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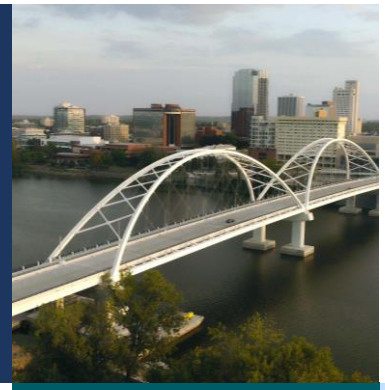


City of LITTLE ROCK

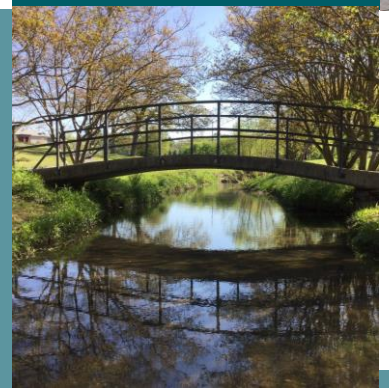
DEPARTMENT OF PLANNING & DEVELOPMENT

The Center at University Park

Little Rock Stormwater Manual Update

City of Little Rock Public Meeting

June 6, 2024



Agenda

PROJECT UPDATE

- Why Update?
- Water Quality Regulations
- Update Process
- Planned Changes
- Revision Impacts

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WHY UPDATE?

This update is designed to improve the stormwater and drainage design manual to more effectively and adequately address future flood risk, new stormwater practices, and state & federal regulations.

The manual is a part of the City's policies and programs to reduce pollutants in compliance with the Municipal Separate Storm Sewer System (MS4) permit issued by ADEQ.

TO REDUCE FLOOD RISK

Require use of the latest technology, methodologies, and data in conjunction with higher design standards.

TO IMPROVE WATER QUALITY

Encourage use of low impact development (LID) and green infrastructure.

TO PROTECT STREAMS

Provide additional resources on use of stormwater best management practices (BMPs)

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WATER QUALITY REGULATIONS

1 Federal

Clean Water Act – Sec. 402(p)(3)(b)
Permits for discharges from municipal storm sewers -
(iii) shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants.

2 State

ADEQ General Permit ARR150000
Part II Section A.4.L
Post-Construction Stormwater Management
A goal of at least **80%** removal of total suspended solids from these flows which exceed predevelopment levels should be used in designing and installing stormwater management controls (where practicable). Where this goal is not met, the operator shall provide justification for rejecting each practice listed above.

3 Local

ADEQ MS4 Permit ARS000002 Part 6.2.2
Areas of New Development
Each co-permittee shall utilize a comprehensive master planning process to develop, implement, and enforce controls that will reduce, to the maximum extent practicable, the discharge of pollutants from areas of new development and significant redevelopment after construction is completed.

SWMM UPDATE PROCESS

1

- Review manual & ordinances
- Benchmark against peer cities
- Identify gaps

2

- Gather stakeholder input
- Determine community priorities

3

- Draft updated manual
- Recommend ordinance revisions

4

- Present to Mayor & Directors
- Adopt new manual & ordinances

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City of LITTLE ROCK

Step 1

REVIEW AND BENCHMARKING

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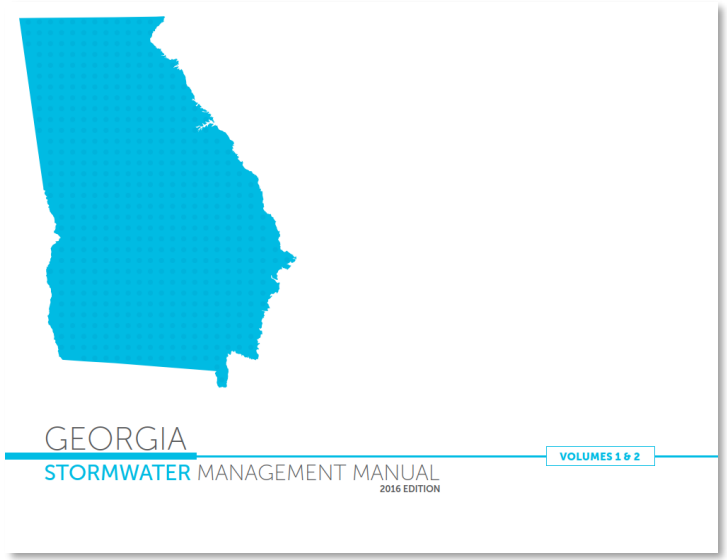
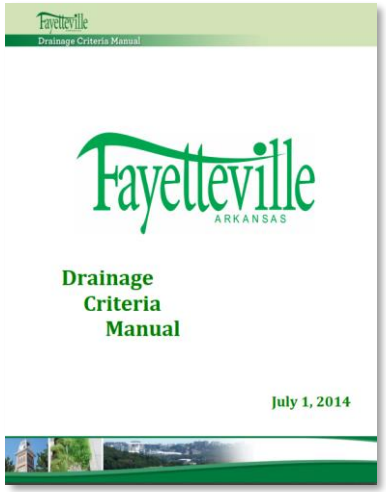
BENCHMARKING

- Municipalities
  - City of Fayetteville
  - City of Memphis
  - City of Springfield, MO
  - City of Rogers
  - City of Tulsa

- State Agencies
  - ARDOT*
  - Georgia Stormwater Manual

*No longer considered a current reference





BENCHMARKING

- Developed a matrix of 38 different criteria for basis of comparison
- Held discussions with city staff from Fayetteville and Memphis

Little Rock Drainage Manual Update - Benchmarking					
		Little Rock Drainage Manual	Fayetteville Drainage Manual	Georgia Stormwater Manual	Memphis Stormwater Management Manual
	II. Determination of Storm Runoff				
2.1	• Rainfall	Hydro 35 & TP 40 IDF Curves 24 hr 10yr - 6.1" , 25yr - 7.0", 50yr - 7.8", 100yr - 8.5"	Hydro-35 & TP-40 IDF Curves 24 hr 10yr - 5.3", 25yr - 6.3", 50yr - 7.1", 100yr - 7.9"	refers to Atlas 14	Atlas 14 IDF Curves DDF Curves
2.2	• Methodology – SCS, Rational	< 200 acres - Rational Method 200 to 2000 acres - SCS TR55 > 2000 acres - HEC I	SCS TR55 up to 2000 acres Rational Method 0 to 40 acres, do not use for detention	Rational Method SCS TR55 for drainage up to 2000 acres. Simplified NRCS TR55	NRCS TR55 Rational Method Unit hydrograph theory
2.3	• Parameters – CN, TC, etc.	C-Values - Table based on storm event RCN - table based on city zones TC - nomograph	NRCS Soil Survey Data (USDA, SSURGO) RCN - table based on cover type Manning's n for sheet flow see table 3.3 C Values can be found in Table 3.5 min. TC 5 minutes Manning's n see table 3.4	NRCS Soil Survey Table 3.1.5-1 for RCN C Values can be found 3.1.4-2	C-values Table 2-4 Soil Classification Table 2-6 CN values Table 2-7, 2-8, 2-9
2.4	• Software	HEC I/ HEC II	HEC-HMS See Appendix H	Not specified only mention some software HEC-HMS HYB	See section 2.7.4 HEC-HMS, WinTR-55, EPA-SWMM
	III. Storm Drains and Drainage Appurtenances				
3.1	• Design Storms – bridges/culverts, roadways	Bridges and culverts: 100yr roadways crossing floodplains 50yr for arterial, 25yr for minor arterials and collectors, 10yr all other streets	100-yr for major drainage system 10-yr for minor drainage system	Roadways use 25-yr to 100-yr Storm drainge systems 10-yr to 50-yr depending on the system. See section 5.1.3	10-yr for storm sewers 50yr for cross drain
3.2	• Design velocities/slopes	min. pipe velocity 2.5 fps min slope 0.4% channels 1.5 to 5.0 fps	min slope 0.5% min velocity 2.5 ft/s	min velocity 2.5 ft/s max slope 5% min slope 1% for grass swales 0.5% min slope for armored pilot channel	max velocity 20 ft/s min velocity 2.5 ft/s
3.3	• Roughness coefficients	concrete 0.012 CMP 0.024	For artificially lined channels see Table 6.15 Uniform flow values of n see Table 6.16	For artificial lined channels see Table 5.4-4 and Table 5.4-5 for uniform flow values	Only shows data for concrete. There is a sheet flow mannings n table 2-10
3.4	• Min. Pipe size	15"	15"	Not specified Min pipe D for detention tanks is 36"	15"
3.5	• Manhole location	30" or smaller - max 500 feet over 30" - max 1200 feet	15" to 36" - max 400 ft 42" and larger - max 500 ft		< 42" max spacing 400 feet >42" max spacing 500 feet
3.6	• Minor losses	Tables of minor loss coefficients			Table 6-5
	IV. Culvert Hydraulics				
4.1	• End treatments	List of guidelines for selection of headwalls or endwalls	Req'd for all culverts installed in public ROW. See sec. 6.3.4.6 for more details regarding apron installation for high depths/velocities.	Headwalls are required for all metal culverts and where buoyancy protection is necessary and use an apron where velocity will cause scour	refers to Table 5-1
4.2	• Discharge velocity	Max allowable discharge velocity: Earth- 6 fps, Sod earth - 8 fps Paved or Riprap Apron - 15 fps Shale - 10 fps, Rock - 15 fps	See table 6.12 and 6.13 for maximum velocities (ft/s)	See Table 5.4-2 and 5.4-3 for velocity limitations	consistent with channel stability requirements at outlet, see chapter 3 for permissible velocities for channel linings
4.3	• Computation method – HYB	FHA methods, software with approval	Appendix H softwares	Section 5.5 provides energy dissipation design	FHWA HDS-5 methods HYB
	V. Stormwater Detention				

KEY BENCHMARKS

- Most manuals reviewed used Atlas 14 rainfall except Rogers, Memphis, and Fayetteville which use Hydro-35/TP-40
- **All** drainage manuals reviewed required Water Quality treatment
- WQ treatment volumes varied
  - Memphis 1",Springfield 1", Fayetteville 1.2", Rogers 85th percentile, Georgia 90th percentile
  - Proposed WQ volume for Little Rock: 90th percentile (1.5")
- Only one manual required less than the 100-year design storm for detention (Memphis – 10-year detention)
- Storm system design storm varied; however, all required analysis and safe passage of 100-year event
  - Memphis 10-year, Springfield 25-year, Fayetteville 10-year, Rogers 10-year, Tulsa 100-year, Georgia recommends 10- to 25-year
  - Proposed design storm for Little Rock: 25-year

Majority of manuals of have undergone major revisions in the last 10 years

- Fayetteville - 2014
- Memphis – 2007*
- Springfield - 2022
- Rogers - 2018
- Tulsa – 2019

*currently being revised

Step 2

STAKEHOLDER INPUT

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PUBLIC MEETINGS

For the first round of public engagement, three public meetings were held to gather input from the public:

May 17th, 2023	Dunbar Community Center
May 22nd, 2023	East Community Center
May 25th, 2023	Adolphine Fletcher Terry Library

For the second round of public engagement, five public meetings were held to gather input from the public:

March 18th, 2024	Dunbar Community Center
March 25th , 2024	West Central Community Center
March 28th, 2024	East Community Center
April 1st, 2024	Adolphine Fletcher Terry Library
April 4th, 2024	Southwest Community Center

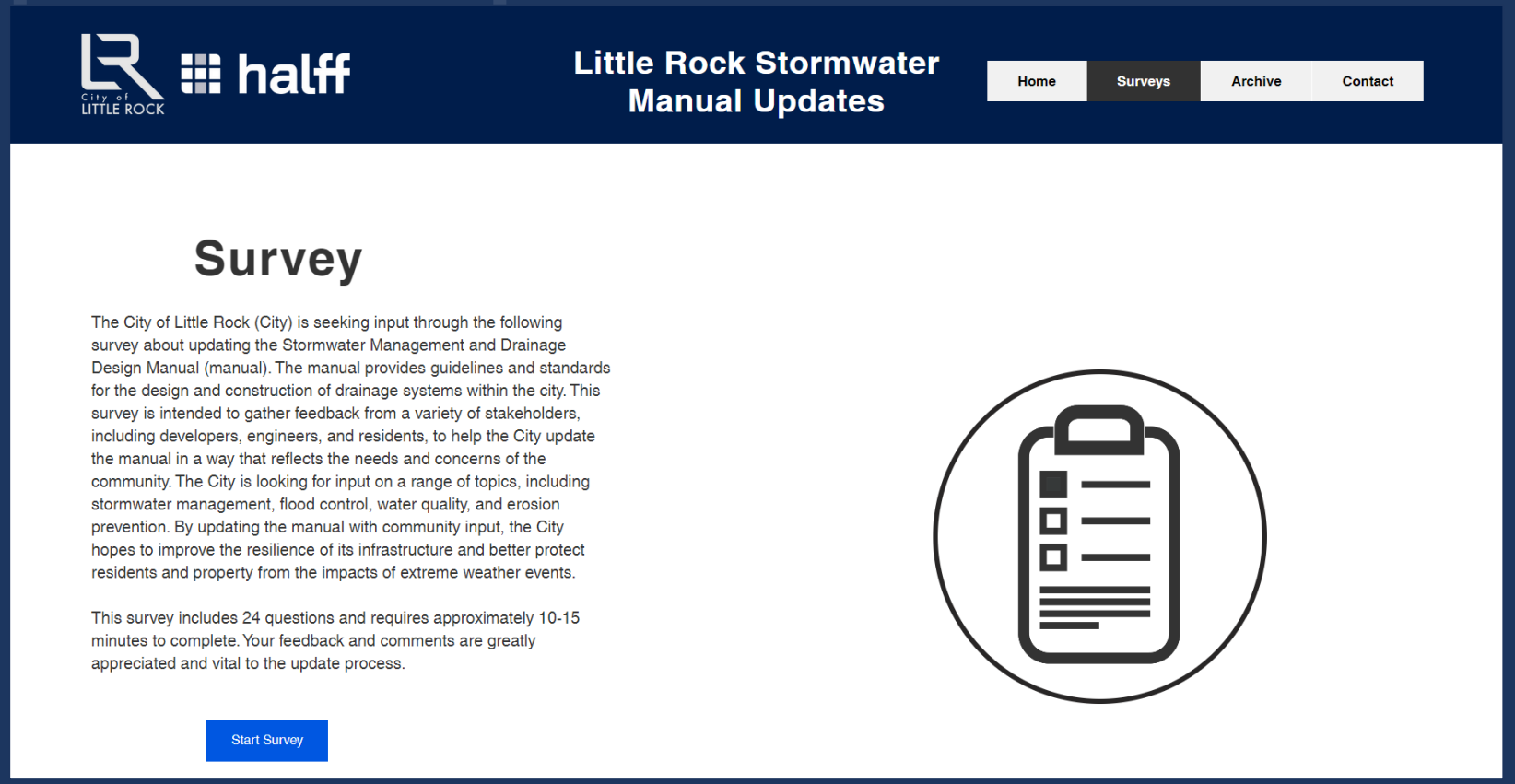
Upcoming Meetings

- **June 3, 2024 -** East Little Rock Community Center (2500 East 6th Street)
- **June 6, 2024** – The Center at University Park (6401 W 12th Street)
- **June 10, 2024** – Southwest Community Center (6401 Baseline Road)
- **June 12, 2024** – Adolphine Fletcher Terry Library (2015 Napa Valley Drive)
- **June 20, 2024** – West Central Community Center (8616 Colonel Glenn Road)

WEBSITE AND SURVEY

The website provides updates on the process, a link to the survey, and upcoming public meeting information.

The purpose of the survey was to gather feedback from stakeholders to help the City update the manual in a way that reflects the needs and concerns of the community.



www.lrswmanualupdate.com

Step 3

DRAFT CHAPTERS

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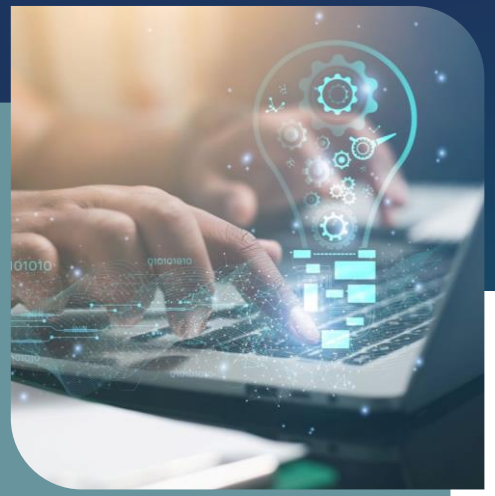
PLANNED CHANGES

The City plans to review and revise the manual to improve the resilience of its infrastructure and better protect residents and property from the impacts of stormwater runoff and extreme weather events.

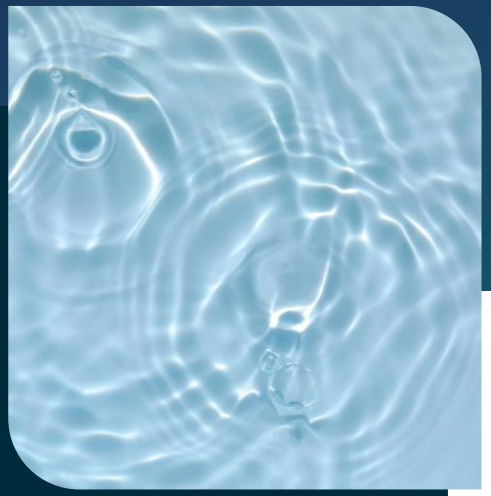
1



MODERNIZE

Streamline manual and improve readability and usability

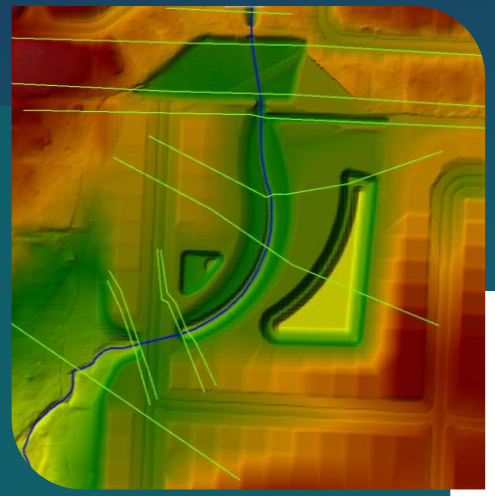
2



ADDRESS WQ

Include measures to remove pollutants and incentivize green infrastructure

3



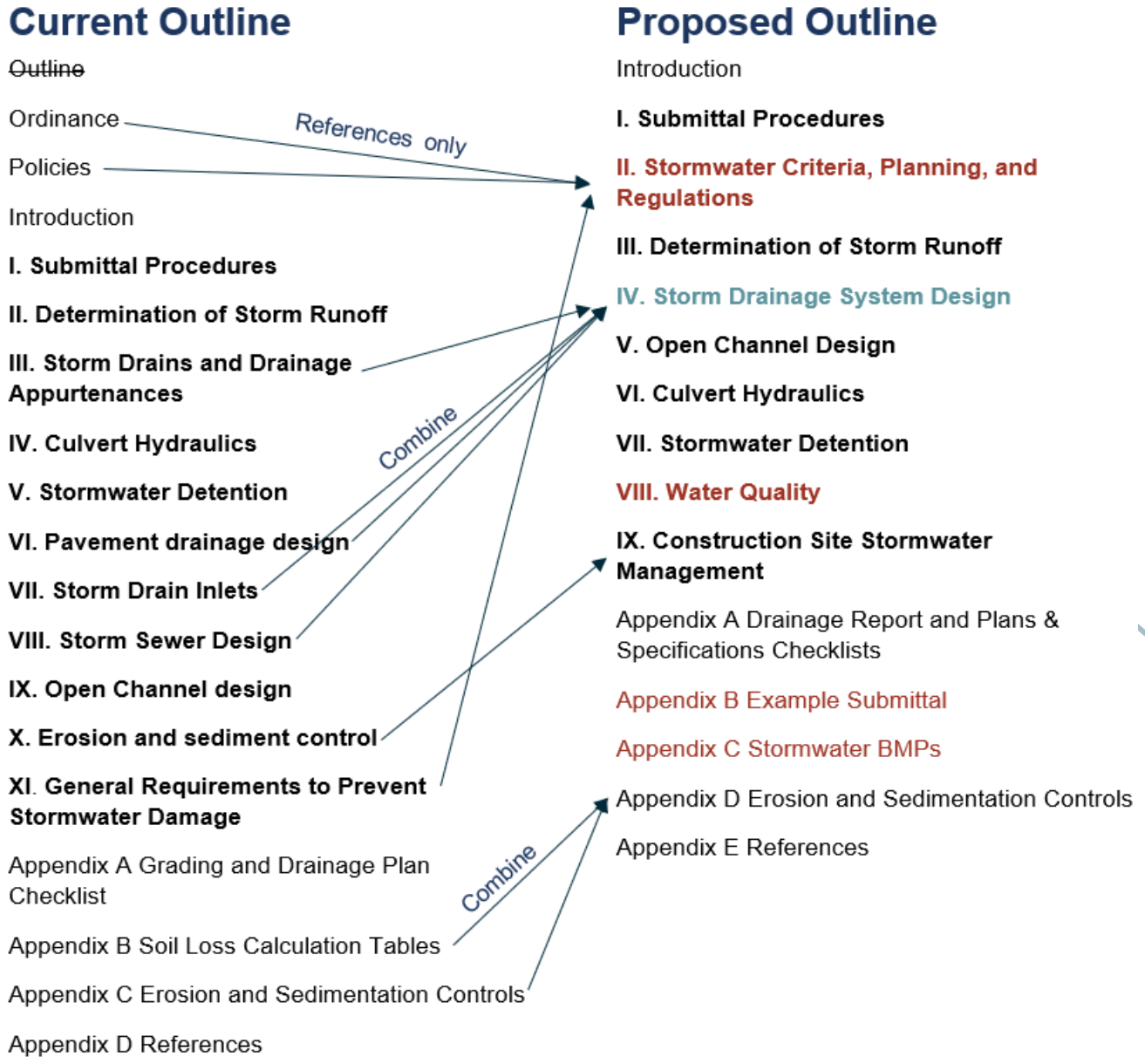
UPDATE METHODS

Utilize latest methods and expand analysis of storm events and offsite impacts

PROPOSED OUTLINE

- In general, the overall layout of the manual is similar. Some chapters were combined and streamlined, and two chapters were added.

Major addition to the manual is the Water Quality chapter.

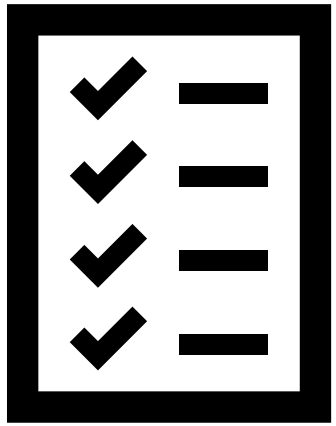


CHAPTER 1 – SUBMITTAL PROCEDURES
CHAPTER 2 – STORMWATER CRITERIA

- Chapter 1 summarizes the submittal procedures and requirements for a stormwater management and drainage plan.
    - This chapter outlines the items to be included in the Final Drainage Report and the Plans and Specifications.
- Chapter 2 summarizes the major stormwater related criteria related to water quality, downstream impacts, and stormwater system Level of Service.

Goals of revision

- Streamline submittal procedures
- Clarify submittal requirements
- Summarize main criteria in one location
- Provide example submittal in Appendix B



CHAPTER 3 – DETERMINATION OF STORM RUNOFF

- Provides rainfall information and accepted runoff determination methodologies.
- Chapter 3 also provides equations and parameters for multiple hydrologic methodologies.

Goal of revision

- Utilize best available rainfall data, Atlas 14, and provide updated IDF equation parameters
- Modernize hydrologic methods
- Revise applicable methodology based on watershed size
- Remove unnecessary calculation aids

Rainfall	TP-40	Atlas 14
10-year	6.1”	5.94”
25-year	7.0”	7.14”
50-year	7.8”	8.13”
100-year	8.5”	9.17”

Table 3.1 Hydrology Methodology

Methodology (Section)	Watershed Size
Rational Method (3.3)	Less than 20 acres.
SCS TR-55 Method (3.4)	Up to 200 acres.
HEC-HMS Method (3.5)	Greater than 200 acres.
Regression Method (3.6)	Greater than 2,000 acres.

CHAPTER 4 – STORM DRAINAGE SYSTEM DESIGN
CHAPTER 5 – OPEN CHANNEL DESIGN
CHAPTER 6 – CULVERT HYDRAULICS

- These chapters focus on the design of the storm drainage system, including inlets, street gutters, roadside ditches, small channels, swales, and the underground pipe system.
- Provides an overview of open channel design criteria and methods.
- Includes design criteria for culvert end treatments and energy dissipators

Goals of revision

- Combine and condense several chapters
- Update design storm, freeboard, and spread limits based on street classification
- Remove unnecessary calculation aids

Table 2.2 Design Storm Street Classification.

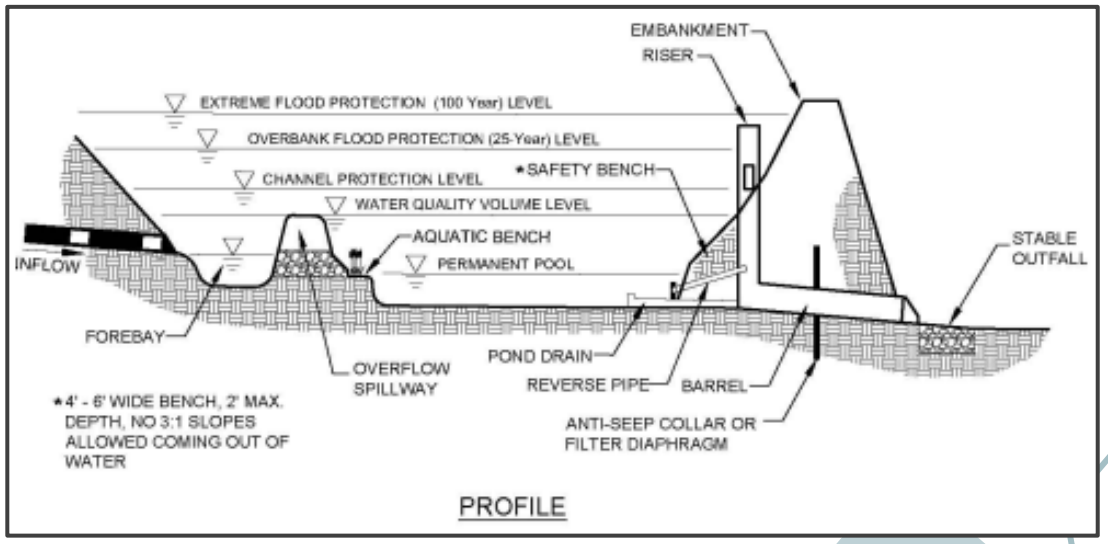
Street Classification	Design Storm	
	Cross Drainage	Storm System
Principal Arterials	100-year	25-year
Major and Minor Arterials	100-year	25-year
All other streets	25-year	25-year

CHAPTER 7 – STORMWATER DETENTION

- Chapter 7 provides guidance on stormwater runoff storage for meeting downstream channel protection criteria and peak flow attenuation.
- The chapter provides analysis methods and allowable methods of detention storage such as dry ponds, wet ponds, and underground detention.

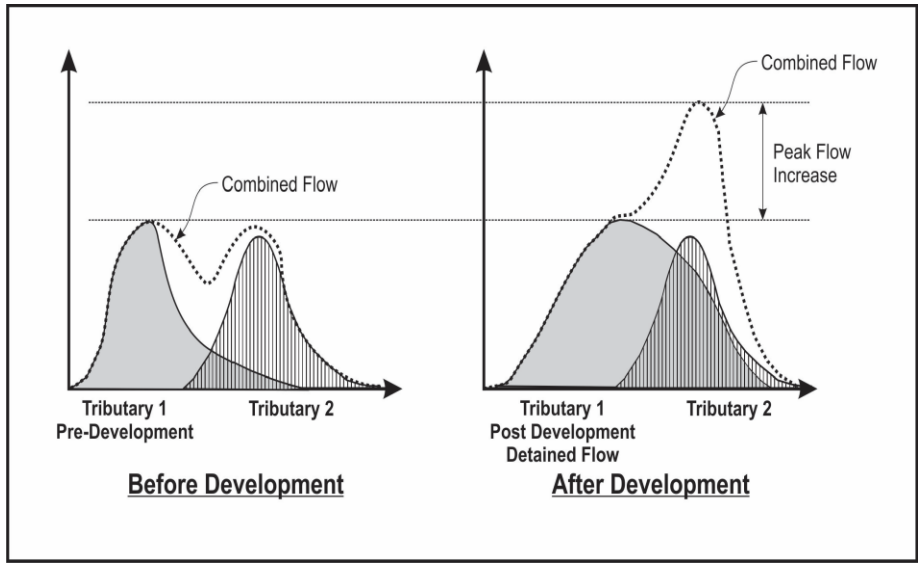
Goals of revision

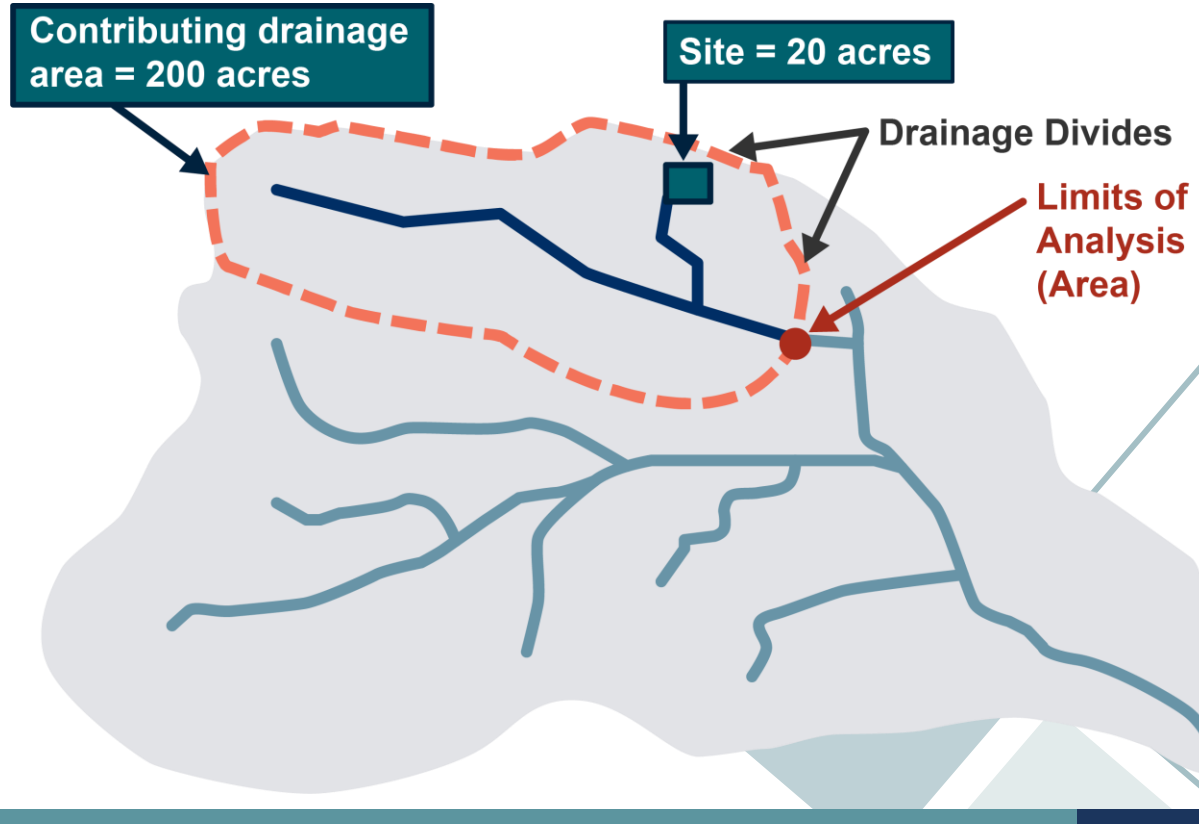
- Update methods of analysis and the storm events analyzed
- Require assessment of downstream impacts



CHAPTER 7 CONTINUED - DOWNSTREAM ANALYSIS

- For sites over 20 acres, a downstream analysis will be required to evaluate the effects of flow timing and increased volume. This analysis should show that the proposed development does not exacerbate flooding problems downstream.
- The downstream analysis will extend downstream until the site comprises 10% or less of the total watershed area.



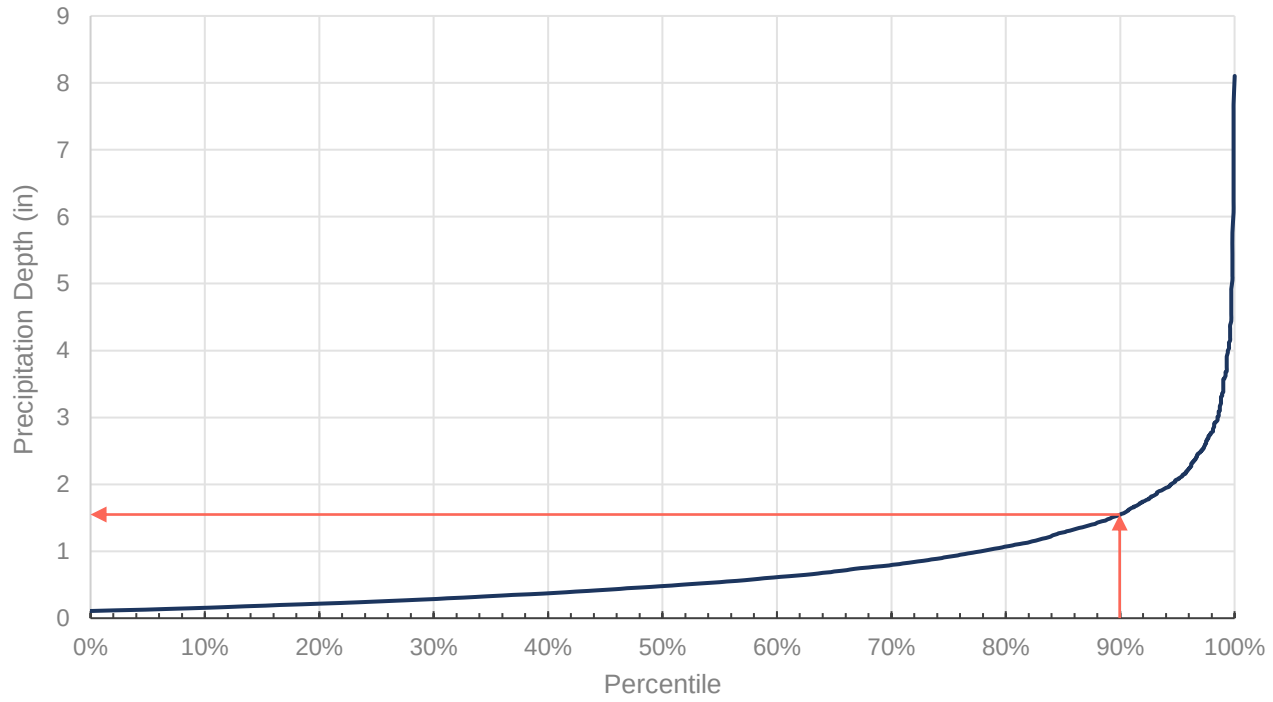


CHAPTER 8 – WATER QUALITY

- Chapter 8 provides criteria for water quality treatment and guidance on the use of Low Impact Development (LID) and stormwater Best Management Practices (BMPs).

Goals of revision

- Develop water quality criteria and BMP guidance
- Establish water quality volume (WQv) based on 90th (1.5”) and 85th (1.3”) percentile storm events



CHAPTER 8 – WATER QUALITY

- The Water Quality Volume (WQv) provides treatment from a site to reduce post-development total suspended solids (TSS) loadings by 80%, as measured on an average annual basis.
- This performance goal is based on the ADEQ NPDES small MS4 permit in accordance with U.S. EPA guidance.

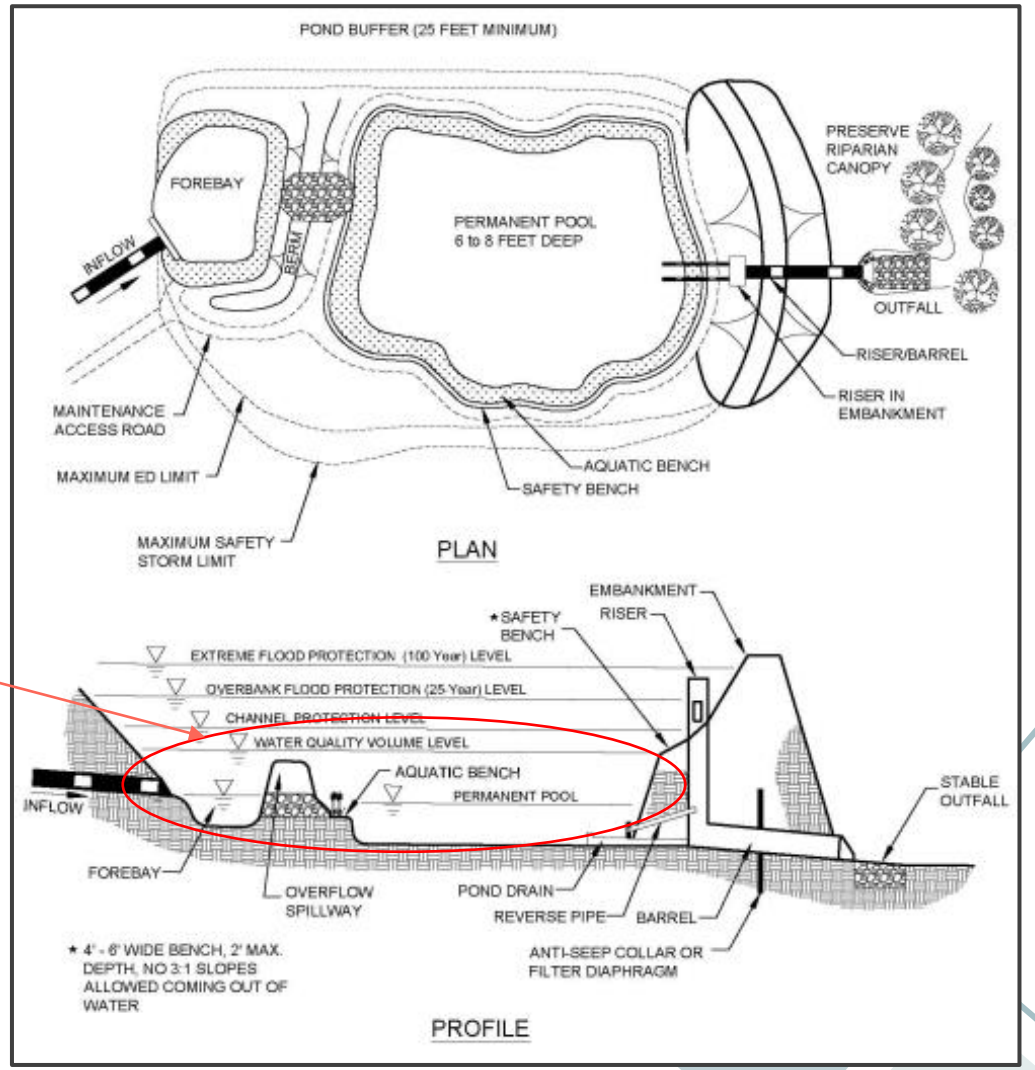
$$WQ_V = \frac{PR_VA}{12}$$

Where: WQv = water quality volume (ac-ft)

Rv = 0.05 + 0.009(I)
where I is the percent impervious cover (i.e., 50% impervious is 50 not 0.5)

A = site area (acres)

P = 1.5 inches (new development) or 1.3 inches (redevelopment)



CHAPTER 8 – WATER QUALITY

- Appendix C provides a list of stormwater control measures with estimated pollutant removal efficiencies.
- Detailed sizing calculations, design criteria, and maintenance requirements are provided for each stormwater control measure.

Removal Efficiencies

Table C-1 Design Pollutant Removal Efficiencies for Structural Stormwater Controls

WQ	Structural Control	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Fecal Coliform	Metal
	General Application					
02	Stormwater Ponds	80	50	30	70*	50
03	Stormwater Wetlands	80	40	30	70*	50
04	Bioretention Areas	80	60	50	---	80
05	Urban Bioretention	80	60	50	---	80
06	Sand Filters	80	50	25	40	50
	Limited Application					
07	Organic Filter	80	60	40	50	75
08	Underground Sand Filter	80	50	25	40	50
09	Submerged Gravel Wetland	80	50	20	70	50
10	Gravity (Oil-Grit) Separator	40	5	5	---	---
11	Proprietary Systems	***	***	***	***	***
	Pre-Treatment					
12	Permeable Pavement	80	50	50	---	60
13	Infiltration Devices	80	60	60	90	90
14	Water Quality Swale	80	25	40	---	20
15	Downspout Disconnect	60	25	25	---	40
16	Grass Channel	50	25	20	---	30
17	Vegetated Filter Strips	60	20	20	---	40
18	Green Roof	80	50	50	---	---

* If no resident waterfowl population present.
*** The performance of specific proprietary commercial devices and systems must be provided by the manufacturer and should be verified by independent third-party sources and data.
--- Insufficient data to provide design removal efficiency.

CHAPTER 9 – CONSTRUCTION SITE STORMWATER MANAGEMENT

- Provides information on construction site stormwater management practices which control erosion and sedimentation.
- Management practices include stabilization practices, erosion control, site runoff control, and sedimentation controls.

Goals of revision

- Streamline chapter
- Clarify requirements and accepted erosion control methods

APPENDICES

- The appendices provide guidance on submittal items and additional resources for water quality stormwater BMPs and construction site erosion controls.

Goals for revision

- Revise guidance for more consistent submittals
- Provide detailed information for selection and design of water quality BMPs
- Update erosion and sediment controls

Appendix A – Report and Plan Checklists

Appendix B – Example Submittal

Appendix C – Stormwater BMPs

Appendix D – Erosion and Sediment Controls

Appendix E – References

APPENDIX A

Final Drainage Report Template and Checklist

The City of Little Rock, Arkansas

Project name _____

Engineer of Record _____

Planning Project Number _____

Revision no. _____

Date _____

Submittal should include the following:

1. ☐ **PROJECT TITLE & DATE**
2. ☐ **PROJECT LOCATION** - Include street address and Vicinity Map.
3. ☐ **PROJECT DESCRIPTION** - Brief description of the proposed project.
4. ☐ **NAME, ADDRESS, TELEPHONE NUMBER, AND EMAIL** of the owner and developer of the property to be permitted.
5. ☐ **NARRATIVE SUMMARY** - The summary shall include a description of the methods used to meet the conveyance, detention, and water quality requirements. This includes at a minimum a description of the target pollutants and treatment train for water quality and a description of the detention strategy used to meet the downstream flood protection requirement. Also include a description of the off-site areas, onsite areas, condition of the downstream receiving areas, existing problems, changes to flows and flow volume, proposed improvements, detention, areas with potential for high pollutant loading, and final conclusions.
6. ☐ **EXISTING DRAINAGE AREA MAP** – Existing drainage area map on a 1-inch = 200-feet minimum scale plan drawing, with 2 foot contours (1 foot contours on "flat" sites), that includes: study points at property lines, time of concentration path, bar scale, and the following information:
   a. ☐ Aerial photograph of the project vicinity, covering the project area and the total lands that contribute runoff;
   b. ☐ Existing drainage areas and flow patterns to downstream property line, establishing the study points;
   c. ☐ Upstream and downstream drainage flow paths for all areas that contribute runoff to the existing site or receive runoff from the site. The downstream area(s) shall be shown as necessary to document the receiving conveyance system; and
   d. ☐ Existing land use conditions for the drainage areas that contribute runoff.

7. ☐ **SOIL MAP** - Provide the most recent U.S. Soil Conservation Service soils and vegetation information for both the project area and the drainage area that contributes runoff on a separate map from the Existing Drainage Area Map.
8. ☐ **PROPOSED DRAINAGE AREA MAP** – Proposed drainage area site map on a 1-inch = 200-feet minimum scale plan drawing, with 2' contours (1 foot contours on "flat" sites), that include: study points, time of concentration path, bar scale, and the following information:
   a. ☐ Proposed drainage areas and flow patterns and, if applicable, natural feature protection areas, green stormwater practice and infiltration areas;
   b. ☐ Upstream and downstream drainage flow paths for all areas that contribute runoff to the proposed development site or receive runoff from the site. The downstream area(s) shall be shown as necessary to document the receiving conveyance system;
   c. ☐ Proposed land use conditions for the development site and drainage areas that contribute runoff; and
   d. ☐ Proposed locations of grading and placement of fill material within the project area and drainage areas that contribute runoff.
9. ☐ **WATER QUALITY** – Calculations and documentation indicating the target pollutants and the required water quality treatment volume.
   a. ☐ Provide calculations for each structural control indicating the corresponding level of treatment; and,
   b. ☐ Provide a map showing the impervious area and structural controls
10. ☐ **DOWNSTREAM FLOOD PROTECTION** – Provide calculations and documentation indicating that the post-development peak discharge rate does not exceed the pre-development rate for the 2-year, 5-year, 10-year, 25-year, and 100-year, 24-hour storm events. The calculations shall include the following information:
    a. ☐ A summary table of runoff discharge flows for the 2-year, 5-year, 10-year, 25-year, and 100-year, 24- hour storm events for the pre-development and post-development conditions for each study point. The summary shall include the existing and proposed flows along with supporting calculations for all of the discharge points to the receiving system. This includes the flow entering each drainage area and the flow generated within each drainage area on the site (do not separate onsite and offsite flows).
    b. ☐ The effects of the 100-year, 24-hour storm event on the stormwater management system, adjacent property, and downstream facilities and property shall be evaluated. The 100-year flow shall be controlled through the use of structural stormwater controls to protect existing downstream property with no increase in the existing base flood elevation, or calculations shall be provided to

APPENDIX B

Table 3: Pond Performance Summary

Underground Storage Pond	2-Year	5-Year	10-Year	25-Year	100-Year
Maximum Water Elevation	1,230.34	1,230.67	1,230.97	1,231.24	1,231.70
Maximum Storage (cubic feet)	4,339	6,362	8,237	11,121	16,277
Peak Inflow (cfs)	6.8	8.9	10.8	13.6	18.1
Peak Discharge (cfs)	2.2	2.5	2.6	2.8	3.0
Difference (cfs)	**-4.6**	**-6.4**	**-8.2**	**-10.8**	**-15.1**

Table 4: Pre-developed vs Post-developed Peak Flow Summary at Study Point "A"

Outfall	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{100} (cfs)
Pre-Developed	3.7	5.6	7.2	9.9	14.6
Post-Developed	2.7	3.1	3.5	4.1	5.0
Difference (cfs)	**-1.0**	**-2.5**	**-3.7**	**-5.8**	**-9.6**

Table 5: Pre-developed vs Post-developed Peak Flow Summary at Study Point "B"

Outfall	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{100} (cfs)
Pre-Developed	2.1	3.0	3.9	5.1	7.3
Post-Developed	2.1	2.9	3.6	4.8	6.7
Difference (cfs)	**0.0**	**-0.1**	**-0.3**	**-0.3**	**-0.6**

As shown in Table 4 and 5, the post-development peak flows are equal to or lower than their pre-development counterparts for all storm events at study point "A" and study point "B", respectively.

D. Water Quality

The ADS System also meets the requirements of Section 2.1.1 (Water Quality) of the Little Rock stormwater drainage manual via the TSS Reduction Method. According to the City of Little Rock Drainage Criteria Manual, the stormwater system shall be designed to be capable of removing at least 80% of TSS from an equivalent onsite impervious area. The detention volume of the ADS Stormtech system is sufficient in holding the Water Quality Volume equal to the first 1.5 inches of rainfall. The total site area is 2.0 acres; the R_v value was determined using 55% impervious cover of the catchment area.

$R_v = 0.05 + 0.009(I)$
$R_v = 0.05 + 0.009(55) = 0.545$
$WQV = (1.5 * R_v * A)/12$
$WQV = (1.5 * 0.545 * 2.0)/12$
$WQV = 0.136$ acre-ft
WQV = 5,924 cubic ft

The total volume of the Stormtech chambers is 16,380 CF, which is above the WQv of 5,924 CF. The bioretention area, located in the parking lot island, is used as pre-treatment for the underground detention to remove heavy metals from the parking lot, reduce TSS loading, and catch floatables. Specifications for the ADS system can be found in Appendix C.

E. Downstream Analysis

A downstream analysis was completed to determine potential impacts. The site area and the contributing drainage areas to the limit of the zone of influence (10% point) is shown in Exhibit VI. Hydraflow Hydrographs software was used to assess the peak flow and timing of the watershed. Figures 1 and 2 provide the pre-development and post-development hydrographs at the 10% point. The calculations and results for all storm events can be found in Appendix B.

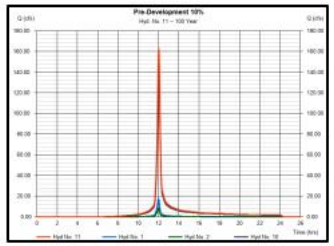


Figure 1: Pre-Development

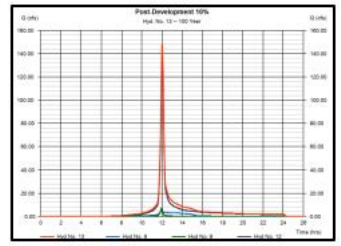


Figure 2: Post Development

F. Storm System Design

Hydraulic calculations for the proposed storm drains were done using Rational Method hydrology and StormCAD software. The contributing drainage areas to the drainage systems are shown in Exhibit VII. The results of the hydraulic and inlet calculations are contained in Appendix D. A summary of the roadway inlets is provided in Table 6. As shown, the storm sewer system is adequate to convey the 25-Year storm event to discharge the points without the surcharge. Analysis of the system under the 100-Year storm event was also completed and can be found in Appendix D.

APPENDIX C

WQ-02 Stormwater Ponds

1. Description

Stormwater ponds (also referred to as retention ponds, wet ponds, or wet extended detention ponds) are constructed stormwater retention basins that have a permanent (dead storage) pool of water throughout the year. They can be created by excavating an already existing natural depression or through the construction of embankments.

In a stormwater pond, runoff from each rain event is detained and treated in the pool through gravitational settling and biological uptake until it is displaced by runoff from the next storm. The permanent pool also serves to protect deposited sediments from resuspension. Above the permanent pool level, additional temporary storage (live storage) is provided for runoff quantity control. The upper stages of a stormwater pond are designed to provide extended detention of the 1-year storm for downstream channel protection, as well as normal detention of larger storm events.

Stormwater ponds are among the most cost-effective and widely used stormwater practices. A well-designed and landscaped pond can be an aesthetic feature on a development site when planned and located properly.

There are several different variants of stormwater pond design, the most common of which include the wet pond, the wet extended detention pond, and the micropool extended detention pond. In addition, multiple stormwater ponds can be placed in series or parallel to increase performance or meet site design constraints. Below are descriptions of each design variant:

- **Wet Pond** – Wet ponds are stormwater basins constructed with a permanent (dead storage) pool of water equal to the water quality volume. Stormwater runoff displaces the water already present in the pool. Temporary storage (live storage) can be provided above the permanent pool elevation for larger flows.
- **Wet Extended Detention (ED) Pond** – A wet extended detention pond is a wet pond where the water quality volume is split evenly between the permanent pool and extended detention (ED) storage provided above the permanent pool. During storm events, water is detained above the permanent pool and released over 24 hours. This design has similar pollutant removal to a traditional wet pond but consumes less space.
- **Micropool Extended Detention (ED) Pond** – The micropool extended detention pond is a variation of the wet ED pond where only a small "micropool" is maintained at the outlet to the pond. The outlet structure is sized to detain the water quality volume for 24 hours. The micropool prevents resuspension of previously settled sediments and prevents clogging of the low flow orifice.
- **Multiple Pond Systems** – Multiple Pond systems consist of constructed facilities that provide water quality and quantity volume storage in two or more cells. The additional cells can create longer pollutant removal pathways and improved downstream protection.

Figure C-3 shows several examples of stormwater pond variants. The Pollutant Removal Capabilities section provides plan view and profile schematics for the design of a wet pond, wet extended detention pond, micropool extended detention pond, and multiple pond system.

Wet Pond

Wet ED Pond

Micropool ED Pond

Wet ED Pond

Figure C-3. Stormwater Pond Examples.

2. Stormwater Management Suitability

Stormwater ponds are designed to control both stormwater quantity and quality. Thus, a stormwater pond can be used to address water quality, channel protection, and overbank flood protection.

Water Quality

Pollutants are removed from stormwater runoff in a wetland through uptake by wetland vegetation and algae, vegetative filtering, and through gravitational settling in the slow-moving marsh flow. Other pollutant removal mechanisms are also at work in a stormwater wetland, including chemical and biological decomposition, and volatilization. The Pollutant Removal Capabilities section of this specification provides median pollutant removal efficiencies that can be used for planning and design purposes.

Downstream Flood Protection

A stormwater pond can also provide storage above the permanent pool to reduce the post-development peak flow of the design storm events to pre-development levels (detention).

APPENDIX D

Construction Temporary BMPs

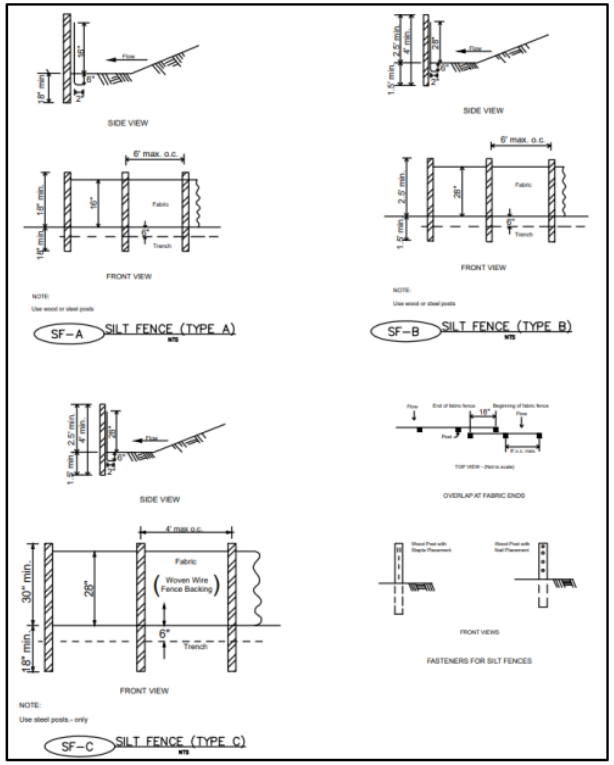
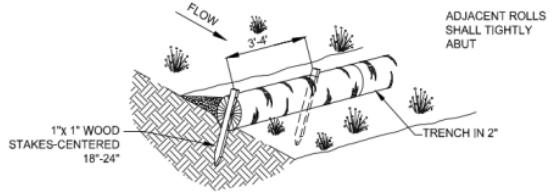


Figure D-1. Silt Fence.

WATTLE SPACING	
SLOPE	MAXIMUM SPACING
1:1	20'
2:1	30'
3:1	40'
4:1	50'



INSTALLATION NOTES

1. WATTLES SHALL CONSIST OF STRAW, COMPOST, EXCELSIOR, OR COCONUT FIBER.
2. NOT FOR USE IN CONCENTRATED FLOW AREAS.
3. THE WATTLES SHALL BE TRENCHED INTO THE GROUND A MINIMUM OF TWO (2) INCHES.
4. WATTLES SHALL BE INSTALLED PER MANUFACTURERS SPECIFICATIONS.
5. ON SLOPES, WATTLES SHOULD BE INSTALLED ON CONTOUR WITH A SLIGHT UPWARD CURVE AT THE END OF THE ROW IN ORDER TO CREATE PONDING.
6. RUNNING LENGTHS OF WATTLES SHOULD BE ABUTTED FIRMLY TO ENSURE NO LEAKAGE AT THE ABUTMENTS.
7. WHEN INSTALLING RUNNING LENGTHS OF WATTLES, BUTT THE SECOND WATTLE TIGHTLY AGAINST THE FIRST, DO NOT OVERLAP THE ENDS. STAKE THE WATTLES AT EACH END AND FOUR FOOT ON CENTER.
8. STAKES SHOULD BE DRIVEN THROUGH THE MIDDLE OF THE WATTLE. LEAVING 2 - 3 INCHES OF THE STAKE PROTRUDING ABOVE THE WATTLE. WHEN INSTALLING WATTLES ON SLOPES, DRIVE THE STAKES PERPENDICULAR TO THE SLOPE.
9. DRIVE THE FIRST END STAKE OF THE SECOND WATTLE AT AN ANGLE TOWARD THE FIRST WATTLE IN ORDER TO HELP ABUT THEM TIGHTLY TOGETHER.
10. THE CITY RECOMMENDS USING WOOD STAKES TO SECURE THE WATTLES. 1/2" TO 5/8" REBAR IS ALSO ACCEPTABLE WITH A SAFETY CAP.. BE SURE TO USE A STAKE THAT IS LONG ENOUGH TO PROTRUDE SEVERAL INCHES ABOVE THE WATTLE.
11. THE CONTRACTOR SHALL INSPECT WATTLES EVERY TWO WEEKS AND AFTER ANY SIGNIFICANT STORM EVENT AND MAKE REPAIRS OR REMOVE SEDIMENT ACCUMULATED BEHIND WATTLE AS NECESSARY.
12. SEDIMENT ACCUMULATED BEHIND WATTLE SHALL BE REMOVED WHEN THE SEDIMENT HAS ACCUMULATED TO ONE HALF THE DIAMETER OF THE WATTLE.
13. WATTLES SHALL REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED AND IS ACCEPTED BY THE CITY.

Figure D-2. Wattle.

Revision Impacts

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DEVELOPMENT IMPACTS

- Drainage manual revisions will potentially impact the cost of engineering and construction for development.
- The cost impact will be highly dependent on the type of development and the mitigation measures selected.

Basis	Proposed Manual Change	Cost Assessment	Cost Change Notes
Industry standard data/methodology	Requires NOAA Atlas 14 precipitation data to be used for all designs	Cost Neutral	No increase to engineering analysis or review. Additional volume included in estimate below.
Industry standard, Existing Code (Sec. 29-102, Sec. 31-90)	Require detention for the 2-, 5-, 10-, 25-, and 100-year storm event	Cost Increase for engineering analysis, and construction	Additional engineering analysis of pond sizing and outlet design. Approximately 25% increase in detention volume, increased excavation or additional underground detention
MS4 Permit (Section 6.2.2), ADEQ General Permit (Part II SectionA.4.L)	Require treating 1.5" of rainfall runoff	Cost increase for engineering analysis, City review, and construction	Additional engineering analysis and City review of Water Quality design. Cost impact highly dependent on control measures selected and integration with already required landscaping/detention.
Master Street Plan	Updated roadway cross drainage design storm to be a minimum 25-year storm event	Cost neutral - increase to engineering analysis. Cost increase to construction	Minimal to no increase in engineering analysis. Increased storm pipe diameter at crossings.
Industry standard data/methodology	Updated acceptable runoff analysis methodology and software based on watershed size	Cost Neutral	Update to methodologies does not require specialized software requiring software purchase.
Existing Code (Sec. 29-102)	Downstream impact analysis	Cost increase for engineering analysis, and City review	Requires additional capacity analysis downstream and additional City review. Potential to impact required detention.
ADEQ General Permit (Part I Section B.14)	Stream buffer requirements	Cost Neutral	Potential for less developable area.

REVISION BENEFITS

Detention and Storm System requirements

- Increased public safety and protection of property
- Fewer nuisance flooding complaints
- Prolong lifecycle of existing infrastructure
- Reduced business interruption and economic impacts from flooding

Water Quality, LID, and Stream Buffer requirements

- Reduced degradation of water quality
- Reduced streambank erosion
- Reduced future maintenance burden on City
- Preserving natural features can increase the value and sale price of residential lots

Mitigation Saves Fact Sheet (fema.gov)

Costs of Low Impact Development: LID Saves Money and Protects Your Community's Resources (epa.gov)

SUMMARY OF MAJOR CHANGES

Rainfall Old manual used Hydro 35 & TP 40	**Rainfall** New manual will require Atlas 14 rainfall
Detention Old manual required detention for the 25-year storm event	**Detention** New manual will require detention for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events
Water Quality Old manual did not have water quality requirements	**Water Quality** New manual will require treating 1.5 inches of rainfall runoff (or 1.3” for redevelopment)
Design Storm Old manual had design storm range from 10 to 100-year based on roadway category	**Design Storm** New manual will have minimum design storm of 25-year and all areas will require dedicated 100-year overland flow path

Step 4

IMPLEMENTATION

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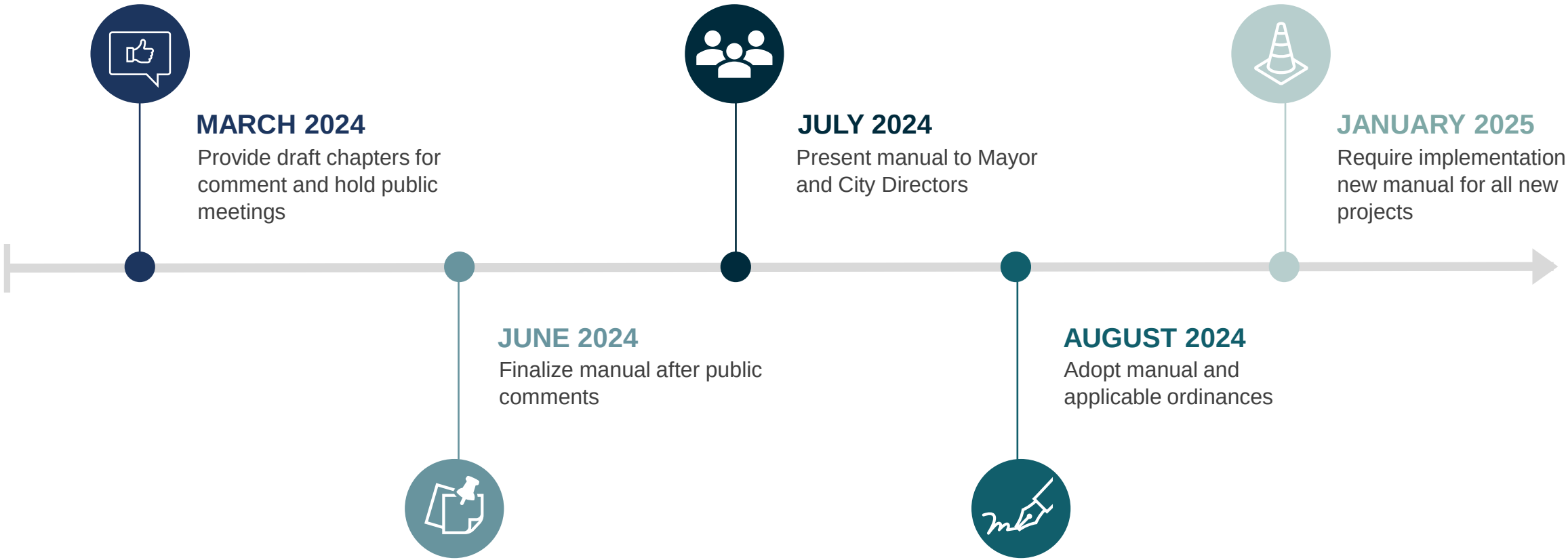
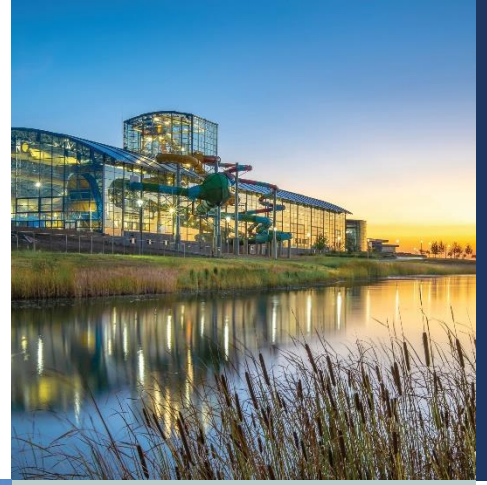
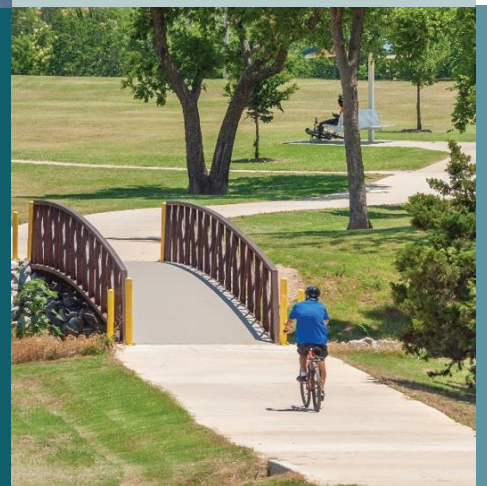
UPCOMING TIMELINE



GET IN TOUCH

Visit the website https://www.lrswmanualupdate.com/ for the latest updates or contact us below.





Natalie Rogers

Water Resources Team Leader

(501) 653-7522

nRogers@halff.com

Miles Simmons

Water Resources Project Manager

(501) 801-2685

mSimmons@halff.com

Jamie Collins

Director Planning and Development

(501) 371-4790

gCollins@littlerock.gov

halff

City of LITTLE ROCK