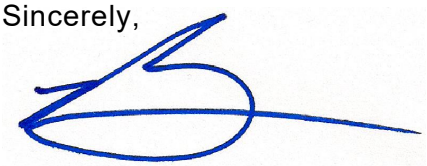
Based on our analysis, assumptions and understanding of the site we believe the proposed drainage flumes will mitigate the existing flooding issues with the subject property.

Sincerely,



Bryan W. Richards, P.E., CFM
BWR DESIGN GROUP, LLC

EXP. 11/30/2022

Supporting Documents Include:

- Rational Method Calculations
- Flow Master Flume Calculations

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ODOT

RATIONAL METHOD

BY BWR
DATE 02-01-2021
SHEET 1 OF 2

Project Location: 3009 Epperly Drive
Drainage Area: Basin X-1 (to south of building - then flows east)
Structure Number: n/a

Zone: 2 **Area:** 0.30 Acres (0.00 Sq. Mi.) **Avg. Slope:** 1.33 % (70.40 ft/mi.)

WEIGHTED RUNOFF COEFFICIENT:

Land Use:	Area (Ac)	% Total Area	C	Lo	K Factor
Woodland	0.00	0.00%	0.10	0.0	0.942
Pasture	0.00	0.00%	0.30	0.0	1.040
Cultivated	0.00	0.00%	0.40	0.0	0.775
Commercial	0.00	0.00%	0.70	0.0	0.445
Residential	0.00	0.00%	0.40	0.0	0.511
Paved	0.28	93.33%	0.95	150.0	0.372
Grassed	0.02	6.67%	0.50	0.0	0.942

Weighted C: 0.92

Weighted K Factor: 0.372

Channel K: [ ] Natural: 0.0102 [Y] Paved: 0.0059

Overland Flow:

Length of Overland Flow, L_o:	150.00	ft
Change in Elevation:	2.00	ft
Overland Average Slope, S_o:	0.0133	ft/ft
Overland K Factor (K):	0.3720	

Overland Time of Concentration, $T_o = K*(L_o^{0.37}) / S_o^{0.20}$ = 5.63 min.

Channel Flow:

Length of Channel Flow, L_f:	0.00	ft
Change in Elevation:	0.00	ft
Channel Average Slope, S_f:	0.0000	ft/ft
Channel K Factor (K'):	0.0059	

Channel Time of Concentration, $T_f = K'*(L_f^{0.77}) / S_f^{0.385}$ = 0.00 min.

NOTE: ODOT Tc AND IDF CURVES USED

Note: Minimum time of concentration is 5 minutes. **Total Time of Concentration:** 5.63 min.

RAINFALL INTENSITY:

$I = a / (T+b)^c$,

	a, Q_2	a, Q_5	a, Q_{10}	a, Q_{25}	a, Q_{50}	a, Q_{100}	b, Q_2	b, Q_5-Q_{100}	c, Q_2	c, Q_5-Q_{100}
Zone 1	52	69	79	91	100	112	10.5	15	0.782	0.7825
Zone 2	56.43	72	82	95	108	120	11.5	15	0.81	0.8
Zone 3	40.85	73	84	97	100	120	7	15	0.772	0.81
Zone 4	51.3	75	88	103	117	129	7.5	15	0.79	0.835
Zone 5	53.38	84	97	114	127	142	10.5	15	0.865	0.882

Intensity, In/hr	
I_2=	5.65
I_5=	6.39
I_{10}=	7.28
I_{25}=	8.43
I_{50}=	9.59
I_{100}=	10.65

PEAK DISCHARGE:

			C		(in/hr		A (Ac)		
Q_2=	1.00	*	0.92	*	5.65	*	0.30	=	1.56 cfs
Q_5=	1.00	*	0.92	*	6.39	*	0.30	=	1.76 cfs
Q_{10}=	1.00	*	0.92	*	7.28	*	0.30	=	2.01 cfs
Q_{25}=	1.10	*	0.92	*	8.43	*	0.30	=	2.53 cfs
Q_{50}=	1.20	*	0.92	*	9.59	*	0.30	=	2.88 cfs
Q_{100}=	1.25	*	0.92	*	10.65	*	0.30	=	3.20 cfs

ODOT

RATIONAL METHOD

BY BWR
DATE 02-01-2021
SHEET 2 OF 2

Project Location: 3009 Epperly Drive
Drainage Area: Basin X-2 (to south of building - then flows west)
Structure Number: n/a

Zone: 2 **Area:** 0.27 Acres (0.00 Sq. Mi.) **Avg. Slope:** 1.21 % (64.00 ft/mi.)

WEIGHTED RUNOFF COEFFICIENT:

Land Use:	Area (Ac)	% Total Area	C	Lo	K Factor
Woodland	0.00	0.00%	0.10	0.0	0.942
Pasture	0.00	0.00%	0.30	0.0	1.040
Cultivated	0.00	0.00%	0.40	0.0	0.775
Commercial	0.00	0.00%	0.70	0.0	0.445
Residential	0.00	0.00%	0.40	0.0	0.511
Paved	0.18	66.67%	0.95	165.0	0.372
Grassed	0.09	33.33%	0.50	0.0	0.942

Weighted C: 0.80

Weighted K Factor: 0.372

Channel K: [ ] Natural: 0.0102
[Y] Paved: 0.0059

Overland Flow:

Length of Overland Flow, L_o:	165.00	ft
Change in Elevation:	2.00	ft
Overland Average Slope, S_o:	0.0121	ft/ft
Overland K Factor (K):	0.3720	

Channel Flow:

Length of Channel Flow, L_f:	0.00	ft
Change in Elevation:	0.00	ft
Channel Average Slope, S_f:	0.0000	ft/ft
Channel K Factor (K'):	0.0059	

Overland Time of Concentration, $T_o = K*(L_o^{0.37}) / S_o^{0.20}$ = 5.95 min.

Channel Time of Concentration, $T_f = K'*(L_f^{0.77}) / S_f^{0.385}$ = 0.00 min.

NOTE: ODOT Tc AND IDF CURVES USED

Note: Minimum time of concentration is 5 minutes. **Total Time of Concentration:** 5.95 min.

RAINFALL INTENSITY:

$I = a / (T+b)^c$,

	a, Q_2	a, Q_5	a, Q_{10}	a, Q_{25}	a, Q_{50}	a, Q_{100}	b, Q_2	b, Q_5-Q_{100}	c, Q_2	c, Q_5-Q_{100}
Zone 1	52	69	79	91	100	112	10.5	15	0.782	0.7825
Zone 2	56.43	72	82	95	108	120	11.5	15	0.81	0.8
Zone 3	40.85	73	84	97	100	120	7	15	0.772	0.81
Zone 4	51.3	75	88	103	117	129	7.5	15	0.79	0.835
Zone 5	53.38	84	97	114	127	142	10.5	15	0.865	0.882

Intensity, In/hr	
I_2=	5.57
I_5=	6.32
I_{10}=	7.19
I_{25}=	8.33
I_{50}=	9.47
I_{100}=	10.53

PEAK DISCHARGE:

			C		(in/hr		A (Ac)		
Q_2=	1.00	*	0.80	*	5.57	*	0.27	=	1.20 cfs
Q_5=	1.00	*	0.80	*	6.32	*	0.27	=	1.36 cfs
Q_{10}=	1.00	*	0.80	*	7.19	*	0.27	=	1.55 cfs
Q_{25}=	1.10	*	0.80	*	8.33	*	0.27	=	1.98 cfs
Q_{50}=	1.20	*	0.80	*	9.47	*	0.27	=	2.46 cfs
Q_{100}=	1.25	*	0.80	*	10.53	*	0.27	=	2.84 cfs

Worksheet for Flume 1

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.882	%
Normal Depth	3.00	in
Left Side Slope	1.00	ft/ft (H:V)
Right Side Slope	1.00	ft/ft (H:V)
Bottom Width	3.16	ft

Results

Discharge	3.34	ft³/s
Flow Area	0.85	ft²
Wetted Perimeter	3.87	ft
Hydraulic Radius	2.65	in
Top Width	3.66	ft
Critical Depth	0.32	ft
Critical Slope	0.00407	ft/ft
Velocity	3.92	ft/s
Velocity Head	0.24	ft
Specific Energy	0.49	ft
Froude Number	1.43	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.00	in
Critical Depth	0.32	ft
Channel Slope	0.882	%

Worksheet for Flume 1

GVF Output Data

Critical Slope	0.00407	ft/ft

Cross Section for Flume 1

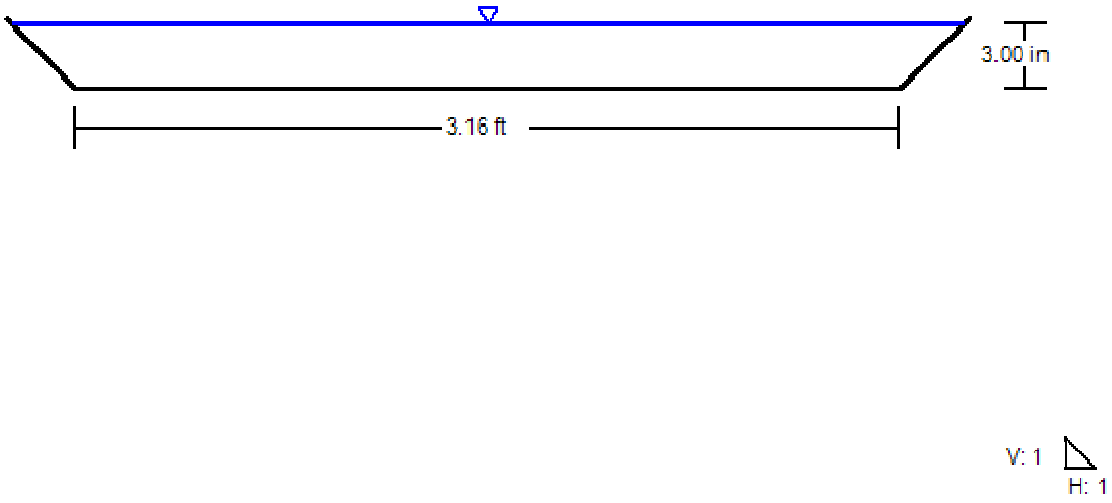
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.882	%
Normal Depth	3.00	in
Left Side Slope	1.00	ft/ft (H:V)
Right Side Slope	1.00	ft/ft (H:V)
Bottom Width	3.16	ft
Discharge	3.34	ft³/s

Cross Section Image



Worksheet for Flume 2

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.730	%
Normal Depth	3.00	in
Left Side Slope	1.00	ft/ft (H:V)
Right Side Slope	1.00	ft/ft (H:V)
Bottom Width	3.00	ft

Results

Discharge	2.88	ft^3/s
Flow Area	0.81	ft^2
Wetted Perimeter	3.71	ft
Hydraulic Radius	2.63	in
Top Width	3.50	ft
Critical Depth	0.30	ft
Critical Slope	0.00415	ft/ft
Velocity	3.55	ft/s
Velocity Head	0.20	ft
Specific Energy	0.45	ft
Froude Number	1.30	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	in
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	in
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.00	in
Critical Depth	0.30	ft
Channel Slope	0.730	%

Worksheet for Flume 2

GVF Output Data

Critical Slope	0.00415	ft/ft

Cross Section for Flume 2

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.730	%
Normal Depth	3.00	in
Left Side Slope	1.00	ft/ft (H:V)
Right Side Slope	1.00	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	2.88	ft³/s

Cross Section Image