Markham Street Jump Start Improvements

Hydrology and Hydraulics Report

METROPLAN
SMART PLANNING MAKES SMART PLACES.

Prepared For:

Metroplan

February 2018

ARDOT Job 080566

GARVER
GarverUSA.com

Hydrology and Hydraulics Report

ARDOT Job No. 080566

MARKHAM ST. JUMP START IMPVTS. (CONWAY) (S)

Faulkner County, Arkansas

Prepared by:

GARVER

831 Parkway, Suite C

Conway, AR 72034

February 2018

Garver Project No.: 16017122

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1.0 Project Introduction

Metroplan is administering a Jump Start Initiative project centered in the Markham Street Neighborhood as a tool for revitalization of the area. The goal of this project is to spark development along Markham Street by providing a functional and attractive corridor for vehicular, pedestrian, and bicycle traffic. An improved Markham Street will serve as a cohesive link between downtown Conway and the campus of Hendrix College.

Garver is providing civil design services along a ½ mile section of Markham Street, beginning at the south at Van Ronkle Street and terminating just north of the intersection with Spruce Street. The existing paved width of 37' will be replaced with two 10' travel lanes, as well as areas of parallel parking. A cycle track and sidewalk will provide dedicated areas for cyclists and pedestrians to reduce potential conflicts between the different modes of transportation. Bioretention planters will be installed adjacent to the curb line to facilitate removal of pollutants from the "first flush", or the initial runoff from a rainstorm which carries the highest concentration of pollutants. Finally, the roadway itself will be reconstructed with a new full-depth pavement section.

2.0 Existing Conditions

The existing typical section of Markham Street through the project area is a 37' concrete pavement width with curb and gutter and asphalt overlay. Numerous driveways connect to the street throughout, with land use varying from mostly commercial on the south end of the project to residential on the north.

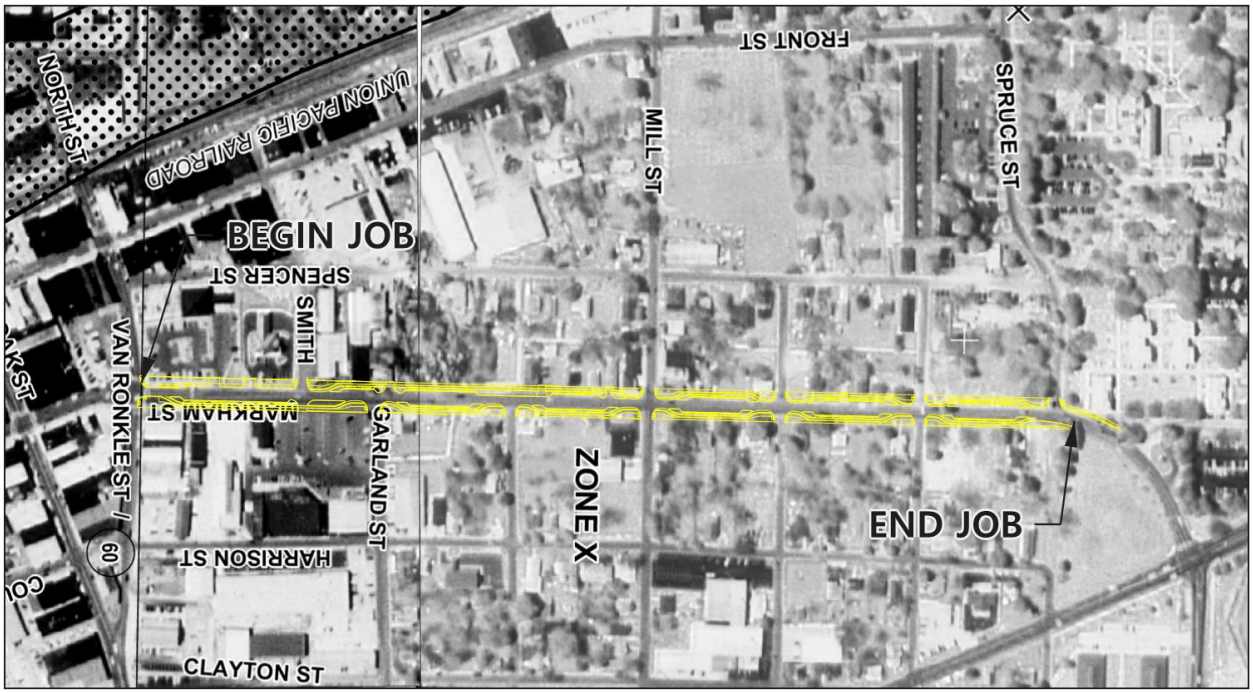
In the project area, the general pattern of drainage is from north to south. Existing drop inlets are typically placed near intersections. Pavement overlays have reduced the effective open area of many of the curb inlet openings. Near the south end of the project, a sag in the roadway profile just south of Smith Street is drained via curb inlets.

The central drainage-way in the vicinity begins as a midblock ditch west of Markham Street on the project's north end. South of Pine Street, it continues as a shallow box culvert. West of the intersection with Willow Street, the shallow box jogs east to run alongside the east side of the Markham Street right-of-way for a half block before crossing under Markham Street and continuing east and south.

Inlets along Markham Street are tied via storm sewer to this shallow box culvert. Due to the lack of depth, storm sewer pipes generally have low amounts of cover. The conditions of existing buried stormwater infrastructure were not investigated for this project.

3.0 Special Flood Hazard Area

There are no Special Flood Hazard Areas (SFHA) within the project limits. See the site below as shown on Flood Insurance Rate Maps 05045C0277H and 05045C0277H, both effective on December 19, 2006.



4.0 Design Criteria

Based on the Project Design Criteria, storm drains on Markham Street shall be designed for the 25-year storm. The hydraulic grade line for the design storm shall be below the lowest structure opening (typically the gutter line) for all drop inlets and manholes. Minimum cover shall be 1' from the top of structure to the bottom of the subgrade.

Pavement spread for the 25-year design storm is limited to ½ the lane width.

5.0 Hydrology

Hydrology is based off of the Arkansas Department of Transportation (ARDOT) *Drainage Manual*, which recommends the rational method for drainage areas under 200 acres. As all drainage areas within the project are well below this threshold, the rational method was used for calculation of flows at all inlets. Runoff coefficients "C" values were taken from Table 3-2. NOAA Atlas 14 rainfall data (Appendix C) was used to determine rainfall intensities. Times of concentration were determined by the kinematic wave equation as presented in the *Drainage Manual*, Section 3-401.2. Minimum times of concentration were 5 minutes for paved surface flow and 10 minutes for areas with significant portions of overland flow, as directed in Section 5-400(e) of the *Drainage Manual*.

6.0 Hydraulics

A computer model of the drainage network was created in Bentley's StormCAD V8i. StormCAD uses Manning's equation to calculate hydraulic and energy grade lines for the pipe network according to the

input flow. In the model, catchments are used to accumulate flow. The flow from catchments is collected by storm drains which are connected by manholes, catch basins, and ditches in the computer model according to the drainage design. For catch basins and curb inlets, StormCAD also calculates gutter flow, spread, and bypass flow. Grate inlets are assumed to be 50% effective to account for clogging. The data from StormCAD is used to size the components in the drainage network to meet the project drainage criteria. As the downstream tailwater conditions were unknown at all connections, the tailwater was approximated at the crown of the pipe.

7.0 Proposed Conditions

Proposed drainage for the Markham Street improvements was designed to maintain existing flow patterns and use existing infrastructure as much as possible. A number of factors contribute to a significant increase in the amount of stormwater structures for this project as compared to the existing system. First, the configuration of the cycle track and parallel parking creates numerous “bump-outs”, which hold water on the downstream end and require a drainage structure at each. Second is the need to avoid existing utilities whenever possible, which necessitated connecting to junction boxes within the pavement area, avoiding the utilities behind the curb. The final factor is the update of the design to meet current standards for a 25-year storm based on current state of practice.

The profile of Markham Street in the proposed condition is lower than the existing pavement. This design encourages positive drainage across the entire right-of-way towards the street, where it can enter the stormwater system, as well as from offsite areas beyond the right-of-way. The need for area drains beyond the proposed curb are eliminated by the proposed profile. One consequence of lowering the profile is the reduction of available cover for the stormwater system, which frequently does not meet the project criteria of 1’ below subgrade. Use of higher class pipe and arch pipes are used throughout the project to ameliorate the low cover conditions.

The storm sewer network in all locations is constrained by the pipe sizes downstream of the connection to the existing system. For reasons of practical economy and debris passage, the size of all proposed pipes were limited to equal to or lesser the existing downstream system size (or arch equivalent). The resulting hydraulic grade lines for approximately one-sixth of the structures were above the lowest structure opening, violating the design criteria. This condition is based upon the sizing and elevations of the downstream system and cannot be rectified within the scope of this project. Complete storm sewer hydraulic information and results are available in Appendix B.

Inlet spread calculations were checked against the design criteria; not all inlets were less than the 25-year spread limits. These inlets fall into three categories:

1. Concentrated offsite runoff flows onto the roadway. Eliminating this violation would require offsite inlets on private property.
2. Side road inlet or significant bypass from side road inlet. Eliminating these violations would require additional inlets along the side roads beyond the project limits.
3. Violation is only marginally over allowable, minimal benefit vs. cost to providing additional inlets.

A summary of all of the inlets, including highlighting of those which do not meet criteria, can be found in Appendix B.

The City of Conway has proposed a future detention pond on the west side of Markham between Garland and Willow Streets. A trunk line with stub is provided for the future outlet of this pond. The trunk line runs along the west side of Markham and continues south beyond Van Ronkle Street to connect to an existing stub line.

8.0 Summary

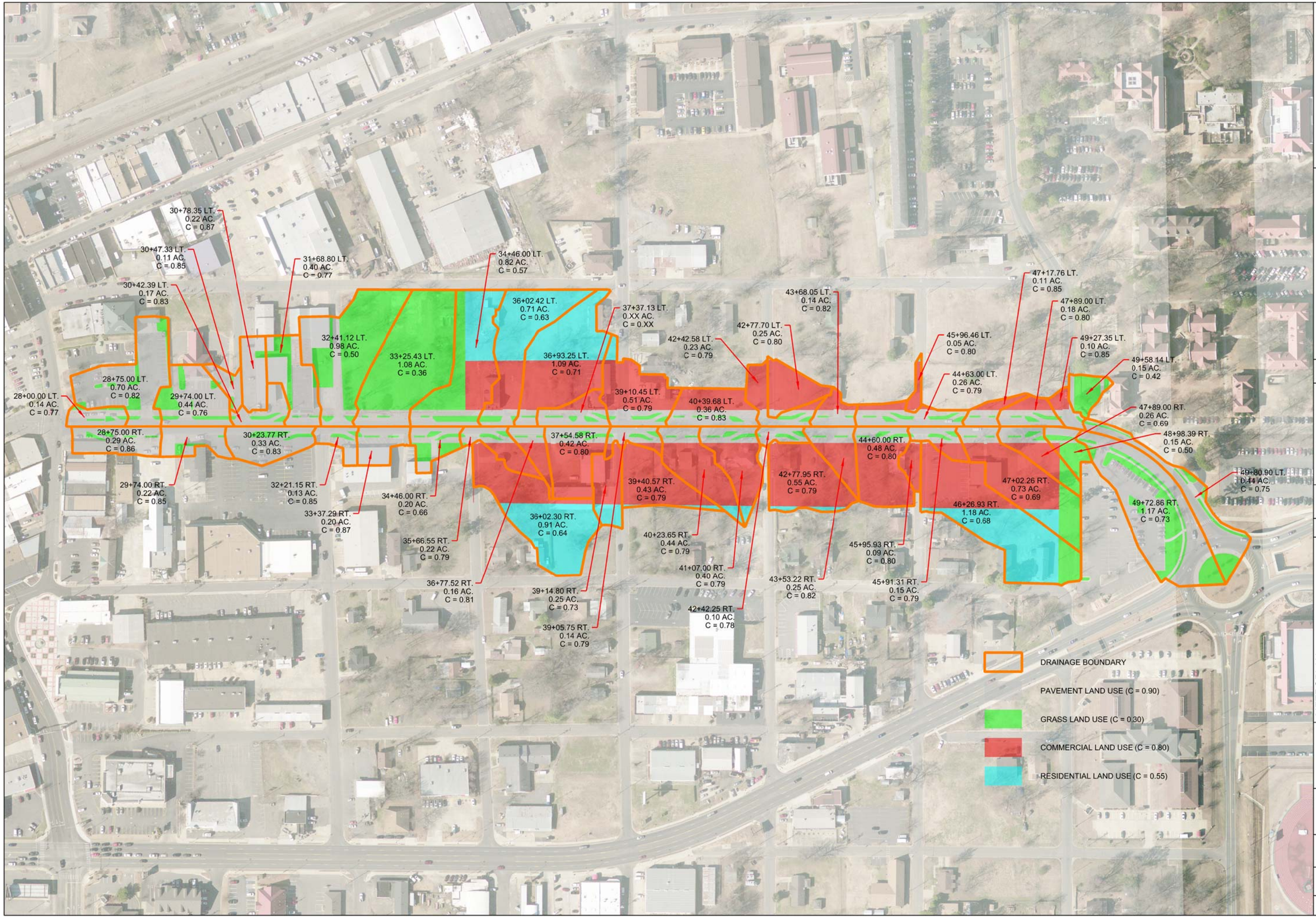
The stormwater system for the Markham Street improvements is significantly constrained by the shallow and undersized existing systems downstream. The proposed system is designed to capture and convey this flow in a reasonable and economical method while working within this framework. The inlet capacities are designed to capture all offsite flow entering the right-of-way; as the corridor develops, the amount of overland flow will likely decrease as the offsite runoff connections will likely be made underground. This will potentially relieve structures currently indicating excess gutter spread.

The storm sewer pipes have been analyzed assuming a developed corridor and reflect that future condition.

Refer to Appendix B for summary sheets for culverts, storm sewers, and inlets. Included in the sheets are flow data and hydraulic results which can be compared to the design criteria.

APPENDIX A

DRAINAGE AREA MAP



PRELIMINARY PLANS
NOT FOR CONSTRUCTION

REV.	DATE	DESCRIPTION	BY

METROPLAN
SMART PLANNING MAKES SMART PLACES.

METROPLAN
LITTLE ROCK, ARKANSAS

MARKHAM ST.
JUMP START IMPVTS.
(CONWAY) (S)

DRAINAGE AREA MAP

JOB NO.: 16017122
DATE: SEPT. 2017
DESIGNED BY: AEW
DRAWN BY: AEW

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRAWING NUMBER
DA-1

SHEET NUMBER 1

APPENDIX B

DRAINAGE STRUCTURE SUMMARIES

a) INLET SUMMARY
b) STORM SEWER SUMMARY

STORM SEWER SUMMARY

Project: Markham Street Drainage Improvments | Client: Metroplan | Location: Conway, Arkansas | Job Number: 16017122 | By: AEW | Date: 2/15/18

FROM	TO	RETURN PERIOD	SYSTEM CA	TIME OF CONCENTRATION	RAINFALL INTENSITY	DISCHARGE (Q)	VELOCITY	DIAMETER	SPAN	RISE	INVERT U/S	INVERT D/S	LENGTH	SLOPE	HYDRAULIC GRADE LINE (HGL) U/S	GUTTER U/S	HGL BELOW GUTTER?
		YEARS	ACRES	MIN	INCHES/HR	CFS	FT/S	INCHES	INCHES	INCHES	FEET	FEET	FEET	%	FEET	FEET	
CB 28+00.00 LT.	MH 28+00.00 LT.	25	0.11	5.0	9.13	0.99	3.80	18			310.84	310.75	7	1.29%	311.21	314.31	YES
CB 28+75.00 LT.	CB 28+75.00 RT.	25	0.46	5.0	9.13	4.21	2.54	18			311.76	311.60	31	0.52%	312.96	314.09	YES
CB 28+75.00 RT.	CB 29+74.00 RT.	25	0.63	5.1	9.07	5.77	3.41	18			311.6	311.32	95	0.29%	312.93	314.06	YES
CB 29+74.00 LT.	CB 29+74.00 RT.	25	0.45	5.0	9.13	4.17	2.47	18			311.48	311.32	31	0.52%	312.72	313.87	YES
CB 29+74.00 RT.	O-1	25	1.73	6.8	8.25	14.40	4.59	24			311.32	310.00	152	0.87%	312.69	313.84	YES
CB 30+21.60 RT.	CB 29+74.00 RT.	25	0.29	6.5	8.38	2.43	1.49		14	22	311.44	311.32	44	0.27%	312.69	313.92	YES
CB 30+42.39 LT.	MH 30+35.15 LT.	25	1.44	11.8	6.24	9.06	2.37		27	44	310.01	309.99	9	0.22%	311.07	314.57	YES
CB 30+47.33 LT.	MH 30+35.15 LT.	25	0.20	5.1	9.06	1.81	4.77	18			310.95	310.80	9	1.67%	311.46	314.97	YES
CB 30+78.35 LT.	CB 30+47.33 LT.	25	0.12	5.0	9.13	1.11	2.12	18			311.1	310.95	27	0.56%	311.49	314.97	YES
CB 31+68.80 LT.	MH 31+68.80 LT.	25	0.35	10.0	6.69	2.36	4.24	18			311.11	311.08	3	1.00%	311.69	314.31	YES
CB 32+21.15 RT.	MH 31+60.00 RT.	25	0.11	5.0	9.13	1.01	0.69		14	22	311.98	311.82	58	0.28%	312.70	314.64	YES
CB 32+41.12 LT.	MH 32+41.12	25	0.45	10.0	6.69	3.01	5.41	18			311.15	311.05	3	3.33%	311.81	314.51	YES
CB 33+25.43 LT.	MH 33+25.43 LT.	25	0.42	10.0	6.69	2.82	1.05		27	44	310.43	310.42	6	0.17%	311.17	314.74	YES
CB 33+37.46 RT.	O-2	25	0.17	5.0	9.13	1.61	0.98		27	44	312.38	312.10	93	0.30%	313.21	314.81	YES
CB 34+46.00 RT.	O-4	25	0.48	5.6	8.85	4.26	2.41	18			312.37	312.25	4	3.00%	313.75	315.11	YES
CB 34+47.00 LT.	O-3	25	0.46	10.0	6.69	3.07	1.74	18			312.37	312.25	4	3.00%	313.75	315.12	YES
CB 35+66.55 RT.	MH 35+05 RT.	25	0.35	5.0	9.13	3.18	2.03	18			312.71	312.54	58	0.29%	313.83	315.61	YES
CB 36+02.42 LT.	O-6	25	2.06	10.3	6.62	13.77	7.79	18			313.13	313.03	21	0.48%	314.89	315.67	YES
CB 36+02.56 RT.	CB 36+02.42 LT.	25	0.40	10.0	6.69	2.72	1.66		14	22	313.35	313.13	55	0.40%	314.89	315.94	YES
CB 36+77.69 RT.	CB 36+93.42 LT.	25	0.15	5.0	9.13	1.35	0.82		14	22	313.47	313.37	35	0.29%	315.81	315.76	NO
CB 36+93.42 LT.	CB 36+02.42 LT.	25	1.23	10.0	6.69	8.31	5.09		14	22	313.37	313.13	87	0.28%	315.81	315.81	NO
CB 37+37.00 LT.	CB 36+93.42 LT.	25	0.46	5.2	9.04	4.15	2.54		14	22	313.48	313.37	40	0.28%	315.82	315.93	YES
CB 37+51.00 RT.	CB 37+37.00 LT.	25	0.32	5.0	9.13	2.95	1.81		14	22	313.57	313.48	32	0.28%	315.83	315.97	YES
CB 39+03.06 RT.	CB 39+07.90 LT.	25	0.29	5.0	9.13	2.63	1.61		14	22	314.34	314.23	36	0.31%	316.61	316.40	NO
CB 39+07.90 LT.	MH 39+40.00 LT.	25	0.69	10.0	6.69	4.63	2.83		14	22	314.23	314.15	28	0.29%	316.60	316.42	NO
CB 39+14.59 RT.	CB 39+40.60 RT.	25	0.17	5.0	9.13	1.57	0.96		14	22	314.44	314.32	21	0.57%	316.60	317.01	YES
CB 39+40.60 RT.	MH 39+40.00 LT.	25	0.35	10.0	6.69	2.35	1.44		14	22	314.32	314.15	55	0.31%	316.60	317.01	YES
CB 40+29.07 RT.	CB 40+44.81 LT.	25	0.38	5.0	9.13	3.48	2.13		14	22	314.68	314.55	33	0.39%	317.10	317.10	NO
CB 40+44.81 LT.	MH 39+40.00 LT.	25	0.96	5.4	8.93	8.63	5.29		14	22	314.55	314.15	101	0.40%	317.20	317.20	NO
CB 41+07.00 RT.	CB 40+44.81 LT.	25	0.28	5.0	9.13	2.58	2.72		14	22	314.88	314.55	66	0.50%	317.41	317.70	YES
CB 42+42.29 RT.	CB 42+46.68 LT.	25	0.20	5.2	9.05	1.86	1.14		14	22	316.48	316.20	55	0.51%	317.39	318.86	YES
CB 42+46.68 LT.	O-8	25	0.39	5.5	8.91	3.48	1.97	18			316.2	315.78	120	0.35%	317.38	318.44	YES
CB 42+46.97 RT.	CB 42+42.29 RT.	25	0.03	5.0	9.13	0.27	0.18		14	22	316.56	316.48	16	0.50%	317.39	319.36	YES
CB 42+77.68 LT.	O-9	25	1.46	10.9	6.45	9.46	5.36	18			316.67	316.13	115	0.47%	318.57	318.51	NO
CB 42+77.97 RT.	CB 42+77.68 LT.	25	0.34	10.0	6.69	2.28	1.40		14	22	316.89	316.67	73	0.30%	318.57	318.95	YES
CB 43+53.39 RT.	MH 43+68.05 LT.	25	0.24	10.0	6.69	1.60	0.98		14	22	317	316.91	30	0.30%	318.62	319.36	YES
CB 43+68.05 LT.	MH 43+68.05 LT.	25	0.19	5.0	9.13	1.71	1.04		14	22	316.93	316.91	4	0.50%	318.62	319.39	YES
CB 44+60.00 LT.	MH 43+68.05 LT.	25	0.49	10.2	6.65	3.31	2.03		14	22	317.17	316.91	88	0.30%	318.63	319.71	YES
CB 44+60.00 RT.	CB 44+60.00 LT.	25	0.36	10.0	6.69	2.40	1.47		14	22	317.26	317.17	29	0.31%	318.64	319.71	YES
CB 45+91.31 RT.	CB 45+96.46 LT.	25	0.99	10.2	6.65	6.66	4.08		14	22	317.96	317.72	52	0.46%	320.38	320.44	YES
CB 45+95.93 RT.	CB 45+91.31 RT.	25	0.59	10.1	6.66	3.95	2.42		14	22	318.07	317.96	13	0.85%	320.38	320.87	YES
CB 45+96.46 LT.	O-10	25	1.04	10.4	6.59	6.88	2.19	24			317.72	317.58	107	0.13%	319.67	320.86	YES
CB 46+26.93 RT.	CB 45+95.93 RT.	25	0.52	10.0	6.69	3.51	2.15		14	22	318.18	318.07	27	0.41%	320.39	320.82	YES
CB 47+02.43 RT.	CB 47+17.92 LT.	25	0.51	10.0	6.69	3.41	2.01		14	22	318.73	318.65	33	0.24%	321.22	321.22	NO
CB 47+17.92 LT.	MH 47+17.92 LT.	25	0.64	10.2	6.64	4.27	2.42	18			318.65	318.60	13	0.38%	321.34	321.34	NO
CB 47+89.00 LT.	MH 47+89.25 LT.	25	0.29	10.7	6.52	1.89	1.07	18			318.84	318.78	13	0.46%	321.49	321.91	YES
CB 47+89.00 RT.	CB 47+89.00 LT.	25	0.18	10.0	6.69	1.23	0.70	18			319	318.84	29	0.55%	321.49	321.91	YES
CB 48+86.85 LT.	MH 48+85.00 LT.	25	0.58	5.3	8.98	5.28	2.99	18			318.85	318.81	9	0.44%	321.53	322.77	YES
CB 48+88.62 RT.	CB 48+86.85 LT.	25	0.42	5.0	9.13	3.91	2.21	18			319.06	318.85	42	0.50%	321.58	322.82	YES
CB 49+58.47 LT.	MH 49+14.03	25	0.82	10.2	6.63	5.48	1.12	30			319.55	319.02	28	1.88%	321.50	324.49	YES
CB 49+72.86 RT.	CB 49+90.00 LT.	25	0.50	10.0	6.69	3.40	2.77	18			320.85	320.60	40	0.63%	321.55	324.30	YES

STORM SEWER SUMMARY

Project: Markham Street Drainage Improvments | Client: Metroplan | Location: Conway, Arkansas | Job Number: 16017122 | By: AEW | Date: 2/15/18

FROM	TO	RETURN PERIOD YEARS	SYSTEM CA ACRES	TIME OF CONCENTRATION MIN	RAINFALL INTENSITY INCHES/HR	DISCHARGE (Q) CFS	VELOCITY FT/S	DIAMETER INCHES	SPAN INCHES	RISE INCHES	INVERT U/S FEET	INVERT D/S FEET	LENGTH FEET	SLOPE %	HYDRAULIC GRADE LINE (HGL) U/S FEET	GUTTER U/S FEET	HGL BELOW GUTTER?
CB 49+90.00 LT.	CB 49+58.47 LT.	25	0.76	10.1	6.65	5.12	2.90	18			320.18	319.55	38	1.66%	321.58	324.59	YES
MH 24+88.00 LT	O-16	25	1.75	14.6	5.55	9.76	1.50		27	44	308.88	306.22	106	2.51%	310.79	313.98	YES
MH 25+70.00 LT.	MH 24+88.00 LT	25	1.75	14.3	5.63	9.90	1.60		27	44	309.32	308.88	88	0.50%	310.83	315.08	YES
MH 28+00.00 LT.	MH 25+70.00 LT.	25	1.75	13.1	5.93	10.43	1.99		27	44	309.66	309.32	228	0.15%	310.94	315.01	YES
MH 29+72.50 LT.	MH 28+00.00 LT.	25	1.64	12.2	6.15	10.16	2.28		27	44	309.91	309.66	169	0.15%	311.03	314.57	YES
MH 30+35.15 LT.	MH 29+72.50 LT.	25	1.64	11.8	6.23	10.29	2.61		27	44	309.99	309.91	57	0.14%	311.07	314.68	YES
MH 31+60.00 RT.	CB 30+21.60 RT.	25	0.11	5.5	8.91	0.98	0.60		27	44	311.82	311.44	134	0.28%	312.70	314.96	YES
MH 31+68.80 LT.	CB 30+42.39 LT.	25	1.22	11.1	6.42	7.85	2.08		27	44	310.2	310.01	123	0.15%	311.14	314.41	YES
MH 32+41.12	MH 31+68.80 LT.	25	0.87	10.7	6.53	5.69	1.70		27	44	310.3	310.20	69	0.14%	311.16	314.61	YES
MH 33+25.43 LT.	MH 32+41.12	25	0.42	10.0	6.68	2.82	0.92		27	44	310.42	310.30	76	0.16%	311.17	314.83	YES
MH 35+05 RT.	CB 34+46.00 RT.	25	0.35	5.3	8.99	3.13	1.84	18			312.54	312.37	55	0.31%	313.78	315.92	YES
MH 39+40.00 LT.	O-7	25	1.99	10.3	6.61	13.28	7.52	18			314.15	314.15	127	0.00%	316.59	316.59	NO
MH 43+68.05 LT.	CB 42+77.68 LT.	25	0.92	10.6	6.53	6.03	3.70		14	22	316.91	316.30	90	0.68%	318.62	319.47	YES
MH 47+17.92 LT.	O-15	25	2.33	11.4	6.34	14.87	2.10	36			318.6	318.44	67	0.24%	321.47	322.12	YES
MH 47+89.25 LT.	MH 47+17.92 LT.	25	1.69	11.0	6.44	10.97	1.58	36			318.65	318.60	67	0.07%	321.48	322.70	YES
MH 48+85.00 LT.	MH 47+89.25 LT.	25	1.40	10.4	6.60	9.33	1.35	36			318.81	318.65	121	0.13%	321.50	323.70	YES
MH 49+14.03	MH 48+85.00 LT.	25	0.82	10.3	6.61	5.46	0.82	36			318.86	318.81	17	0.30%	321.50	324.18	YES

INLET SUMMARY

Project: Markham Street Drainage Improvments Client: Metroplan Location: Conway, Arkansas Job Number: 16017122 By: AEW Date: 2/15/18

LOCATION	RETURN PERIOD	INLET DRAINAGE AREA	INLET C	INLET FLOW TIME	GUTTER FLOW	INTERCEPTED FLOW	BYPASSED FLOW	CAPTURE EFFICIENCY	ELEVATION RIM	ELEVATION GUTTER	ELEVATION INVERT	HEIGHT	SPREAD	ALLOWABLE SPREAD	SPREAD < ALLOWABLE?	SEE NON-COMPLIANCE NOTE #
	YEARS	ACRES		MIN	CFS	CFS	CFS	%	FEET	FEET	FEET	FEET	FEET	FEET		
CB 28+00.00 LT.	25	0.14	0.77	5.0	0.99	0.99	0.00	100.0	314.84	314.31	310.84	4'- 0''	8.30	13.0	YES	
CB 28+75.00 LT.	25	0.70	0.82	5.0	5.30	4.21	1.09	79.5	314.62	314.09	311.76	2'- 10''	15.60	13.0	NO*	1
CB 28+75.00 RT.	25	0.29	0.86	5.0	2.33	1.59	0.74	68.2	314.06	314.06	311.60	2'- 6''	11.50	13.0	YES	
CB 29+74.00 LT.	25	0.44	0.76	5.0	4.17	4.17	0.00	100.0	314.40	313.87	311.48	2'- 11''	12.90	13.0	YES	
CB 29+74.00 RT.	25	0.22	0.85	5.0	3.32	3.32	0.00	100.0	313.84	313.84	311.32	2'- 6''	11.10	13.0	YES	
CB 30+21.60 RT.	25	0.33	0.83	5.0	2.50	1.64	0.86	65.5	313.92	313.92	311.44	2'- 6''	11.70	13.0	YES	
CB 30+42.39 LT.	25	0.17	0.83	5.0	2.07	2.07	0.00	100.0	314.04	314.57	310.01	4'- 0''	11.90	13.0	YES	
CB 30+47.33 LT.	25	0.11	0.85	5.0	0.83	0.71	0.12	86.0	315.50	314.97	310.95	4'- 7''	6.20	6.5	YES	
CB 30+78.35 LT.	25	0.22	0.87	5.0	1.76	1.11	0.65	63.3	315.50	314.97	311.10	4'- 5''	8.20	6.5	NO*	2
CB 31+68.80 LT.	25	0.40	0.77	10.0	2.36	2.36	0.00	100.0	314.85	314.31	311.11	3'- 9''	11.10	13.0	YES	
CB 32+21.15 RT.	25	0.13	0.85	5.0	1.01	1.01	0.00	100.0	315.17	314.64	311.98	3'- 2''	6.30	13.0	YES	
CB 32+41.12 LT.	25	0.98	0.50	10.0	3.29	3.01	0.28	91.4	315.06	314.51	311.15	3'- 11''	12.70	13.0	YES	
CB 33+25.43 LT.	25	1.08	0.36	10.0	2.82	2.82	0.00	100.0	315.32	314.74	310.43	4'- 11''	12.50	13.0	YES	
CB 33+37.46 RT.	25	0.20	0.87	5.0	1.61	1.61	0.00	100.0	314.81	314.81	312.38	2'- 5''	8.60	13.0	YES	
CB 34+46.00 RT.	25	0.20	0.66	5.0	1.21	1.21	0.00	100.0	315.11	315.11	312.37	2'- 9''	9.10	13.0	YES	
CB 34+47.00 LT.	25	0.82	0.57	10.0	3.28	3.07	0.21	93.6	315.12	315.12	312.37	2'- 9''	13.20	13.0	NO*	3
CB 35+66.55 RT.	25	0.22	0.79	5.0	3.18	3.18	0.00	100.0	316.14	315.61	312.71	3'- 5''	13.60	13.0	NO*	3
CB 36+02.42 LT.	25	0.71	0.63	10.0	3.02	2.89	0.14	95.5	316.19	315.67	313.13	3'- 1''	12.80	5.5	NO*	1
CB 36+02.56 RT.	25	0.91	0.64	10.0	3.91	2.72	1.19	69.6	316.47	315.94	313.35	3'- 1''	10.20	5.5	NO*	2
CB 36+77.69 RT.	25	0.16	0.81	5.0	1.35	1.35	0.00	100.0	316.27	315.76	313.47	2'- 10''	7.60	13.0	YES	
CB 36+93.42 LT.	25	0.87	0.68	10.0	4.26	4.26	0.00	100.0	315.81	315.81	313.37	2'- 5''	16.50	13.0	NO*	2
CB 37+37.00 LT.	25	0.21	0.81	5.0	1.59	1.24	0.35	78.0	315.93	315.93	313.48	2'- 5''	9.60	13.0	YES	
CB 37+51.00 RT.	25	0.42	0.80	5.0	3.11	2.95	0.16	94.9	315.97	315.97	313.57	2'- 5''	13.00	13.0	YES	
CB 39+03.06 RT.	25	0.14	0.79	5.0	2.63	2.63	0.00	100.0	316.93	316.40	314.34	2'- 7''	11.90	13.0	YES	
CB 39+07.90 LT.	25	0.51	0.79	10.0	2.70	2.70	0.00	100.0	316.95	316.42	314.23	2'- 9''	12.20	13.0	YES	
CB 39+14.59 RT.	25	0.25	0.73	5.0	1.68	1.57	0.11	93.6	317.25	317.01	314.44	2'- 10''	7.30	5.5	NO*	2
CB 39+40.60 RT.	25	0.43	0.79	10.0	2.31	1.20	1.12	51.8	317.01	317.01	314.32	2'- 8''	8.50	5.5	NO*	2
CB 40+29.07 RT.	25	0.44	0.79	5.0	3.48	3.48	0.00	100.0	317.10	317.10	314.68	2'- 5''	11.40	13.0	YES	
CB 40+44.81 LT.	25	0.36	0.83	5.0	2.77	2.77	0.00	100.0	317.20	317.20	314.55	2'- 8''	12.30	13.0	YES	
CB 41+07.00 RT.	25	0.40	0.79	5.0	2.89	2.58	0.30	89.5	317.70	317.70	314.88	2'- 10''	10.90	13.0	YES	
CB 42+42.29 RT.	25	0.10	0.78	5.0	1.61	1.61	0.00	100.0	319.39	318.86	316.48	2'- 11''	8.60	13.0	YES	
CB 42+46.68 LT.	25	0.23	0.79	5.0	1.70	1.70	0.00	100.0	318.97	318.44	316.20	2'- 9''	8.90	5.5	NO*	
CB 42+46.97 RT.	25	0.04	0.80	5.0	0.27	0.27	0.00	100.0	319.36	319.36	316.56	2'- 10''	3.70	5.5	YES	2
CB 42+77.68 LT.	25	0.25	0.80	5.0	1.87	1.84	0.04	98.1	319.04	318.51	316.67	2'- 4''	9.00	5.5	NO*	2
CB 42+77.97 RT.	25	0.55	0.79	10.0	2.95	2.28	0.67	77.4	319.48	318.95	316.89	2'- 7''	9.10	5.5	NO*	2
CB 43+53.39 RT.	25	0.25	0.82	10.0	1.60	1.60	0.00	100.0	319.36	319.36	317.00	2'- 4''	8.60	13.0	YES	
CB 43+68.05 LT.	25	0.14	0.82	5.0	1.71	1.71	0.00	100.0	319.92	319.39	316.93	2'- 12''	8.90	13.0	YES	
CB 44+60.00 LT.	25	0.26	0.79	5.0	1.91	1.27	0.64	66.4	319.71	319.71	317.17	2'- 6''	9.40	13.0	YES	
CB 44+60.00 RT.	25	0.48	0.80	10.0	2.60	2.40	0.20	92.3	319.71	319.71	317.26	2'- 5''	10.50	13.0	YES	
CB 45+91.31 RT.	25	0.15	0.79	5.0	3.73	3.73	0.00	100.0	320.97	320.44	317.96	3'- 0''	15.10	13.5	NO*	2
CB 45+95.93 RT.	25	0.09	0.80	5.0	0.69	0.63	0.06	91.0	321.39	320.87	318.07	3'- 4''	5.80	5.5	NO*	2
CB 45+96.46 LT.	25	0.05	0.80	5.0	0.38	0.38	0.00	100.0	321.39	320.86	317.72	3'- 8''	3.10	5.5	YES	
CB 46+26.93 RT.	25	1.18	0.68	10.0	5.41	3.51	1.91	64.8	321.35	320.82	318.18	3'- 2''	12.50	13.0	YES	
CB 47+02.43 RT.	25	0.73	0.69	10.0	3.41	3.41	0.00	100.0	321.22	321.22	318.73	2'- 6''	14.20	13.0	NO*	1
CB 47+17.92 LT.	25	0.11	0.85	5.0	1.22	1.22	0.00	100.0	321.34	321.34	318.65	2'- 8''	7.10	13.0	YES	
CB 47+89.00 LT.	25	0.18	0.80	5.0	1.29	0.97	0.32	75.1	321.91	321.91	318.84	3'- 1''	7.70	13.0	YES	
CB 47+89.00 RT.	25	0.26	0.69	10.0	1.23	1.23	0.00	100.0	321.91	321.91	319.00	2'- 11''	7.50	13.5	YES	

INLET SUMMARY

Project: Markham Street Drainage Improvments Client: Metroplan Location: Conway, Arkansas Job Number: 16017122 By: AEW Date: 9/21/17

LOCATION	RETURN PERIOD	INLET DRAINAGE AREA	INLET C	INLET FLOW TIME	GUTTER FLOW	INTERCEPTED FLOW	BYPASSED FLOW	CAPTURE EFFICIENCY	ELEVATION RIM	ELEVATION GUTTER	ELEVATION INVERT	HEIGHT	SPREAD	ALLOWABLE SPREAD	SPREAD < ALLOWABLE?	SEE NON-COMPLIANCE NOTE #
	YEARS	ACRES		MIN	CFS	CFS	CFS	%	FEET	FEET	FEET	FEET	FEET	FEET		
CB 49+27.35 LT.	25	0.10	0.85	5.0	1.46	1.46	0.00	100.0	324.28	323.73	319.28	5'- 0"	11.4	13.0	YES	
CB 49+58.47 LT.	25	0.15	0.42	5.0	0.56	0.52	0.05	91.6	324.97	324.49	319.55	5'- 5"	4.9	13.0	YES	
CB 49+72.86 RT.	25	1.17	0.73	10.0	5.74	3.40	2.34	59.2	324.85	324.30	320.85	4'- 0"	11.9	13.5	YES	
CB 49+80.90 LT.	25	0.44	0.75	5.0	3.05	2.39	0.67	78.1	325.00	324.46	320.50	4'- 6"	9.5	10.5	YES	

NON-COMPLIANCE NOTES

1. Concentrated offsite flow onto roadway. Eliminating this violation would require offsite inlets on private property.
2. Side road inlet. Eliminating this violation would require additional inlets along the side roads beyond the project limits.
3. Violation is only marginally over allowable, minimal benefit vs. cost to providing additional inlets.

APPENDIX C

RUNOFF CALCULATIONS

a) NOAA ATLAS 14 RAINFALL DATA

NOAA Atlas 14, Volume 9, Version 2
Location name: Conway, Arkansas, USA*
Latitude: 35.0965°, Longitude: -92.4399°
Elevation: 321.83 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	5.17 (4.18-6.40)	5.87 (4.74-7.25)	6.98 (5.62-8.64)	7.90 (6.32-9.79)	9.13 (7.12-11.5)	10.1 (7.70-12.8)	11.0 (8.20-14.1)	11.9 (8.59-15.5)	13.2 (9.17-17.4)	14.1 (9.61-18.8)
10-min	3.79 (3.06-4.68)	4.30 (3.47-5.30)	5.11 (4.12-6.32)	5.78 (4.63-7.17)	6.69 (5.21-8.41)	7.38 (5.64-9.34)	8.06 (6.00-10.3)	8.74 (6.29-11.4)	9.63 (6.71-12.7)	10.3 (7.04-13.7)
15-min	3.08 (2.49-3.80)	3.49 (2.82-4.32)	4.16 (3.34-5.14)	4.70 (3.76-5.83)	5.44 (4.23-6.84)	6.00 (4.59-7.60)	6.55 (4.88-8.40)	7.11 (5.12-9.25)	7.83 (5.46-10.3)	8.37 (5.72-11.2)
30-min	2.24 (1.81-2.76)	2.54 (2.05-3.14)	3.03 (2.44-3.75)	3.43 (2.75-4.25)	3.97 (3.08-4.98)	4.37 (3.34-5.53)	4.77 (3.54-6.11)	5.16 (3.71-6.71)	5.67 (3.95-7.48)	6.05 (4.13-8.07)
60-min	1.47 (1.19-1.82)	1.66 (1.34-2.06)	1.97 (1.59-2.44)	2.23 (1.79-2.77)	2.59 (2.02-3.27)	2.88 (2.20-3.65)	3.16 (2.35-4.06)	3.45 (2.48-4.49)	3.83 (2.67-5.07)	4.12 (2.82-5.50)
2-hr	0.914 (0.748-1.12)	1.03 (0.840-1.25)	1.22 (0.991-1.49)	1.38 (1.12-1.69)	1.60 (1.27-2.00)	1.78 (1.38-2.24)	1.97 (1.48-2.51)	2.15 (1.57-2.79)	2.41 (1.70-3.17)	2.61 (1.80-3.46)
3-hr	0.687 (0.566-0.832)	0.768 (0.632-0.930)	0.907 (0.745-1.10)	1.03 (0.840-1.25)	1.21 (0.961-1.50)	1.35 (1.05-1.69)	1.50 (1.14-1.90)	1.65 (1.21-2.13)	1.87 (1.32-2.45)	2.04 (1.41-2.70)
6-hr	0.420 (0.350-0.502)	0.470 (0.391-0.562)	0.557 (0.463-0.668)	0.636 (0.526-0.764)	0.753 (0.609-0.931)	0.850 (0.672-1.06)	0.953 (0.731-1.20)	1.06 (0.786-1.37)	1.22 (0.870-1.59)	1.34 (0.934-1.76)
12-hr	0.253 (0.214-0.298)	0.285 (0.241-0.337)	0.343 (0.289-0.406)	0.395 (0.331-0.468)	0.472 (0.386-0.578)	0.536 (0.429-0.660)	0.604 (0.468-0.756)	0.678 (0.505-0.863)	0.781 (0.562-1.01)	0.864 (0.604-1.13)
24-hr	0.151 (0.129-0.175)	0.172 (0.147-0.201)	0.210 (0.179-0.245)	0.243 (0.206-0.284)	0.292 (0.241-0.353)	0.332 (0.268-0.405)	0.375 (0.293-0.464)	0.421 (0.316-0.531)	0.484 (0.351-0.623)	0.535 (0.377-0.693)
2-day	0.087 (0.076-0.100)	0.100 (0.087-0.115)	0.123 (0.106-0.141)	0.142 (0.122-0.164)	0.171 (0.143-0.204)	0.194 (0.158-0.233)	0.218 (0.172-0.267)	0.244 (0.185-0.305)	0.280 (0.204-0.357)	0.308 (0.219-0.396)
3-day	0.063 (0.055-0.072)	0.072 (0.063-0.082)	0.088 (0.076-0.100)	0.101 (0.087-0.116)	0.121 (0.101-0.143)	0.137 (0.112-0.163)	0.153 (0.122-0.187)	0.171 (0.130-0.213)	0.196 (0.144-0.249)	0.216 (0.154-0.276)
4-day	0.051 (0.045-0.057)	0.057 (0.050-0.065)	0.069 (0.060-0.079)	0.079 (0.069-0.091)	0.094 (0.080-0.111)	0.107 (0.088-0.127)	0.119 (0.095-0.145)	0.133 (0.102-0.165)	0.152 (0.112-0.193)	0.167 (0.119-0.213)
7-day	0.034 (0.030-0.038)	0.038 (0.034-0.042)	0.045 (0.040-0.051)	0.051 (0.045-0.058)	0.061 (0.052-0.071)	0.068 (0.057-0.080)	0.076 (0.061-0.091)	0.084 (0.065-0.103)	0.095 (0.070-0.120)	0.104 (0.075-0.132)
10-day	0.027 (0.024-0.030)	0.030 (0.027-0.033)	0.035 (0.031-0.039)	0.040 (0.035-0.045)	0.046 (0.040-0.054)	0.052 (0.043-0.060)	0.057 (0.046-0.068)	0.063 (0.049-0.077)	0.071 (0.053-0.089)	0.077 (0.056-0.098)
20-day	0.018 (0.016-0.020)	0.020 (0.018-0.022)	0.023 (0.020-0.025)	0.025 (0.022-0.028)	0.028 (0.025-0.032)	0.031 (0.026-0.036)	0.034 (0.028-0.040)	0.037 (0.029-0.045)	0.041 (0.030-0.051)	0.044 (0.032-0.055)
30-day	0.015 (0.013-0.016)	0.016 (0.015-0.017)	0.018 (0.016-0.020)	0.020 (0.018-0.022)	0.022 (0.020-0.025)	0.024 (0.021-0.028)	0.026 (0.022-0.031)	0.028 (0.022-0.034)	0.031 (0.023-0.038)	0.033 (0.024-0.042)
45-day	0.012 (0.011-0.013)	0.013 (0.012-0.014)	0.015 (0.014-0.016)	0.016 (0.015-0.018)	0.018 (0.016-0.021)	0.020 (0.017-0.023)	0.022 (0.018-0.025)	0.023 (0.018-0.028)	0.025 (0.019-0.031)	0.027 (0.019-0.033)
60-day	0.010 (0.009-0.011)	0.011 (0.010-0.012)	0.013 (0.012-0.014)	0.014 (0.013-0.016)	0.016 (0.014-0.018)	0.018 (0.015-0.020)	0.019 (0.016-0.022)	0.021 (0.016-0.024)	0.022 (0.017-0.027)	0.024 (0.017-0.029)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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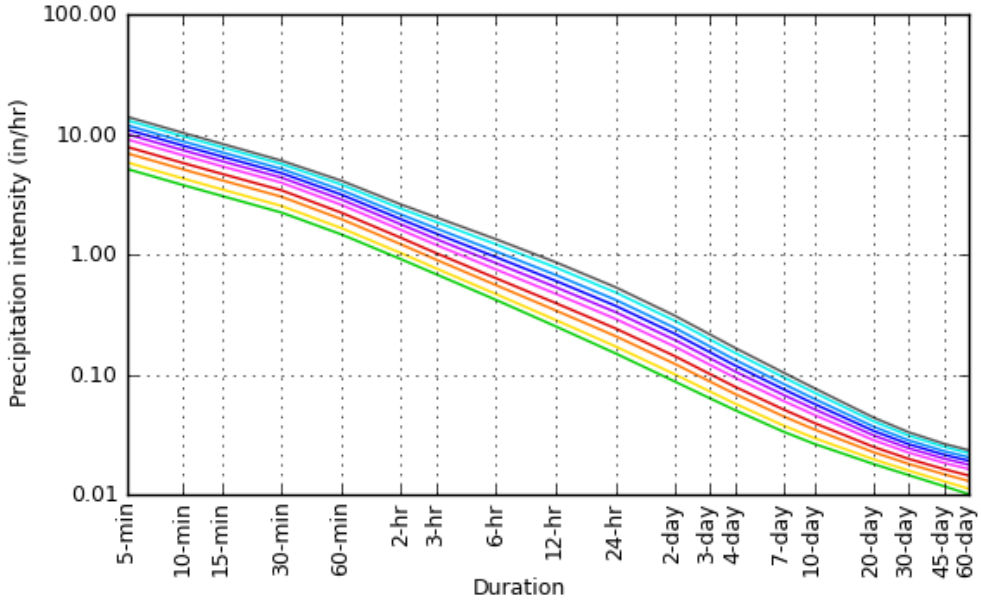
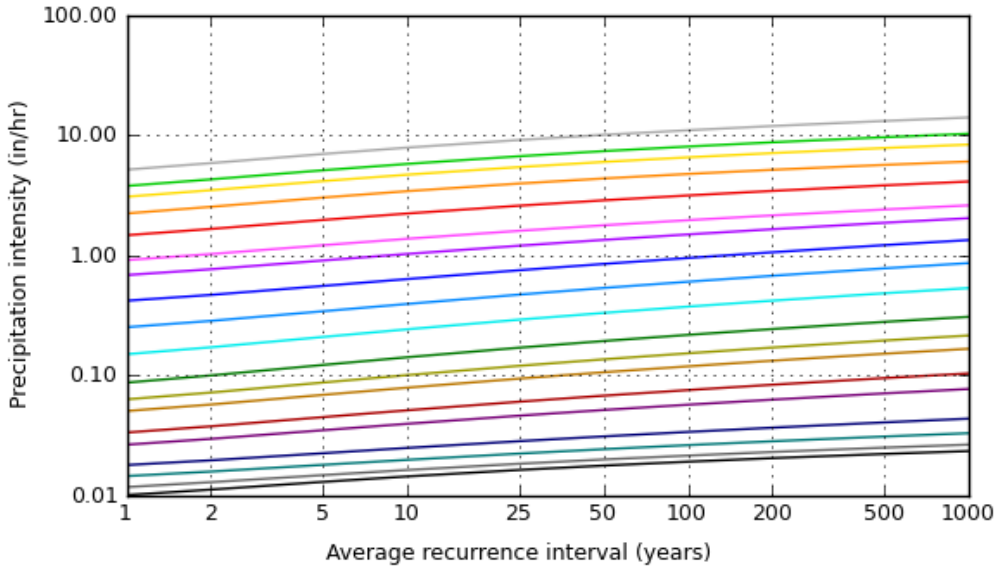
PF graphical

PDS-based intensity-duration-frequency (IDF) curves
Latitude: 35.0965°, Longitude: -92.4399°





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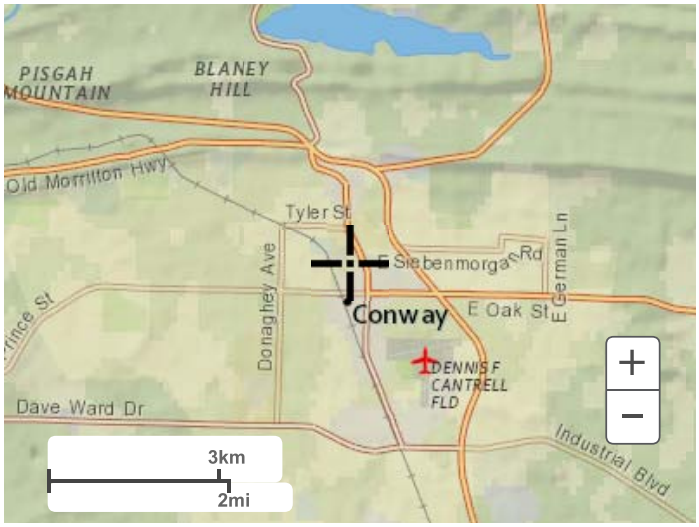
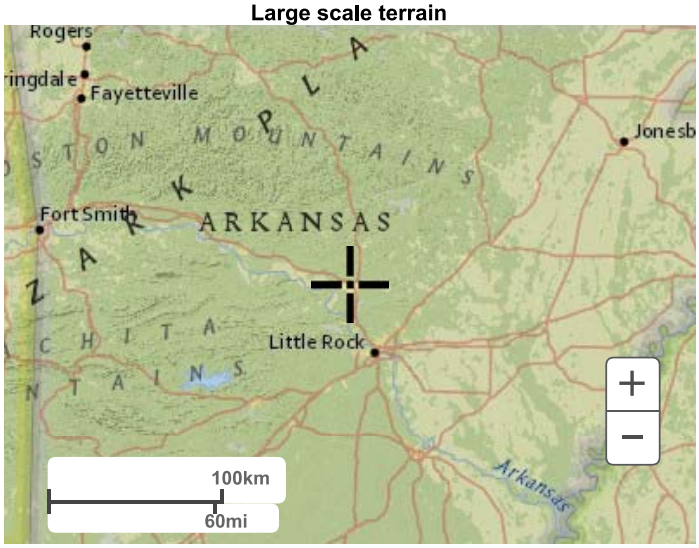
Maps & aerials

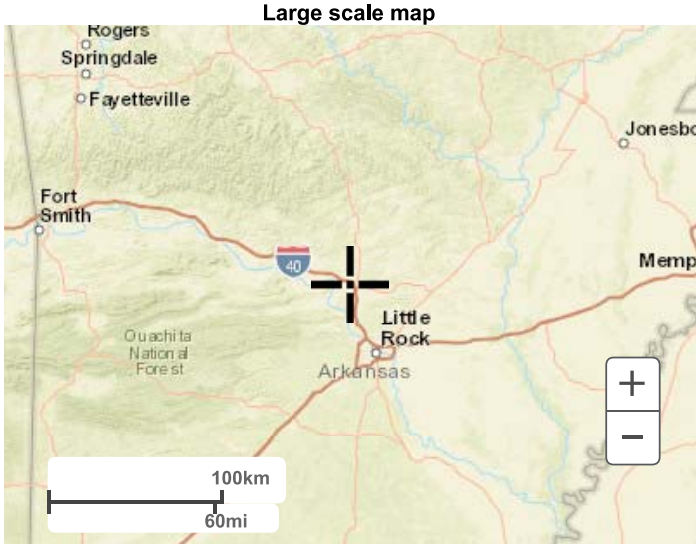
Small scale terrain



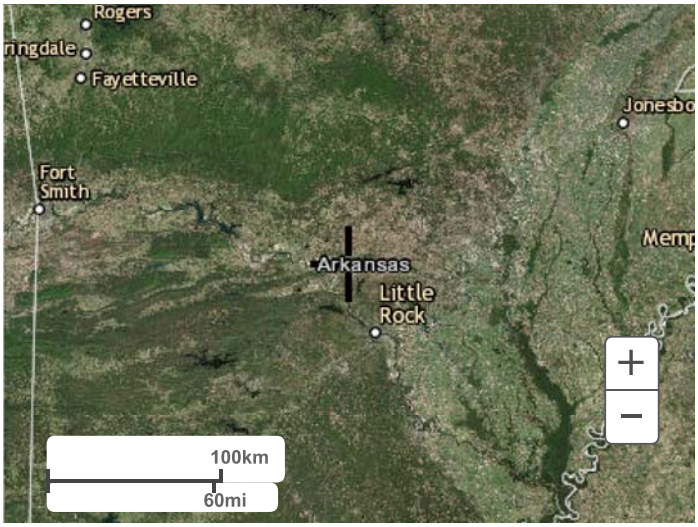
Large scale terrain



Large scale map



Large scale aerial



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