

STORMWATER POLICY & DESIGN CRITERIA IMPLEMENTATION PLAN

CITY OF
Warsaw



September 23, 2022



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ABBREVIATIONS

Abbreviation	Description
APWA	American Public Works Association
BMP	Best management practice
CFS	Cubic feet per second
City	City of Warsaw
DEM	Digital Elevation Model
ESRI	Environment Systems Research Institute, Inc.
FEMA	Flood Emergency Management Agency
FHWA	Federal Highway Administration
GIS	Geographic Information System
GSI	Green stormwater infrastructure
HEC	Hydrologic Engineering Center
LiDAR	Light detection and ranging
MARC	Mid-America Regional Council
MUTCD	Manual on Uniform Traffic Control Devices
NOAA	National Oceanic and Atmospheric Administration
SCS	Soil Conservation System

SECTION 1

BACKGROUND & PURPOSE

The City of Warsaw (City) is a waterfront community that relies heavily on the tourism this draws to support their local economy. The City recognizes that its strongest community asset is its waterfront, and with that it strives to protect the integrity of this natural system. Warsaw has been gaining momentum for new and redevelopment opportunities along the waterfront and in other commercially and residentially zoned areas north of the downtown. Along with these development opportunities, the City is working to improve major streets in the community. While these are all positive improvement opportunities for Warsaw, the City has observed how development expansion can influence downstream flooding and stream degradation. Warsaw aims to promote healthy and sustainable growth that is not detrimental to the community and its waterfront assets.

A stormwater study was completed for the City in 2022 that further emphasized this need. The currently adopted stormwater design criteria and policies were found to be extremely dated and not current with today's best practices. Evaluation of the existing drainage patterns also showed that stormwater is currently managed in a relatively natural manner through overland drainage to open roadside ditches and culverts, ultimately discharging to the larger open channel of Town Branch Creek. Without adequate stormwater management standards in place to protect these natural overland drainage patterns and control stormwater runoff from increased impervious areas, the City is at risk for increased levels of erosion and flooding, potentially rising to a level where property damage may occur. Figure depicts flooding that was experienced along the creek in 2018.



Figure 1: Town Branch Creek Flooding

(Source: <https://www.ky3.com/content/news/PICTURES-Heavy-rains-flood-roads-Wednesday-in-Benton-County-Mo-488504871.html>)

To achieve the goal of sustainable and resilient growth, it is critical that the City has adequate stormwater policies and design criteria in place. The current policies and design criteria leave the City vulnerable to the negative impacts added impervious area and enclosed storm sewer systems could have on the community. For this reason, the City is pursuing alternative, more innovative and sustainable stormwater management strategies for both public and private improvements in the future. This approach integrates green stormwater infrastructure into more traditional stormwater management technologies to better manage stormwater runoff for both small and large storm events based on more current rainfall data. This plan includes incorporation of these more sustainable stormwater management practices into the City's stormwater policy and design criteria.

SECTION 2

APPROACH

For functional implementation of stormwater policy, a community must have in place an adopted ordinance that gives them legal jurisdiction to dictate the requirements, technical guidance defining how those requirements are to be achieved, and a process for verifying that these requirements are being met. The approach to these recommendations focuses on getting stormwater management requirements in place for the City for the following key systems:

1. Policy (Code of Ordinance)
2. Design Criteria
3. Review Mechanism (Drainage Permit)

While these are independent documents/systems, it is critical that they communicate with one another appropriately and that conflicts are not created with other existing City requirements. This implementation plan proposes draft redlines to existing Code of Ordinances sections as well as the current regional stormwater management design criteria, the February 2011 version of *Kansas City Metropolitan Chapter American Public Works Association Standard Specifications and Design Criteria Section 5600 Storm Drainage Systems & Facilities*¹ (APWA 5600). This approach provides a ready-made format that the City can take forward into review, approval, and implementation.

In addition to the redlined documents, a proposed drainage permit application digital workbook tool has been developed to provide the City with a consistent review mechanism to verify that the stormwater policy and design criteria are being met. This tool also provides users with clear expectations of the analysis and design that is required for approval of the drainage permit.

This implementation plan recommends that the stormwater management requirements be triggered for all development projects that create 5,000 square feet or more of impervious area, and all redevelopment projects that increase impervious area by 1,000 square feet or more. These projects would require submittal of the drainage permit to verify compliance with the stormwater management criteria. This requirement and trigger are added to the Code of Ordinances draft redline sections and detailed in the draft redline stormwater management design criteria.

The following sections provide a summary of the review and proposed revisions to the code and design criteria as well as the draft drainage permit application, with the detailed revisions and full drainage permit application included in the following Appendices:

- Appendix A: Code of Ordinances Revision Redlines
- Appendix B: Stormwater Management Design Criteria (APWA 5600) Redlines
- Appendix C: Drainage Permit Application

¹ Kansas City Metropolitan Chapter American Public Works Association (APWA); February 16, 2011; Standard Specifications and Design Criteria Section 5600 Storm Drainage Systems & Facilities

SECTION 3

CODE OF ORDINANCES RECOMMENDATIONS

The Code of Ordinances provides the City and its citizens with current, enforceable laws. The code provides the framework and processes to regulate where and what type of development can occur to align with Warsaw's vision for growing their community. It is important that the stormwater management policies serve the community by protecting both the citizens and the natural resources on which they rely.

This section discusses the City's existing review processes currently established by the Code of Ordinances and summarizes review and recommendations for amendments to chapters of the code specific to implementation of the recommended stormwater policy.

3.1 CITY REVIEW PROCESSES

Section 405.020 includes procedures for the overall planning process, and Section 405.030 includes specific procedures for each application type. The City should follow these procedures as defined in the code so that development can be properly reviewed and approved and so that the public can have a chance to comment on development applications. This not only verifies that future development is planned, designed and built per code, but also avoids potential legal conflicts due to deviating from the procedures defined in the code. Figure 2 shows all of the application types that have procedures in the code and who is authorized to approve those applications. The proposed code revisions integrate the drainage permit requirement into the existing procedures so that applicants are not submitting multiple, separate applications at once. Figure 3 is an overview of the planning process, defined in Section 405.020.

Figure 2: Application Types and Approval Authorities



Figure 3: Warsaw's Planning Process

Procedure	Description
Preapplication Meeting	The applicant may schedule a meeting with the City to discuss the development concept prior to the application submission. Certain submittal requirements may be waived by the Director at or following the meeting, in order to reduce the burden on the applicant and to tailor the requirements.
Neighborhood Meeting	The applicant shall provide notice of the neighborhood meeting a minimum of 10 days in advance of the meeting. The applicant shall provide a written summary or transcript of the meeting within 10 days of the meeting conclusion or with the completed application, whichever is sooner.
Response to Summary	Any person in attendance at the neighborhood meeting may submit a written response within 5 days after the summary has been made public.
Submit Application	The applicant shall submit the application form and any other required documents either via hard copies or electronic copies.
Determine Application Completeness	City Staff shall make its determination of an incomplete application in writing (email or on-line tracking system) within 10 days after the application has been submitted.
Resubmit Application	The applicant shall submit the information required to make the application complete within 30 days after the notice of an incomplete application or the application shall be deemed rejected .
Staff Review	City Staff ensures that the application complies with all applicable standards, requirements and criteria. Staff shall identify all major issues and request additional information, data, or reports from the applicant.
Public Notice	The City/Director is responsible for preparing content of the notice and publishing, posting, and/or mailing it to appropriate property owners at least 15 days prior to date of public hearing.
Recommendation by Review Authority	The review authority shall evaluate the application, referral comments, staff report, and public testimony, if any, and make a recommendation to the decision-making authority to approve, approve with conditions, continue for additional information or for further study, or deny the application.
Review and Action by Decision-Making Authority	A decision-making authority may approve, approve with conditions, continue or remand for additional information or for further study, or deny the application or appeal. In taking action, the decisionmaking authority shall evaluate the application, referral comments, staff report, public testimony, and the review authority's recommendation.
Continuation of Public Hearings	The review or decision-making authority may continue the public hearing for its consideration of the application, not to exceed 60 days , unless a longer time is agreed to by the applicant in writing or at a public hearing.
Color Key: Applicant Action Public Action City Action Authority Action	

3.2 REVIEW OF APPLICABLE ORDINANCES

Sections of the City's Code of Ordinances that potentially impact implementation of stormwater management were reviewed to identify weaknesses, ambiguities, and inconsistencies with the current policy and to provide recommended next steps for policy updates. These chapters were also reviewed for barriers to implementation of green infrastructure as a sustainable stormwater management alternative. Table 1 provides a list of the sections that were reviewed as part of this effort.

Table 1: Code of Ordinances Sections Reviewed for Stormwater Management Policy

CHAPTERS	SECTIONS
400 Planning and Zoning Commission	080 Definitions**
	130 Regulation of Public Improvements**
	210 Major Street Plan**
	240 Complete Streets Policy
405 Unified Development Code	020 Common Development Review Procedures
	030 Specific Procedures
	040 Zoning Districts
	050 Uses and Use Standards**
	060 Purpose and Applicability of Development Standards
	070 Natural Resource Area Protection Development Standards
	080 Mobility and Connectivity Development Standards
	090 Commercial and Mixed-Use Design and Development Standards
	100 Multifamily and Townhouse Design Standards
	110 Parking and Loading
	120 Landscaping and Screening
	130 Sustainability
	140 Subdivision Design Standards
	180 Rules of Construction; Interpretation; Definitions
415 Floodplain Management	150 General Standards
	160 Specific Standards**
	180 Floodway**
	280 Definitions
500 Building Regulations	050 Standards and Procedures for the Construction of All Public Works Projects
705 Sewers	010 Definitions
	210 Discharge of Surface Runoff or Ground Water into Building Sewer Connected to Public Sewer Prohibited**
	250 Stormwater, Surface Water, Etc. - Discharge Into Sanitary Sewer Prohibited**
	260 Stormwater, Surface Water, Etc. - Discharge Into Approved Sewers or Outlets**
**Cursory reviewed but determined limited revisions needed and/or found not applicable to stormwater management.	

This section includes a summary of the recommended code amendments necessary to implement the stormwater management design criteria. Redlines to each code section implementing these

recommendations are included in Appendix A: Code of Ordinances Revision Redlines. A summary of additional recommendations for other reviewed code sections not imperative to the immediate implementation of the proposed stormwater management design criteria are found in Appendix D: Summary Recommendations for Future Code of Ordinances Revisions.

SECTION 405.020 COMMON DEVELOPMENT REVIEW PROCEDURES

Revise Tables 405.020-1 and 405.020-2. As part of these recommendations, a drainage permit application has been developed for the City's use. This code section describes the procedures for review of all applications for land use and development activity in Warsaw. [Table 405.020-1, Specific Procedures](#) and [Table 405.020-2, Notice Requirements](#) will need to be amended to add the drainage permit as an application type. It is recommended to have the drainage permit listed after grading permit, in Section 405.030(O).

SECTION 405.030 SPECIFIC PROCEDURES

Revise [Table 405.030-1, Summary of Administrative Review Procedures](#). This table summarizes the procedures for review and approval for land use and development applications. Drainage permit (O) is added to the bottom of this table to indicate how each is approved.

Additionally, adjusting the table heading so that the "Key" row is only shown under Planning Director/City Engineer to Board of Adjustment is recommended. The second column that indicates what subsection each application type can be found in is useful, but the 'key' below it causes confusion between the subsection letter and the key letters. The recommended change to Table 405.030-1 header is depicted in Figure 4.

Existing Table Heading

Table 405.030-1 Summary of Administrative Review Procedures					
Procedure	Section 405.030.	Planning Director/ Staff	Planning and Zoning Commission	Board of Aldermen	Board of Adjustment
Key: R = Review A = Approve PH = Public hearing X = Appeal					
Comprehensive Plan amendment	B	R	A	Adopt by resolution	

Proposed Table Heading

Table 405.030-1 Summary of Administrative Review Procedures					
Procedure	Section 405.030.	Planning Director/City Engineer Staff	Planning and Zoning Commission	Board of Aldermen	Board of Adjustment
Key: R = Review A = Approve PH = Public hearing X = Appeal					
Comprehensive Plan amendment	B	R	A	Adopt by resolution	

Figure 4: Recommended Changes to Table 405.030-1 Headers

For Site Plan applications, the Administrative subtype only shows a review by the Planning Director/Staff but no approval authority. Based on [Subsection \(F\), Site Plan](#), the “R” under Planning Director/Staff is changed to “A”. The recommended change to the Administrative Site Plan Review row of Table 405.030-1 is depicted in Figure 5.

Existing - Administrative Site Plan Review					
Site plan	F				X
Administrative		R			X
PZC review		R	A	X	

Proposed - Administrative Site Plan Approval					
Site plan	F				X
Administrative		A			X
PZC review		R	A	X	

Figure 5: Recommended Changes to Table 405.030-1 Administrative Site Plan Review Rows

Add Submittal Requirements for Subsection (F), Site Plan. Per [Subsection \(F\)\(1\), Purpose](#), building or land use permits shall be issued only after a site plan has been approved. Additionally, the following application types listed in [Table 405.030-1](#) require a site plan pursuant to Subsection (F) be submitted with the application:

- Rezoning
- Conditional use permit
- Planned development

In the existing code section, there are no submittal requirements for site plans, nor were there any in an application form provided by the City. Community ReCode recommends that a list of submittal requirements be included under Subsection (F)(3)(b), *Application and notice*, which includes site, zoning, project specific, and stormwater management information. Alternatively, the detailed list could be put into application forms rather than the code. The stormwater management line directs applicants to submit a drainage permit with the site plan if the project meets the applicability requirements of Section 405.030(O), *Drainage Permit*. This language should be in the code, even if the submittal requirements get added to application forms instead. This allows projects that do not trigger the stormwater requirements to be exempt from submittal of the drainage permit. Projects that do trigger the stormwater requirements can then submit the drainage permit with the site plan and relevant application, rather than two applications that may require separate fees.

Remove Section 405.070 from Allowed Alternative Compliance. This procedure allows for alternative compliance for certain sections of the code. It is recommended to remove Section 405.070 from the list in [Subsection \(H\)\(2\), Applicability](#), so that alternative compliance is not allowed for stormwater management.

Add Submittal Requirements to Subsection (I), Major Subdivision. Another application type that needs to incorporate the drainage permit is the preliminary plat application. In the existing code section, there are no submittal requirements for preliminary plats. There are existing requirements in the application form provided by the City, however the form is dated. Similar to the revisions for

Subsection (F), *Site Plan*, a proposed list of submittal requirements is drafted under Subsection (I)(3)(c), *Application and notice*, per Community ReCode's recommendation, which includes site, lot and zoning, project specific, and stormwater management information. The stormwater management line directs applicants to submit a drainage permit with the plat if the project meets the applicability requirements of Section 405.030(O), *Drainage Permit*.

Reference Plat Requirements in Subsection (J), *Minor Subdivision and Administrative Lot Combination*. Minor subdivision and lot combination applications are applicable in four different instances, as defined in [Subsection \(J\)\(2\), *Applicability*](#). Currently there is no requirement to submit a plat with these applications. It is recommended that a reference be added to Subsection (J)(3)(b)(1) that directs the applicant to submit a plat pursuant to the new preliminary plat submittal requirements. This will lead the applicant to review the drainage permit applicability and submit a drainage permit along with the plat and application if applicable. **Clarify Standards Not Allowed for Minor Modification.** A minor modification application can be submitted with another application for the purpose of amending the standards applicable to the proposed project. A line should be added under [Subsection \(M\)\(2\), *Standards subject to minor modification*](#), to make it clear that stormwater standards cannot be modified.

Revise Purpose and Authority for Grading Permit. [Subsection \(N\)\(1\), *Purpose*](#) should be revised slightly to remove the review of drainage patterns as part of the grading permit since this is covered under the proposed Drainage Permit. Additionally, the City may want to change the authority approval from the Director of Public Works to City Engineer under [Subsection \(N\)\(4\)](#) to better align with actual positions within the City.

Insert Subsection (O), *Drainage Permit*. A new subsection is included that details the purpose, applicability, procedures, and action by review and decision-making bodies for the new drainage permit. The drainage permit generally follows the same format as the grading permit.

Move Permits to Subsection (P), *Permits*. The existing Subsection (O), *Permits* is moved down a letter to allow room for the drainage permit to be listed before it.

SECTION 405.040 ZONING DISTRICTS

Revise Definitions in Subsection (I), *Waterfront Overlay District*. Several terms defined in [Subsection \(I\)\(2\), *Definitions*](#) are not referenced anywhere within this code section. It is recommended to delete terms that are not referenced.

Revise [Subsection \(I\)\(6\)\(i\), *Natural features*](#). This part prohibits destruction of natural features. Additions to this text are recommended to require compliance with Section 405.070, *Stormwater Management and Natural Area Protection*.

SECTION 405.060 PURPOSE AND APPLICABILITY OF DEVELOPMENT STANDARDS

Simplify Applicability. For redevelopment, the code states that if the assessed valuation of external additions is between 10% and 75% of the assessed value of the property, then the developer can only comply with the development standards up to that percent. The purpose of this is to not cause undue hardship on applicants by requiring them to apply all the standards to their project when the cost of meeting the standards could be greater than the value added to their property. However, this allows for the developer to define what the estimated increase in assessed value would be without an objective way to verify this value. Furthermore, for the majority of the

standards there is not a functional or methodical way to apply a percent of the requirements, and the ambiguity of the policy leaves room for legal conflicts.

Community ReCode has revised this section to only allow exemptions for Section 405.110, *Parking and Loading*, and Section 405.120, *Landscaping and Screening*, rather than all of the development standards (Sections 405.070 to 405.120). They also changed “most recent county assessed value” to “building permit valuation” for the improvement valuation method. Depending on who completes the building permit valuation, this could still be too subjective in allowing the developer to define a lower value to avoid meeting the full requirements. Additionally, it is Burns & McDonnell’s understanding that the building permit valuation would take place after the design has been proposed and may be based on the construction cost of the proposed improvements. If this is the case, then it is unclear how this process to establish percent of compliance would work within the timeline of the project. For instance, if an applicant needed to know the value in order to establish percent of compliance, and the percent of compliance determines what improvements need to be made, but the value is determined by the improvements in the design, this creates a circular reference.

Burns & McDonnell recommends that the City considers revising this policy to direct applicants to ask for a variance to the standards if it is believed meeting the standards will cause undue hardship, rather than having it be determined based on value. [Section 405.030\(K\)](#) establishes the procedures and the requirements for requesting a variance. This gives the opportunity for the City to decide what standards are appropriate for the project to follow on a case-by-case basis.

SECTION 405.070 NATURAL RESOURCE AREA PROTECTION DEVELOPMENT STANDARDS

The majority of the recommended code revisions to align stormwater policy with stormwater criteria are within Section 405.070. Recommendations include reorganization and renaming of the section, revisions to existing text, and additional requirements for stormwater management and natural drainage paths.

Change Section Name. This section is renamed to *Stormwater Management and Natural Area Protection Standards* so that the title better represents the content and so that stormwater management standards can quickly be found within the code.

Reorganize Section. Changes to the layout and headings are recommended so that the policies apply to more types of development and to group similar policies together under the correct heading. Major changes to the existing section include:

- Subsection (C)(4)(b), *Natural drainage patterns*
 - Moved up a level so that the requirements apply to all development, not just development on slopes between 15% and 20%.
- Subsection (C)(5), *Winter erosion blanket*
 - Moved to Erosion Prevention and Sediment Control.
- Subsection (D)(2), *Grading plan; revegetation of disturbed sites*
 - Moved up a level, as it includes requirements for the grading permit.
- Subsection (D)(3), *Stormwater Management; Redevelopment of Existing Lot or Parcel*

- Moved up a level, as stormwater management includes more requirements than just for erosion prevention and sediment control. Additionally, the “redevelopment of existing lot or parcel” was removed as stormwater management should apply to all types of development, not just redevelopment.

Other items within the major headings have been moved around in the draft redlines. Each change is not detailed in this report. The table below compares the existing section layout and major headings to the proposed layout and major headings:

Existing 405.070	Proposed 405.070
Natural Resource Area Protection Development Standards	Stormwater Management and Natural Area Protection Standards
A. Purpose	A. Purpose
B. Applicability	B. Definitions
C. Steep Slope and Ridgeline Development	C. Stormwater Management Requirements
1. Purpose	D. Natural Drainage Path Requirements
2. Applicability	1. Natural drainage path preservation
3. Development of slopes greater than 20%	2. Stormwater drainage setbacks
4. Development on slopes between 15% & 20%	E. Drainage easements
a. Site design	F. Maintenance agreements
b. Natural drainage patterns	G. Grading plan; revegetation of disturbed sites
5. Winter erosion blanket	H. Erosion Prevention and Sediment Control
6. Utilities on slopes	I. Steep Slope and Ridgeline Development
7. Cutting, grading, and filling	1. Purpose
8. Raising or lowering of natural grade	2. Applicability
9. Vehicular routes	3. Development of slopes greater than 20%
10. Trails	4. Development on slopes between 15% & 20%
D. Erosion Prevention and Sediment Control	5. Utilities on slopes
1. Standards	6. Cutting, grading, and filling
2. Grading plan; revegetation of disturbed sites	7. Raising or lowering of natural grade
E. Stormwater Management; Redevelopment of Existing Lot or Parcel	8. Vehicular routes
	9. Trails

Applicability to the Waterfront. [Subsection \(B\), Applicability](#) states that these development standards do not apply to the “City’s downtown waterfront”, which was assumed to mean the Waterfront Overlay District. However, it is especially important that the standards in the section apply to waterfront development. The applicability section is removed in the draft redlines, as the standards are generally applicable.

Definitions. A definition section is included in the proposed redlines for terms that are relevant to the new content of the section. If in the future the City decides to consolidate definitions, the definitions here can be moved as well so that they apply to the entire code, not just Section 405.070.

Stormwater Management Requirements. The existing reference to stormwater criteria is buried at the very end of the section and does not apply to new development or include post-construction stormwater requirements. The proposed revisions move this subsection to the front of the section and requires stormwater management to be applied to all projects as described in Section 405.030(O), *Drainage Permit*. The revision references the City of Warsaw stormwater management design

criteria, rather than detailing any requirements in the code itself. It also references the Section 405.030 for procedures to demonstrate compliance.

Stormwater Drainage Setbacks. Along with moving the natural drainage path requirements out of the steep slopes section so that it applies to all types of development, requirements have been added for stormwater drainage setbacks. The policy is based on other stream buffer policies that have been implemented in the Kansas City metropolitan area but is tailored for application in Warsaw. The additions to the code include guidance for defining the setback, minimum setback widths, and allowable uses within different setback zones.

Also included in this subsection is a takings provision that states the application of the stormwater drainage setbacks shall not deprive any landowner of substantially all of the market value of their property or otherwise constitute an unconstitutional taking without compensation. If application to a specific project would create a taking, then the Board of Aldermen may allow a variance, but only to the extent necessary to avoid a taking. This is to protect property owners who have lots substantially within the drainage setback from economic hardship, and to protect the city from legal action.

Drainage Easements and Maintenance Agreements. Storm drainage systems must be maintained after they are built. To ensure long-term maintenance of these systems, the property owner will be required to enter into a stormwater management operations and maintenance agreement that commits them to maintaining the storm drainage systems they build. To ensure they are being maintained, the City will need access to inspect them via a drainage easement. Both of these requirements have been included in the recommendations as 405.070(E), *Drainage easements* and 405.070(F), *Maintenance agreements* in the draft redlines.

The City does not currently have a process for dedicating easements. One should be established when adopting these recommendations so that the City will be prepared to accept easements as development begins to adhere to the new stormwater policy. This process is important for other public utilities as well, such as water and sewer. Additionally, the City may want to have a template maintenance agreement prepared to work from when accepting easements.

Other Text Revisions. For the existing policies that are to remain within the section, text revisions are proposed throughout to align the code with the proposed stormwater criteria and to improve on the guidance for steep slope development and erosion control.

SECTION 405.080 MOBILITY AND CONNECTIVITY DEVELOPMENT STANDARDS

Reference to Stormwater Management Standards. Subsection (C)(1), *Street standards* currently states that streets shall meet the standards of Section 405.140, Subdivision Design Standards. It is recommended to add additional references for Section 405.070, *Stormwater Management and Natural Area Protection Standards* and Section 500.050, *City of Warsaw Standards and Procedures for Design and Construction*.

SECTION 405.090 COMMERCIAL AND MIXED-USE DESIGN AND DEVELOPMENT STANDARDS

Native Plant Reference. Subsection (B)(2)(b) points to Section 405.120 for recommended native plant species. However, there are no recommend plants in this section, only a reference to the

Planning and Zoning Commission. It is recommended to replace this reference with a reference to the stormwater management design criteria, where regional native plant lists are linked/referenced.

Stormwater Management in Site Design. A statement under [Subsection \(B\)\(2\), Site design requirements](#) should be added to remind developers that site design must incorporate stormwater management requirements, with a reference to Section 405.070, *Stormwater Management and Natural Area Protection Standards*.

SECTION 405.100 MULTIFAMILY AND TOWNHOUSE DESIGN STANDARDS

Stormwater Management in Site Design. A statement under [Subsection \(C\), Site Design](#) should be added to remind developers that site design must incorporate stormwater management requirements, with a reference to Section 405.070, *Stormwater Management and Natural Area Protection Standards*.

SECTION 405.120 LANDSCAPING AND SCREENING

Promote use of Green Infrastructure in Landscape Buffer. [Section 405.120\(A\)\(3\)\(b\), Landscape buffer, \(2\) Uses and easements](#) prohibits permanent detention basins within the landscape buffer area. Additional language is recommended to encourage use of green stormwater infrastructure (GSI)/ stormwater best management practices (BMPs) to meet both landscaping and stormwater retention requirements per the design criteria. Revisions to allow for drainage easements within the landscape buffer are also recommended for GSI/stormwater BMP applications.

Allow Exceptions for Curbs. Exceptions to curb requirements in [Section 405.120\(A\)\(3\)\(d\), Parking Lot Landscaping, \(3\) Curbs](#) are recommended for applications of GSI/stormwater BMPs.

Replace Reference to Plant List. [Section 405.120\(A\)\(4\)\(b\), Allowed plant materials](#) states that a list of permissible plant species shall be adopted by the Planning and Zoning Commission. It is recommended to replace this reference with a reference to the stormwater management design criteria, where regional native plant lists are linked/referenced.

Correct Terminology. In [Section 405.120\(A\)\(4\)\(c\), Revegetation, \(1\)](#) the code states,

- (1) "A revegetation bond, satisfactory to the Director, must be furnished as a condition of certificate of occupancy and shall remain in full force and effect until the landscaping plan is completed, vegetation is sufficiently established, and **structural** best management practices (BMPs), such as silt fence and straw bales, are removed from the site."

What is described in the existing text are temporary erosion and sediment control BMPs, whereas structural BMPs refer to permanent post-construction installations such as green infrastructure. This recommended change from "structural best management practices" to "temporary erosion and sediment control" has been drafted and included in Appendix A.

Reference Section 405.070 in Landscaping Standards. A statement should be added under [Section 405.120\(A\)\(4\), Landscaping Standards](#) that encourages designers to consider how they might be able to meet both the landscaping requirements and the stormwater management requirements using the same site features, with a reference pointing back to Section 405.070.

SECTION 405.130 SUSTAINABILITY

This section provides the City an opportunity to demonstrate their commitment to sustainability and encourage use of green stormwater infrastructure for all public and private improvements. Green stormwater infrastructure is becoming more of an industry standard practice for stormwater management and integration into projects is positively viewed for state and federal funding opportunities. Similar to the complete streets policy, the proposed additions for sustainability codify Warsaw's commitment to resiliency and sustainability.

New Green Stormwater Infrastructure Subsection. Section [405.130, Sustainability](#) provides standards for wind and solar energy. A third subsection has been drafted in support of green stormwater infrastructure to be included in this section. The subsection includes the following:

- **Purpose.** Supports the use of green stormwater infrastructure, lists other terminology, and distinguishes between construction and post-construction stormwater management.
- **Applicability.** References the requirements of Section 405.030(O), *Drainage Permit* and Section 405.070, *Stormwater Management and Natural Area Protection Standards*.
- **Principles.** Provides three guiding principles of Warsaw's stormwater management approach:
 1. Utilize and protect the natural stormwater system
 2. Capture rain where it falls
 3. Minimize impervious surfaces

SECTION 405.140 SUBDIVISION DESIGN STANDARDS

Remove Submittal Requirements. [Subsection \(B\), Submittal Requirements](#) includes procedures and submittal requirements for preliminary and final plats. Procedures were already described in [Section 405.030](#) in great detail, and submittal requirements have been added to Section 405.030 as part of these recommendations. The subsection here should be removed to prevent conflicting guidance.

Reference Section 405.070 in Drainage Easements. [Subsection \(C\)\(4\)\(b\), Drainage easements](#) includes standards for drainage easements, which as written is ideal for surface flow, including defined channels and natural drainage paths. This language has been streamlined to reference the requirement for drainage easements in Section 405.070 and the stormwater management design criteria which provides detailed requirements for easements for specific drainage system components.

Reference Section 405.070 in Required Improvements. In [Subsection \(E\)\(3\), Storm drainage](#) the code states, "*The subdivider shall install culverts, storm sewers, riprap slopes, stabilized ditches, and these and other improvements shall comply with the minimum standards of the Board of Aldermen as such plans shall be examined by the City Engineer and approved prior to construction.*" It is recommended that this language be generalized to reference the stormwater requirements found in Section 405.070 and drainage permit requirements per Section 405.030 (O) rather than listing specific stormwater management techniques here.

SECTION 500.05 STANDARDS AND PROCEDURES FOR THE CONSTRUCTION OF ALL PUBLIC WORKS PROJECTS

Change Section Name. This section is renamed to *City of Warsaw Standards and Procedures for Design and Construction* so that the standards and procedures referenced apply broadly to all types of work in the City, not just for public works projects.

Design Criteria Reference. The code currently references the 1997 Edition of the Kansas City Metro Chapter of the APWA standard specifications and design criteria². It is recommended that the City not include a reference to a specific version, but rather direct people to the City's website and post a link to the APWA website so that developers will use the most current version. Additionally, the revised APWA 5600 criteria should be posted as the City's own stormwater management design criteria. This allows the City to stay current in the future when any APWA standard is updated without amending the code.

Additionally, item A. 2. currently references to the "construction and materials specification within the Water Division II Section 2900 of the American Water Works Association." Section 2900 correlates with the American Public Works Association (APWA) rather than the American Water Works Association (AWWA), and as currently referenced this standard does not exist. It is recommended that this item be deleted and allow the item 1 reference to APWA be the consistent standard specifications and design criteria reference.

² Kansas City Metropolitan Chapter American Public Works Association (APWA); 1997; *Standard Specifications and Design Criteria*

SECTION 4

DESIGN CRITERIA RECOMMENDATIONS

4.1 CURRENTLY ADOPTED STORMWATER DESIGN CRITERIA

The City's currently adopted design criteria is the 1997 Edition of APWA 5600³ (Ord. No. 2004-03 §1, 2-17-2004). The stormwater criteria and requirements for this reference are included in Section 5600 Storm Drainage Systems and Facilities, adopted March 21, 1990. Because the currently adopted standards are relatively dated and have gone through multiple updates since the adopted version, design criteria review focused on the current version of APWA Section 5600, dated February 16, 2011⁴.

4.2 APWA 5600 REVIEW

The current version of APWA Section 5600 was reviewed and marked up with recommended revisions for applicability in Warsaw. A summary of the major recommended changes is discussed in the following subsections. Appendix B: Stormwater Management Design Criteria (APWA 5600) Redlines includes all proposed revisions.

5601 ADMINISTRATIVE

5601.1 INTRODUCTION AND 5601.2 DEFINITIONS

Revisions were made to geographically associate the criteria with the City of Warsaw. Definitions were added and revised to account for revisions throughout the criteria document and to be consistent with the recommended revisions to the Code of Ordinance. A reference to the Kansas City, Missouri Green Stormwater Infrastructure Manual (KCMO GSI Manual) was included to provide a resource for the detailed design and construction of GSI practices. The KCMO GSI Manual includes design guidance for sizing of GSI practices, design considerations and checklists for GSI components, design detail templates, construction specification templates, as well as establishment and maintenance recommendations.

5601.3 GENERAL REQUIREMENTS AND APPLICABILITY

The applicability of the criteria was clarified to apply to all development and redevelopment projects. Exceptions are provided based on impervious area created, or existing stormwater management as follows:

- Redevelopment that causes an increased area of impervious surface on the site less than 1,000 square feet
- New development any one new single family or duplex dwelling unit that creates less than 5,000 square feet of impervious area
- Construction on a site having previously provided stormwater management as part of a larger unit of development assuming fully developed conditions. If previously provided

³ Kansas City Metropolitan Chapter American Public Works Association (APWA); 1997; *Standard Specifications and Design Criteria*

⁴ Kansas City Metropolitan Chapter American Public Works Association (APWA); 2011; *Standard Specifications and Design Criteria* Section 5600 Storm Drainage Systems & Facilities

stormwater management for the project predates these standards, stormwater management shall be re-evaluated for compliance with the current requirements.

5601.5 STORMWATER MANAGEMENT REQUIREMENTS

This is a new subsection created that consolidates requirements that were previously distributed throughout varying sections of APWA 5600. The proposed section clarifies the desired approach to stormwater management and the necessity to preserve the existing natural drainage paths and streams in Warsaw. The Stormwater Drainage Permit is introduced to demonstrate compliance with the stormwater management requirements and includes reference to the Code of Ordinances section that specifies this process. Stormwater management criteria is then summarized as follows:

- **Protection of Property:** Requires protection of property and buildings from the 100-year storm event. This language is consistent with current version of APWA 5600. Additional detail is specified for good lot-to-lot grading practices for tributary areas less than 2 acres.
- **Retention:** Requires retention be provided for the 0.5-inch rainfall event over the tributary impervious area of the site. Retention-based facilities either capture and infiltrate or re-use the required retention volume with no discharge from the site during the design event. Retention requirements may be achieved in conjunction with detention storage.
- **Detention:** Requires controls for the peak discharge of the 2-, 10-, and 100-year design storms. More stringent requirements were added for peak flow control of the less extreme rain events, while allowing for the more extreme, infrequent events to stay consistent with the current version of APWA 5600, as shown in Table 2.

Table 2: Allowable Release Rates by Tributary Area

Design Event Average Recurrence Interval	Temporal Distribution	Allowable Release Rate by Tributary Area (cfs/acre)
2-Year	50% (Median)	0.1
10-Year	50% (Median)	0.2
10-Year	10%	2.0
100-Year	10%	3.0

- **Conveyance:** Conveyance requirements are defined for natural drainage path preservation/overflow systems, open systems, enclosed systems, and street crossings.
 - Natural Drainage Path/Overflow Systems: requires preservation overland drainage path to allow for conveyance of storm events in excess of the designed system capacity. Requires stormwater drainage setbacks be dedicated through Drainage Easements.
 - Open Systems: designed to convey the 10-year design storm
 - Enclosed systems: designed to convey the 10-year design storm with gravity flow and pressure flow requirements.
 - Street Crossings: updated street classification terminology to be consistent with the Warsaw Livable Community Transportation Improvement Plan. Level of service requirements stayed consistent with current version of APWA 5600.
- **Collection:** gutter spread requirements revised to limit to one lane width for emergency vehicle access during the 10-year design storm.

5602 HYDROLOGY

Proposed changes made throughout the hydrology section are related to updating the currently referenced Soil Conservation Service (SCS) Type II 24-hour rainfall distribution requirements to National Oceanic and Atmospheric Administration (NOAA) *Atlas 14 Volume 8 Precipitation Frequency Atlas of the United States for Midwestern States*⁵, herein referred to as NOAA Atlas 14. Background analysis and justification for this recommendation is summarized in the *Warsaw Stormwater Study Hydrologic Analysis & Hydraulic Review*⁶ included in Appendix E for reference. Rainfall distribution mass and rainfall intensity tables were updated to include median (50%) and 10% temporal distributions. To streamline the design criteria, recommended revisions also include removing of several tables and graphics that are either no longer applicable, dated, or not directly usable in applying the criteria.

Additionally, a new runoff parameters table (Table 5602-1) has been developed to better align with City of Warsaw zoning designations. Calculation of the rational coefficient “C” using known percent impervious area was moved to the beginning of the section such that this method is used first when impervious area information is available rather than assumed coefficients based on land use.

5603 HYDRAULICS

The majority of the hydraulics calculations section remains consistent with the current version of APWA 5600. Updates were made to allow for use of industry standard hydraulic modeling software for hydraulic calculations. This approach avoids use of a static list of software that becomes dated with technological advancements.

5604 INLETS, MANHOLES AND JUNCTION BOXES

5604.1 DESIGN CRITERIA

Design criteria consistent with the requirements specified in Section 5601.5 are repeated here for ease of reference when designing drainage system components specific to this section.

5604.2 INLET DESIGN

Proposed revisions include updating inlet design criteria to follow methods prescribed in the Hydraulic Engineering Circular No. 22 Urban Drainage Manual (HEC-22)⁷. HEC-22 serves as the basis for current industry standard practices for calculating inlet capacity and gutter spread. To assist designers in consistent application of HEC-22 calculations, inlet parameters are provided based on APWA standard details for inlets as well as curb and gutter.

5605 NATURAL DRAINAGE PATHS & STREAMS

5605.1 DESIGN CRITERIA

Design criteria consistent with the requirements specified in Section 5601.5 are repeated here for ease of reference when designing drainage system components specific to this section.

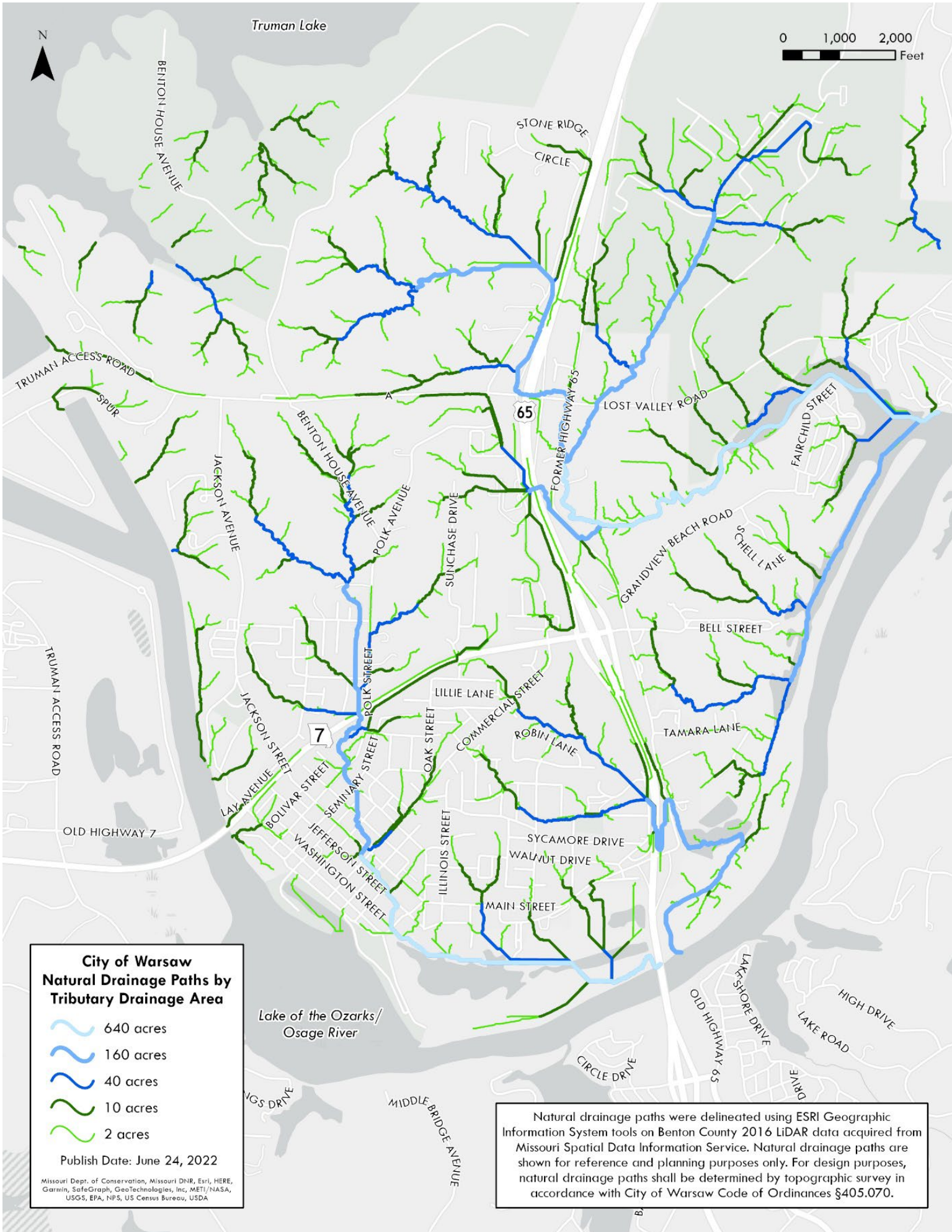
⁵ National Oceanic and Atmospheric Administration (NOAA); 2013; NOAA Atlas 14: Precipitation-Frequency Atlas of the United States; Volume 8, Version 2.0: Midwestern States (Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, Wisconsin); https://www.nws.noaa.gov/oh/hdsc/PF_documents/Atlas14_Volume8.pdf

⁶ Burns & McDonnell; 2020; Warsaw Stormwater Study Hydrologic Analysis & Hydraulic Review

⁷ Federal Highway Administration; 2013; Hydraulic Engineering Circular No. 22

5605.2 EASEMENTS (STORMWATER DRAINAGE SETBACKS)

The current version of APWA 5600 includes a subsection for stream preservation and buffer zones. The proposed revisions replace this subsection with specific requirement recommendations for Warsaw. This subsection was added to define requirements for preservation of natural drainage paths with stormwater drainage setbacks dedicated to the City as a drainage easement. Natural drainage paths delineated from light detection and ranging (LiDAR) data for the City of Warsaw are shown in Figure 6 and included as a full-size figure in Appendix A of the criteria document. Natural drainage paths were delineated using Environment Systems Research Institute, Inc. (ESRI) Geographic Information System (GIS) tools on Benton County 2016 LiDAR data acquired from Missouri Spatial Data Information Service. Natural drainage paths are shown for reference and planning purposes only. For design purposes, natural drainage paths shall be determined by topographic survey in accordance with City of Warsaw Code of Ordinances §405.070.



**City of Warsaw
Natural Drainage Paths by
Tributary Drainage Area**

- 640 acres
- 160 acres
- 40 acres
- 10 acres
- 2 acres

Publish Date: June 24, 2022

Missouri Dept. of Conservation, Missouri DNR, Esri, HERE,
Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA,
USGS, EPA, NPS, US Census Bureau, USDA

Natural drainage paths were delineated using ESRI Geographic Information System tools on Benton County 2016 LiDAR data acquired from Missouri Spatial Data Information Service. Natural drainage paths are shown for reference and planning purposes only. For design purposes, natural drainage paths shall be determined by topographic survey in accordance with City of Warsaw Code of Ordinances §405.070.

Proposed setback widths were determined based on tributary drainage area as listed in Table 3 and shown in Figure 7. The dedicated drainage easement would consist of the defined setback widths with limitations on development within each as follows:

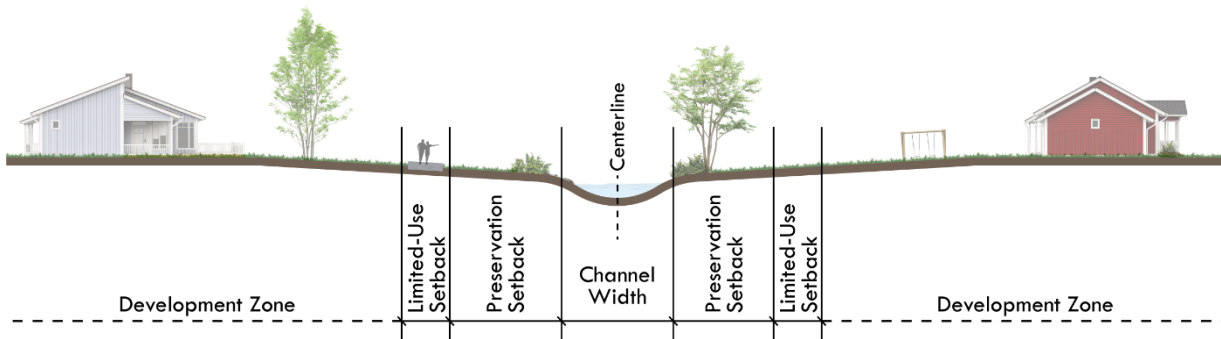
- **Channel Width:** centered on the natural drainage path is preserved for frequent stormwater flows with no other allowable uses.
- **Preservation Setback Width:** begins at the top of bank of the natural drainage path/stream and is preserved for vegetation or other forms of bank stabilization with no other allowable uses.
- **Limited-Use Setback Width:** extends a predetermined distance from the preservation setback or to the extents of the 100-year Federal Emergency Management Agency (FEMA) floodplain, whichever is greater. Allowable uses within the protection setback width include community amenities such as trails and greenways, as well as utility rights-of-way.

Table 3: Stormwater Drainage Setbacks

Drainage Area (acre)	Assumed Channel Width (feet)*	Preservation Setback Width (feet)	Limited-Use Width (feet)	Total Setback Width (feet)
2 to < 10	5	5	-	15
10 to < 40	10	10	10	50
40 to < 160	30	30	10	110
160 to < 640	60	60	20	220
640+	80	80	20	280

*Actual channel width may differ from Assumed Channel Width values presented in table based on results of topographic survey.

Figure 7: Stormwater Drainage Setbacks



5606 ENCLOSED PIPE SYSTEMS

Design criteria consistent with the requirements specified in Section 5601.5 are repeated here for ease of reference when designing drainage system components specific to this section. The majority of the remaining enclosed pipe system section remains consistent with the current version of APWA 5600.

5607 ENGINEERED CHANNELS

Design criteria consistent with the requirements specified in Section 5601.5 are repeated here for ease of reference when designing drainage system components specific to this section. The majority of the remaining engineered channels section remains consistent with the current version of APWA 5600.

5608 STORMWATER DETENTION AND RETENTION

5605.1 DESIGN CRITERIA

Design criteria consistent with the requirements specified in Section 5601.5 are repeated here for ease of reference when designing drainage system components specific to this section. Equations are included for calculation of the required retention volume. These requirements replace the majority of the current version of APWA 5600 performance criteria subsection.

5608.2 RETENTION CRITERIA

Recommended design criteria for retention through use of green stormwater infrastructure (GSI)/post-construction permanent stormwater best management practices (BMPs) is included. Equations are included for calculating provided retention volume based on storage capacity in surface ponding, subsurface soil, aggregate, piping or storage chamber layers of a GSI/BMP. Parameter assumptions for common media types used in GSI/BMPs are also provided. Retention requirements may be achieved in conjunction with detention storage, or independently. A reference to the Kansas City, Missouri Green Stormwater Infrastructure Manual (KCMO GSI Manual) was included to provide a resource for the detailed design and construction of GSI practices. The KCMO GSI Manual includes design guidance for sizing of GSI practices, design considerations and checklists for GSI components, design detail templates, construction specification templates, as well as establishment and maintenance recommendations.

5608.5 DETENTION CRITERIA

Minor modifications are recommended to grading and side slope design requirements for detention basins. Allowance for underground detention to meet peak flow reduction requirements on a request for variance basis was also included with associated design criteria.

Revisions were made to align computation methods and basin sizing requirements consistent with the proposed design criteria rainfall distribution and retention requirements. Revised criteria requires the 2- and 10-year design storm with median (50%) temporal distribution to be controlled by the primary outlet structure, but allows for the 10- and 100-year design storms with 10% temporal distribution to pass through the emergency spillway with 0.5-feet of freeboard from basin overtopping. Primary outlet and emergency spillway requirements were revised accordingly.

Previously included subsection for required submittals was removed to avoid conflict and/or duplication with requirements prescribed in Section 5609 Submittal Requirements.

5609 SUBMITTAL REQUIREMENTS

The current version of APWA 5600 references this section in several locations within the criteria for requirements for a drainage report/study, however, the section does not include any such requirements. Instead, the current section includes requirements for construction plans. The proposed revisions add a subsection to summarize the requirements for the Stormwater Drainage Permit to demonstrate compliance with this design criteria. The requirements summarized here align with the inputs required for the Drainage Permit Application Excel worksheet. The proposed Stormwater Drainage Permit includes the following items:

1. Watershed Location Map: identifies the project location in the watershed and depicts project drainage area, natural overland drainage paths, and natural water bodies that the project is tributary to for reference.
2. Existing and Proposed Site Conditions Maps: compares existing and proposed site conditions to verify that proposed site conditions mimic natural topography, maintain overland drainage paths, and provide appropriate stormwater drainage setbacks to protect natural resources.
3. Stormwater Improvement Calculations Tables: summary tables for applicable stormwater drainage system components demonstrating compliance with design criteria for hydrology, conveyance, collection, retention, and detention calculations.

The majority of the construction plan submittal requirements are consistent with the current version of APWA 5600.

SECTION 5

DRAINAGE PERMIT REQUIREMENTS

The stormwater drainage permit application is a digital workbook tool that provides the City with a consistent review mechanism to verify that the stormwater policy and design criteria are being met. This tool also provides users with clear expectations of the analysis and design that is required for approval of the drainage permit.

The drainage permit workbook includes up to six tabs for a designer to fill out that provides sufficient documentation to verify that all applicable stormwater management design criteria requirements are being met. Each tab includes detailed instructions on how the user is intended to input the project-specific information. Where applicable, fields have been setup to auto-populate from previous inputs or auto-calculate based on design requirements to streamline the application process and avoid requesting repetitive information. In general, auto-populated/calculated fields are designated with gray shading and are locked to prohibit the user from accidentally editing.

The tabs are not intended to provide every detailed design parameter and calculation for each component of the drainage system, but instead to provide the minimum parameters and calculations needed to verify that the criteria are being met. The following sections present the six tabs with guidance on how each is intended to be used. The full permit application is included in Appendix C: Drainage Permit Application.

5.1 GENERAL

The General tab serves as the verification summary for project compliance with the design requirements. It first requires the user to input general information on the project starting with the type of project, location, engineer of record, and site parameters. The site parameter inputs then dictate whether or not additional information is required for submittal with the drainage permit. As drafted in the Code of Ordinances and Design Criteria redlines, all development projects that create 5,000 square feet or more of impervious area, and all redevelopment projects that increase impervious area by 1,000 square feet or more require submittal of the Drainage Permit. This section also allows the user to input information regarding a request for variance, if that is being pursued. Figure 8 shows the General Information section of the drainage permit General tab.

Figure 8: Drainage Permit General Tab – General Information

City of Warsaw Stormwater Drainage Permit: General Requirements		
General Project Information		
General Information		
Engineer of Record:		
MO PE Number:		
Project Name:		
Date:		
Project Location		
Address:		
Nearest Intersection:		
Type of Construction		
<input type="checkbox"/> Redevelopment, Expansion, Renovation, Repair and/or Maintenance <input type="checkbox"/> New Construction (individual construction of one single family or duplex dwelling unit) <input type="checkbox"/> New Construction (all other types, including subdivision development, commercial, industrial, etc.)		
Site Parameters		
Total Site Drainage Area (acres)		acres
Existing Impervious Area (square feet)		square feet
Proposed Impervious Area (square feet)		square feet
Difference in Impervious Area (square feet)		square feet
Effective FEMA floodplain?		(Select Yes/No)
Describe Known Stormwater Issues:		
<div style="border: 1px solid black; height: 70px; width: 100%;"></div>		
Permit Requirements/Variance		
Drainage Permit Required?	-	(Select Yes/No)
Request for Variance?		
Why? Explain:		
<div style="border: 1px solid black; height: 100px; width: 100%;"></div>		

The subsequent section of the General tab requires the user to check the box that the permit application includes the three required maps discussed in Section 5609 of the design criteria, as shown in Figure 9.

Figure 9: Drainage Permit General Tab – Required Maps

Required Maps	
<input type="checkbox"/>	Watershed Location Map. Describes the project's location within the greater watershed depicting:
	<ol style="list-style-type: none"> 1. Watershed boundary and area (acres) 2. Delineated drainage area to the project (acres) 3. Natural drainage paths 4. Water bodies (lakes, rivers, streams, creeks, wetlands, etc.) 5. Stormwater retention/detention facility location(s) in watershed affecting stormwater management at project site (if applicable) 6. Conveyance route for overflow system to downstream destination of runoff
<input type="checkbox"/>	Existing Site Conditions Map. Demonstrates existing conditions of the site depicting:
	<ol style="list-style-type: none"> 1. Existing contours 2. Aerial imagery 3. Water bodies (lakes, rivers, streams, creeks, wetlands, etc.) 4. Utilities, including existing stormwater infrastructure 5. Natural drainage paths 6. Parcel boundaries 7. Impervious surfaces 8. Key statistics (areas of boundaries, area of impervious surfaces, etc.)
<input type="checkbox"/>	Proposed Site Conditions Map. Demonstrates proposed conditions of the site depicting:
	<ol style="list-style-type: none"> 1. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information 2. Utilities, including existing stormwater infrastructure overland drainage paths 3. Parcel boundaries 4. Impervious surfaces and types (i.e. building, parking lot, etc.) 5. Stormwater improvements (i.e. detention/retention facilities, open and enclosed conveyance systems, storm drainage structures, etc.) 6. Drainage easements depicting maintained stormwater drainage setbacks and dimensions

Lastly, the designer is required to verify compliance with the design criteria. This section lists out the stormwater management requirements specified in the design criteria with check boxes for “yes,” “no,” and “N/A.” It also automatically pulls in the design inputs from subsequent tabs to compare to the required parameters, which are set based on the site parameters input previously on this tab.

Figure 10: Drainage Permit General Tab – Verification of Compliance with Design Criteria

Designer Verification of Compliance with Design Criteria				
Retention				
Requirements Met?	Design Criteria	Retention Volume (CF)		
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Easement(s) provided?	Required	Designed	
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	0.5" design storm over impervious area of the site			
Detention				
Requirements Met?	Design Criteria	Release Rates (cfs)		
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Easement(s) provided?	Maximum Allowable	Designed	
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	2-year (50% temporal distribution)		0	
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	10-year (50% temporal distribution)		0	
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	10-year (10% temporal distribution)		0	
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	100-year (10% temporal distribution)		0	
Conveyance				
Requirements Met?	Design Criteria			
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Easement(s) provided?			
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Natural Drainage Path Preservation / Overflow System per Section 5605			
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Open system, ditches, swales per Section 5607			
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Enclosed System, Gravity per Section 5606			
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Enclosed System, Pressure per Section 5606			
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Street Crossings / Culverts per Section 5606			
Collection				
Requirements Met?	Design Criteria			
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Inlet placement and gutter spread per Section 5604 (street applications only)			
<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	Inlets placed in low or sump areas on the site			

The General tab serves as a checklist for both the user and the reviewer to verify that the application includes all required components and meets the stormwater management design requirements for approval. This is the most important tab for the City reviewer as it verifies and summarizes that all stormwater management requirements being met. The remaining tabs provide back-up documentation validating the inputs made on the General tab.

5.2 HYDROLOGY

The Hydrology tab requires the user to input the hydrologic parameters and calculations from their design, in accordance with Section 5602 of the design criteria. This includes the drainage areas, impervious areas, and peak runoff flow rates that are used in the subsequent tabs to demonstrate compliance with the design criteria.

Figure 11: Hydrology Tab

Upstream Structure ID	Downstream Structure ID	Drainage Area		Impervious Area (%)	Rational Runoff Coefficient, C	Peak Runoff Flow Rates, Design Storm (Temporal Distribution)							
		Incremental (acres)	Cumulative (acres)			10-Year (50% Distribution)		10-Year (10% Distribution)		25-Year (10% Distribution)		50-Year (10% Distribution)	
						Incremental Q _{10, 50%} (cfs)	Cumulative Q _{10, 50%} (cfs)	Incremental Q _{10, 10%} (cfs)	Cumulative Q _{10, 10%} (cfs)	Incremental Q _{25, 10%} (cfs)	Cumulative Q _{25, 10%} (cfs)	Incremental Q _{50, 10%} (cfs)	Cumulative Q _{50, 10%} (cfs)

5.3 CONVEYANCE

The Conveyance tab requires the user to input the hydraulic parameters and calculations for the various conveyance types included in their design. The spreadsheet requires the user to select the type of conveyance system for each segment in accordance with Sections 5606 for enclosed systems, including street crossings, and 5607 for open systems.

Figure 12: Conveyance Tab – Conveyance System Parameters

Upstream Structure ID	Downstream Structure ID	Conveyance System Segment Type	Conveyance System Parameters								
			Manning's n (Table 5603-1)	Cross-Sectional Area, A (sf)	Wetted Perimeter, P (ft)	Length, L (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope (ft/ft)	Flow Full Velocity, v (ft/s)	Flow Full System Capacity, Q (cfs)
		Open System									
		Enclosed System									
		Street Crossing - Principal Arterial									
		Street Crossing - Primary Connector									
		Street Crossing - Minor Street									

Based on the type of conveyance system selected from the drop down for each row, the spreadsheet will automatically input the design criteria performance standard that the segment is required to meet based on system capacity and hydraulic grade line elevation for the specified design storm. This information populates under the “Design Criteria Check” section of this tab.

The designer must then input the calculated hydraulic grade line elevations for the required design storm based on the specific conveyance system type design requirements listed. Lastly, the designer must input the controlling design elevations for each segment that dictates the hydraulic grade maximums (i.e., structure rim elevation, pavement overtopping elevation, lowest opening of building elevation, etc.). The designer must input “yes/no” for whether the conveyance design inputs meet both the system capacity and the hydraulic grade elevation design requirements for verification of compliance.

Figure 13: Conveyance Tab – Design Criteria Check

Conveyance System Segment Type	System Capacity Required Flow Rate (cfs)	Design Criteria Check					
		System Capacity Design Storm	Maximum Hydraulic Grade Line Design Storm	Hydraulic Grade Line Elevation for Design Storm, HGL _{Design Max} (ft)	Structure RIM, Pavement Overtopping or Lowest Opening Elevation (ft)	System Capacity (yes/no)	Hydraulic Grade Elevation (yes/no)
Open System		10-Year Design Storm (10% Temporal Distribution)	10-Year Design Storm with 10% Temporal Distribution				
Enclosed System		10-Year Design Storm (50% Temporal Distribution)	10-Year Design Storm with 10% Temporal Distribution				
Street Crossing - Principal Arterial		50-Year Design Storm (10% Temporal Distribution)	50-Year Design Storm with 10% Temporal Distribution				
Street Crossing - Primary Connector		25-Year Design Storm (10% Temporal Distribution)	25-Year Design Storm with 10% Temporal Distribution				
Street Crossing - Minor Street		10-Year Design Storm (10% Temporal Distribution)	10-Year Design Storm with 10% Temporal Distribution				

5.4 COLLECTION

The Collection tab requires the designer to input inlet design parameters and calculations based on the requirements specified in Section 5604 of the design criteria. The designer must input all inlet IDs for the project. The spreadsheet will auto-populate the incremental drainage area and flow rates from the Hydrology tab. The designer must populate the “Collection Design Criteria Met” column with “yes/no” for whether design inputs meet the collection requirements.

5.5 RETENTION

The Retention tab requires the designer to input retention design parameters and calculations to meet the requirements specified in Section 5608 of the design criteria. The designer must input information on each retention facility for their site including the total tributary area and the

impervious tributary area to each facility. The spreadsheet then auto-populates the percent impervious and the required retention volume columns.

Figure 14: Retention Tab – Required Retention Volume

Retention Facility ID	Description	Tributary Drainage Area A (acres)	Impervious Tributary Drainage Area A_{imp} (acres)	Percent Impervious I (%)	Retention Volume V_R (ac-ft)
BIO-01 (example)					0
					0
					0
					0
					0
					0
					0
					0
					0
					0
					0
Total Required Retention Volume					0

The designer then inputs the physical parameters for each retention facility design including the geometry of each media layer and the assumed porosity. The volumes for each layer and the retention facility as a whole are then automatically calculated and summed for the project.

Figure 15: Retention Tab – Retention Facility Storage Volume

Retention Facility ID	Ponding			Material 1			Material 2			Material 3			Material 4			Storage Chamber Volume, V_{layer} (ft ³)	Provided Volume (ft ³)	Provided Volume (ac-ft)
	Area, A_{layer} (ft ²)	Height, h_{layer} (ft)	Volume, V_{layer} (ft ³)	Area, A_{layer} (ft ²)	n	Height, h_{layer} (ft)	Volume, V_{layer} (ft ³)	Area, A_{layer} (ft ²)	n	Height, h_{layer} (ft)	Volume, V_{layer} (ft ³)	Area, A_{layer} (ft ²)	n	Height, h_{layer} (ft)	Volume, V_{layer} (ft ³)			
BIO-01 (example)			0				0				0				0		0	0
			0				0				0				0		0	0
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5.6 DETENTION

The Detention tab requires the designer to input modeled detention performance to meet the requirements specified in Section 5608 of the design criteria. The tributary area of the site is auto-populated from inputs made on the General tab, and required release rates are auto-calculated. The designer must then input the stage (elevation), storage, and discharge results for each modeled design storm. The spreadsheet then auto-populates a “yes/no” for whether the design inputs meet the peak discharge and water surface elevation requirements specified in the design criteria.

Figure 16: Detention Tab

Drainage Area	
Tributary Drainage Area to Site (acres)	
Drainage Area Tributary to Detention (acres)	
Design Parameters	
Invert Elevation of Primary Outlet (ft)	
Spillway Crest Elevation (ft)	
Top of Embankment Elevation (ft)	

Design Storm by ARI	Peak Discharge Criteria		Modeled Performance Results			Design Criteria Check	
	Allowable Discharge per Acre Drainage Area (cfs/acre)	Allowable Discharge (cfs)	Modeled Peak Discharge (cfs)	Modeled Maximum Water Surface Elevation (ft)	Modeled Maximum Storage Volume (acre-ft)	Peak Discharge (yes/no)	Water Surface Elevation (yes/no)
2-year (50% temporal distribution)	0.1						
10-year (50% temporal distribution)	0.2						
10-year (10% temporal distribution)	2						
100-year (10% temporal distribution)	3						

SECTION 6

COMMUNITY ENGAGEMENT

For successful implementation of new stormwater management standards, it is important to get the community's feedback and buy-in. An initial community engagement survey is recommended to evaluate the current use and understanding of stormwater policy, design criteria, and planning processes in the community. The goal of the survey is to listen and understand feedback from the community, to gauge current understanding and use of the City's existing stormwater design requirements, to provide initial encouragement and considerations for resilient development that benefits both the community and developer, and to assist in identification of potential barriers to adoption of the proposed stormwater management policy and criteria updates.

It is recommended that the survey be provided on a stormwater management informational landing page on the City's website. This webpage could provide educational information on what stormwater management is and why it is important, including photos of erosion and flooding, information about overland drainage paths, information about green infrastructure, as well as a button that directs to the survey. The survey could then be distributed through social media posts, mailings, bill inserts, flyers, or other efforts that direct users via a QR code or simple vanity URL to the stormwater management informational landing page.

6.1 COMMUNITY ENGAGEMENT SURVEY

The following draft survey questions are recommended for the initial community engagement survey.

PAGE 1

1. Among Warsaw's many priorities, how would you describe each of the below? (Choices for each: Very high priority, high priority, neutral, low priority, not a priority)
 - ☐ Protecting private property;
 - ☐ Protecting public property and infrastructure;
 - ☐ Protecting Warsaw's waterfront;
 - ☐ Building desirable real estate;
 - ☐ Efficient permitting process to facilitate Warsaw's growth efforts;
 - ☐ Extending Warsaw's trail system;
 - ☐ Protecting Warsaw's water quality

Have you experienced or witnessed flooding or erosion of property / land due to rain in Warsaw?

- ☐ Yes
 - ☐ No
2. If yes, where?
 - ☐ Fill in the blank
 3. How would you describe your feelings toward development / redevelopment efforts in Warsaw? (Choices: very positive, positive, neutral, negative, very negative)
 - ☐ Comment box

PAGE 2

New development and redevelopment, especially related to increased impervious surfaces (like parking lots, streets, and roofs) can influence downstream flooding and stream degradation. Warsaw aims to promote healthy and sustainable growth that is not detrimental to the community and its waterfront assets.

A stormwater study was completed for the City in 2020 and evaluation of existing drainage patterns showed that stormwater is currently managed in a relatively natural manner through overland drainage to open roadside ditches and culverts, ultimately discharging to the larger open channel of Town Branch Creek. Without adequate stormwater management practices, the City is at risk for increased levels of erosion and flooding, potentially rising to a level where property damage may occur.

1. What is your role related to development and stormwater management in Warsaw?
(select all that apply)
 - ☐ Resident
 - ☐ Business Owner
 - ☐ Technical Professional/Designer
 - ☐ Developer
 - ☐ City Employee
 - ☐ Planning and Zoning Commissioner
 - ☐ Other (please specify)
2. Do you live or own property directly adjacent to any of the green or blue lines in the figure below? (insert Figure 6)
 - ☐ Yes
 - ☐ No
3. Are you familiar with the City's application process(es) for development/redevelopment?
 - ☐ Yes, I have submitted and been approved for development/redevelopment
 - ☐ Yes, I am familiar but have not gone through the application process
 - ☐ No, I am not familiar with the application process
4. Are you familiar with the City's currently adopted stormwater management criteria, the Kansas City Metro Chapter of the American Public Works Association Standard Specifications and Design Criteria Division V Design Criteria Section 5600 Storm Drainage Systems and Facilities, adopted March 21, 1990 (APWA 5600)?
 - ☐ Yes, I have used the City's currently adopted stormwater management criteria (1990 edition of APWA 5600)
 - ☐ Yes, I am familiar with the currently adopted version but instead have used the current version of APWA 5600 (February 16, 2011)
 - ☐ Yes, I am familiar with APWA 5600 but have not used the design criteria
 - ☐ No, I am not familiar with the City's stormwater management criteria
5. Are you supportive of City efforts to update stormwater management policies?
 - ☐ Yes
 - ☐ I'm not sure, I need more information
 - ☐ No, the current policies are sufficient

6. The City plans to solicit feedback on proposed stormwater policy updates. Are you interested in the opportunity to provide review and feedback on proposed changes to the City's stormwater management policies and design criteria?
 - ☐ Yes, please include me on communications regarding stormwater management policy updates
 - ☐ No
7. Are you interested in learning more about Warsaw's stormwater management policies and design criteria? Please add a comment if there is anything you would specifically like more information about.
 - ☐ Yes
 - ☐ No
 - ☐ If you selected "Yes," what would you like to learn more about? (open comment box)
8. What learning platform would you prefer for training about Warsaw's stormwater management policies and design criteria?
 - ☐ In-person
 - ☐ Online videos
 - ☐ "How-to" document handouts

PAGE 3

1. Contact Information (fill in the blank)
 - ☐ Name
 - ☐ Email Address
 - ☐ Phone
 - ☐ Mailing Address
2. Preferred contact method (select one)
 - ☐ Email
 - ☐ Phone

The survey should end with a "Done" / "Submit" button. When the user selects the button, it can redirect them back to the informational landing webpage.

As specified in the contract Scope of Work, the City will need to identify the targeted audiences and contact information for distribution of the survey. It is recommended that the City target technical, construction, development or community professionals in addition to the residents and business owners including:

- Community Stakeholders
- Residents and property owners
- Designers
- Contractors
- Developers

SECTION 7

RECOMMENDED NEXT STEPS

7.1 COMMUNITY ENGAGEMENT

Upon review and acceptance of the proposed revisions detailed in Appendix A, B, and C, it is recommended that the City move forward with community engagement and solicitation of public feedback on the proposed stormwater policy recommendations. An educational public meeting to provide background for the proposed changes and a summary of what those changes are could be helpful context for the community ahead of distributing the survey. It is recommended that this be integrated into an existing planned public or standing meeting.

Once survey results are received, it is recommended that the City post the draft revisions to their website for public comment and feedback for a 14-day period. Survey results can be used to distribute the comment link directly to responders who conveyed interest in this review. Comments received should be made available to the Planning and Zoning Commission and Board of Alderman during their review of the code amendments so that survey results are transparent and actionable.

7.2 UNIFIED DEVELOPMENT CODE AMENDMENT

If community engagement and provided public feedback are in agreement with the stormwater policy recommendations, it is recommended that the City move forward with a Unified Development Code Amendment per Section 405.030 (D). This requires review by the Planning and Zoning Commission with final decision by the Board of Alderman. Both parties are required to hold a public hearing to make recommendations to approve, approve with revisions, postpone, or deny the application for text amendment. Public notice of the proposed changes is also required. This code section outlines five criterion the proposed amendments should consider for approval. The Planning and Zoning Commission and the Board of Alderman are directed to review the proposed revisions in accordance with the criterion. Table 4 provides a summary of the defined review criteria and supporting justification outlining how the proposed stormwater policy amendments meet these considerations.

Table 4: Unified Development Code Text Amendment Review Criteria

Review Criteria	Stormwater Policy Amendment Supporting Justification
Corrects an error or meets the challenge of some changing condition, trend, or fact since the time that the original text designations were established	The proposed amendments address use of out-of-date stormwater management standards.
Consistent with the Warsaw Comprehensive Plan or other applicable City plans and policy guides;	The proposed approach to stormwater management is directly in agreement with Comprehensive Plan vision: Building on Success to Capitalize on the Future. The stormwater management requirements protect and build on the foundation of Warsaw's waterfront assets. Proposed requirements protect natural, scenic, and recreation areas within and adjacent to stormwater drainage setbacks while allowing for use for trails. This supports the plan's connector and path, development, and recreation objectives by creating added value to lands adjacent to natural drainage paths and streams with opportunities for trail connectivity and community recreation.
Consistent with the purpose and intent of this Code;	The proposed stormwater management policy and design criteria are consistent with the purpose defined within 405.060 to set the standards for layout and design of development in Warsaw, addressing the "...physical relationship between development and adjacent properties, public streets, neighborhoods, and the natural environment..."
Will result in a logical and orderly development pattern;	Stormwater Drainage Setbacks promote development to occur more intentionally and outside of areas that are at risk of flooding or cause damage to public downstream.
Is in the best interests of the City as a whole.	Proposed requirements encourage sustainable and healthy development practices that protect the public and benefit the community as a whole.

7.3 DRAINAGE PERMIT APPLICATION & DESIGN CRITERIA POSTED TO CITY WEBSITE

In order to provide clear guidance for the City's adopted standards, it is recommended that links to those standards be provided on the City website. References to the following documents and links are recommended to be added to the existing "[Codes](#)" webpage. It is recommended that this menu item be renamed to "Standards and Procedures for Design and Construction" for clarification.

DESIGN GUIDANCE DOCUMENTS

- American Public Works Association (APWA) Kansas City Metro Design Guidance Documents
 - Link: <http://kcmetro.apwa.net/PageDetails/439>
 - This link routes the user directly to the APWA website where they can reference the full list of design guidance documents.
- City of Warsaw Stormwater Management Design Criteria: Section 5600 - Storm Drainage Systems & Facilities
 - Link: (PDF of clean version of Attachment B of this document)
 - This link would route to Attachment B of this document which includes the proposed revisions to APWA 5600
- Manual of Best Management Practices for Stormwater Quality (October 2012)
 - Link:
http://kcmetro.apwa.net/content/chapters/kcmetro.apwa.net/file/Specifications/BMPManual_Oct2012.pdf
 - This link routes to the 2012 version of the MARC BMP Manual that is referenced throughout the stormwater management design criteria
- Kansas City, Missouri Green Stormwater Infrastructure Manual
 - Link:
<https://www.kcsmartsewer.us/home/showpublisheddocument/5588/637308596807530000>
 - This link routes to the KCMO GSI Manual that is referenced as a design guidance resource throughout the stormwater management design criteria.
- [Federal Highway Administration Manual on Uniform Traffic Control Devices](#)
 - Link: <https://mutcd.fhwa.dot.gov/>
 - This link routes directly to the FHWA MUTCD website

SPECIFICATION SECTIONS

- Link: <http://kcmetro.apwa.net/PageDetails/439>
- This link routes the user directly to the APWA website where they can reference the full list of specification sections.

STANDARD DRAWINGS

- Link: <http://kcmetro.apwa.net/PageDetails/439>
- This link routes the user directly to the APWA website where they can reference the full list of standard drawings.

APPENDIX A: CODE OF ORDINANCES REVISION CLEAN FOR PUBLISH

§ 405.020. Common Development Review Procedures.

A. Purpose And Organization.

1. *Procedural requirements.* This Section describes the procedures for review of all applications for land use and development activity in Warsaw.
 - a. Section 405.020(A)(2), Table of Procedures, includes a summary table listing the land use and development procedures in this Code.
 - b. Section 405.020, Common Development Review Procedures, Subsections (B) through (J), describe standard procedures that are applicable to all or most types of specific applications based on the following review steps:
 - (1) Preapplication meeting.
 - (2) Neighborhood meeting.
 - (3) Application submissions, content and fees.
 - (4) Complete application and staff review.
 - (5) Public notice requirements.
 - (6) Action by review and decisionmaking authorities.
 - (7) Appeals.
2. *Table of procedures.* Section 405.030, Specific Procedures and Approval Criteria, Subsections (A) through (O), include additional provisions unique to each type of application, such as public hearing requirements and approval criteria. The specific procedures work in conjunction with the common procedures. The following procedures are included:

Table 405.020-1 Specific Procedures	
Section	Application Type
405.030(B)	Comprehensive Plan amendment
405.030(C)	Rezoning (Zoning Map amendment)
405.030(D)	Unified Development Code amendment (text amendment)
405.030(E)	Conditional use permit
405.030(F)	Site plan
405.030(G)	Planned development
405.030(H)	Alternative compliance
405.030(I)	Major subdivision
405.030(J)	Minor subdivision
405.030(K)	Variance
405.030(L)	Appeal
405.030(M)	Minor modification
405.030(N)	Grading permit
405.030(O)	Drainage permit

3. *Administrative Manual for additional materials.* The Director may compile the requirements for application contents, forms, fees, submission materials, and review schedule in an Administrative Manual, which shall be made available to the public. The Director may amend and update the Administrative Manual from time-to-time.

B. *Preapplication Meeting.*

1. *Purpose.* The purpose of the preapplication meeting is to provide an opportunity for the applicant and the City to discuss the development concept prior to the application submission for a project in order to:
 - a. Determine the required application(s) and, if necessary, the timing of multiple application submittals (i.e., whether they may be processed concurrently or must be processed sequentially);
 - b. Provide the applicant with application materials and inform the applicant of submittal requirements;
 - c. Provide the applicant with an estimated time frame for the review process;
 - d. Discuss generally compliance with the Code's zoning, use, density, development, and design standards, and attempt to identify potentially significant issues regarding compliance;
 - e. Discuss the need for any neighborhood meetings and public notice requirements; and
 - f. Refer the applicant to other departments or agencies to discuss potential significant issues prior to application submittal.
2. *Applicability.*
 - a. *Preapplication meeting recommended.* A preapplication meeting is recommended prior to submitting most development applications. The preapplication meeting is designed to help the applicant understand the Warsaw development approval process.
 - b. *Record of preapplication conference.* The City is not responsible for making or keeping a summary of the topics discussed at the preapplication conference.

C. *Neighborhood Meeting.*

1. *Purpose and intent.* The purpose of the neighborhood meeting is for applicants to educate residents, occupants, and owners of nearby lands about the proposed development and application, receive comments, address concerns about the development proposal, and resolve conflicts and outstanding issues, where possible. The intent is to have applicants take primary responsibility for the neighborhood meetings.
2. *Applicability.*
 - a. A neighborhood meeting is required for the following applications: Comprehensive Plan amendments, rezonings, planned developments, and major subdivisions.
 - b. The Director may require a neighborhood meeting for any application type if the Director determines the application may have significant adverse neighborhood

- impacts, including but not limited to traffic, noise, visual, or environmental impacts, or where substantial objections have been raised by neighbors. To the maximum extent practicable, the Director shall determine the necessity for a neighborhood meeting at the preapplication meeting.
- c. If either the Planning and Zoning Commission or Board of Aldermen find that the circumstances of an application justify a neighborhood meeting where a neighborhood meeting was not previously scheduled, or that an additional meeting is necessary as the application process is underway, they may continue the application and instruct the applicant to schedule a meeting following the procedure established in this Section.
3. *Procedure.* If a neighborhood meeting is held by the applicant, it shall be held at the applicant's expense and comply with the following procedures:
 - a. *Time and place.* The neighborhood meeting shall be held at a place that is convenient and generally accessible to neighbors that reside in proximity to the land subject to the application. It shall be scheduled after 5:00 P.M. on a weekday unless the Director specifies another time that is more convenient under the circumstances.
 - b. *Notification.*
 - (1) The applicant shall provide notification of the neighborhood meeting a minimum of ten (10) calendar days in advance of the meeting by mail to:
 - (a) All owners and occupants within two hundred (200) feet of the land subject to the application;
 - (b) Any neighborhood organization registered with the City of Warsaw within such two-hundred-foot radius; and
 - (c) Board of Aldermen or Planning and Zoning Commission, when the neighborhood meeting is required by either of those review boards as described in Subsection (C)(2)(c), above.
 - (2) The notification shall State the time and place of the meeting, contain a vicinity map and short description of the project, and State the purpose of the meeting.
 - c. *Conduct of meetings.* At the neighborhood meeting, the applicant shall explain the development proposal and application, answer any questions, and respond to concerns neighbors have about the application and proposed ways to resolve conflicts.
 - d. *Staff attendance.* The applicant shall be responsible for scheduling the meeting, coordinating the meeting, and for retaining an independent facilitator if needed. The meeting shall be held prior to submittal of the subject development application. Attendance at the neighborhood meeting by City planning staff is not required, unless deemed necessary by the Director.
 - e. *Written summary of neighborhood meeting.* The applicant shall provide the Director a written summary or transcript of the neighborhood meeting within ten (10) business days of its conclusion or with the completed application, whichever is sooner. The written summary shall include a list of those in attendance, a summary of the issues

related to the development proposal discussed, comments by those in attendance about the development proposal, and any other information the applicant deems appropriate. The written summary of the neighborhood meeting shall be included with the application materials and be made available to the public for inspection.

- f. *Response to summary.* Any person in attendance at the neighborhood meeting, within five (5) calendar days after the meeting summary has been made public, may submit a written response stating his or her understanding of the issues related to the development proposal discussed, comments by those in attendance about the development proposal, and any other information deemed appropriate. All written responses to a summary of the neighborhood meeting shall be included with the application materials and be made available for public inspection.
4. *Failure to hold meeting.* If an applicant fails to hold a neighborhood meeting or does not demonstrate a reasonable effort was made in the notification of such meeting, such failure shall not stop or delay the review process or create a legal cause of action. However, such omission may be just cause for denial of the application.

D. *Application Submission, Content And Fees.*

1. *Form of application.*
 - a. Application submittal requirements, contents and fees shall be established in the individual application forms provided by the City.
 - b. In addition to the information required by the application form, the Director may require applicants for rezoning, conditional use permit, preliminary or final development plan, or preliminary plat to submit any technical studies that the Director deems necessary to enable the Planning and Zoning Commission, Board of Aldermen, or Board of Adjustment to fully evaluate the application. Examples of technical studies include, but are not limited to: traffic studies, engineering studies, geologic or hydrogeologic studies, flood studies, environmental impact assessments, noise studies, photometric (lighting) studies, or surface water management/drainage studies.
2. *Authority to file application.* The person having legal authority to take action according to the approval sought shall file an application for development review or approval under this Code. The person is presumed to be the record owner, purchaser under a sale or option to purchase, or the duly authorized agent of the record owner. Agents may only submit applications where the owner indicates consent in writing, a copy of which consent shall be submitted with the application.
3. *Where to file applications.* All applications required by this Section shall be submitted to the City offices unless otherwise specified.
4. *Contact person designation.*
 - a. The applicant shall designate one (1) person on the application as the primary contact person who will be responsible for all notification, including meeting dates, deadlines and requirements. The City will communicate with the contact person about the application and review procedures. It is the contact person's responsibility to inform

the owners or applicant of such information.

- b. The applicant shall notify the Director in writing if there is to be a change in the contact person. The Director will continue to communicate with the designated contact person until the notice of change has been received.
5. *Concurrent applications.* Where an applicant seeks approval of two (2) different requests for the same parcel simultaneously, the applicant shall submit all necessary documents, plans, maps and other required information in accordance with the provisions relating to both of the submitted applications and pay all appropriate fees for both applications.
 6. *Application content and fees.*
 - a. *Application contents: general.* The Director is authorized to establish submittal requirements for all land use development applications required by this Section and to update and amend such requirements as necessary to ensure effective and efficient City review. Applicants shall refer to the individual application forms for submittal requirements for each type of land use development application. The applicant shall provide any additional information, documents, or other material relevant to the application that the Director reasonably believes is necessary in order for the City to evaluate, analyze and understand the subject matter of the application.
 - b. *Submittal waivers pursuant to preapplication meetings.* At or following a preapplication meeting, the Director may waive certain submittal requirements set forth in the application form, except for fees, in order to reduce the burden on the applicant and to tailor the requirements to the information necessary to review a particular application. The Director may waive such requirements where the Director finds that the projected size, complexity, anticipated impacts, or other factors associated with the proposed development or subdivision clearly justify such waiver. This discretion may only be exercised if a preapplication meeting is held.
 - c. *Fees.* Nonrefundable fees are required at the time of the filing of any development application and are payable to the City in accordance with the fee schedules adopted by City ordinance. The City may require, in addition to the fees above, that the applicant pay all or a portion of the reasonable fees charged by private consultants retained by the City for the purposes of reviewing the application and advising City officials and agencies with respect thereto. The Director will notify the applicant prior to retaining any such consultant.
 - d. *Authorization and payment required.* The City shall adopt and amend from time to time a fee schedule setting forth an assessment of fees to defray the cost of processing land development applications under this Section. At the time of submittal, all applications shall include payment of the processing fee, as well as any review fees charged by agencies which the City has agreed to collect.
 - e. *No required fees for City-initiated applications.* No fee shall be required for land development applications initiated by the City.

E. *Complete Application And Staff Review.*

1. *Complete application required for processing.* All application submissions must be

complete prior to any processing by the City of Warsaw. A complete application includes all of the submittal information identified on the application form and any items or exhibits requested by the Director that are consistent with the standards and requirements of this Code. A complete application is also accompanied by the applicable fee. Incomplete applications shall be denied.

2. *Official submission.* An application shall be officially submitted when it is presented to the Director, either through hand submitted copy of the application, or electronically submitted copy of the application filed pursuant to instructions for electronic filing identified on the City of Warsaw webpage or portal at such time as the City makes this technology available, filed on a business day during normal office hours.
3. *Determination of completeness.* The City's acceptance of an application for completeness review does not bind the City to accept an incomplete application.
 - a. *Completeness determination.* Staff shall determine whether an application is complete no later than ten (10) calendar days after the official submission of the application.
 - (1) Staff shall make its determination of an incomplete application in writing. An e-mail to the applicant or comment in the City's permit on-line tracking system, if one is established, shall be considered a determination in writing.
 - (2) Notice occurs upon dispatch or publication, not upon receipt.
 - (3) The determination shall identify the documents, studies, or other information needed to make the application complete.
 - b. *Incomplete applications rejected.* An incomplete application shall not be processed by the City. The City may retain the application fee paid for any submitted application. Following notice of an incomplete application, the applicant shall have thirty (30) days to submit the information required to make the application complete or the application shall be deemed rejected. After thirty (30) days the City shall require that any additional or further requests by the applicant be accompanied by a new application and fee.
4. *Staff review.*
 - a. *Review by other departments and divisions.*
 - (1) In addition to internal review, staff may distribute the complete application to other City departments and divisions and to any other appropriate governmental or quasi-governmental agencies and bodies to solicit comments and ensure that the proposal complies with all applicable standards, requirements and review criteria. The applicant shall be responsible for submitting any additional information or revised plans required by staff or the referral agencies in a timely manner. As applicable, the review and decisionmaking bodies shall consider the services and facilities provided by the referral agencies as a factor in approval of the complete application. The criteria for evaluating sufficiency of the services that must be satisfied for the approval of the application shall be provided to the review and decisionmaking bodies as a part of any referral response.
 - (2) Referral agencies shall comment in writing after receiving a complete application.

The failure of any agency to respond shall be considered no comment on the application by that agency. As applicable, referring agencies will provide the review and decisionmaking bodies with a summary of any capacity evaluation study that assesses the availability of City-provided facilities or services to the proposed development. The summary will include an explanation of the agency's assumptions regarding available capacity.

- b. *Subsequent requests for information.* Staff and referral agencies shall use best efforts to identify all major issues and to request additional information, data, or reports from the applicant during the review period described above. This provision shall not be interpreted to preclude staff or referral agencies from requesting revisions or corrections to previously submitted materials if such materials are subsequently found to be inaccurate, incomplete, or if subsequent plan revisions do not comply with this Section.
- F. *Public Notice Requirements.* Applications for development approval shall comply with the Missouri Statutes and the provisions of this Section with regard to public notification.
- 1. *General notice requirements and timing of notice.*
 - a. Unless otherwise stated in this Code, notice for all public hearings shall be given pursuant to this Section. Notice may be written (mailed), published or posted as further described in this Section. Agenda notice shall be posted and published on the City's website a minimum of seventy-two (72) hours prior to a meeting.
 - b. Table 405.020-2 sets forth the specific notice requirements for applications requiring any type of notification.

Table 405.020-2 Notice Requirements					
Procedure	Section	Type of Notice Required			
		Publish	Written/ Mailed	Posted	Agenda
Comprehensive Plan amendment	405.030(B)	♦		♦	♦
Rezoning (Zoning Map amendment)	405.030(C)	♦	♦	♦	♦
Unified Development Code amendment (text amendment)	405.030(D)	♦			♦
Conditional use permit	405.030(E)	♦	♦		♦
Site plan	405.030(F)				
Planned development	405.030(G)	♦	♦	♦	♦
Alternative compliance	405.030(H)				
Major subdivision	405.030(I)			♦	♦
Minor subdivision	405.030(J)				
Variance	405.030(K)	♦	♦		♦
Appeal	405.030(L)		♦		♦
Minor modification	405.030(M)				
Grading permit	405.030(N)				
Drainage permit	405.030(O)				

2. *Content.* Notices, whether by publication or written, shall at a minimum:
 - a. Identify the address or location of the property subject to the application and the name, address and telephone number of the applicant or the applicant's agent;
 - b. Specify the date, time and place of the public hearing;
 - c. Describe the nature, scope and purpose of the application or proposal;
 - d. Notify the public where to view the application; and
 - e. Include a statement that the public may appear at the public hearing or be heard, if any, and submit evidence and written comments with respect to the application.
3. *Published notice.* When the provisions of this Code require that notice be published, the City shall be responsible for preparing the content of the notice and publishing the notice in a newspaper of general circulation that has been selected by the City. The content and form of the published notice shall be consistent with Section 405.020(F)(2), Content, above and the requirements of Missouri Statutes. Unless otherwise specified in the specific procedure section, published notice shall be provided before the 15th day before the date of the hearing.
4. *Written (mailed) notice.*

- a. When the provisions of this Code require that written or mailed notice be provided, the Director shall be responsible for preparing and mailing notice to specific property owners of their opportunity to be heard.
 - (1) Written notice shall be sent via regular mail notice at least fifteen (15) days prior to the date of the hearing.
 - (2) Written notice of the public hearing on the application shall be provided to the owner of the property for which the approval is sought and all property owners within one hundred eighty-five (185) feet of the subject property.
 - (3) In cases of an application where a protest petition may be submitted, the notice shall also contain a statement explaining that property owners within an area determined by lines drawn parallel to and one hundred eighty-five (185) feet from the boundaries of the district to be changed shall have the opportunity to submit a protest petition.
- b. Written notice to property owners shall be required only for the initial presentation of the proposed development at a public hearing. Additional mailed notice shall not be required where the application is not decided at the initial public hearing unless otherwise directed by the City.
- c. If the hearing is deferred or continued at the applicant's request, the applicant shall be responsible for paying any additional fees for the purposes of renotifying adjacent property owners.

5. *Posted notice.*

- a. For applications where posted notice is required, it shall be posted on the property and maintained for at least fifteen (15) days prior to the date of the public hearing.
- b. Any posted notice shall be a minimum of twenty-four (24) inches by thirty-six (36) inches and printed so that the following information is visible from a distance of one hundred (100) feet from a public street or right-of-way:
 - (1) Current zoning classification;
 - (2) Proposed zoning classification/use;
 - (3) Proposed type of development review (e.g., rezoning, subdivision, variances); and
 - (4) Date and time of the hearing.
- c. Projects abutting more than one (1) right-of-way may be required to post additional notices.

6. *Constructive notice.*

- a. *Minor defects.*
 - (1) Minor defects in any notice shall not impair the notice or invalidate proceedings pursuant to the notice if a bona fide attempt has been made to comply with

applicable notice requirements. Minor defects in notice shall be limited to errors in a legal description, typographical or grammatical errors, or errors of actual acreage that do not impede communication of the notice to affected parties.

- (2) Failure of a party to receive written notice shall not invalidate subsequent action.
- (3) In all cases, however, the requirements for the timing of the notice and for specifying the time, date and place of a hearing shall be strictly construed.
- (4) If questions arise at a review hearing regarding the adequacy of notice, the decisionmaking authority shall direct the Director to make a formal finding as to whether there was substantial compliance with the notice requirements of this Code, and such finding shall be made available to the decisionmaking authority prior to final action on the request.
- b. *Presumption of notice.* When the City records of publication, mailing and posting of notices as required by this Section, it shall be presumed that notice of a public hearing was given as required by this Section.

G. Action By Review And Decisionmaking Authorities.

1. Recommendations by review authority.

- a. The proper review authority (Director, Planning and Zoning Commission, Board of Aldermen, or Board of Adjustment) is established for each type of procedure in the specific review procedures. The review authority shall evaluate the application, referral comments, staff report, and public testimony, if any, and make a recommendation to the decisionmaking authority to approve, approve with conditions, continue for additional information or for further study, or deny the application.
- b. The review authority's actions shall be based on the evidence presented and compliance with the general review criteria identified in Section 405.020(G)(7), below, and the specific review criteria for each application as identified in Section 405.030(B) through (N).

2. Review and action by decisionmaking authority.

- a. The proper decisionmaking authority (Director, Planning and Zoning Commission, Board of Aldermen, or Board of Adjustment) is established for each type of procedure in the specific review procedures. A decisionmaking authority may take action on an application or appeal by approving, approving with conditions, continuing, or remanding for additional information or for further study, or denying the application or appeal.
- b. In taking action, the decisionmaking authority shall evaluate the application, referral comments, staff report, public testimony, if any, and the review authority's recommendation. All final decision actions shall be based on the application or appeal's compliance with the general review criteria identified in Section 405.020(G)(7), below, and the specific review criteria for each application as identified in Section 405.030(B) through (N).

3. *Withdrawal of application by applicant.* An applicant shall have the right to withdraw an application, without prejudice, at any time prior to action on the application at a public hearing or meeting. The applicant shall submit in writing the withdrawal request to the Director, and after such withdrawal, the City will not take further action on the application. The application shall be considered terminated, and no rights shall vest based on the application. To reinstate review, the applicant may resubmit the application; in all respects it shall be treated as a new application for purposes of review, scheduling, and payment of application fees. Withdrawal of an application from a public hearing or meeting agenda is at the review or decisionmaking authority's discretion.
4. *Continuation of public hearings.* The review or decisionmaking authority may continue the public hearing for its consideration of the application for a definite time not to exceed sixty (60) days, unless a longer period is agreed to by the applicant in writing or at a public hearing. The continuance may be granted by the review or decisionmaking authority on its own initiative or at the request of the applicant or affected property owners. A review or decisionmaking body may also deny a request for continuation.
5. *Written findings of fact.*
 - a. Unless otherwise specifically required by this Code or other applicable laws, written findings are not required for a final decision on any application. However, any decision may be expressly made subject to the subsequent adoption of written findings and, in that case, the decision shall not be final until the findings are adopted.
 - b. Where an appeal of any quasi-judicial decision has been filed with the Circuit Court of Benton County, in cases where written findings have not been adopted, written findings shall be adopted by the approving authority within forty-five (45) days of service of the appeal on the City and thereafter shall be certified by the Circuit Court as part of the administrative record. The forty-five-day time period for adoption and certification of findings may be extended with the permission of the court.
6. *Conditions of approval.*
 - a. The review or decisionmaking authority may recommend or impose such conditions upon the subject development as is necessary to carry out the general purpose and intent of this Code. Conditions and additional information requirements shall be in written form and attached to the approved plan, plat, or permit.
 - b. Conditions of approval shall be reasonably related to the anticipated impacts of the proposed use or development and shall be based upon the review criteria specified in each procedure's adopted standards.
 - c. The decisionmaking authority may place specific time limits on the satisfaction of any condition of approval. If a time limit is not specified in the approval or in the specific provisions of this Code, then a one-year time limit shall apply.
 - d. The decisionmaking authority may require financial guaranties, as identified in Section 405.030, from the applicant where it finds such guaranties are necessary to ensure compliance with conditions of approval and to protect the public health, safety, or welfare. The City shall release such guaranties when the Director has determined that

all conditions attached to the approval have been or will be satisfied.

- e. Conditions of approval shall be met or financial guaranties provided prior to the issuance of a certificate of occupancy or the appropriate final permit required by the City.

7. *Generally applicable review criteria.* Unless otherwise specified in this Section or the specific procedure, City review and decisionmaking bodies shall review all development applications submitted pursuant to this Section for compliance with the general review criteria stated below. The application may also be subject to additional review criteria specific to the type of application. In case of conflict between the general review criteria set forth in this Section and the specific review criteria, the specific review criteria shall apply. A development application must be in compliance with these review criteria prior to the issuance of a certificate of occupancy or the appropriate final permit required by the City unless otherwise provided for in the development approval.

- a. *Consistent with prior approvals.* Where a preliminary plan or plat was submitted and approved, a subsequent application for the same development shall be consistent with the terms and conditions of such prior preliminary plan or plat approval for the project including, without limitation, an approved phasing plan for development and installation of public improvements and amenities.
- b. *Consistent with Comprehensive Plan.* The proposal is consistent with the City of Warsaw Comprehensive Plan and any applicable subarea, neighborhood, sector or district plan. The decisionmaking authority shall weigh competing plan goals, policies and strategies and may approve an application that provides a public benefit even if the development is contrary to some of the goals, policies or strategies in the Warsaw Comprehensive Plan or other applicable plans.
- c. *Compliance with use and development standards.* The proposal complies with all applicable use standards, site development standards, design standards, subdivision standards, public improvement standards, floodplain management standards and all other applicable substantive standards stated in this Code or other applicable City code. Such compliance shall be applied at the level of detail required for the subject submittal and those standards which are not otherwise modified, varied or waived as allowed by this Code.
- d. *Compliance with other applicable regulations.* As applicable, prior to final approval of the proposed development pursuant to this Code, the proposed development complies with all other City regulations and with all applicable regulations, standards, requirements or plans of the Federal or State governments and other relevant jurisdictions, including but not limited to wetlands, water quality, erosion control and wastewater regulations.
- e. *Minimizes adverse environmental impacts.* The proposed development meets or exceeds all environmental protection standards in this Code, is designed to minimize negative impacts, and does not cause significant adverse impacts on the natural environment, including but not limited to water, air, noise, stormwater management, scenic resources, wildlife habitat, soils, native vegetation and the natural functioning of the environment.

- f. *Minimizes adverse impacts on surrounding property.* The proposed development meets or exceeds all neighborhood protection standards in this Code and all other site development standards intended at least in part to protect the existing character of neighboring properties and uses and does not cause significant adverse impacts on surrounding properties.
- g. *Minimizes adverse fiscal or economic impacts.* The proposed use will not result in significant adverse fiscal or economic impacts on the community or the City.
- h. *Compliance with utility, service and improvement standards.* As applicable, the proposed development complies with Federal, State, county and/or service district standards and design/construction specifications for roads, access, drainage, water, sewer, schools and emergency/fire protection.
- i. *Provides adequate road systems.* There is adequate road capacity available to serve the proposed use, and the proposed use is designed to ensure safe ingress and egress onto the site and safe road conditions around the site, including adequate access onto the site for fire, public safety and EMS services.
- j. *Provides adequate public services and facilities.* There will be capacity to provide adequate public services and facilities to accommodate uses permitted under the proposed development at the time such needs or demands arise while maintaining adequate levels of service to existing development. Public services and facilities include, but are not limited to, roads, domestic water, sewer, schools, public safety, fire protection, libraries and vehicle/pedestrian connections and access within the site and to adjacent properties.
- k. *Rational phasing plan.* As applicable, the proposed phasing plan for development of the project is rational in terms of available infrastructure capacity. In addition, each phase of the development shall contain all of the required streets, utilities, landscaping, open space and other improvements that are necessary and desirable for the residents and users of that phase and shall not be dependent upon subsequent phases for those improvements.

H. *Appeals.*

- 1. *Procedures.* Appeal procedures depend on the type of application and the appropriate review and decisionmaking authority. The applicant should consult with the specific provisions of this Code for requirements. This Section refers only to appeals to be heard by a City decisionmaking authority. Certain decisions that may be appealed by State law to a court are not covered by this Section.
 - a. *Board of Adjustment.* Most appeals of administrative determinations shall be made to the Board of Adjustment as provided in Section 405.030(L).
 - b. *Planning and Zoning Commission.* As identified in the specific provisions, some decisions of the Director or other departments may be appealed to the Planning and Zoning Commission by filing a written notice of appeal with the Director within ten (10) calendar days after the rendering of the decision. Upon filing of a written notice of appeal, the matter shall be placed on the agenda of the next regularly scheduled

meeting of the Planning and Zoning Commission no later than thirty (30) calendar days after the notice of appeal has been filed. The Planning and Zoning Commission may hear the appeal at its regular meeting or set a special hearing date at its discretion.

- c. *Board of Aldermen.* As identified in the specific provisions, some decisions of the Planning and Zoning Commission or Director may be appealed to the Board of Aldermen by filing a written notice of appeal with the Director within ten (10) calendar days after the rendering of the decision by the Planning and Zoning Commission or Director. Upon filing of a written notice of appeal, the matter shall be placed on the agenda of the next regularly scheduled meeting of the Board of Aldermen, no later than thirty (30) calendar days after the notice of appeal has been filed. The Board of Aldermen may hear the appeal at its regular meeting or set a special hearing date at its discretion.
- d. *Board of Aldermen decisions.* A decision by the Board of Aldermen may be appealed to a Missouri court of record as permitted by Missouri Statutes.

2. *Effect.*

- a. *Stay of proceedings.* The appeal of any decision or administrative action stays all proceedings in furtherance of the decision or administrative action.
- b. *Abandoned appeal.* If an appeal is filed but not pursued (either withdrawn or continued at the applicant's request) for a period of ninety (90) days, the appeal shall be considered abandoned and the decision or administrative action shall be considered final.
- c. *Imminent peril.* Where a stay of proceedings would cause imminent peril to life or property, the official from whom the appeal is taken or the Director may certify in writing to the decisionmakers hearing the appeal that the stay would cause such harm. The stay will be lifted pending hearing on the appeal. In such case, the action may be stayed only by a restraining order granted by a decisionmaking body or court of record if due cause is shown following notice to the official or Director.

I. *Inactive Applications.*

- 1. *Criteria.* The Director may notify the applicant in writing that an application will be considered inactive unless corrective action is taken within forty-five (45) days, if at any point in a development review process the following have occurred:
 - a. The applicant fails to attend any scheduled mandatory neighborhood meeting, meeting with the Director, meeting or hearing before the Planning and Zoning Commission, Board of Adjustment or Board of Aldermen; or
 - b. The applicant has not responded to a staff report, has not agreed to a date for a meeting or hearing before the Planning and Zoning Commission or Board of Adjustment, has not given proper public notice as required by this Chapter, or has not taken some other affirmative step within a reasonable time frame that is within the applicant's control and is necessary to advance the application for a final determination. A reasonable time frame shall be determined by the Director taking into account average response times from similar applicants on similar applications; or
 - c. The applicant fails to submit an application for the next required permit for the

approved application within two (2) years.

2. *Application terminated.* No further processing of such application shall occur until the deficiencies are corrected. If the applicant does not correct the deficiencies within the forty-five-day correction period, the application shall be considered automatically withdrawn and terminated. Any resubmittal of the application thereafter by the applicant will be treated as a new application for purposes of review, scheduling and payment of application fees.

J. *Actions And Limitations Following Development Approval Or Denial.*

1. *Termination of approval.* Approvals granted under this Code terminate if unused by the applicant after a reasonable period of time.
 - a. *Lapse.* Except as otherwise specified in the specific procedures sections of this Code, an approval granted under these regulations shall lapse and shall become void one (1) year following the date of final approval unless, prior to the expiration date, a building permit based upon such approval is issued and construction is commenced and diligently pursued toward completion.
 - b. *Extension.*
 - (1) An approval may be extended by up to one (1) year by the body that issued the original approval. Requests for extensions of more than one (1) year must show good cause for the need for extension.
 - (2) All requests for extensions shall be submitted to the Director in writing at least thirty (30) days prior to the expiration of approval. An extension request shall include payment of required fees and a written description of the reasons for the applicant's inability to comply with the specified deadlines, listing any changes in the character of the neighborhood, any changes to the Comprehensive Plan or this Code that have occurred since approval of the permit/ plan as these changes affect the permit/plan, and the anticipated time schedule for completing the review project and/or the specific project. Additional review of the permit/plan may result in additional conditions.
 - (3) If the extension is denied, the applicant may resubmit a new application, subject to the fees and regulations in effect at the time of resubmittal, for the same project.
2. *Limitations on successive applications.*
 - a. *Limitations on resubmittals.* No application on the same request shall be permitted within one (1) year of an application denial unless the Commission determines that extenuating circumstances exist. A notation of "denied without prejudice" on the minutes of the prior action on an application shall be evidence of the existence of extenuating circumstances and resubmission shall be permitted.
 - b. *Amendments.*
 - (1) All substantial changes, modifications, removal or release of the provisions of an approved plan or plat that do not qualify as minor modifications under Section 405.030(M) shall be considered amendments. Amendments shall include, but are

not be limited to, changes in use, access, layout, any condition of approval, any change resulting in significant increased off-site impacts, and similar changes as determined by the Director.

- (2) For purposes of review and scheduling, proposed amendments are treated as new applications subject to the applicable procedures and review criteria set forth in this Chapter unless otherwise noted in the specific review procedures.
 - (3) All approved amendments to a recorded plan or plat shall be recorded within ninety (90) days of the amendment's approval.
- c. *Modification of conditional use permits.* A request to modify, expand, or otherwise change an approved conditional use permit not in substantial conformance with the approved permit shall be processed according to the provisions of this Section as a new application.

§ 405.030. Specific Procedures.

- A. *Summary Of Specific Procedures.* Table 405.030-1 summarizes the land use and development procedures in this Section and identifies the bodies that have review and decisionmaking responsibilities for each procedure. Exceptions to these general rules apply; see Subsections (B) through (O) for details on each procedure. Other boards, commissions, government agencies, and nongovernmental agencies may be asked by staff, the Planning and Zoning Commission, or the Board of Aldermen to review some applications, including, but not limited to, rezoning and plat approvals.

Table 405.030-1 Summary of Administrative Review Procedures					
Procedure	Section 405.030.	Planning Director/City Engineer	Planning and Zoning Commission	Board of Aldermen	Board of Adjustment
Key: R = Review A = Approve PH = Public hearing X = Appeal					
Comprehensive Plan amendment	B	R	A	Adopt by resolution	
Rezoning	C	R	PH/R	A	
Unified Development Code amendment (text amendment)	D	R	PH/R	A	
Conditional use permit	E	R	R	A	
Site plan	F				X
Administrative		A			X
PZC review		R	A	X	
Planned development	G				
Preliminary plan		R	PH/A		
Final plan		R	R	A	
Alternative compliance	H	R	R/X	A	
Major subdivision	I	R	R	A	
Preliminary plat		R	PH/A		
Final plat		R	R	A	
Minor subdivision	J	A	X		
Variance	K	R			PH/A
Appeal	L	R			PH/A
Minor modification	M	A			X
Grading permit	N	A			X
Drainage permit	O	A			X

B. *Comprehensive Plan Amendments.*

1. *Purpose.* The purpose of this Subsection is to provide standards and requirements for amending the Warsaw Comprehensive Plan and other adopted City plans. The amendment process is established in order to provide flexibility in response to changing circumstances, to reflect changes in public policy, and to advance the general welfare of the City.

2. *Applicability.* An application for plan amendment may be initiated by the Board of Aldermen, Planning and Zoning Commission or Director, or requested by a property owner in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* A plan amendment applicant is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Notice for a plan amendment shall be by publication, pursuant to Section 405.020(F).
 - c. *Action by review and decisionmaking bodies.* A plan amendment application is reviewed and approved by the Planning and Zoning Commission and certified to the Board of Aldermen. The Board of Aldermen may adopt the plan amendment by resolution.
 - d. *Planning and Zoning Commission hearing.* The Planning and Zoning Commission shall hold a public hearing and determine whether to approve, approve with revisions, postpone, or deny the application for plan amendment based on consideration of the following criteria:
 - (1) The existing plan and/or any related element of the plan is in need of the proposed amendment;
 - (2) The proposed amendment is compatible with the surrounding area and the goals and policies of the plan;
 - (3) The proposed amendment will have no major impact on transportation services and facilities;
 - (4) The proposed amendment will have minimal effect on service provision, including adequacy or availability of facilities and services, and is compatible with existing and planned service provision;
 - (5) The proposed amendment is consistent with the City's ability to annex the property (if applicable);
 - (6) The proposed amendment is consistent with the logical expansion of services (if applicable);
 - (7) Strict adherence to the current plan would result in a situation neither intended nor in keeping with other key elements and policies of the plan; and

- (8) The proposed plan amendment will promote the public welfare and will be consistent with the goals and policies of the Warsaw Comprehensive Plan and the major elements of the plan.
- (9) The following review criteria from Section 405.020(G)(7), Generally applicable review criteria, shall also be applicable:
 - (a) Minimizes adverse environmental impacts;
 - (b) Minimizes adverse impacts on surrounding property; and
 - (c) Minimizes adverse fiscal or economic impacts.

C. *Rezoning (Zoning Map Amendment).*

1. *Purpose.* The boundaries of any zone district may be changed or the zone classification of any parcel of land may be changed pursuant to this Subsection. The purpose of rezoning is to make adjustments to the official Zoning Map that are necessary in light of changed conditions, changes in public policy, to conform to the Warsaw Comprehensive Plan or other applicable plans, or to advance the general welfare of the City. Rezonings should not be used as a way to legitimize nonconforming uses or structures or when a conditional use, variance or minor administrative modification could be used to achieve the same result.
2. *Applicability.* An application for a rezoning may be initiated by the Board of Aldermen, Planning and Zoning Commission or the Director, or requested by a property owner in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant for rezoning is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Rezoning applications shall be submitted with a site plan pursuant to Section 405.030(F).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Published, written, and posted notice shall be provided before the 15th day prior to the Planning and Zoning Commission public hearing according to Section 405.020(F).
4. *Action by review and decisionmaking bodies.* A rezoning application is reviewed by the Planning and Zoning Commission and decided upon by the Board of Aldermen.
 - a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public meeting and make a recommendation to approve, approve with revisions, postpone, or deny the application for rezoning.

b. *Board of Aldermen review.*

- (1) The Board of Aldermen shall hold a public hearing to review the application and shall approve, approve with conditions, postpone, or deny the proposed rezoning.
- (2) If there is a valid protest against the change of zoning that is signed by the owners of at least thirty percent (30%) of either: the area of land (exclusive of street and alleys) included in the proposed change, or within an area determined by lines drawn parallel to and one hundred eighty-five (185) feet distant from the boundaries of the district proposed to be changed, a Zoning Map amendment will not become effective except upon the affirmative vote of two-thirds (2/3) of all members of the Board of Aldermen.

c. *Review criteria.* The application shall comply with all of the criteria in Section 405.020(G)(7) as well as the following specific criteria:

- (1) Whether the proposed rezoning corrects an error or meets the challenge of some changing condition, trend, or fact since the time that the original text or map designations were established;
- (2) Whether the proposed rezoning is consistent with the Warsaw Comprehensive Plan or other applicable City plans or policy guides;
- (3) Whether the proposed rezoning is consistent with the purpose and intent of this Code;
- (4) Whether and the extent to which the proposed rezoning addresses a demonstrated community need;
- (5) Whether the proposed rezoning will protect the health, safety, morals, and general welfare of the public;
- (6) Whether the proposed rezoning will contribute to mitigation of adverse impacts on the natural environment, including air, water, noise, stormwater management, wildlife, and vegetation;
- (7) Whether the proposed rezoning will ensure efficient development within the City;
- (8) Whether the proposed rezoning will result in a logical and orderly development pattern; and
- (9) Whether the property has remained unused or underutilized under the current zoning designation.

5. *Adoption by ordinance.* Amendments to the Zoning Map shall be approved in the form of an ordinance and shall be indicated on the official Zoning Map.

6. *Successive applications.*

- a. If the Board of Aldermen denies an application for rezoning, an application for the same or more intensive zoning shall not be refiled for one (1) year from the advertised public hearing date of the Board of Aldermen. An application for a less intensive zoning

classification may be submitted at any time.

- b. The Planning and Zoning Commission may, upon petition of the applicant, permit a filing of the application after six (6) months from the date of the original Board of Aldermen hearing when it determines that significant physical, economic, or land use changes have taken place on or in the immediate vicinity of the subject parcel.

D. *Unified Development Code Amendment (UDC Text Amendment).*

1. *Purpose.* The purpose of this Subsection is to provide standards and requirements for amending the text of this Code. The purpose of text amendments is to make adjustments to the text of this Code that are necessary in light of changed conditions, changes in public policy, or that are necessary to advance the general welfare of the City. Text amendments are not intended to relieve particular hardships or to confer special privileges or rights on any person.
2. *Applicability.* An application for a UDC text amendment may be initiated by the Board of Aldermen, Planning and Zoning Commission, or Director, or requested by an owner of land in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* A nonCity applicant for a UDC text amendment is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Published notice shall be provided before the 15th day prior to the Board of Aldermen public hearing according to Section 405.020(F).
4. *Action by review and decisionmaking bodies.* A UDC text amendment application is reviewed by the Planning and Zoning Commission and decided upon by the Board of Aldermen.
 - a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public hearing and make a recommendation to approve, approve with revisions, postpone, or deny the application for text amendment.
 - b. *Board of Aldermen public hearing.* The Board of Aldermen shall hold a public hearing and shall approve, approve with edits, postpone, or deny the proposed UDC text amendment.
 - c. *Review criteria.* Recommendations and decisions on UDC text amendments shall be based on consideration of the following criteria:

- (1) Whether the proposed amendment corrects an error or meets the challenge of some changing condition, trend, or fact since the time that the original text designations were established;
 - (2) Whether the proposed amendment is consistent with the Warsaw Comprehensive Plan or other applicable City plans and policy guides;
 - (3) Whether the proposed amendment is consistent with the purpose and intent of this Code;
 - (4) Whether the proposed amendment will result in a logical and orderly development pattern; and
 - (5) Whether the proposed amendment is in the best interests of the City as a whole.
5. *Adoption by ordinance.* UDC text amendments shall be approved in the form of an ordinance.

E. *Conditional Use Permit.*

1. *Purpose and applicability.*
 - a. The City of Warsaw recognizes certain uses that may be appropriate in a specific zoning district, but which may have characteristics that, depending upon the location, design, and manner of operation, may have a greater impact than permitted uses on adjoining properties, businesses, or residences. Such uses require more comprehensive review, including the ability of the City to establish specific conditions for the project in order to mitigate any potential adverse impacts.
 - b. All uses listed as "conditional" in Table 405.050-1 shall be required to follow the procedures set forth below.
2. *Applicability.* An application for a conditional use permit may be initiated by the Board of Aldermen, Planning and Zoning Commission, or the Director, or requested by a property owner in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant for a conditional use permit is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Conditional use permit applications shall be submitted with a site plan pursuant to Section 405.030(F).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Posted notice shall be provided before the 15th day prior to the Planning and Zoning

Commission public hearing according to Section 405.020(F).

4. *Action by review and decisionmaking bodies.* A conditional use application is reviewed by the Planning and Zoning Commission and decided upon by the Board of Aldermen.
 - a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public hearing and make a recommendation to approve, approve with revisions, postpone, or deny the application for conditional use permit.
 - b. *Board of Aldermen review.* The Board of Aldermen shall hold a public meeting to review the application and shall approve, approve with conditions, postpone, or deny the conditional use permit.
 - c. *Review criteria.* The conditional use permit application shall comply with all of the criteria in Section 405.020(G)(7) as well as the following specific criteria:
 - (1) The proposed conditional use is consistent with the Warsaw Comprehensive Plan;
 - (2) The proposed conditional use complies with all applicable provisions of the UDC;
 - (3) The proposed conditional use will not have a negative impact on the value of surrounding property or the general neighborhood;
 - (4) The location and size of the conditional use, the nature and intensity of the operation involved or conducted in connection with it, and the location of the site with respect to streets giving access to it are such that the conditional use will not dominate the immediate neighborhood so as to prevent the development and use of neighborhood property in accordance with the applicable zoning district regulations. In determining whether the conditional use will dominate the immediate neighborhood, consideration shall be given to:
 - (a) The location, nature, and height of buildings, structures, walls, and fences on the site; and
 - (b) The nature and extent of the proposed landscaping and buffering on the site.
 - (5) Whether adequate utility, drainage, and other necessary facilities have or will be provided; and
 - (6) Whether adequate access roads or entrance and exit drives will be provided and shall be designed to prevent traffic hazards and minimize traffic congestion.
5. *Special conditions.* The Planning and Zoning Commission may stipulate conditions and limitations on the approval of the conditional use permit in the interest of the public welfare and to assure that the intent of this Code is carried out.
 - a. *Conditions.* The approval of a conditional use permit may place reasonable stipulations or conditions on the operation, location, arrangement, or construction of a conditional use in order to assure the protection of adjacent properties and uses in the vicinity, and to safeguard the welfare of the citizenry as a whole as it may be affected by the use.
 - b. *Time limits and expiration.*

- (1) All conditional use permits expire upon any transfer of ownership of the property on which the conditional use is located.
 - (2) The Planning and Zoning Commission may impose any time limits on the duration of a conditional use permit use that the Commission finds appropriate for the circumstances of the use.
6. *Extension of time or amendment.* When a conditional use permit is set to expire due to an imposed time limit and the property owner wishes to continue the use, or when an applicant wishes to amend an approved conditional use permit, a new application for conditional use permit following the procedures established in this Subsection shall be submitted.
7. *Termination for failure to pursue the conditional use or abandonment.*
- a. All conditional use permits approved prior to the passage of this Section and all conditional use permits approved after the effective date of this Code shall automatically terminate if the conditions set out below occur.
 - (1) Approval of the conditional use permit shall automatically terminate one (1) year after the date of approval of the conditional use permit unless a building permit or a certificate of occupancy has been granted for the use.
 - (2) Approval of the conditional use permit shall automatically terminate if the use is abandoned or is discontinued for a period of six (6) months or more.
 - b. Extensions of the approval period may be requested at any time prior to termination or within sixty (60) days after termination. When it is determined that no significant changes affecting the conditional use permit have occurred, the Planning and Zoning Commission may extend the approval. All approvals and extensions shall be valid for one (1) year from the date of action, unless the Planning and Zoning Commission approves a greater or lesser period.

F. *Site Plan.*

1. *Purpose.* The purpose of the site plan review process is to ensure compliance with the development and design standards and provisions of this Code. It is designed to encourage quality development reflective of the goals, policies, and objectives of the Comprehensive Plan. For land uses requiring a site plan review, such uses may be established in the City, and building or land use permits may be issued only after a site plan showing the proposed development has been approved in accordance with the procedures and requirements of this Subsection.
2. *Types of site plan review.*
 - a. *Administrative site plan review.* The following types of projects or amendments to existing site plan approvals may be approved by the Director using the administrative site plan approval process:
 - (1) A single use proposed in a structure that is less than twenty-five thousand (25,000) square feet in building size for that use;

- (2) A combination of uses proposed in a single structure, such as a shopping center, that is less than twenty-five thousand (25,000) square feet in building size;
 - (3) Multiple buildings proposed where the combined total of all structures will not exceed twenty-five thousand (25,000) square feet in building size;
 - (4) Detached one-family dwellings and related accessory uses and buildings in approved subdivisions;
 - (5) Nonstructural remodeling of facade treatment in downtown Warsaw;
 - (6) Relocation of development pads, buildings, or dwelling units for some practical reasons such as topography, road alignment or easements, provided that the modification does not significantly alter the site design in terms of parking layouts, vehicular circulation, landscape design, and other similar components of the development plans;
 - (7) An increase or decrease in a proposed setback, provided that Code requirements are still met;
 - (8) A change in building design relating to items such as materials, colors, window, and door locations and mechanical units, provided that the design remains essentially the same as that previously approved by the Planning and Zoning Commission or Board of Aldermen;
 - (9) A modification to a recreation area or open space design, but not elimination or a significant reduction; or
 - (10) A change in landscape design/plant types or minor parking lot/site revisions.
- b. *Planning and Zoning Commission site plan review.* The following types of projects shall require approval by the Planning and Zoning Commission:
- (1) Any development, with the exception of single-family detached dwellings, that exceeds twenty-five thousand (25,000) square feet in building size;
 - (2) Any administrative site plan referred to the Planning and Zoning Commission by the Director;
 - (3) Any change that may affect an adjoining residential neighborhood;
 - (4) Any request that in the opinion of the Director would significantly alter the design of the site and/or building(s); or
 - (5) A request to change or delete a condition of approval established by the Planning and Zoning Commission or Board of Aldermen.
3. *Procedures.*
- a. *Preapplication meeting.* A preapplication meeting is not required.
 - b. *Application and notice.*

- (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Site plan applications shall include the following information unless waived by the City Administrator as part of a pre-application meeting. Items listed as “required” or “if required” may not be waived:

(a) Site Information (Required):

- i. North arrow and scale
- ii. Vicinity map
- iii. Name, address, phone number, and email address for site plan preparer, applicant, and owner
- iv. Property address, legal description, and parcel number
- v. Property boundaries, dimensions, and lot size(s), individual lots must be dimensioned
- vi. Existing and proposed road alignment, right-of-way lines, pavement width, and grade
- vii. Name of streets abutting and within 50 feet of the property

(b) Zoning Information (Required):

- i. Total lot coverage by lot, including building coverage and paved surfaces
- ii. Existing and proposed building(s): location and footprint dimensions, height, setbacks from all property lines and the road ROW along with identification of setbacks required by the applicable zone district; location and depth of riparian setback where applicable
- iii. Any changes to zone district dimensional standards with a reference to the UDC provision that permits the proposed change
- iv. Residential development: lot size per dwelling unit, total number of dwelling units, floor area of each dwelling unit, where applicable
- v. Proposed uses by building, structure, or site location
- vi. Compliance with any use-specific standards that affect site design, such as accessory structure dimensional standards or ADU minimum lot sizes
- vii. Existing and proposed site access locations

(c) Project Specific Information:

- i. Existing and proposed utilities on the site, including utility size, easement size, and culverts.
- ii. Location and type of existing and proposed wireless communication facilities.

- iii. Topographic lines at two-foot intervals and grades, both existing and proposed; spot grades of completed improvements.
- iv. Indication of prominent natural features, such as existing trees, streams, and ridgelines, the 100-year floodplain line and elevation above floodplain.
- v. Expected water consumption per day in gallons; required flow rate in GPM and/or peak instantaneous demand; proposed fire service line size if required; proposed water meter size.
- vi. Required Industrial uses: expected wastewater discharge flow per day and waste stream characteristics (i.e., TSS or BOD)
- vii. Site-specific utility service information such as on-site manholes, clean-outs, and connection points.
- viii. Location, type, and area of on-site sewage disposal systems, if applicable.
- ix. If required for the project, traffic impact analysis report.
- x. Sidewalk location and design.
- xi. Total number of required parking spaces and a detailed floor plan to calculate usable floor space for parking space requirements. Shared parking agreements must be included if used for parking allotments and shall be irrevocable to protect everyone's current and future interests.
- xii. Dimensions and design of parking and loading areas, including specifications for paving and striping.
- xiii. Location and dimensions of fire lanes and identification of adequate hydrant access.
- xiv. Dimensions and design of stacking spaces for drive-thru facilities.
- xv. A landscape plan that meets the requirements of Section xx. Plant materials, sizes, and quantities may be shown in a table on the side of the landscape sheet.
- xvi. Identification of screening materials, design, dimensions, and estimated time of maturity.
- xvii. Parking lot landscaping layout, materials.
- xviii. Where required, the location and dimensions of public and/or private open space.
- xix. Provide information on outdoor lighting indicating height, fixture type, and locations.

(d) Stormwater Management Information: If the project meets the applicability

requirements of 405.030(O), Drainage Permit, then a drainage permit shall be included with the site plan. Any application fees associated with the drainage permit may be waived when submitted with the site plan.

- (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
- (3) Notice is not required.
- c. *Multiple applications.* Where a site plan is submitted in conjunction with another application that requires a preapplication meeting and notice of public hearing, the site plan shall be included in the preapplication meeting discussion and shall be made available for public review with all related applications.
4. *Action by review and decisionmaking bodies.*
 - a. *Action by Director.* The Director shall review each administrative site plan application and, as deemed necessary, distribute the application to other reviewers. Taking into account the results of those reviews, the Director shall take final action on the application and approve, approve with conditions, deny, or defer decision on the application based on the applicable approval criteria below. The Director's review and decision, including referral to other agencies and bodies, shall be completed within thirty (30) working days of receipt of a complete application. Failure to complete such review in thirty (30) working days shall not constitute deemed approval of the site plan.
 - b. *Referral to Planning and Zoning Commission.* The Director may refer to the Planning and Zoning Commission any application involving any requested deviation, modification, or exemption from the requirements of this Code, and/or any application that in the Director's opinion presents issues that require Planning and Zoning Commission attention. Such applications shall State all reasons for requesting any deviation, modification, or exemption from the rules, requirements, and regulations of this Code.
 - c. *Action by Planning and Zoning Commission.* Where a site plan has been referred by the Director to the Planning and Zoning Commission or is identified for Planning and Zoning Commission review by this Code, the Planning and Zoning Commission shall hold a hearing on the proposed application and approve, approve with conditions, or deny the proposed site plan, based on the applicable approval criteria below.
 - d. *Approval criteria.* The Director may approve a site plan upon a finding that the application meets all of the following criteria:
 - (1) The site plan is consistent with the Warsaw Comprehensive Plan;
 - (2) The site plan is consistent with any previously approved subdivision plat, planned development, or any other precedent plan or land use approval as applicable;
 - (3) The site plan complies with all applicable development and design standards set forth in this Code;
 - (4) Stormwater management is provided in compliance with Section 405.070,

Stormwater Management and Natural Area Protection Standards, if applicable;

- (5) Any significant adverse impacts reasonably anticipated to result from the structure or use will be mitigated or offset to the maximum extent practicable;
 - (6) The development proposed in the plan and its general location is or will be compatible with the character of surrounding land uses; and
 - (7) The development can be adequately served by City services, including but not limited to roads, water and wastewater.
5. *Appeal.* Appeal of a Director's determination on a site plan may be made to the Board of Adjustment. Appeal of a Planning and Zoning Commission determination on a site plan may be made to the Board of Aldermen by filing an appeal within fourteen (14) days of the date of the Planning and Zoning Commission's determination.
6. *Modifications to site plans.* The holder of an approved site plan may request a modification to the document or the conditions of approval by submitting amended documents to the Director. The amended documents shall be filed and processed in accordance with the procedures for an initial site plan submittal.

G. *Planned Development.*

- 1. *Purpose.*
 - a. Planned development district (PD) rezoning is appropriate for the purpose of providing design flexibility not normally available through standard zoning procedures. Planned development district rezoning is available in any zoning district classification except mixed use. Planned development rezoning is intended to encourage high-quality smart-growth development that provides:
 - (1) More efficient infrastructure;
 - (2) Reduced traffic demands;
 - (3) More usable public or private open space and pedestrian connectivity;
 - (4) Needed housing choices and affordability;
 - (5) Assurance of new quality development; and
 - (6) Protection of the quality and integrity of existing neighborhoods.
 - b. Planned development approval is a two-step process: approval of a preliminary site plan followed by approval of a final site plan. Preliminary plan approval may take place at the same time as rezoning if both applications are submitted together. The approved final development plan shall serve as a basis for use (permitted within the district), density, and design criteria.
 - c. The sale, subdivision or replatting of the lot after zoning approval does not exempt the project from complying with applicable development standards, architectural quality,

sign concepts, or other conditions that were committed to at the time of rezoning.

2. *Procedures.*

a. *Preapplication meeting.* An applicant for PD rezoning is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.

b. *Application and notice.*

(1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). PD rezoning applications shall be submitted with a site plan that meets the requirements identified in Section 405.030(F).

(2) All applicants are required to submit complete applications as identified in Section 405.020(E).

(3) Published, written and posted notice shall be provided before the 15th day prior to the Planning and Zoning Commission public hearing according to Section 405.020(F).

3. *Planned development standards.* The design of the PD shall be shown on the preliminary site plan and may include the following changes to the base zone district standards:

a. *Revisions to site standards.* All applications for planned developments may propose to revise zone district dimensional standards, such as setbacks or lot sizes, provided that they are reduced to not less than twenty-five percent (25%) of the underlying district standard and provided that the revisions are appropriate to the location and design of the development. For example, a front yard setback could be reduced from twenty-five (25) feet to six and twenty-five hundredths (6.25) feet to better suit a specific development layout.

b. *Density bonus.* A density bonus of up to ten percent (10%) over what is allowed by the underlying zoning district may be granted to projects that offer higher development standards and enhanced site amenities such as:

(1) Providing additional landscaping and buffering beyond the minimum amounts required under the standards in Section 405.120;

(2) Providing quality enhancements to the overall commercial architectural design for the site;

(3) Dedication of trails and open space, including on-site trail connections or preservation of riparian areas beyond that required by Section 405.070 Stormwater Management and Natural Area Protection Standards; and

(4) Maximizing traffic efficiency and connectivity while minimizing congestion by providing shared access to existing businesses and proposed land uses.

4. *Action by review and decisionmaking bodies.* A PD rezoning application is reviewed by the Planning and Zoning Commission and decided upon by the Board of Aldermen.

- a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public hearing and make a recommendation to approve, approve with revisions, postpone, or deny the application for PD rezoning.
- b. *Board of Aldermen review.*
 - (1) The Board of Aldermen shall hold a public meeting to review the application and shall approve, approve with conditions, postpone, or deny the proposed PD rezoning.
 - (2) If there is a valid protest against the change of zoning that is signed by the owners of at least thirty percent (30%) of either: the area of land (exclusive of street and alleys) included in the proposed change, or within an area determined by lines drawn parallel to and one hundred eighty-five (185) feet distant from the boundaries of the district proposed to be changed, a zoning amendment will not become effective except upon the affirmative vote of two-thirds (2/3) of all members of the Board of Aldermen.
- c. *Approval criteria.* The Planning and Zoning Commission and Board of Aldermen shall consider the following criteria when reviewing a preliminary site plan:
 - (1) The development meets the terms of the underlying zoning district except as modified by the planned development district standards;
 - (2) The site is capable of providing the required amount of open space (green space) for the buildings, parking and drive areas;
 - (3) The site plan provides for safe and easy ingress, egress and internal traffic circulation;
 - (4) Stormwater management is provided in compliance with Section 405.070, Stormwater Management and Natural Area Protection Standards, if applicable;
 - (5) All easements and utilities shall be at or above the engineering standards/service capacities of the approving departments and agencies;
 - (6) The plan is consistent with good land use planning and site engineering design principles, particularly with respect to safety and aesthetics;
 - (7) The architectural designs are consistent with Warsaw's policies and regulations and compatible with surrounding features;
 - (8) The plan represents an overall development pattern that is consistent with the Comprehensive Plan, Master Street Plan, Master Land Use Plan and other adopted planning policies;
 - (9) Right-of-way and easements have been identified by the City for dedication; and
 - (10) Recreational and aesthetic amenities associated with the planned developments shall be of an equal or higher quality than what is required of normal (nonplanned) developments.

5. *Preliminary site plan amendment.* Once property has been rezoned to a planned development district, changes to the preliminary site plan may be made only after approval of a revised preliminary site plan. Minor revisions or changes that are not considered significant may be approved by the Director without a public hearing. If these revisions or changes are not approved, they may be appealed to the Planning and Zoning Commission. Significant changes may only be approved after a rehearing by the Planning and Zoning Commission, which shall be subject to the same procedural requirements of the original application.
 - a. *Determining significant changes.* For the purposes of this Subsection, whether the changes to the preliminary site plan are significant shall be determined by the Director and shall mean any of the following as compared to the approved preliminary site plan:
 - (1) Any changes that exceed any terms specified by the Planning and Zoning Commission and/or Board of Aldermen;
 - (2) Increases in density or intensity of residential uses by more than five percent (5%);
 - (3) Increases in total floor area (entire plan) of all nonresidential buildings by more than five percent (5%) or five thousand (5,000) square feet, whichever is less;
 - (4) Increases of lot coverage by more than five percent (5%);
 - (5) Changes in architectural style that make the project less compatible with surrounding land uses;
 - (6) Changes in ownership patterns or stages of construction that lead to a different development concept;
 - (7) Changes in ownership patterns or stages of construction that impose substantially greater traffic volumes on streets and load capacities on other public facilities;
 - (8) Decreases in any peripheral setback of more than five percent (5%);
 - (9) Decreases in areas devoted to open space of more than five percent (5%) or the substantial relocation of such areas;
 - (10) Changes to the traffic circulation patterns that may affect traffic outside of the project boundaries;
 - (11) Modification or removal of conditions and stipulations to the preliminary site plan approval; or
 - (12) Modifications that change, amend, or violate the terms of the Comprehensive Plan.
 - b. *Appeal.* Appeal of the Director's determination of significance may be made to the Planning and Zoning Commission, whose decision shall be final. No further action shall be taken to process the application pending the Planning and Zoning Commission's determination.
6. *Final site plan approval.*

- a. *Submission.* Following approval of a preliminary site plan, an applicant may submit a final site plan for approval. The final plan shall include the information specified on the final site plan application form.
- b. *Submitting preliminary and final plans.* The developer may submit preliminary and final development plans simultaneously at the developer's own risk.
- c. *Grading and construction.* Permits for grading or construction shall be issued only after final plans have been approved by the Director or Planning and Zoning Commission.
- d. *Conditions for approval.* Final plans shall be approved only after the following conditions have been met:
 - (1) Final plans conform to the approved preliminary site plan and meet any special amendments or requirements imposed at the time of rezoning. Significant changes, as determined by the Director, between the preliminary plan and the final plan shall be sufficient reason to require the resubmission of a preliminary plan.
 - (2) If the project is being constructed in phases, each phase shall be functional and shall be adequately served by access drives, parking, storm drainage system(s), and utilities as a freestanding project and shall not have adverse effects on the neighborhood if the later phases of development are not carried out.
- e. *Director action.*
 - (1) A final site plan that contains no modifications or additions from the approved preliminary plan shall be approved by the Director if the Director determines that all of the submission requirements have been satisfied.
 - (2) A final development plan that contains modifications from the approved preliminary development plan but which changes are not significant as measured against the original approved preliminary development plan may be approved by the Director if the Director determines that all of the submission requirements have been satisfied.
 - (3) If the final site plan has significant changes from the preliminary plan, the Director shall not be consider the final plan and shall return it to the applicant.
 - (4) Appeal of the Director's determination may be made to the Planning and Zoning Commission, whose determination shall be final. No further action shall be taken to process the application pending the Planning and Zoning Commission's determination.

H. *Alternative Compliance.*

1. *Purpose and scope.* To encourage creative and unique design, the alternative compliance process allows development to occur in a manner that meets the intent of this Code yet through an alternative design that does not strictly adhere to the Code's standards. This is not a general waiver of regulations. Rather, this Subsection authorizes a site-specific plan that is equal to or better than the strict application of the standard.

2. *Applicability.* The alternative compliance procedure is available only for the following sections of this Code:
 - a.
 - b. Section 405.080, Mobility and Connectivity;
 - c. Section 405.090, Commercial and Mixed Use Design and Development Standards;
 - d. Section 405.100, Multifamily and Townhouse Residential Design Standards; and
 - e. Section 405.120, Landscaping and Screening.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant proposing alternative compliance shall request and attend a preapplication conference prior to submitting application materials for the applicable permit(s) to discuss the project, the applicable Code standards, and the proposed method of alternative compliance. The application should include sufficient explanation and justification, in both written and graphic form, for the requested alternative compliance.
 - b. *Application and notice.* An alternative compliance request shall be submitted as part of another application, such as with the landscaping portion of a site plan application or lot layout in a subdivision application. The alternative compliance request shall be clearly labeled on the application.
4. *Decisionmaking responsibility.* Final approval of any alternative compliance proposed under this Subsection shall be the responsibility of the decisionmaking body responsible for deciding upon the application. Administratively approved projects proposing alternative compliance shall receive written approval of the alternative compliance from the Director.
5. *Review criteria.* Alternative compliance requests may be approved if the applicant demonstrates that the following criteria have been met by the proposed alternative:
 - a. Achieves the intent of the subject standard to the same or better degree than the subject standard;
 - b. Advances the goals and policies of the Comprehensive Plan and this Code to the same or better degree than the subject standard;
 - c. Results in benefits to the community that are equivalent to or exceed benefits associated with the subject standard; and
 - d. Imposes no greater impacts on adjacent properties than would occur through compliance with the specific requirements of this Code.
6. *Effect of approval.* Alternative compliance approval shall apply only to the specific site for which it is requested and shall not establish a precedent for approval of other requests.

I. *Major Subdivision.*

1. *Purpose.* The purpose of the subdivision review procedures is to ensure compliance with the standards and requirements in Section 405.140, Subdivision Design Standards, and encourage quality development consistent with the goals, policies and objectives in the Comprehensive Plan.
2. *Applicability.* The procedures of this Subsection and the standards in Section 405.140, Subdivision Design Standards, shall apply to all subdivisions or resubdivisions that result in the portioning, dividing, combining or altering of any lot, parcel or tract of land into two (2) or more lots, tracts, parcels or other divisions of land, except any subdivisions that are specifically excluded by State law or are defined as minor subdivisions in Section 405.030(J), below. However, unless the method of disposition is adopted for the purpose of evading the requirements of this Code, this procedure shall not apply to any division of land that:
 - a. Is created by any transfer by operation of law;
 - b. Creates cemetery lots;
 - c. Creates an interest or interests in oil, gas, minerals or water that are severed from the surface ownership of real property;
 - d. Is created by the acquisition of an interest in land in the name of a husband and wife or other persons in joint tenancy, or as tenants in common of such interest. For the purpose of this Subsection, any interest in common owned in joint tenancy shall be considered a single interest; or
 - e. Creates a leasehold interest with a term of less than twenty (20) years and involves no change in use or degree of use of the leasehold estate.
3. *Preliminary plat: procedures.*
 - a. *Generally.* All major subdivisions are processed in two stages: the preliminary plat, and the final plat. The final plat can only be filed with the City for review and processing after the preliminary plat has been approved or conditionally approved by the Board of Aldermen. Specific procedures for preliminary and final plats are outlined below.
 - b. *Preliminary plat preapplication meeting.* An applicant for a preliminary plat approval is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - c. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Preliminary plats shall include, at a minimum:
 - (a) Site information (Required):
 - i. Name of the proposed subdivision
 - ii. North arrow and scale (not less than 1" = 100')

- iii. Vicinity map
- iv. Name, address, phone number, and email address for site plan preparer, applicant, and owner
- v. Property address and legal description for all of the land to be platted as well as any platted or unplatted adjacent properties in the same ownership
- vi. Property boundaries, dimensions, and lot size(s), individual lots must be dimensioned
- vii. Name of streets abutting and within 50 feet of the property

(b) Lot and Zoning Information (Required)

- i. Existing and proposed building(s): (a) location and footprint dimensions, (b) height, (c) building setbacks from all property lines and the road ROW along with setbacks required by the applicable zone district
- ii. Total lot coverage by lot, including building coverage, accessory structures with a roof, and paved surfaces
- iii. Residential development: lot size per dwelling unit, total number of dwelling units, floor area of each dwelling unit, where applicable
- iv. Any changes to zone district dimensional standards with a reference to the UDC provision that permits the proposed change
- v. Compliance with any use-specific standards that affect site design, such as accessory structure dimensional standards or ADU minimum lot sizes

(c) Project Specific Information:

- i. Topographic lines at two-foot intervals and grades, both existing and proposed; spot grades of completed improvements.
- ii. Existing environmental features such as significant trees, streams, and ridgelines; location and direction of drainage channels; identification of areas subject to 100-year flood; proposed riparian buffers
- iii. Location and design of any proposed low impact development features.
- iv. Existing and proposed road alignments, rights-of-way lines, pavement width, and appropriate grades
- v. Existing and proposed utilities on the site, including utility size, easement size, and culverts.
- vi. Location and type of existing and proposed wireless communication facilities.
- vii. Expected water consumption per day in gallons; required flow rate in GPM and/or peak instantaneous demand; proposed fire service line size if

required; proposed water meter size.

- viii. Required: Industrial uses: expected wastewater discharge flow per day and waste stream characteristics (i.e., TSS or BOD)
- ix. Site-specific utility service information such as on-site manholes, clean-outs, and connection points.
- x. If required for the project, traffic impact analysis report.
- xi. Location, type, and area of on-site sewage disposal systems, if applicable.

(d) Stormwater Management Information: If the project meets the applicability requirements of 405.030(O), Drainage Permit, then a drainage permit shall be included with the preliminary plat application. Any application fees associated with the drainage permit will be waived when submitted with the preliminary plat.

(2) All applicants are required to submit complete applications as identified in Section 405.020(E).

(3) No notice is required for preliminary plat consideration.

4. *Preliminary plat: action by review and decisionmaking bodies.*

- a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public meeting and approve, approve with revisions, postpone, or deny the application for preliminary plat. The Planning and Zoning Commission shall act on the application within sixty (60) days of the opening of the public meeting to consider the application or the application shall be deemed approved. The sixty-day time frame may be extended with the applicant's consent.
- b. *Board of Aldermen action.* The Board of Aldermen shall review the Planning and Zoning Commission's action on the preliminary plat and take action by resolution. If the Planning and Zoning Commission has denied the preliminary plat, the Board may, by a vote of not less than three-fourths (3/4) of its full membership, overrule the disapproval.
- c. *Review criteria.* Recommendations and decisions on preliminary plat approvals shall be based on consideration of the following criteria:
 - (1) Compliance with the purpose and intent provisions of this Code.
 - (2) Consistency with the Warsaw Comprehensive Plan.
 - (3) Physical suitability of the land for the proposed development or subdivision.
 - (4) Compatibility of the subdivision design and development intensity with surrounding land uses.
 - (5) Whether there are adequate facilities available to serve the development as designed.

- (6) Stormwater management is provided in compliance with Section 405.070, Stormwater Management and Natural Area Protection Standards, if applicable;
 - (7) Evidence of approval by the appropriate utilities, including water and sewer utilities.
 - (8) Right-of-way and easements have been identified by the City for dedication.
 - (9) Compliance with all applicable use, density, development, and design standards set forth in this Code that have not otherwise been modified or waived pursuant to this Chapter and that would affect or influence the layout of lots, blocks and streets. Applicants shall avoid creating lots or patterns of lots in the subdivision that will make compliance with such development and design standards difficult or infeasible.
 - (10) That the general layout of lots, roads, driveways, sidewalks, utilities, drainage facilities, and other services within the proposed subdivision is designed in a way that minimizes the amount of land disturbance, maximizes the amount of open space in the development, preserves existing trees/vegetation and riparian areas, protects critical wildlife habitat, and otherwise accomplishes the purposes and intent of this Code.
 - (11) Evidence that provision has been made for a public sewage disposal system or, if other methods of sewage disposal are proposed, adequate evidence that such system shall comply with State and local laws and regulations.
 - (12) Evidence that all areas of the proposed subdivision that may involve soil or topographical conditions presenting hazards or requiring special precautions have been identified by the applicant and that the proposed use of these areas is compatible with such conditions.
 - (13) Provision has been made for assumption of responsibility for maintaining all roads, open spaces and other public and common facilities in the subdivision.
 - (14) As applicable, the proposed phasing for development of the subdivision is rational in terms of available infrastructure capacity and financing.
5. *Preliminary plat: effect of approval.* Approval of the preliminary plat does not constitute acceptance of the subdivision but is merely an authorization to proceed with preparation of the final plat for record. No grading of streets or construction shall be done in the subdivision before the final plat is approved by the Planning Commission and by the Board of Alderman except by special permission of the Board of Aldermen. Upon refusal of the Planning and Zoning Commission to approve a preliminary plat, the applicant may make such changes as are required for approval and resubmit the plat or he/she may appeal the decision to the Board of Aldermen who may reverse the decision of the Planning Commission and approve said preliminary plat. The approval of the preliminary plat shall be effective for a period of two (2) years; such period may be extended by the Planning Commission upon the request of the property owner.
6. *Preliminary plat: termination.* An approved preliminary plat terminates after two (2) years

without further notice unless a final plat has been filed. Final plats may be filed for less than the entire preliminary plat; however, any portions of the preliminary plat that are not subject to a final plat at the end of two (2) years shall be deemed terminated. A new preliminary plat application will be required for any areas of the development subject to a terminated preliminary plat.

7. *Engineering and construction plans.*

a. *Engineering and construction plans required.* Completed engineering and construction plans, prepared by an engineer licensed in the State of Missouri, shall be submitted to the City Engineer prior to or concurrently with the submission of a final plat application. The City Engineer shall determine whether the engineering and construction plans conform to the City's engineering specifications. If the engineering and construction plans do not comply, the City Engineer shall provide the applicant with information as necessary to modify the plans. Engineering and construction plans must be approved by the City Engineer prior to City approval of a final plat application.

b. *Submission requirements.*

(1) Upon the approval of the preliminary plat, the subdivider shall have prepared engineering drawings for proposed required improvements containing the data and information specified below:

(a) Plans, profiles, details, specifications and cost estimates for roadway and sidewalk construction, including plans and profiles for each street with a typical cross section of the roadway. The profiles of grade lines shall be shown to a scale of one (1) inch equals fifty (50) feet horizontal and one (1) inch equals five (5) feet vertical. This information shall be shown on standard plan and profile sheets unless otherwise required.

(b) Plans, profiles, details, specifications and cost estimates of proposed storm drainage improvements.

(c) Plans, profiles, details, specifications and cost estimates of proposed water distribution systems and proposed water supply facilities and hydrants, if any.

(d) Plans, profiles, details, specifications and cost estimates of sewage systems and of any required sewage treatment facilities.

(e) Grading plans for all lots and other sites in the subdivision.

(f) When unusual site conditions exist, the governing body may require such additional plans, specifications and drawings as may be necessary for an adequate review of the improvements to be installed.

(g) All plans shall be based on City or United States Geological Survey datum for vertical control.

(2) Any or all of the required drawings may be waived or modified by the Board of Aldermen, after consideration of the City Engineer's opinion, upon a showing by the subdivider that such drawings are either unnecessary or create a substantial

hardship.

8. *Final plat: procedures.*

- a. *Final plat preapplication meeting.* An applicant for a final plat approval is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
- b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) No notice is required for final plat consideration.

9. *Final plat: action by review and decisionmaking bodies.*

- a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public meeting and recommend approval, approval with revisions or denial of the application for final plat. The Planning and Zoning Commission shall act on the application within sixty (60) days of the opening of the public meeting to consider the application or the application shall be deemed approved. The sixty-day time frame may be extended with the applicant's consent.
- b. *Board of Aldermen action.* The Board of Aldermen shall review the Planning and Zoning Commission's recommendation on the final plat and approve, approve with revisions or deny the final plat application. Approval of the final plat does not constitute acceptance of the public improvements identified on the plan; the Board of Aldermen shall take a separate action to review and determine whether to accept dedication of the public improvements.
- c. *Review criteria.* The Planning and Zoning Commission shall not recommend approval of and the Board of Aldermen shall not approve any final plat unless the final plat meets all of the following criteria:
 - (1) The proposed final plat complies with the conditions of approval of the preliminary plat;
 - (2) The layout and design of the proposed final plat is in substantial compliance with the approved preliminary plat, including but not limited to number of lots or parcels, street and block layout, and access; and
 - (3) The improvement plans for any required on-site or off-site public or private improvements have been reviewed and approved by the City for construction.

10. *Recordation.* The approved plat shall be recorded at the Benton County Recorder of Deeds office at the applicant's expense within one (1) year of approval. A final plat that is not recorded within one (1) year shall be considered void.

11. *Improvements.*

a. *General.*

- (1) After the approval of the final plat and any required permits, the subdivider may do the grading and any drainage work that is required, all according to plans approved by the City Engineer.
- (2) Prior to the issuance of any building permits, all street paving, storm drainage, and utility lines must be installed in accordance with Section 405.140.

b. *Construction of improvements.* No improvements shall be constructed nor shall any work preliminary thereto be done until such time as a final plat and the engineering drawings accompanying it shall have been approved by the Board of Aldermen and there shall have been compliance with all of the requirements relating to an agreement, bond or deposit specified in these regulations.

c. *Inspection.* All improvements constructed or erected shall be subject to inspection by the City or its designated representative responsible for setting and enforcing the applicable design and construction standards of the required improvement. The subdivider shall give at least twenty-four (24) hours' notice to such official prior to the performance of any work item which the City requests to inspect.

d. *Acceptance of improvements.* Upon the determination by the Board of Aldermen, after consideration of the opinion of the official, that there are no defects, deficiencies or deviations in the improvements, and that all improvements have been installed in conformance with the approved engineering drawings, and with the requirements of this Code, and all other applicable State and Federal statutes, ordinances and regulations, the Board of Aldermen and/or such appropriate utility shall thereupon by resolution or by letter, respectively, formally accept such improvements. The improvements shall become the property of the Board of Aldermen or appropriate utility company involved.

J. *Minor Subdivision And Administrative Lot Combination.*

1. *Purpose.* The purpose of the minor subdivision review procedure is to ensure compliance with the standards and requirements in Section 405.140, Subdivision Design and Improvements, and to encourage quality development consistent with the goals, policies and objectives in the Comprehensive Plan.
2. *Applicability.* The minor subdivision procedure is applicable for the following, provided that the proposed lots and resulting density are permitted under the existing zoning designation of the subject property:
 - a. A condominium, timesharing, or duplex subdivision as defined in this Code;
 - b. A subdivision that creates no more than three (3) lots where no new roads or public infrastructure is required, provided that parcels are eligible for minor subdivision only once, and further subdivision of the original or newly created parcels shall be processed as a major subdivision;

- c. Consolidation of two (2) or more lots into a single lot in a previously recorded subdivision plan; and
 - d. Lot line adjustments where the resulting number of lots does not change.
3. *Minor subdivision plat: procedures.*
- a. *Minor subdivision plat preapplication meeting.* An applicant for a minor subdivision plat approval is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Minor subdivision applications shall be submitted with a plat pursuant to Section 405.030(I)(3)(c).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020.(E).
 - (3) No notice is required for minor subdivision plat consideration.
4. *Action by review and decisionmaker.*
- a. *Authority.* The Director shall have decisionmaking authority for minor subdivisions.
 - b. *Review and approval criteria.*
 - (1) Compliance with the purpose and intent provisions of this Code;
 - (2) Consistency with the Warsaw Comprehensive Plan;
 - (3) Physical suitability of the land for the proposed development or subdivision;
 - (4) Compatibility with surrounding land uses;
 - (5) Whether there are adequate facilities available to serve development for the type and scope suggested by the proposed minor subdivision;
 - (6) Stormwater management is provided in compliance with Section 405.070, Stormwater Management and Natural Area Protection Standards, if applicable;
 - (7) Evidence of adequate sewage treatment for each lot; and
 - (8) Evidence that the subdivision will not create any hazards due to geology, soil, topography, drainage, fire protection, or any other condition, and that all lots will contain safe, adequate building sites.
5. *Recordation.* The applicant shall cause the minor plat to be recorded within ninety (90) days from the date of approval and acceptance of the Director. In the event that the plat is not recorded, the approval of the Director shall be deemed to be void.
6. *Administrative lot combination.* The Director has the authority to approve lot combinations

in which the configuration of the property is created by the assembly or combination of existing tracts of record where the Director finds that the proposed lot combination does not substantially increase demands on public infrastructure serving existing and proposed tracts, parcels or lots, and the following conditions are satisfied:

- a. The proposed lot combination is in compliance with all other provisions of this Code;
- b. The proposed lot combination will not create any tract, parcel, or lot that does not meet the minimum lot standards of the zoning district in which it is located;
- c. The proposed lot combination shall not cause any construction over a public sanitary sewer line or sewer easement; and
- d. The proposed lot combination is consistent with the surrounding area. In determining consistency, the size and dimensions of lots previously developed, the layout and design of existing subdivisions and the degree of deviation from previous development shall be considered.

K. *Variance.*

1. *Purpose and applicability.* In order to prevent or to lessen such practical difficulties and unnecessary physical hardships inconsistent with the objectives of the Code as would result from strict or literal interpretation and enforcement, variances from certain regulations may be granted.
2. *Applicability.* An application for a variance may be requested by a property owner in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant for a variance is encouraged to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). All variance applications shall be accompanied by a site plan.
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Published, mailed, and posted notice shall be provided before the 15th day prior to the Board of Zoning Adjustment public hearing according to Section 405.020(F).
4. *Action by review and decisionmaking bodies.*
 - a. *Review by Board of Adjustment.* A variance application is reviewed by the Board of Adjustment at a public hearing.
 - b. *Review criteria.* In exercising the power to grant variances from the specific requirements of these regulations, the Board of Adjustment shall find each of the

following factors to exist:

- (1) The variance requested arises for such condition which is unique to the property in question and which is not ordinarily found in the same zone or district and is not created by an action or actions of the property owner or applicant.
- (2) The granting of the permit for the variance will not adversely affect the rights of adjacent property owners represented in the application.
- (3) The strict application of the provisions of the zoning regulations for which the variance is requested will constitute unnecessary hardship upon the property owners represented in the application.
- (4) The variance desired will not adversely affect the public health, safety, morals, order, convenience, prosperity or general welfare.
- (5) The granting of the variance desired will not be opposed to the general spirit and intent of the zoning regulations.

c. *Conditions of approval.*

- (1) In granting a variance, the Board of Adjustment may impose such conditions, safeguards and restrictions upon the premises benefitted by the variance as may be necessary to reduce or minimize any potentially injurious effect of such variance upon other property in the neighborhood and to carry out the general purpose and intent of this Code.
- (2) The Board of Adjustment may require a performance bond to guarantee the installation of improvements. The amount of the bond shall be based on a general estimate of cost for the improvements as determined by the Board of Adjustment and shall be enforceable by or payable to the City in the sum equal to the cost of constructing the required improvements.
- (3) In lieu of performance bonds or other conditions, the Board of Adjustment may specify a time limit for the completion of such required improvements, and in the event the improvements are not completed within the specified time, the Board of Adjustment may, after reconsideration, declare the granting of the application null and void, or the variance may be made contingent on the performance of certain actions.

- d. *Action on approval.* If an application for variance is granted by the Board of Adjustment, it shall be signed by the Chairman of the Board and shall state on the application the conditions of the approval established by the Board. A copy of the approved variance application shall be forwarded to the Director who shall issue a permit setting out the terms of the variance

L. *Appeal.*

1. *Purpose.* The Board of Adjustment shall be authorized to hear and decide appeals where it is alleged there is an error in any order, requirement, decision or determination made by an administrative official of the City in the administration or enforcement of this Code.

2. *Applicability.* Appeals to the Board of Adjustment may be taken by any person aggrieved, by any neighborhood organization as defined in Section 32.105, RSMo., representing such person or by any officer, department, board or bureau of the municipality affected by any decision of the administrative officer.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant for an appeal is encouraged to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). The application shall specify all grounds for the appeal. All grounds not specified in the application shall be deemed waived by the applicant.
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) No notice is required for an appeal.
 - c. *Timing of application.* An appeal shall be taken within thirty (30) days of the date of the decision. The officer whose decision is being appealed shall immediately, after being served with the notice of appeal, transmit all the papers constituting the record upon which the action appealed from was taken to the Secretary of the Board of Adjustment.
4. *Action by review and decisionmaking bodies.*
 - a. *Review by Board of Adjustment.*
 - (1) An appeal is reviewed by the Board of Adjustment at a regular meeting.
 - (2) The Board of Adjustment shall grant to the administrative official's decision a presumption of correctness, placing the burden of persuasion of error on the appellant. An appeal shall be sustained only if the Board of Adjustment finds that the administrative official erred.
 - (3) In exercising the appeal power, the Board of Adjustment shall have all the powers of the official from whom the appeal is taken, and the Board of Adjustment may reverse or affirm wholly or partly or may modify the decision being appealed.
 - (4) If the Board of Adjustment determines that it is necessary to obtain additional evidence in order to resolve the matter, it shall remand the appeal to the official from whom the appeal is taken, with directions to obtain such evidence and to reconsider the decision in light of such evidence.
 - b. *Time frame for action.* The Board of Adjustment shall take action on an appeal within a reasonable period of time after application submittal, but in no case more than sixty (60) days after receipt of a complete application.

- c. *Vote to reverse administrative determination.* A concurring vote of four (4) members of the Board of Adjustment shall be necessary to reverse any order, requirement, decision or determination of an administrative official. Every decision of the Board of Adjustment shall be accompanied by a written finding of fact specifying the reason for the decision.
- 5. *Effect of appeal.* An appeal stays all proceedings in furtherance of the action appealed from, unless the officer from whom the appeal is taken certifies to the Board of Adjustment, after the notice of appeal has been filed, that by reason of facts stated in the certificate a stay would, in his/her opinion, cause immediate peril to life or property. In such case, proceedings shall not be stayed otherwise than by a restraining order which may be granted by the Board of Adjustment or by a court of record on application or notice to the officer from whom the appeal is taken and on due cause shown.

M. *Minor Modification.*

- 1. *Purpose.* Applications for minor modification may be submitted along with an application for development permit for the purpose of making a minor amendment to a development standard applicable to the proposed project. Minor modifications may also be made to approved site plans that conform to the requirements of this Section. A minor modification allows a change of up to ten percent (10%) to the applicable standard.
- 2. *Standards subject to minor modification.*
 - a. Up to four (4) minor modifications may be provided for a pending development application. No more than two (2) minor modifications may be permitted to correct measurement errors on an approved application through the submission of a site plan.
 - b. The following standards may be subject to minor modifications of up to a maximum of ten percent (10%) from the general development and zoning district standards, provided that the applicable approval criteria below are met.
 - (1) Minimum lot area requirements;
 - (2) Setback requirements; and
 - (3) Quantitative development standards (e.g., percentage of site landscaping, number of parking spaces, etc.).
 - c. Stormwater standards cannot be modified.
- 3. *Measurement.* The modification is calculated by applying the ten-percent modification to the required development standard or measurement, rounded to the nearest whole number. For example, a required ten-foot side yard setback may be modified by ten percent (10%) or one (1) foot, allowing a nine- foot setback.
- 4. *Approval criteria.* Minor modifications may be approved only upon a finding that all of the following criteria have been met:
 - a. The requested adjustment is consistent with the stated purposes of this Code.

- b. The adjustment will not substantially interfere with the convenient and enjoyable use of adjacent lands and will not pose a danger to the public health or safety.
- c. Any adverse impacts resulting from the administrative adjustment will be mitigated to the maximum practical extent.
- d. The administrative adjustment is of a technical nature (i.e., relief from a dimensional or design standard), and is either:
 - (1) Required to compensate for some unusual aspect of the site or the proposed development that is not shared by landowners in general;
 - (2) Supporting an objective or goal from the purpose and intent statements of the zoning district where located; or
 - (3) Proposed to protect sensitive natural resources or better integrate development with the surrounding environment.
- 5. *Review process.* Final approval of any proposed minor modification shall be the responsibility of the decisionmaker of the application to whom the minor modification request has been submitted. Minor modifications to approved site plans may be made by the Director.

N. *Grading Permit.*

- 1. *Purpose.* The purpose of this Subsection is to provide procedures for grading permits. Grading permits are required to review the extent of grading activity proposed to minimize and mitigate the disturbance of land, vegetation, and any existing or potential hazards.
- 2. *Applicability.*
 - a. It shall be unlawful for any person to conduct any activity resulting in any of the following total disturbed areas without first obtaining a grading permit pursuant to this Subsection. A grading permit shall be required for disturbed areas of:
 - (1) One (1) acre or more.
 - (2) Less than one (1) acre if such activities are part of a larger common plan of development, even though multiple, separate and distinct land development activities may take place at different times on different schedules.
 - b. The City may also require a grading permit regardless of the size of the total disturbed area in conjunction with approval of a final subdivision plat, conditional use permit, or site development plan, or if the construction activities are adjacent to a floodplain boundary or wetlands.
 - c. Grading not relating to a development application shall be prohibited, except as exempted below.
 - d. *Exemptions.* The following activities are exempt from this Subsection:
 - (1) Agricultural cropping and land management activities, not including construction

activities.

- (2) Maintenance and repair of any stormwater facility, utilities, irrigation ditch, watercourse, or related practice deemed necessary by the City Engineer.
- (3) Emergency repairs to streets, utilities and other similar facilities deemed necessary by the City Engineer.

3. *Procedures.*

a. *Preapplication meeting.* A preapplication meeting is not required.

b. *Application and notice.*

- (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).
- (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
- (3) Notice is not required.

4. *Action by review and decisionmaking bodies.*

a. *City Engineer.*

- (1) The grading plan and statement shall be reviewed for consistency with applicable regulations and standards and approval criteria below, and if approved by the City Engineer, a permit shall be issued within ten (10) working days of application.
- (2) If determined inadequate by the City Engineer, the application shall be returned within ten (10) working days, and the owner may resubmit, without additional fees, an amended grading plan or statement.

b. *Approval criteria.* The City Engineer shall approve a grading permit application if it meets the following criteria:

- (1) The grading proposed will have adequate on- and off-site sedimentation and erosion control measures;
- (2) The grading proposed is the minimum amount necessary to carry out development plans;
- (3) The grading proposed avoids any adverse impact on natural drainage patterns on- and off-site; and
- (4) To the maximum extent practicable, the grading proposed avoids any disturbance of ridgelines, streams or existing trees and vegetation.

O. *Drainage Permit.*

1. *Purpose.* The purpose of this Subsection is to provide procedures for drainage permits. Drainage permits are required to minimize and mitigate the impact of stormwater runoff

from development and increase in impervious area.

2. *Applicability.*

- a. A drainage permit shall be required for all new development and redevelopment, including subdivision development and construction. It shall be unlawful for any person to alter the surface of the land to create additional impervious surfaces, including, but not limited to, pavement, buildings, and structures without first obtaining a drainage permit pursuant to this Subsection.
- b. *Exemptions.* The following activities are exempt from this Subsection:
 - (1) *Existing Development.* Improvements that cause an increased area of impervious surface on the site less than 1,000 square feet.
 - (2) *New Development.* Construction of any one new single family or duplex dwelling unit provided the total impervious area of the site is less than 5,000 square feet.

3. *Procedures.*

- a. *Preapplication meeting.* A preapplication meeting is not required.
- b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) All applicants shall submit the drainage permit at the beginning stages of the project so that the City may verify that proper stormwater management is incorporated into the design and that any drainage easements will be dedicated on the plat, if applicable. As design progresses, any major changes that result in a change in stormwater management shall require a resubmittal/update of the drainage permit.
 - (4) Notice is not required.

4. *Action by review and decisionmaking bodies.*

- a. *City Engineer.*
 - (1) The drainage permit shall be reviewed for consistency with applicable regulations, standards and approval criteria below, and if approved by the City Engineer, a permit shall be issued within fifteen (15) working days of application.
 - (2) If determined inadequate by the City Engineer, the application shall be returned within fifteen (15) working days, and the owner or applicant may resubmit, without additional fees, an amended drainage permit.
- b. *Approval criteria.* The City Engineer shall approve a drainage permit application if it meets the following criteria:

- (1) The drainage system is designed in accordance with Section 405.070, Stormwater Management and Natural Area Protection Standards;
- (2) The improvements proposed avoid any adverse impact on natural drainage patterns on- and off-site, including but not limited to flooding, erosion, loss of property, etc.;
- (3) Drainage easements for all stormwater management components including stormwater drainage setbacks for natural overland drainage paths are dedicated to the City ;
- (4) Maps and calculation tables per the City's stormwater management design criteria are included with the permit application; and
- (5) Permit application meets design requirements for retention, detention, collection, and conveyance.

P. *Permits.*

1. *Permit required.*

- a. No building or other structure shall be erected, constructed, reconstructed, or moved, nor shall it be altered without first obtaining a building permit in accordance with the terms of this Subsection.
- b. No open, vacant or unimproved land shall be used for any purpose other than agriculture without first obtaining a land use permit from the Director to be issued in accordance with the terms of this Subsection.

2. *Uses subject to permit.* The following uses shall be required to obtain a land use permit:

- a. Salvage yards and junkyards.
- b. Used car or auto storage lots.
- c. Machinery, equipment or materials storage.
- d. Mines, quarries or soil stripping.
- e. Skeet shoots or target ranges.
- f. Refuse dump or sanitary fill.
- g. Railroad yards.
- h. Picnic groves; fishing lakes.
- i. Golf courses, baseball field and other privately owned recreation areas.
- j. Nurseries.

3. *Application.* Applications for permits shall be filed with the Zoning Administrator upon forms prescribed, setting forth, among other things, the legal description of the lot, tract or parcel of land, together with a general description of the building or structure to be

constructed, erected or altered thereon, including the approximate size and shape, location of the building or structure upon the lot, tract or parcel and the intended use.

4. *Conformity with Code.* No such permit shall be issued for any building, structure, construction or use of land unless the same is in conformity in every respect with all the provisions of this Code.
5. *Issuance.*
 - a. The Director shall be empowered to act within the provisions of this Chapter, upon all applications for building permits, and the same shall be approved or denied not later than the fifth business day succeeding as herein provided. The applicant may appeal to the Board of Adjustment.
 - b. For each building permit issued there shall be charged and collected from the applicant a fee as set out in Section 500.020.
 - c. For radio tower, trailer court, sign, or other use of land of a type not providing floor space to which the above schedule is applicable, there shall be charged a fee of ten cents (\$0.10) for each one hundred dollars (\$100.00) of the total cost of the work to be performed, provided that the minimum fee shall be two dollars (\$2.00).
 - d. There shall be a separate permit for each building or structure to be constructed, erected or altered, except accessory buildings and appurtenances which may be included in the permit for the main building when construction is simultaneous.
6. *Revocation.* A permit may be revoked by the Director at any time prior to the completion of the building or structure for which the same was issued when it shall appear that there is departure from the plans, specifications or conditions as required under terms of the permit, that the same was procured by false representation or was issued by mistake, or that any of the provisions of this Code are being violated. Upon the failure, refusal or neglect of any owner, his/ her agent, contractor or duly authorized representative to secure such permit and pay the prescribed fee therefore as herein provided, the Building Inspector may issue a stop order; provided, however, that twenty-four (24) hours' written notice of such revocation or order to stop shall be served upon the owner, his/ her agent or contractor or upon any person employed upon the building or structure for which such permit was issued, and thereafter no such construction shall proceed.

§ 405.040. Zoning Districts.**A. General Provisions.**

1. *Purpose.* This Section establishes the zoning districts and contains basic information pertaining to the districts, including statements of purpose and dimensional standards.

- a. *Residential district purposes.* The residential zoning districts are intended to:

- (1) Provide appropriately located areas for residential development that are consistent with the Warsaw Comprehensive Plan and with the public health, safety and general welfare;
- (2) Ensure adequate light, air and privacy for all dwelling units;
- (3) Protect the scale and character of existing residential neighborhoods and the community;
- (4) Discourage any use that would generate traffic or create congestion on neighborhood streets other than the normal traffic that serves the residents of the district; and
- (5) Discourage any use that, because of its character or size, would create additional requirements and costs for public services that are in excess of such requirements and costs if the district were developed solely for the intended type of residential uses.

- b. *Mixed-use district purposes.* Mixed-use districts are intended to:

- (1) Promote higher-density residential development near and within downtown Warsaw;
- (2) Concentrate higher-intensity commercial and office employment growth efficiently in and around the downtown and other centers of community activity;
- (3) Encourage mixed-use redevelopment, conversion and reuse of aging and underutilized areas, and increase the efficient use of available commercial land in the City;
- (4) Create pedestrian-oriented environments that encourage pedestrian access, bicycle use, and more sustainable land use patterns; and
- (5) Ensure that the appearance and function of residential and nonresidential uses are of high and unique aesthetic character and quality and are integrated with one another and the character of the area in which they are located.

- c. *Commercial and industrial district purposes.* Commercial and industrial districts are intended to:

- (1) Help implement the Warsaw Comprehensive Plan by accommodating a full range of office, retail, commercial, service, and mixed uses needed by Warsaw's residents, businesses, visitors and workers;

- (2) Encourage site planning, land use planning, and architectural design that create an interesting, pedestrian-friendly environment where appropriate;
 - (3) Maintain and enhance the City's economic base and provide shopping, entertainment and employment opportunities close to where people live and work;
 - (4) Preserve, protect and promote employment-generating uses;
 - (5) Create suitable environments for various types of commercial and industrial uses and protect them from the adverse effects of incompatible uses;
 - (6) Allow flexibility to encourage redevelopment and positive improvements to existing businesses and residences;
 - (7) Minimize potential negative impacts of heavy-impact nonresidential development on adjacent residential areas; and
 - (8) Provide suitable locations for public and semipublic uses needed to complement nonresidential development.
2. *Zoning districts established.* For the purpose of regulating and restricting the use of land and the erection, construction, reconstruction, alteration, moving or use of buildings, structures or land, all lands within the corporate limits of Warsaw are hereby divided into the following districts:

Table 405.040-1 Zoning Districts		
Classification	District	Abbreviation
Base Districts		
Residential Districts	Single-Family Dwelling District	R-1
	Two-Family Dwelling District	R-2
	Multiple-Family Dwelling District	R-3
	Mobile Home District	R-4 (Retired)
Commercial Districts	Local Business District	C-1
	Central Business District	C-2
	Commercial District	C-3
Industrial Districts	Light Industrial District	M-1
	Heavy Industrial District	M-2
Open Space District	Open Space District	O
Overlay Districts		
	Waterfront Overlay District	WOD

3. *Zoning Map.*
- a. *Official Zoning Map.* The location and boundaries of the zoning districts are established as shown on a map prepared for that purpose designated as the "Zoning District Map." The Zoning Map, along with all of the notations, references and information shown on the Map are incorporated into and made part of this UDO.
 - (1) If changes are made in district boundaries or other items portrayed on the official Zoning District Map in accordance with the procedures established in this UDO, the changes shall be entered on the Map.

- (2) The official Map shall be located in the office of the City Clerk and shall be the final authority as to the current zoning status of land, buildings and other structures in the City.
- b. Zoning Map interpretation.
- (1) When definite distances in feet are not shown on the Zoning District Map, the district boundaries are intended to be along existing street, alley or platted lot lines or extensions of the same, and if the exact location of such lines is not clear, it shall be determined by the Zoning Administrator, due consideration being given to location as indicated by the scale of the Zoning District Map.
- (2) When streets or alleys on the ground differ from the streets or alleys as shown on the Zoning District Map, the Zoning Administrator may apply the district designations on the Map to the streets or alleys on the ground in such a manner as to conform to the intent and purpose of this Chapter.
4. *Annexation.* All territory hereafter annexed to the City of Warsaw shall be classified as Residential Holding - Open (RH-O) until other zoning, where appropriate, is approved in accordance with required procedures. No permit for use of property or erection of structures shall be issued unless such use and structure is permitted in the RH-O District.

B. *Single-Family Residential (R-1).*

1. *Purpose.* The purpose of this district is to provide for low-density, single-family detached residential development in a traditional neighborhood setting. This district implements the Low-Density Residential classification in the Warsaw Comprehensive Plan and should be located along a local road with most homes taking access from a secondary connector.
2. *Uses.* Uses permitted in the R-1 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the R-1 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-2 R-1 Single-Family Residential District Dimensions								
Lot Dimensions		Maximum Density (units/lot)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
6,000 ¹	80	1	50%	25	7	25	30	35

NOTES:

¹ Minimum lot size for all structures other than single-family detached units is 10,000 square feet.

4. *Building Area.* The minimum floor area for dwellings shall be a minimum of six hundred

fifty (650) square feet in "R-1" District. [Ord. No. 385, 10-7-2019]

C. *Two-Family Residential (R-2).*

1. *Purpose.* The purpose of this district is to provide for single-family and two-family medium-density residential development, either as a neighborhood of similar units or in a development with a mix of unit types. This district implements the Low-Density Residential classification of the Warsaw Comprehensive Plan and should be located along a local road with most homes taking access from a secondary connector.
2. *Uses.* Uses permitted in the R-2 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the R-2 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-3 Two-Family Residential District Dimensions									
Dwelling Type	Lot Dimensions		Maximum Density (units/lot)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Single-family	6,000	80	1	50%	25	7	25	30	35
Two-family	8,000 (4,000 per dwelling unit)								

NOTES:

¹ Minimum lot size for all structures other than single-family detached or two-family units is 10,000 square feet.

4. *Building Area.* The minimum floor area for dwellings shall be a minimum of six hundred fifty (650) square feet in "R-2" District. [Ord. No. 385, 10-7-2019]

D. *Multifamily Residential (R-3).*

1. *Purpose.* The purpose of this district is to provide sites for single-family, two-family, and multifamily dwellings in either traditional neighborhoods or in a setting with a mix of dwelling unit types. The R-3 District implements the Medium- and High-Density Residential classification of the Warsaw Comprehensive Plan and can be located as a transitional use between lower-density single-family development and mixed-use development or commercial development. R-3 development should be located along a local road with most homes taking access from a secondary connector.
2. *Uses.* Uses permitted in the R-3 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the R-3 District along

with any supplemental regulations provided in Section 405.040(M):

Table 405.040-4 R-3 Multifamily Residential District Dimensions									
Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Single-family detached	4,000	40	10	50%	15	7	15	10	35
Two-family	5,500 (2,250 per dwelling unit)	40	10	50%	15	7	15	10	45
Townhouse/ multifamily	n/a ¹	40	10	60%	15	7	15	10	45
Group living facilities	n/a ¹	40	n/a ¹	60%	15	7	15	10	35
Nonresidential	n/a ¹	40	n/a ¹	60%	10	7	10	10	35

NOTES:

¹ Must meet setback, height, and lot coverage requirements.

4. Building Area. The minimum floor area for dwellings shall be a minimum of six hundred fifty (650) square feet in "R-3" District. [Ord. No. 385, 10-7-2019]

E. *Mobile Home (R-4) Retired.* The R-4 District is retired as of the adoption date of this Code. Property can no longer be rezoned to R-4. The lawful use of property for parking mobile homes may be continued only to the extent that it exists as of the effective date of this Code. No mobile home may be replaced on any lot within the City after the effective date of this Code.

1. *Purpose.* The purpose of this district is to provide regulations for the continued use of moderate-density mobile home developments in a residential atmosphere as they existed as of the effective date of this Code. All land in this district shall be subject to the following requirements except as may be modified by Section 405.050(B)(1)(b).

2. *Uses.* Uses permitted in the R-4 District are identified in Table 405.050-1, Use Table.

3. *Dimensions.* The following dimensions shall apply to development in the R-4 District:

Table 405.040-5 Mobile Home District Dimensions				
	Lot Dimensions	M a x	M a x	Setbacks
				M a x

Dwelling Type	Minimum Lot Size (acres or square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Mobile home	1 acre per park	150	n/a	n/a	25	7	n/a	30	35
Single-family dwelling	8,000	80	n/a	n/a	25	7	n/a	30	35
All other uses	10,000	80	n/a	n/a	25	7	n/a	30	35

4. *Use limitations.*

- a. All mobile homes shall be connected to public water and sewer systems.
- b. Mobile homes in mobile home parks shall be blocked at a maximum of ten-foot centers around the perimeter of each mobile home and each blocking shall provide two hundred fifty-six (256) square inches bearing upon the ground or pad. All mobile homes shall be secured to the ground by tie downs and ground anchors in conformance with the standards of the State of Missouri.
- c. All electrical, gas or propane hookups shall be in conformance with the requirement of the supplier.
- d. All spaces in mobile home parks shall front on either a public street or a private street constructed to the City's standards for public streets.
- e. Mobile homes in mobile home parks shall not be closer than twenty (20) feet to another mobile home or to the boundary of the mobile home park.
- f. Mobile homes on individual residential lots shall be limited to one (1) per lot and shall be required to meet the minimum lot requirements of this district. Accessory structures, as defined under Section 405.180, Definitions, shall be placed in conformance with the setback and dimensional requirements established for this district.
- g. Preowned manufactured homes are allowed as provided in under Chapter 405, Section 405.050.

5. *Nonconformity.* All existing occupied mobile homes located on an individual lot shall be permitted to remain in place so long as occupied, but provided that they may not be replaced unless made to conform to the requirements of this Chapter. Any such existing mobile home shall be removed when unoccupied for a period in excess of twelve (12) months.

F. *Local Business Mixed-Use (C-1).*

1. *Purpose.* The purpose of this district is to provide for a compatible mix of residential and small-scale neighborhood serving commercial and civic uses. This district is intended to be placed in a neighborhood setting providing a comfortable and safe pedestrian

environment and further enhancing the character of the neighborhood. The C-1 District implements the Commercial/ Office and Medium- and High-Density Residential classification of the Warsaw Comprehensive Plan and should be located along a primary collector street.

2. *Uses.* Uses permitted in the C-1 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the C-1 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-6 Local Business District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Maximum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Single-family detached	4,000	0	10	60%	15	0, 15 ²	15	0 ²	35
Two-family	5,500 (2,250 per dwelling unit)	0	10	60%	15	0, 15 ²	15	0 ²	35
Townhouse/ multifamily	¹	0	10	70%	15	0, 15 ²	15	0 ²	45
Nonresidential	¹	0	n/a	70%	15	0, 15 ²	15	0 ²	35

NOTES:

¹ Must meet setback, height and lot coverage requirements.

² Fifteen-foot setback is required where C-1 abuts a residential district or use.

4. *Use limitations.* Retail and service uses shall conduct all business within an enclosed structure; no drive-in, drive-through or curb service.
5. *Building Area.* The minimum floor area for dwellings shall be a minimum of six hundred fifty (650) square feet in "C-1" District. [Ord. No. 385, 10-7-2019]

G. *Central Business Mixed-Use (C-2).*

1. *Purpose.* The purpose of this district is to accommodate the broad range of retail shopping activities, office uses, lodging and vacation destinations, and some residential options that are normally found in downtown Warsaw. The Central Business District should be distinguished from other areas in the City and serve as the focal point for social, business, and cultural activities. This district contains the highest intensity of uses and should serve as the hub of pedestrian accessibility. The C-2 District implements the Medium- and High-Density Residential, Public/Institutional, and Commercial/Office classifications of the Warsaw Comprehensive Plan and should only be located in downtown Warsaw and along Main Street.

2. *Uses.* Uses permitted in the C-2 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.*
 - a. *Dimensional table.* The following dimensions shall apply to development in the C-2 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-7 Central Business District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density(units/acre)	Maximum Lot Coverage(percent)	Setbacks				Maximum Building Height(feet)
	Minimum Lot Size(square feet)	Minimum Lot Width(feet)			Maximum Front(feet)	Minimum Interior Side(feet)	Minimum Corner Side(feet)	Minimum Rear(feet)	
Single-family detached	3,000	0	7.5	60%	15	0 ²	15	0 ²	35
Two-family	4,000	0	15	60%	15	0 ²	15	0 ²	35
Townhouse/multifamily	0 ¹	0	15	80%	15	0 ²	15	0 ²	60
Nonresidential	0 ¹	0	n/a	80%	0	0 ²	15	0 ²	60

NOTES:

¹ Must meet setback, height and lot coverage requirements.

² Fifteen-foot setback is required where C-2 abuts a residential district or use.

b. *Additional standards.*

(1) *Commercial floor-to-ceiling heights and floor area of ground floor space.*

- (a) All commercial floor space must have a minimum floor-to- ceiling height of eleven (11) feet.
- (b) All commercial floor space provided on the ground floor must contain the following minimum floor area:
 - i. At least eight hundred (800) square feet or twenty-five percent (25%) of the buildable lot area, whichever is greater, on lots with street frontage of less than fifty (50) feet; or
 - ii. At least twenty percent (20%) of the buildable lot area on lots with fifty (50) feet or more of street frontage.

H. *Mixed-Use Commercial (C-3).*

1. *Purpose.* The C-3 District is established to group and link places used for working, shopping, educating and recreating with residential uses thereby creating a compact community form. This district allows commercial, office, civic, townhouse and apartment uses. The siting and architectural design and scale of structures in this district should be compatible with surrounding neighborhoods while contributing to the image and character

of the area. C-3 implements the Medium- and High-Density Residential and Commercial/Office land use classifications of the Warsaw Comprehensive Plan.

2. *Uses.* Uses permitted in the C-3 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the C-3 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-8 Mixed-Use Commercial District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Maximum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Single-family detached and two-family	3,000	40	12	60%	15	0 ²	15	0 ²	35
Townhouse/multifamily/lodging	n/a ¹	40	18	80%	15	0 ²	15	0 ²	60
Office/commercial/mixed use	n/a ¹	40 ³	n/a ¹	80%	0	0 ²	15	0 ²	60

NOTES:

¹ Must meet setback, height and lot coverage requirements.

² Fifteen-foot setback is required where C-3 abuts a residential district or use.

³ No minimum lot width for nonresidential structures in downtown Warsaw.

4. **Building Area.** The minimum floor area for dwellings shall be a minimum of six hundred fifty (650) square feet in "C-3" District. **[Ord. No. 385, 10-7-2019]**

I. *Waterfront Overlay District (WOD).*

1. *Purpose.* The purpose of the Waterfront Overlay District is to allow additional protections to all waterfront districts when an alteration to existing conditions occurs. The Waterfront Overlay District provisions have the following purposes:
 - a. To preserve natural, recreational, scenic and historic values along the City of Warsaw's waterfronts on the Osage River and Truman Lake.
 - b. To preserve, provide and enhance recreation areas and other green space.
 - c. To provide a continuous bicycle/pedestrian trail along the Osage River.
 - d. To strengthen the vitality of the district and capitalize on the asset of the waterfronts.
 - e. To promote the Osage River waterfront district as a unique destination place that brings

- pedestrian traffic to downtown Warsaw.
- f. To maximize the potential utility and enjoyment of the Osage River waterfront through active and passive uses, such as waterfront dining, public walkways and seating areas.
 - g. To protect the public health and safety.
 - h. To regulate uses and structures along the waterfront to avoid increased erosion and sedimentation.
 - i. To recognize areas of significant environmental sensitivity that should not be intensely developed.
 - j. To allow reasonable uses of land on the waterfront while directing more intensive and non-water-related development to the most appropriate areas of the community and region.
2. *Definitions.* The following definitions apply to this Chapter:

ENCROACH — To permanently occupy space within the physical boundaries of (such as a wetland).

FLOODPLAIN — Flood hazard areas as determined by the National Flood Insurance Agency.

IMPERVIOUS SURFACE — Any nonporous area covered by a substance that does not, by its physical qualities, permit infiltration by water, including but not limited to asphalt, slate, brick, aluminum, and concrete.

NONPOINT POLLUTION — Waterborne substances that can have adverse impacts on fish, wildlife, habitats and water quality, and that enter the groundwater via a diffuse number of points, possibly from the same source, as opposed to one particular point of entrance.

PHYSICAL OBSTACLE — Any structure or piece of structure that prevents visual or physical contact.

PIER — A structure that encroaches on a body of water specifically for the purpose of providing the general public with access for recreational fishing.

STORMWATER MANAGEMENT — The intentional containment, treatment or alteration of flow of water that results from precipitation specifically for the purpose of preventing flooding, erosion or nonpoint pollution.

WATER-DEPENDENT USES — Activities which require a location in, on, over or adjacent to the water because the activities require direct access to water and the use of water is an integral part of the activity. Examples of water-dependent uses include public and private marinas, yacht clubs, boat yards, commercial and recreational fishing facilities, tour boat and charter boat facilities, unloading and aggregate transshipping facilities, waterborne commerce, ferries, marine educational or laboratory facilities, and water-related public and quasi-public utilities.

3. *Applicability.* The Waterfront Overlay District is applicable where shown on the Warsaw Zoning Map.
4. *Uses.* Uses permitted in the WOD District are identified in Table 405.050-1, Use Table.
5. *Dimensions.* Development in the WOD shall conform to the dimensions applicable in the underlying base zone district along with any supplemental regulations provided in Section 405.040(M), except as follows:
 - a. *Visual and physical access.* Any new development that creates a visual or physical obstacle to public access on land that was previously accessible to the public shall mitigate the impact to ensure that physical and visual access is provided in another form.
 - b. *Waterfront setback.* Properties adjacent to the Osage River shall have a setback of fifty (50) feet from the top of the riverbank, as defined by the Director of Public Works on a site-by-site basis.
6. *District regulations.* Development otherwise permitted in the underlying zone shall meet the following standards:
 - a. *Docks and piers.* Access to the water from lots in any proposed subdivision shall be from a single common dock unless a single dock is considered infeasible, as determined by the Director.
 - b. *Water-dependent uses.* Any applicant proposing development adjacent to a water-dependent use will be required to notify the owner of the water-dependent use and submit his/her comments with the site plan, if comments were received. New development that permanently interferes with existing use of the water or will permanently inhibit the continued operation of a water-dependent use is prohibited.
 - c. *Residential uses.* All habitable space within dwelling units in the WOD shall be located above the one-hundred-year floodplain.
 - d. *Water-enhanced uses.* Any proposed water-enhanced use that will have a significant negative environmental or economic impact on existing water-dependent uses [more than one (1)] will not be permitted.
 - e. *Marinas.* All site plans for new marinas or expansion of existing ones must include a stormwater management plan signed and prepared by a Missouri licensed engineer and must include a pump out.
 - f. *Hazards to water quality.* No structure or building shall be used in such a way as to significantly threaten or cause significant pollution to the water quality of the Osage River or Truman Lake.
 - g. *Relation to water.* Any use encroaching on water or that will exist permanently above water that is not water-dependent will not be permitted.
 - h. *Building orientation.* Primary structures shall be oriented toward the Osage River as well as the street by providing windows, doorways and other architectural features on

the riverfront side of buildings.

- i. *Natural features.* Destruction of natural features that serve to protect from floods or erosion shall not be permitted. Development shall comply with requirements of Section 405.070 Stormwater Management and Natural Area Protection Standards. Any party responsible for the illegal or unauthorized destruction of such features will be compelled to replace them or compensate the City for their replacement.
- j. *Pedestrian trails.* A continuous publicly accessible municipally owned pedestrian trailway, the Osage Trail, shall be created along the Osage River waterfront in the Waterfront Overlay District. An applicant for site plan approval of a lot or parcel which contains land along the Osage River waterfront shall be required to reserve a continuous right-of-way having a minimum width of twenty five (25) feet measured laterally from the riverbank of the Osage River in which a minimum twelve-foot-wide paved public trailway shall be developed on that lot or parcel in accordance with City's Master Trail Plan.

J. *Light Industrial (M-1).*

1. *Purpose.* This district is intended to provide for a variety of businesses, including warehouses, research and development firms, repair shops, wholesale distributors, and light manufacturing. This district may include supporting office and commercial uses where appropriate. Uses permitted in this district are intended to serve community and regional needs. This district is intended to be located away from low- and medium-density residential development. The M-1 District implements the Industrial and Transportation/Utilities classifications of the Warsaw Comprehensive Plan and should take access from a primary connector or principal arterial street.
2. *Uses.* Uses permitted in the M-1 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the M-1 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-9 Light Industrial District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Office/ Commercial/ Industrial	8,000	80			25	7		20	45

K. *Heavy Industrial (M-2).*

1. *Purpose.* The purpose of this district is to accommodate a broad range of manufacturing, warehousing and wholesaling uses. This district is intended to be located away from residential development. The M-2 District implements the Industrial and Transportation/Utilities classifications of the Warsaw Comprehensive Plan and should take access from a primary connector or principal arterial street.
2. *Uses.* Uses permitted in the M-2 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the M-2 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-10 Heavy Industrial District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Office/ Commercial/ Industrial	15,000	100			25	15		20	45

L. *Rural Holding And Open Space (RH-O).*

1. *Purpose.* The purpose of this district is to conserve and protect open land uses, accommodate low-intensity uses on land which is either unsuited for intensive development or which is not yet served by public utilities. Nonagricultural uses must be rezoned to a different classification prior to subdivision or development.
2. *Uses.* Uses permitted in the RH-O District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the RH- O District along with any supplemental regulations provided in Section 405.040(M).

Table 405.040-11 Open Space District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (acres)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
	5	100			25	15		20	35

M. *Supplementary Dimensional Standards.* No lot or yard shall be established in any district that does not meet the minimum requirements of that district along with any applicable regulations in this Section.

1. *Maximum height.* Chimneys, cooling towers, elevator headhouses, grain elevators, stage towers, scenery lofts, water towers, ornamental towers, church steeples, radio and television towers, antennas and mechanical equipment usually required to be placed above the roof level and not intended for human occupancy are not subject to any height limitations.
2. *Double-frontage lots.* Lots with two (2) nonadjoining frontages (double- frontage lots) shall maintain the required front yard setback along both frontages.
3. *Accessory buildings.*
 - a. No accessory building shall be erected in any required front or side yard, and no detached accessory building shall be erected closer than five (5) feet to any other building.
 - b. Accessory buildings may be located in the rear yard but shall not be closer than five (5) feet to the rear lot line and shall not be closer to the side lot line than the required side yard setback.
 - c. No accessory building shall cover more than thirty percent (30%) of the required rear yard.
4. *Number of structures and uses per lot.* Where a lot or tract is used for other than a single-family dwelling, more than one (1) principal use and structure may be located upon the lot or tract, provided that all structures and uses conform to all requirements for the district in which the lot or tract is located.
5. *Sight triangle.* On a corner lot in any district except C-2, development and landscaping shall not obstruct the sight triangle as defined by these regulations.

§ 405.060. Purpose and Applicability of Development Standards.

A. *Purpose And General Provisions.* The development and design standards set forth in Sections 405.070 through 405.120 shall apply to the physical layout and design of development in Warsaw. These provisions address the physical relationship between development and adjacent properties, public streets, neighborhoods, and the natural environment, in order to implement the Comprehensive Plan vision for a more attractive, efficient and livable community. The specific purposes of these Sections include:

1. To implement the Warsaw Comprehensive Plan through the creation and application of development standards that reflect Warsaw's community character and development choices;
2. To encourage the proper use of the land by promoting an appropriate balance between the built environment and the preservation and protection of open space and natural resources;
3. To protect public and private investment through preservation of open spaces, protection of natural resources, including existing trees, providing buffers between incompatible uses and along roadways, and encouraging the planting of new trees and vegetation as deemed appropriate;
4. To promote sound management of water quality and quantity through preservation of natural areas and their functions and by encouraging soil management and the use of native plant materials;
5. To provide appropriate standards to ensure a high-quality appearance for Warsaw and promote good design while also allowing flexibility, individuality, creativity and artistic expression;
6. To strengthen and protect the image, identity and unique character of Warsaw and thereby enhance its business economy;
7. To protect and enhance residential neighborhoods, downtown Warsaw, commercial districts and other areas by encouraging physical development that is of high quality and is compatible with the character, scale and function of its surrounding area;
8. To encourage developments that relate to adjoining public streets, open spaces and neighborhoods with building orientation and physical connections that contribute to the surrounding network of streets and walkways; and
9. To provide road connectivity for the movement of people, goods and services

B. *Applicability.* The development standards in Sections 405.070 through 405.120 are fully applicable to new development. In order to promote redevelopment and balance the costs of development in compliance with these standards on an existing structure against the benefits to the community of bringing all development into compliance with community development standards, some exemptions from Section 405.110, Parking and Loading, and Section 405.120, Landscaping and Screening development standards are allowed for redevelopment on a sliding scale based on the amount of redevelopment taking place on the site as described in Table 405.060-1, Applicability of Development Standards, and more completely described below:

Table 405.060-1 Applicability of Development Standards				
	Percent Compliance with Development Standards			
	Multifamily	Commercial	Mixed-Use	Industrial
New development				
New development	100%	100%	100%	100%
Existing development				
Less than 10%	n/a	n/a	n/a	n/a
Between 10% and 75%	Per Section 405.060(B)(2)(a)(2), below			
Greater than 75%	100%	100%	100%	100%
Interior changes	n/a	Off-street parking standards apply		
Nonconformities [Section 405.050(F)]				
Nonconforming lots	Applicable to structures only, not lots			
Nonconforming uses	Nonconforming uses are not permitted to be altered			
Nonconforming structures				
Enlargement, alteration, movement	100%	100%	100%	100%
Damage or destruction	100%	100%	100%	100%

NOTES:

¹ If there is more than one (1) structure on a lot, this is based on the individual structure subject to the addition, not the total for the lot.

1. *New development.* The development standards in this Section shall apply to all new development unless otherwise specified in the Section. Single and two-family residential development may be exempt from some requirements as identified in the specific development standards section.
2. *Existing development.*
 - a. *External additions.* The development standards in this Section shall apply to all external additions as follows:
 - (1) External additions that increase the assessed valuation of the existing structure by less than ten percent (10%), as determined by the building permit valuation, shall not be required to comply with these development standards.
 - (2) External additions that increase the assessed valuation of the existing structure by more than ten percent (10%) but less than seventy-five percent (75%), as determined by the most recent building permit valuation, shall require a corresponding percent increase in compliance with these development standards or until the site reaches compliance, whichever is less.
 - (3) External additions that increase the building permit valuation of an existing structure by seventy-five percent (75%) or greater, as determined by the most recent county assessed value, shall be required to fully comply with these standards.
 - b. *Interior changes.* Where development changes are wholly internal to the existing structure, only the off-street parking requirements included in Section 405.110 are applicable. This requirement may be waived by the Director where the applicant can

show that there is sufficient existing parking to service the interior changes.

- c. *Ten-year time frame.* Any application by property owners to expand structures shall remain on record for ten (10) years from the date of said work completion. Any subsequent application to expand structures shall be cumulative to any requests made within the previous ten (10) years. The total shall be used by the City to determine the property owner's necessary level of compliance

§ 405.070. Stormwater Management and Natural Area Protection Standards.

A. *Purpose.* The City contains many natural amenities, including stream corridors, river corridors, natural drainage paths, significant viewsheds and hillsides, as well as tree cover, and open space, all of which contribute to stormwater management and flood risk reduction as well as the City's character, quality of life and property values. The regulations of this section are intended to implement the Warsaw Comprehensive Plan and stormwater management design criteria to ensure that the natural character of the City is reflected in patterns of development and redevelopment, and significant natural features are protected and incorporated into open space areas. This section regulates stormwater management for development and redevelopment, as well as uses and activities within identified stormwater drainage setbacks, to preserve, conserve and manage disturbance to the City's stream corridors so that the following objectives may be achieved:

1. Encourage sustainable and healthy development practices that benefit the community as a whole;
2. Protect the public by preventing or regulating development in hazardous areas, such as locations within natural drainage paths or on steep slopes;
3. Mitigate impacts to the public from stream erosion and degradation;
4. Encourage only minimal grading that relates to the natural contour of the land;
5. Discourage mass grading activities, excessive tree and vegetation removal, and excessive terracing;
6. Improve surface and ground water quality by reducing the amount of nutrients, sediment, organic matter, pesticides, and other harmful substances that reach watercourses, wetlands, subsurface and surface water bodies;
7. Recognize that natural features contribute to the welfare and quality of life of the City's residents;
8. Provide natural, scenic, and recreation areas within and adjacent to stormwater drainage setbacks for community's benefit, thereby creating added value to lands adjacent to natural drainage paths and streams.

B. *Definitions.*

1. Best Management Practice (stormwater BMP): post-construction, permanent stormwater BMPs designed to manage stormwater runoff. Stormwater BMPs may also be referred to as green stormwater infrastructure practices.
2. Drainage Easement: Authorization by the property owner to the public, a corporation or persons of the use of an area of land for stormwater management purposes.
3. Green Stormwater Infrastructure (GSI): Stormwater management solutions designed to capture, filter, absorb, and/or re-use stormwater by mimicking natural hydrologic processes. GSI may also be referred to as stormwater BMPs.

4. **Natural Drainage Path:** The overland route in which water concentrates based on the natural topography of the land. Natural drainage paths function as the surface drainage component of a stormwater drainage system and represent the path stormwater will take when the design capacity is exceeded in the enclosed system. Natural drainage paths typically begin with approximately 2 acres of drainage area.
 5. **Stream Corridor:** Perennial or intermittent waters included within a channel of land, and its adjacent riparian zones, which serve as a transitional zone between the aquatic and terrestrial upland ecosystems.
 6. **Storm Drainage System:** All of the natural and man-made facilities and appurtenances such as natural drainage paths, streams, pipes, culverts, bridges, open channels, swales, street gutters, inlets, retention/detention facilities, and stormwater BMPs/GSI which serve to convey and control surface drainage.
 7. **Stormwater Drainage Setbacks:** preservation of vegetated areas adjacent to a natural drainage path or stream defined by the drainage easement with limitations on allowable development and uses. Stormwater drainage setbacks consist of preservation, protection, and limited-use setback zones.
 8. **Top of Bank:** The vertical point along a stream bank where an abrupt change in slope is evident, typically representative of the bank-full or channel-forming flow caused by approximately the two-year design storm as defined by the City's stormwater management design criteria.
- C. *Stormwater Management Requirements.* All improvements shall be in compliance with the City's stormwater management design criteria, per Section 500.050, City of Warsaw Standards and Procedures for Design and Construction. Applicability standards are set forth in 405.030(O), Drainage Permit. The applicant shall follow the procedures established in Section 405.030 to demonstrate compliance with the design criteria.
- D. *Natural Drainage Path Preservation.* Natural drainage paths and stream corridors shall be preserved and protected by limiting development activity in and adjacent to these areas to reduce risk of property damage from flooding and stream bank erosion, and to protect the safety of the public.
1. *Natural drainage path requirements.* Site design shall not change natural drainage paths. Natural drainage path preservation shall be as follows:
 - a. All final grading and drainage shall comply with applicable City and State requirements.
 - b. To the maximum extent feasible, development shall preserve the natural drainage paths unique to each site as a result of topography and vegetation. Natural drainage paths may be modified on site only if outside of the stormwater drainage setback. If natural drainage paths are modified, appropriate stabilization techniques shall be employed.
 - c. Streets, roads, private access roads and other vehicular routes shall, to the maximum extent feasible, not be constructed within a natural drainage path.

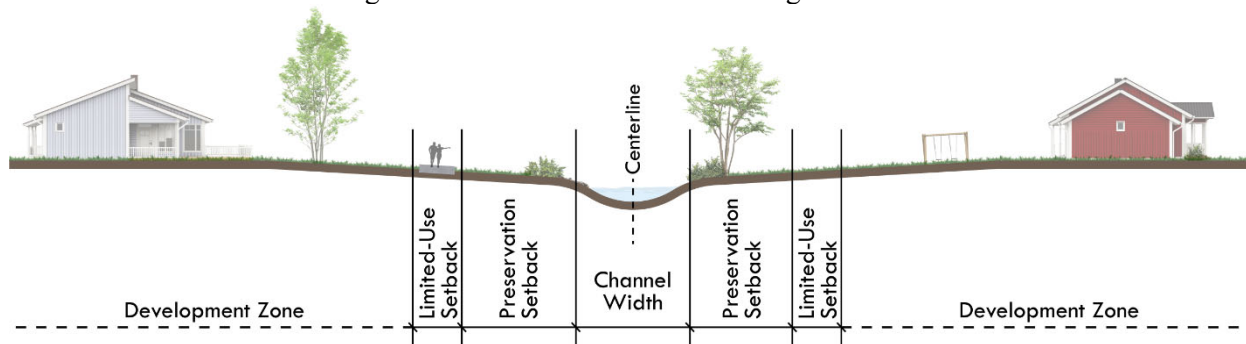
- d. Grading shall be designed such that drainage flows away from all structures and heavily used areas.
 - e. Development shall be designed to mitigate all negative or adverse drainage impacts, such as flooding and erosion, on adjacent and surrounding properties.
2. *Stormwater drainage setbacks.* Stormwater drainage setbacks shall apply to all land or development that includes natural drainage paths as defined herein and identified in the stormwater management design criteria. The requirements for stormwater drainage setbacks are as follows:
- a. The stormwater drainage setback shall start at the top of bank of the natural drainage path/stream, to be determined by topographic survey, and move outward on either side of the channel. If a top of bank cannot be determined, one of the following methods may be applied to define the top of bank for the stormwater drainage setback:
 - (1) Apply the assumed channel width to the centerline of the natural drainage path.
 - (2) Delineate the bank-full or channel-forming flow caused by approximately the two-year rainfall event as defined by the City's stormwater management design criteria.
 - b. Stormwater drainage setbacks shall be identified on the site plan and dedicated on the preliminary and final plats as a Drainage Easement.
 - c. Stormwater drainage setback widths have been determined based on tributary drainage area, as shown in Table 405.070-1 and Figure 405.070-1, with the following defined setback widths:
 - (1) *Channel Width:* centered on the natural drainage path is preserved for frequent stormwater flows with no other allowable uses.
 - (2) *Preservation Setback Width:* begins at the top of bank of the natural drainage path/stream and is preserved for vegetation or other forms of bank stabilization with no other allowable uses.
 - (3) *Limited-Use Setback Width:* extends a predetermined distance from the preservation setback or to the extents of the 100-year effective FEMA floodplain, whichever is greater. Allowable uses within the limited-use setback include community amenities such as trails and greenways, as well as utility rights-of-way.

Table 405.070-1 Stormwater Drainage Setbacks

Drainage Area (acre)	Assumed Channel Width (feet)*	Preservation Setback Width (feet)	Limited-Use Setback Width (feet)	Total Setback Width (feet)
2 to < 10	5	5	-	15
10 to < 40	10	10	10	50
40 to < 160	30	30	10	110
160 to < 640	60	60	20	220

Drainage Area (acre)	Assumed Channel Width (feet)*	Preservation Setback Width (feet)	Limited-Use Setback Width (feet)	Total Setback Width (feet)
640+	80	80	20	280
*Actual channel width may differ from Assumed Channel Width values presented in table based on results of topographic survey.				

Figure 405-070-1: Stormwater Drainage Setbacks



- d. No construction or disturbance of any type, including clearing, grubbing, stripping, fill, excavation, linear grading, paving, or building is allowed in the setback zones except as falls within the allowable setback uses or by permission of the City Engineer. Dense stands of native vegetation shall be maintained, particularly in the preservation setback.
 - e. Unless otherwise accepted by the Director, any maintenance of stormwater drainage setbacks shall be the responsibility of the property owner.
 - f. For work on existing facilities already located closer to the stream than allowed above, the improvements shall not increase the encroachment any closer to the stream. Bank stability concerns shall be addressed for improvements to existing land within the setback zones. Formal designation of a stormwater drainage setback is not required.
 - g. The application of stormwater drainage setbacks shall not operate to deprive any landowner of substantially all of the market value of their property or otherwise constitute an unconstitutional taking without compensation. If application of the stormwater drainage setbacks to a specific project would create a taking, then the Board of Aldermen may allow a variance, but only to the extent necessary to avoid a taking.
- E. *Drainage easements.* All storm drainage systems shall be placed in a drainage easement, per the City of Warsaw's stormwater management design criteria. If a subdivision is traversed by a natural drainage path or stream, a stormwater drainage setback shall be applied per Table 405.070-1. The entirety of the stormwater drainage setback shall be placed in a drainage easement to provide adequate stormwater drainage and for access for maintenance thereof.
- F. *Maintenance agreements.* Any person engaged in work of development or redevelopment that requires a drainage easement shall enter into a stormwater management operations and

maintenance agreement assuring the continued operation and maintenance of such stormwater management components by the property owner and allowing access and inspection by the City. The agreement shall be recorded in the office of the Register of Deeds and be binding upon all owners of the property.

G. *Grading plan; revegetation of disturbed sites.* A grading plan, submitted pursuant to Section 405.030(N), Grading Permit, and demonstrating compliance with the above standards is required. The grading plan shall include a section outlining the type and extent of revegetation proposed to accomplish the following requirements:

1. Following construction, the site shall be reclaimed and revegetated following the standards of Section 405.120, Landscaping and Screening.
2. In areas of subdivisions and large lot development sites, phased grading and revegetation is preferred.
3. In areas of subdivisions and development sites where landscaping is not required or not anticipated by the Director, the developer shall reclaim all disturbed property and replant the entire area with native vegetation as described in Section 405.120, Landscaping and Screening.
4. Temporary or permanent irrigation shall be provided to the revegetated areas if the City Engineer determines that it is necessary.

H. *Erosion Prevention And Sediment Control.* Erosion control methods shall be used during construction to protect water quality, control drainage, and reduce soil erosion in accordance with Section 500.050 City of Warsaw Standards and Procedures for Design and Construction. All new development shall be subject to the following erosion prevention and sediment control standards:

1. Compliance with applicable City and State requirements.
2. Water shall be managed within the site to a pre-project conditions. Site disturbance shall cause no adverse impacts downstream. Erosion and sediment control shall contain erosion and sediment on the site, and protect stormwater management infrastructure within the site during construction.
3. Erosion control measures as necessary to control erosion and sedimentation during site development and construction shall be implemented.

I. *Steep Slope And Ridgeline Development.*

1. *Purpose.* The purpose of this subsection is to:
 - a. Prevent soil erosion and landslides;
 - b. Protect the public by preventing or regulating development in hazardous areas, such as locations with steep slopes;
 - c. Provide safe circulation of vehicular and pedestrian traffic to and within hillside areas and provide access for emergency vehicles necessary to serve the hillside areas;

- d. Preserve the most visually significant slope banks and ridgelines in their natural state;
 - e. Preserve visually significant rock outcroppings, native plant materials, natural hydrology and other areas of visual significance;
 - f. Encourage variety in building types, grading techniques, lot sizes, site design, density, arrangement and spacing of buildings in developments;
 - g. Encourage innovative architectural, landscaping, circulation and site design; and
 - h. Require revegetation and reclamation of slopes disturbed during development.
2. *Applicability.* This Subsection shall apply to any development or subdivision proposal or lot created after December 21, 2015 for properties with an average slope of fifteen percent (15%) or greater, or where adverse conditions associated with slope stability, erosion or sedimentation are present as determined by the City Engineer. Determinations of adverse conditions shall be identified by the City Engineer within ten (10) days of applicable application filing.
3. *Development on slopes greater than twenty percent (20%).* Site areas with slopes greater than twenty percent (20%) shall remain undisturbed except as follows:
- a. This requirement shall not apply to small, isolated steep slope areas within a site that do not exceed two thousand five hundred (2,500) square feet.
 - b. Slope areas of twenty percent (20%) or greater shall count toward minimum lot size, as defined in Section 405.040 Zoning Districts.
 - c. Development is permitted outside of the slope area of twenty percent (20%) if the Director determines that there is sufficient buildable area on the lot for the proposed structure.
4. *Development on slopes between fifteen percent (15%) and twenty percent (20%).* The following standards apply to site design for all proposed development on sites where the average slope of the site measures between fifteen percent (15%) and twenty percent (20%).
- a. Roads and building sites shall be oriented to minimize grading.
 - b. Buildings shall be oriented to consider views from the site as well as the aesthetic impact of views of the site from surrounding properties.
 - c. Hilltops, if graded, should be rounded to blend with natural slopes rather than leveled.
 - d. Slopes providing a transition from graded areas into natural areas should be varied in percent grade both up-slope and across the slope, in the undulating pattern of surrounding natural slopes so that the top or the toe (or both) of the cut or fill slope will vary from a straight line in plan view.
 - e. Parking areas should be constructed on multiple levels and follow natural contours as necessary to minimize cut and fill.

- f. Roads should follow natural topography to the extent feasible, to minimize cut and fill. Necessary grading should be constant half-cut and half-fill along the length of the road (versus all cut or all fill at points) unless other arrangements would result in less severe alteration of natural terrain.
 - g. Typical design should utilize full split pads (separate level for a down-slope lower story), a split foundation (adapting a single story to a slope), setting the building into a cut in the hillside, or a combination of techniques. Repetitive padding or terracing of a series of lots (stair-stepping up a slope) is discouraged. Creation of a single large pad or terrace (especially creating a single pad or terrace of an entire lot) should be an exception to typical design to deal with circumstances that cannot be managed with other techniques.
- 5. *Utilities on slopes.* Where buried utilities are placed on side slopes and where the utility corridor runs transverse to the side slope, the side slope portion of the corridor shall be no more than ten percent (10%).
- 6. *Cutting, grading and filling.*
 - a. Cutting and grading to create benches or pads for buildings or structures shall be avoided to the maximum extent feasible.
 - b. Except for driveways, cut and fill slopes shall be entirely contained within a lot (i.e., natural grade at the lot lines shall be maintained).
 - c. Sharp angles shall be rounded off in a natural manner at the top and ends of cut and fill slopes [within approximately five (5) feet of the sharp angle] unless steep angles are a natural character of the site. Where this would damage tree root systems, the amount of rounding off may be reduced and shrubs used instead to hide the transition.
- 7. *Raising or lowering of natural grade.* The original, natural grade of a lot shall not be raised or lowered more than four (4) feet at any point for construction of any structure or improvement, except:
 - a. The site's original grade may be raised or lowered a maximum of six (6) feet if retaining walls are used to reduce the steepness of man-made slopes,.
 - b. As necessary to construct a driveway from the street to a garage or parking area, grade changes or retaining walls up to six (6) feet may be allowed.
 - c. For the purposes of this Subsection, basements and buildings set into a slope are not considered to lower the natural grade within their footprint.
- 8. *Vehicular routes.* The following regulations apply to vehicular routes on slopes of fifteen percent (15%) or greater.
 - a. No street, road, private access road, driveway or other vehicular route shall cross slopes greater than fifty percent (50%).
 - b. Streets, roads, private access roads, driveways and other vehicular routes shall not be allowed to cross slopes between thirty percent (30%) and fifty percent (50%), except

that a short run of no more than one hundred(100) feet or ten percent (10%) of the road/street's entire length, whichever is less, may be allowed by the Director upon finding that:

- (1) Such street or road will not have significant adverse safety or environmental impacts, or appropriate engineering or other measures will be taken by the developer to substantially mitigate any such adverse impact; and
 - (2) No alternate location for access is feasible or available.
- c. Streets, roads, private access roads and other vehicular routes shall, to the maximum extent feasible, follow natural contour lines and not be within a natural drainage path.
 - d. Grading for streets, roads, private access roads and other vehicular routes shall be limited to the paved portion of the right-of-way, plus up to an additional ten (10) feet on either side of the paved portion as needed, except that when developing access on slopes in excess of twenty-five percent (25%) only the paved right-of-way shall be graded, plus the minimum area required for any necessary curb, gutter or sidewalk improvements. The remainder of the access right-of-way shall be left undisturbed to the maximum extent feasible.
9. *Trails.* Public trails are permitted on all slopes provided proper safety buffers are in place. Private trails may be allowed if the Director determines that there will be no significant adverse impacts.

§ 405.080. Mobility and Connectivity Development Standards.

A. *Purpose.* These standards attempt to avoid the creation of large, isolated tracts without routes for through traffic or pedestrian and bicycle connections. The purpose of this Section is to:

1. Support the creation of a highly connected transportation system within Warsaw in order to provide choices for drivers, bicyclists and pedestrians;
2. Increase effectiveness of local service delivery; promote walking and bicycling; connect neighborhoods to each other and to local destinations, such as employment, schools, parks and shopping centers;
3. Reduce vehicle miles of travel and travel times, improve air quality, reduce emergency response times; and
4. Mitigate the traffic impacts of new development and free up arterial capacity to better serve regional long-distance travel needs.

B. *Traffic Impact Mitigation.*

1. *Applicability of traffic impact analysis requirement.* The transportation system for new development shall be capable of supporting the proposed development in addition to the existing and future uses in the area. Evaluation of system capacity shall be undertaken through a Traffic Impact Analysis (TIA) that should consider the following factors without limitation: street capacity and level of service; vehicle access and loading; on-street parking impacts; the availability of transit service and connections to transit; impacts on adjacent neighborhoods; and traffic safety, including pedestrian safety. A TIA shall be required with applications for development review and approval when:
 - a. Trip generation during any peak hour is expected to exceed two hundred fifty (250) trips per day or more than one hundred (100) trips during any one-hour peak period, based on traffic generation estimates of the Institute of Transportation Engineers' Trip Generation Manual (or any successor publication); or
 - b. A TIA is required by the Planning and Zoning Commission or Board of Aldermen as a condition of any land use application approved pursuant to the requirements of this Code; or
 - c. The Director, in his or her sole discretion, requires a TIA for:
 - (1) Any project that proposes access to a street with Level of Service D or below;
 - (2) Any application for a rezoning or specific plan review;
 - (3) Any case where the previous TIA for the property is more than two (2) years old;
 - (4) Any case where increased land use intensity will result in increased traffic generation; or
 - (5) Any case in which the Director determines that a TIA should be required because of other traffic concerns that may be affected by the proposed development.

2. *Traffic impact analysis and development review process.*

- a. A scoping meeting between the developer and the Director shall be required prior to the start of the TIA in order to determine the parameters of the study. This may be conducted as part of a preapplication meeting. The Director shall define the vicinity of the TIA study in as limited a geographic area as is feasible to make adequate traffic determinations for the project. Where a larger boundary is necessary to make adequate traffic determinations, the City shall work with the applicant to provide traffic information and perform such modeling as is necessary to study the area outside of the project vicinity.
- b. The TIA shall be submitted with the applicable development application.
- c. When access points are not defined or a site plan is not available at the time the TIA is prepared, additional studies may be required when a site plan becomes available or the access points are defined.

3. *Traffic mitigation measures.*

- a. The applicant shall, as part of the TIA, recommend measures to minimize and mitigate the anticipated impacts and determine the adequacy of the development's planned access points. Mitigation measures shall be acceptable to the Director and may include, without limitation: an access management plan; transportation demand management measures; street improvements on or off the site; placement of proportionate pedestrian, bicycle or transit facilities on or off the site; or other capital improvement projects, such as traffic calming infrastructure or capacity improvements.
- b. Following City approval of the TIA, the developer and the City shall enter into an agreement specifying the implementation program and time frame for the required traffic improvements and identifying mitigation requirements where the project construction time frame varies from the anticipated traffic improvement time frame.

C. *Streets And Vehicular Circulation.*

- 1. *Street standards.* All streets shall meet the standards of Section 500.050, City of Warsaw Standards and Procedures for Design and Construction, Section 405.070, Stormwater Management and Natural Area Protection Standards, and Section 405.140, Subdivision Design Standards, and shall be consistent with the transportation element of the Warsaw Comprehensive Plan.
- 2. *Street connectivity.*
 - a. *Purpose.* Street and block patterns should include a clear hierarchy of well-connected streets that distributes traffic over multiple streets and avoids traffic congestion on principal routes. Within each development, the access and circulation system should accommodate the safe, efficient and convenient movement of vehicles, bicycles and pedestrians through the development and provide ample opportunities for linking adjacent neighborhoods, properties and land uses. Local neighborhood street systems are intended to provide multiple direct connections to and between local destinations, such as parks, schools and shopping. These connections should knit separate

developments together rather than forming barriers between them.

b. *Residential streets.*

- (1) Residential streets shall be laid out so that use by through traffic will be discouraged. Traffic-calming techniques, such as diverters, neck-downs, street gardens and curvilinear alignments, are encouraged to reduce speeds and cut-through traffic.
- (2) Should topography or other constraints require the use of straight streets that extend more than six hundred (600) feet without being punctuated by cross streets, an oblong median, traffic-calming device or similar feature shall be used to slow traffic and break-up the runway appearance. (See Figure 405.080-A.)
- (3) To the maximum extent practicable, streets shall be arranged to follow the natural contours of the site.

c. *Vehicular access to public streets and adjacent land.*

- (1) All development shall provide public street connections to all existing, proposed or preliminary platted adjacent public streets.
- (2) If there are no adjacent public streets, subdivisions and/or site plans shall provide for connections along each boundary abutting adjacent vacant land for future connections spaced at intervals not to exceed one thousand (1,000) feet for arterials, or six hundred sixty (660) feet for other street types, or as otherwise approved by the Director.
- (3) When connections to surrounding streets are required, public right-of-way shall be dedicated and streets developed pursuant to Section
 - (a) 405.140 to existing paved rights-of-way. The City may also require temporary turnarounds to be constructed and paved for temporary culs-de-sac between development phases.

d. *Culs-de-sac and dead-end streets discouraged.*

- (1) The design of street systems shall use through streets. Permanent culs-de-sac and dead-end streets shall only be used when topography, the presence of natural features, and/or vehicular safety factors make a vehicular connection impractical.
- (2) All permanent dead-end streets shall be developed as culs-de-sac and extend no further than six hundred sixty (660) feet.
- (3) All culs-de-sac shall conform to the requirements of the present adopted International Fire Code.
- (4) Half streets (i.e., streets of less than the full right-of-way and pavement width) shall not be permitted except where such streets, when combined with a similar street (developed previously or simultaneously) on property adjacent to the development, creates or comprises a street that meets the right-of-way and pavement requirements.

- (5) Whenever cul-de-sac streets are created, at least one (1) eight-foot wide pedestrian access easement shall be provided, to the maximum extent practicable, between each cul-de-sac head or street turnaround and the sidewalk system of the closest adjacent street or pedestrian pathway. This requirement shall not apply where it would result in damage to or intrusion into significant natural areas, such as stream corridors, wetlands and steep slope areas. The pedestrian access easement will be dedicated to the City and maintained as part of the sidewalk system. (See Figure 405.080-B.)

D. Driveways And Access.

1. General.

- a. Every lot shall have access that is sufficient to afford a reasonable means of ingress and egress for emergency vehicles, as well as for those needing access to the property in its intended use.
- b. Private driveways and parking lots that provide access from residential lots and districts to businesses in nonresidential districts shall not be permitted.
- c. All driveway entrances and other openings onto streets shall be constructed so that:
 - (1) Vehicles may safely enter and exit from the lot in question;
 - (2) Interference with the free and convenient flow of traffic in abutting or surrounding streets is minimized; and
 - (3) The driveway is not less than twenty (20) feet in length from the face of the garage to the nearest street improvement.
- d. Each driveway shall be not more than thirty (30) feet in width, measured at right angles to the center line of the driveway, except as that distance may be increased by permissible curb return radii.
- e. Joint driveways are desirable whenever possible in order to minimize the number of access points to streets and access easements. (See Figure 504.080-C.)
- f. One (1) curb cut is allowed for each legal lot. Curb cuts should be spaced at intervals of one hundred fifty (150) feet along the street frontage, unless the Director determines that a lesser amount is appropriate. A second curb cut may be requested for residential lots with more than two hundred (200) feet of frontage through Section 405.030(M), Minor Modification.
- g. Unless no other practicable alternative is available, all driveways and other openings shall be located a minimum of:
 - (1) Seventy-five (75) feet from a street intersection;
 - (2) Forty (40) feet from another access driveway; and
 - (3) Ten (10) feet from an interior property line for single-family development and twenty (20) feet from an interior property line for multifamily and nonresidential

development.

2. *Residential.* In addition to the above general requirements, all residential development shall be subject to the following:
 - a. Direct driveway access (ingress or egress) from any single-family residential lots to any arterial street or highway shall be prohibited on any lot platted after the effective date of this Code.
 - b. In order to prevent sidewalk obstructions caused by parked cars, garages shall be set back either three (3) feet from the right-of-way line or a minimum of twenty (20) feet from the right-of-way line. No garage may be setback a distance between three (3) feet and twenty (20) feet from the right-of-way.
 - c. Multifamily development sites greater than five (5) acres shall include a minimum of two (2) through-access drives. An exception may be made by the Director where a site is landlocked by existing development or other physical constraints, or where existing natural features on the site require the use of protective measures that would otherwise make a second access drive infeasible.
3. *Nonresidential.* In addition to the above general requirements, all nonresidential development shall be subject to the following unless otherwise provided for in the downtown Warsaw design standards:
 - a. All uses shall have access limited to the collector or arterial streets.
 - b. All nonresidential buildings, structures and parking and loading areas shall be physically separated from all nonarterial or collector streets by vertical curbs and other suitable barriers and landscaping to prevent unchanneled motor vehicle access. Each property shall not have more than two (2) accessways to any one street unless unusual circumstances demonstrate the need for additional access points. In addition, each accessway shall comply with the following:
 - (1) To the maximum extent possible, unless prohibited by existing site constraints, the width of any accessway leading to the arterial street shall be median-divided to provide separation from incoming and outgoing traffic. (See Figure 504.080-E.)
 - (2) Curb returns shall have a minimum radius of thirty (30) feet.
 - (3) On corner lots for nonresidential development, no part of any accessway shall be nearer than one hundred (100) feet to the intersection of any two (2) street rights-of-way.
4. *Visibility at intersections.* On all lots or parcels of land on which a front setback is required, no obstruction that will obscure the view of motor vehicle drivers shall be placed within the triangular area formed by the adjoining street property lines and a line connecting them at points of forty-five (45) feet from the intersection of said street property lines. (See Figure 504.080-F.)

E. *Pedestrian Circulation.*

1. *Sidewalks required.* Sidewalks shall be installed on both sides of all arterials, collector streets and local streets (including loop streets and culs-de-sac) as identified within the Warsaw Transportation Improvement Plan and within and along the frontage of all new development or redevelopment. Sidewalk entries shall be provided to all buildings and individual units that front on the sidewalk.
2. *On-site pedestrian connections.*
 - a. All commercial, multifamily, mixed-use, and attached residential development shall provide a network of on-site, paved, pedestrian walkways with a minimum width of five (5) feet to and between the following areas (See Figure 504.080-G.):
 - (1) Entrances to each commercial, multifamily, mixed-use and/or attached residential building on the site, including pad site buildings;
 - (2) Public sidewalks, walkways or trails on adjacent properties that extend to the boundaries shared with the subject development;
 - (3) Public sidewalks along the perimeter streets adjacent to the development;
 - (4) Adjacent land uses and developments; and
 - (5) Adjacent public park, greenway, trail or other public or civic use.
 - b. Internal pedestrian walkways shall be provided through parking areas in excess of fifty (50) spaces, constructed of materials distinguishable from the driving surface through the use of one (1) or more of the following methods:
 - (1) Changing paving material, patterns or paving color (See Figure 504.080-H.);
 - (2) Changing paving height;
 - (3) Decorative bollards;
 - (4) Painted crosswalks;
 - (5) Raised median walkways with landscaped buffers; or
 - (6) Stamped asphalt.

§ 405.090. Commercial and Mixed-Use Design and Development Standards.

A. *Purpose.* The commercial and mixed-use design standards are intended to protect and preserve the quality and character of the built environment in the City. More specifically, the purposes of this Section are to:

1. Encourage high-quality development as a strategy for investing in the City's future;
2. Emphasize Warsaw's unique community character while maintaining and enhancing the quality of life for its citizens;
3. Enhance the sense of place by shaping the appearance, aesthetic quality and spatial form of structures and developments;
4. Protect and enhance property values;
5. Minimize negative impacts of development on the natural environment;
6. Provide property owners, developers, architects, builders, business owners and others with a clear and equitable set of parameters for developing land;
7. Encourage a pedestrian- and bicyclist-friendly environment;
8. Ensure greater public safety, convenience, and accessibility through the physical design and location of land use activities; and
9. Promote both the sustainability of the structure and the overall community.

B. *Generally Applicable Design Standards.*

1. *Design intent.* It is the intent of these regulations to preserve and protect property values by creating an aesthetic quality throughout the built environment of Warsaw. Warsaw's design character is that of a vibrant, small- town lake resort, complementary to the natural landscape and unbuilt environs.
2. *Site design requirements.*
 - a. The location of structures and access shall complement the existing topography and views of the site. Excessive grading and/or the use of engineer-designed retaining walls shall be minimized when an alternate site layout would avoid such disturbances. Buildings on sloping lots with a grade differential in excess of ten (10) feet shall be designed with foundations that step with the existing (natural) grades.
 - b. All disturbed areas shall be revegetated within fourteen (14) days of disturbance using native plant species . For a list of permissible plant species, refer to the resources found within the stormwater management design criteria. Where revegetation is not possible within fourteen (14) days, the applicant shall be required to provide a surety bond or enter into an agreement to complete the work as determined by the Director.
 - c. Where development has been proposed on a site, construction activity shall, at a minimum, avoid the following:

- (1) All drainage and utility easements;
 - (2) Any required development setbacks;
 - (3) All areas over thirty percent (30%) in slope; and
 - (4) Any unique and sensitive natural site features as identified by the Director.
- d. Continuous, linear strip development shall be discouraged.
 - e. Transformers, switchgear and related utility service equipment shall not be located above ground in pedestrian access easements. Building service panels are to be located on the inside of all buildings.
 - f. The requirements of Section 405.070, Stormwater Management and Natural Area Protection Standards shall be incorporated during site design.
3. *Building orientation and entrances.* Except as otherwise specified in these design standards, the following regulations shall apply.
- a. *Individual buildings.*
 - (1) The front building facade shall be oriented toward a public street and pedestrian walkways.
 - (2) In cases where the long axis of a building is perpendicular to the primary street, the portion of the structure facing the primary street shall be configured with at least one (1) operable entrance and one or more transparent windows.
 - b. *Corner lots.* Buildings on corner lots shall be oriented to the corner and to the street fronts and should make a strong tie to the building lines of each street unless the applicant can demonstrate that to do so would be infeasible. Parking and curb cuts shall be located away from corners.
 - c. *Multiple buildings.*
 - (1) Buildings within mixed-use and commercial developments shall be organized to promote a compact pattern of development, pedestrian- friendly spaces, streetscapes, areas of naturalized landscaping and screened parking areas.
 - (2) Buildings shall be arranged and grouped so that their primary orientation complements one another and adjacent, existing development by:
 - (a) Framing the corner of an adjacent street intersection or entry point to the development;
 - (b) Framing and enclosing a pedestrian and/or vehicle road or access corridor within or adjacent to the development site;
 - (c) Framing and enclosing on at least three (3) sides parking areas, public spaces or other site amenities;
 - (d) Framing and enclosing outdoor dining or gathering spaces for pedestrians

between buildings; or

(e) Framing one (1) or more areas of natural vegetation.

4. *Build-to-zone.*

a. *Intent:* to create a consistent and well-designed building edge that contributes to the overall character of the site and promotes a more pedestrian-oriented environment while allowing for flexibility to accommodate amenities such as outdoor seating and gathering spaces.

b. *Standards.*

(1) Except as otherwise specified in the Downtown Warsaw Design Standards, mixed-use and commercial buildings shall build a minimum of seventy percent (70%) of the building wall to the back of the sidewalk along primary street frontages. See Figure 405.090-B.

(2) Portions of the street frontage not occupied by the building wall shall be occupied by community amenities, such as plazas or streetscape or pedestrian walkways that provide access to rear parking.

5. *Building design.*

a. *Four-sided design.*

(1) All sides of a building shall be architecturally finished with equal levels of materials and detailing. Blank walls void of architectural details or other variation are prohibited. Except as otherwise provided in the Downtown Warsaw Design Standards, any wall that faces a street, connecting pedestrian walkway, or residential use, and that exceeds thirty (30) feet in length shall include a minimum of two (2) of the following within each successive thirty-foot section or fraction thereof:

(a) Change in wall plane, such as projections or recesses, having a depth of at least three percent (3%) of the length of the facade and extending at least twenty percent (20%) of the length of the facade;

(b) Change in texture or masonry pattern.

(c) Windows.

(d) Trellises with vines.

(e) Covered walkways.

(f) Structural canopies.

(g) An equivalent element that subdivides the wall into human scale proportions.

(2) Ground floor facades that face public streets shall have arcades, display windows, entry areas, awnings or other such features along no less than sixty percent (60%) of their horizontal length.

- (3) Rear facades of buildings shall either be screened from view of the public or be landscaped and incorporate architectural facade elements resembling the elements in the front facade.
- (4) Corporate or franchise architecture is discouraged in favor of architecturally compatible designs. The Director may require photographic examples of the more minimized corporate architecture in the designs and completed structure by the same company in other communities.

b. *Building materials and colors.*

- (1) Except as otherwise specified for downtown Warsaw, all primary exterior building materials shall be durable, economically maintained, and of a high quality that will retain its appearance over time, including but not limited to: brick; native or manufactured stone (Renaissance stone or similar masonry materials); integrally colored, burnished, textured, or glazed concrete masonry units; prefinished metal panel systems; quality metals, such as copper; high-quality prestressed concrete systems; tilt-up concrete panels with an architectural finish; and drainable (water managed) EIFS. Exceptions to these material requirements may be made by the Director for the M-1 and M-2 Districts.
- (2) The following exterior materials are prohibited: split shakes, rough- sawn wood; painted concrete block; tilt-up concrete panels without an architectural finish; field-painted or prefinished standard corrugated metal siding; standard single- or double-tee concrete systems; or barrier-type EIFS. The Director may permit the use of these materials on up to ten percent (10%) of any facade as an accent material.
- (3) Metal is not permitted as a primary facade material. Architectural aluminum or steel panels (designed to ensure absence of any "oil canning") are permitted, but use of architectural aluminum or steel panels should be limited to specific architectural elements or features. This Section does not prohibit the use of metal siding designed to look like clapboard siding.
- (4) Building materials, except glass, shall be of low reflectance and finished in subtle, neutral or earth tone colors (brown, tan, grey, green, blue, red in muted, flat colors) characteristic of the soil types and vegetation found in Warsaw.
- (5) Building trim and accent areas may feature brighter colors, but fluorescent colors and neon tubing accents are not permitted.

c. *Roofs.* Roofs shall be designed and constructed as follows:

- (1) Flat roofs shall include parapets concealing flat roofs and rooftop equipment, such as HVAC units, from public view. Parapet roofs should be of sufficient height to conceal HVAC units and other similar roof-mounted apparatus from public view from adjacent street levels. Parapet roofs shall have cornices or be stepped.
- (2) Sloping roofs shall have a vertical rise of not less than one (1) foot for every three (3) feet of horizontal run and no more than one (1) foot for every one (1) foot of horizontal run. Sloping roofs shall have three (3) or more roof slope planes where a

building exceeds three thousand (3,000) square feet. Two (2) or more roof slope planes shall be required for buildings of three thousand (3,000) square feet or less.

C. Highway Commercial And Big Box Design Standards.

1. *Applicability.* The standards in this Subsection apply to:

- a. All retail establishments with twenty-five thousand (25,000) square feet of gross leasable area or more; and
- b. All formula or chain retail, restaurant, or personal service businesses that have ten (10) or more substantially similar businesses in the United States at the time of application. This Subsection does not apply to gas stations, offices, hotels or banks.

2. *Site layout and design.*

- a. *Structures.* In order to develop and maintain a strong street edge, buildings for stand-alone projects or individual pad developments associated with a larger commercial center shall be located at the front of the site at the minimum setback line with the exception of a single drive- through lane or additional landscaping.
- b. *Pedestrian flow.*
 - (1) Sidewalks at least eight (8) feet in width shall be provided along all sides of the lot that abut a public street.
 - (2) Sidewalks at least eight (8) feet in width shall be provided along the full length of the building across any facade featuring a public entrance and along any facade abutting public parking areas. These sidewalks shall be located at least ten (10) feet from the front of the facade of the building to provide planting beds for foundation landscaping, except where features such as arcades or entryways are part of the facade.
 - (3) In parking lots with one hundred (100) spaces or more, sidewalks at least eight (8) feet in width shall be provided from all public entrances to the perimeter of the side to permit for the safe movement of pedestrians through the parking lot.

3. *Building facade.*

- a. *Small retail stores.* Where large retail establishments contain additional separately owned stores that occupy less than thirty thousand (30,000) square feet of gross floor area, with separate, exterior customer entrances, the street level facade of such stores shall be transparent above the walkway grade for no less than fifty percent (50%) of the horizontal length of the building facade of such additional stores.
- b. *Entrances.* All sides of a large retail establishment that directly face an abutting public street shall feature at least one (1) customer entrance. Where a large retail establishment directly faces more than two (2) abutting public streets, this requirement shall apply only to two (2) sides of the building, including the side of the building facing the primary street, and another side of the building facing a second street. Each entrance shall be prominent, visible from the street, connected by a walkway to the public

- sidewalk, and include human-scale elements. Movie theaters are exempt from this requirement.
- c. *Service functions.* Service functions like refuse collection, incidental storage and similar functions shall be integrated into the architecture of the building unless an alternate location places these functions farther from adjacent residential uses.
4. *Off-street parking location.*
- a. Outside of downtown Warsaw, no more than seventy percent (70%) of the off-street parking for the entire store shall be located in front of the building. Off-street parking shall be established in one (1) or more of the locations listed below. The locations are listed in priority order; the applicant shall select the highest feasible location from this list and shall demonstrate why that application was selected over other alternative locations.
 - (1) Adjacent to off-street parking lots serving nonresidential uses on abutting lots;
 - (2) Adjacent to lot lines abutting nonresidential development;
 - (3) Adjacent to lot lines abutting mixed-use development;
 - (4) Behind the building;
 - (5) In front of the building; or
 - (6) Adjacent to lot lines abutting residential uses.
 - b. In cases where an off-street parking lot serving a nonresidential use is located on an abutting lot, connection between the two (2) parking areas via a cross-accessway with a minimum width of twelve (12) feet and a maximum width of twenty-four (24) feet is strongly encouraged. A cross- access easement shall be recorded.
 - c. The property shall not be advertised or marketed as available for camping, long-term parking, or any use other than typical customer parking for shopping patrons. Parking lots shall not be used for short-term or long-term storage of motor homes, campers, trailers or recreational vehicles.
 - d. Except for the purpose of normal loading and unloading operations, no trailers, semitrailers and trucks, truck-tractors, or outdoor containers shall be stored on site.
5. *Relationship to surrounding uses.*
- a. Multibuilding developments shall be configured to locate the tallest and largest structures within the core of the site and provide a gradual decrease in building height and mass towards adjacent residential land uses.
 - b. Horizontally integrated mixed-use developments shall locate nonresidential uses away from lots in adjacent residential areas.
 - c. Medium- to high-density housing shall be incorporated to the maximum extent feasible, both within and around the development, to facilitate connections between residential

and nonresidential uses.

- d. Nonresidential structures taller or larger than adjacent residential uses shall be broken up into modules or wings with the smaller or shorter portions of the structure located adjacent to residential uses.

D. *Downtown Warsaw Design Standards.* The Downtown Warsaw Design Standards are applicable to property within the boundaries identified in Figure 405.090-C.

- 1. *General design considerations.* The following design considerations are applicable to all historic buildings in downtown Warsaw regardless of the style, age or location of the building.

- a. *Context.* The context of surrounding buildings should be a top consideration when designing changes to the physical environment. Changes to existing buildings should take into consideration the relationship to neighboring buildings. All buildings should relate to surrounding buildings in set back, size, shape, rhythm of window openings, regulating lines of traditional building features, materials, color, and ornamentation.
- b. *Style.* Downtown Warsaw does not have one, single architectural style. The majority of buildings are typical historic commercial buildings constructed in the late 1800s and early 1900s, commonly referred to as "early 20th Century commercial buildings." However, there are several post World War II buildings that have replaced original commercial buildings as well as some modern (post-1970) buildings, particularly on the outer edges of the downtown boundaries. Rehabilitation of all existing buildings should respect and relate to the historic commercial buildings.
- c. *Existing fabric.* All existing historic building materials and details should be retained. Care should be taken not to obscure the facade or details on the facade by covering it with metal, plastic, masonry or wood panels. Existing nonhistoric cover-up materials should be removed when possible. The original size and shape of masonry openings should be retained. Original openings should not be altered by blocking in or downsizing windows or storefronts.

- 2. *Streetscape design and character.*

- a. *Intent.* A distinguishing feature in most historic commercial districts is the consistent set back from the street and sidewalk. The wall of commercial buildings along the sidewalk forms a relationship with the street that is essential to the pedestrian as opposed to automobile orientation of the business district. The edge can be interrupted by unequal setbacks and/or the absence of buildings (parking lots or vacant lots). These interruptions are often a result of destination-oriented businesses and may be appropriate for the outer edges of the downtown district. Interruptions in the continuous wall of buildings can disrupt pedestrian flow. This condition is currently illustrated toward the north and south ends of Main Street. See Figure 405.090-D for the location streetscape elements.
- b. *Design standards.*

- (1) All existing buildings shall maintain a consistent setback from the street, flush with the facades of neighboring buildings. See Fig. 405.090-E.
 - (2) Curb cuts shall not be allowed off of Main Street in the core area of downtown between Polk Street and State Street.
 - (3) Where disruptions in the continuous street wall of buildings already exist, landscaping shall be used to recreate the edge to minimize the disruption.
 - (4) Demolition of existing buildings shall be permitted only when either a professionally prepared cost-benefit analysis or structural analysis finds that no other feasible alternative exists.
- c. *Building size and shape.* All commercial buildings shall maintain the overall size, scale, height and horizontal or vertical orientation of the original commercial buildings in the area which is approximately either twenty (20) feet to twenty-five (25) feet or forty (40) feet to fifty (50) feet wide and one (1) or two (2) stories tall, except for corner buildings in the core area where buildings are wider than fifty (50) feet; these buildings shall be composed of at least two (2) twenty- to twenty-five-foot bays. Structural design precedent shall be established by neighboring buildings.
- d. *Design rhythm.* The repetition of the storefront bays and the location and size of the door and window openings creates a pattern or rhythm along the street. The rhythm created by the traditional historic commercial buildings shall be maintained on all buildings.
- e. *Regulating lines.*
- (1) *Intent.* The majority of downtown buildings relate to some or all of the regulating lines on adjacent buildings: building height, cornice or building cap, upper level windows, distinction between upper facade and storefront, transom and display windows and bulkhead. Even when there are a variety of one- and two-story buildings in the same block, there are typically predominant regulating lines. See Figure 405.090-F for the location of regulating lines.
 - (2) *Design standards.* When regulating lines are prevalent, as determined by the Director, the following guidelines should be followed.
 - (a) Building heights shall be emphasized by the horizontal alignment of cornices or building caps. All building heights shall relate to neighboring buildings in the block, as addressed in Subsection (D)(2), above. Where a one-story building adjoins two-story buildings, the one-story building shall relate to the height of other one-story buildings in the block. Regulating lines are not always established by immediately adjacent buildings and may be established by the block as a whole.
 - (b) The alignment of upper level windows along the block shall be maintained to the maximum extent possible.
 - (c) The clear distinction between the storefront and upper facade shall be

maintained to the maximum extent possible.

- (d) The alignment of storefront elements (transom window, display windows, bulkhead) shall be maintained to the maximum extent possible with neighboring buildings.

f. *Building materials.*

(1) *Intent.*

- (a) Building materials are an important consideration in how buildings relate to each other and their surroundings. Materials can be indicative of architectural styles and often establish the basic color scheme on a building facade. Historic commercial buildings in downtown Warsaw are predominately red or blond brick; a few pressed metal upper facades and wood (Trader's Alley) are original to the area as well. Most buildings have a decorative, corbeled brick or applied pressed metal cornice. The majority of brick buildings have brick or limestone window lintels and sills. Upper floor windows in two-story buildings were typically double-hung windows with wood frames; some have been replaced with aluminum frames and single, fixed panes.
- (b) Most storefronts were originally wood, some with cast-iron columns and brick or limestone piers. Most buildings have a steel I-beam spanning the storefront bay that serves as the lower cornice (many have decorative rosettes). Alterations over the years have included the installation of aluminum, brick, stone and wood siding on several storefronts; in many instances, these materials altered the proportions and regulating lines of the original storefront. The bulkheads or base of the storefronts were originally brick or wood.

(2) *Design standards.*

- (a) All existing historic building materials shall be retained to the maximum extent possible.
- (b) Proposed building improvements shall use traditional materials or materials similar to the traditional ones. Questions about traditional materials shall be determined by the Director.
- (c) Contemporary materials may be appropriate if the design and composition relate to the context and other design standards are met. Aluminum or wood siding, wood or asphalt shingles and dark or mirrored glass is prohibited except as accent materials limited to use on twenty percent (20%) or less of the structure.

g. *Color.*

(1) *Intent.*

- (a) Color plays an important role in how well a building fits into its environment and should be considered when rehabilitating existing buildings. A good source for paint colors typical of and appropriate for historic commercial buildings are the

heritage or historic paint colors offered by many paint manufacturers. Although personal preference is a major factor in the selection of paint color, the following standards should be considered when selecting colors.

- (b) The brick facades have already been painted on a number of buildings in downtown Warsaw. Typically, when the facade of a brick building must be repainted, it should be painted a color similar to the natural color of the brick. Likewise, when brick or limestone trim, such as window lintels or sills, is painted, it should be painted a color to match the natural color of the material. Accent colors should be used primarily on wood trim, such as window frames, storefront frames and bulkheads. By introducing a new paint color on decorative brick, limestone or pressed metal details, the details are accented making the building appear more ornate than it was originally designed. It was very rare for masonry or components, such as window lintels or sills, or cornices to be painted on traditional historic commercial buildings in this area of the country.

(2) *Design standards.*

- (a) A paint scheme for historic commercial buildings shall consist of no more than three (3) colors: one (1) primary color for the body and no more than two (2) accent colors for the primary and secondary trim. The predominant building material (brick or pressed metal) shall be considered the primary body color. If the historic building material has been altered, a natural color, similar to the historic material, shall be used for the body. Questions about color appropriateness shall be resolved by the Director.
- (b) Accent colors should complement the natural colors that already exist in the downtown district.
- (c) Color schemes shall be modest or muted color schemes with bright colors limited to accents.
- (d) Masonry that has been previously painted may be repainted if it is not feasible to remove existing paint from the masonry surfaces. Masonry buildings or details that have not been painted previously shall not be painted.

- 3. *Building facade.* Building facades should relate to the surrounding buildings as described in this Section. Existing buildings should retain the traditional elements outlined below. See Figure 405.090-G for the location of building facade elements.

a. *Storefront.*

- (1) *Intent.* Storefronts were historically composed almost entirely of glass, creating visual openness. This openness creates an inviting relationship to the street, emphasizes the pedestrian orientation of the commercial district and should be retained.

(2) *Design standards.*

- (a) The storefront shall fit within its original opening. The original building

entrance(s) should be retained when possible.

- (b) Doors on the storefront shall use clear glass and shall not be made of solid metal or solid wood.
- (c) Storefront revisions shall retain the original elements: transom window, display windows, bulkhead and entrance (door), and use only appropriate materials as described here or in Subsection (D)(2)(f), Building materials. The size, proportions and alignment of windows, door and bulkhead shall relate to neighboring buildings.
- (d) Display and transom windows that have been downsized or covered shall, to the maximum extent possible, be reopened.
- (e) Display windows shall be clear glass and retain the size and proportion of the original opening.
- (f) Ideally, where transom windows have been altered, they shall be restored to their original appearance to the maximum extent possible.
 - i. When restoration of the transom window glass is not feasible, the size and proportion of the original opening shall be maintained.
 - ii. When ceiling heights have been lowered, opaque panels shall be framed in to resemble the form and profile of an historic transom window.
- (g) When installing new display or transom glass in a storefront, consideration should be given to reducing heat gain. There are a variety of glass products that minimize heat gain without affecting visibility. Examples of such products include thermal glazing with clear or Low E glass. The important aesthetic consideration is that it be clear glass.

b. *Upper facade.*

- (1) *Intent.* On two-story buildings, the upper windows are a predominant character-defining feature.
- (2) *Design standards.*
 - (a) The historic masonry window openings shall be maintained to the maximum extent possible. Windows that have been downsized or covered shall be reopened to maintain the size and proportion of the historic window openings.
 - (b) For fire safety purposes, window openings shall not be blocked in or covered with a solid material.
 - (c) When upper level windows are missing or are in need of replacement, the openings shall not be downsized to accept stock sizes; replacement windows shall be provided to fill the entire opening and resemble the style and profile of the original window.
 - (d) Windows shall be clear glass. Reflective or tinted glass is prohibited in

downtown Warsaw.

c. *Cornice or building cap.*

(1) *Intent.* The cornice defines the top of the building and emphasizes the relationship of the top of the building to adjacent buildings.

(2) *Design standards.*

(a) Existing cornices shall be retained to the maximum extent possible and repaired as needed.

(b) When cornices have been removed, they shall be replaced with an historic cornice to the maximum extent feasible. If replacement is not feasible, a simplified cornice shall be designed to define the top of the building and maintain the visual unity of building tops along the block.

d. *Rear facades.* Where rear or secondary public entrances are used for customer access or where rear facades are visible to the general public, the following standards shall apply:

(1) Rear facades that are visible from a public street should complement the main facade in their design and material usage.

(a) Materials selected for facades of buildings facing Harrison Street, including accessory uses, may differ from those approved for the Main Street facade, but general design treatment and color schemes shall be consistent around all sides of the building.

(b) The rear facades shall be constructed of the primary building material, such as brick or stone. When concrete or concrete block is the predominant material of an existing rear facade, it shall be painted to match the color of existing brick or stone.

(c) Rear facades that are covered with wood or metal siding shall be painted a neutral color to blend with the natural colors found in the predominant building materials.

(2) Architectural embellishments, awnings, landscaping and signs should be used to mark the secondary entrance.

(3) A minimum of twenty percent (20%) of the building's rear facade facing a public right-of-way, parking area, or open space shall consist of transparent materials.

(4) Shed additions and stairs that are not in use shall be removed where possible.

(5) Service necessities, including trash dumpsters, downspouts, gas tanks, satellite dishes and utility boxes shall be screened from public view with fencing or landscaping pursuant to Section 405.120.

(6) It is recommended that a coordinated effort be made to encourage businesses to share dumpsters.

(7) Rear customer entries shall be well maintained.

4. *Demolition controls for historic structures.*

- a. *Purpose.* This Subsection is intended to work in conjunction with Warsaw Municipal Code Chapter 500, Article III, Demolition, by establishing standards for the demolition of historic structures. The purpose of this Subsection is to:
 - (1) Effect and accomplish the protection, enhancement and perpetuation of such areas and improvements and of districts which represent or reflect elements of the City's cultural, social, economic, political and architectural history.
 - (2) Safeguard the City's historic, aesthetic and cultural heritage, as embodied and reflected in such areas, improvements and districts.
 - (3) Stabilize and improve property values in such districts.
 - (4) Foster civic pride in the beauty and accomplishments of the past.
 - (5) Protect and enhance the City's attractions to tourists and visitors and the support and stimulus to business and industry thereby provided.
 - (6) Strengthen the economy of the City.
 - (7) Promote the use of historic districts and landmarks for the education, pleasure, and welfare of the people of the City.
- b. *Applicability.* The standards of this Subsection are applicable to historic structures in downtown Warsaw, defined as those buildings that have some or all of the architectural features identified in this Section that were common to building design in the period generally from the late 1800s through the early 1900s and any other structure located in the downtown design standards area that is fifty (50) years of age or older.
- c. *Demolition restriction.* No historic structure shall be demolished unless the owner has first given the City at least six (6) months' notice of his or her intention to demolish the building. During that six-month period, the City will work with the owner to identify any alternative uses that would allow the existing building to produce a better economic return that would allow it to remain in active use, or that would allow it to be used for the purposes or land uses the owner wants to achieve, or to identify a purchaser for the building who would preserve it from demolition. In the event the owner does not accept the alternatives, if any, offered by the City during that six-month period, the demolition may proceed, but only after the owner has provided at least thirty (30) days' additional time for the City or other parties to document the building through photographs or other means. The owner is encouraged, but not required, to allow access to the building during the thirty-day period in order to allow documentation of the interior of the building as well.
- d. *Maintenance.* Property owners are required to maintain historic buildings and structures, as defined above, in a State of normal repair and not allow demolition by neglect. Demolition by neglect is the gradual deterioration of a building when routine maintenance is not performed. The City has the authority to impose enforcement

provisions on property owners who are found to have allowed an historic structure to fall into a state of neglect.

§ 405.100. Multifamily and Townhouse Design Standards.

A. *Purpose.* The purpose of the multifamily and townhouse residential design standards is to preserve the quality and character of the built environment in the City. More specifically, the purposes of this Section are to:

1. Encourage high-quality development as a strategy for investing in the City's future;
2. Emphasize the City's unique community character;
3. Maintain and enhance the quality of life for the City's citizens;
4. Shape the City's appearance, aesthetic quality, and spatial form;
5. Protect and enhance property values;
6. Provide property owners, developers, architects, builders, business owners, and others with a clear and equitable set of parameters for developing land; and
7. Promote the sustainability of both the structure and the overall community.

B. *Applicability.*

1. The design standards in this Section apply to all new dwellings intended or constructed to be occupied by three (3) or more households, including individually constructed buildings, townhomes, and multiple buildings constructed as parts of a larger development.
2. Section 405.060(B), Applicability, identifies how these provisions apply to redevelopment and infill development.

C. *Site Design.*

1. *Building separation.* The minimum separation between multifamily buildings, including accessory buildings, on the same lot or development parcel is fifteen (15) feet.
2. *Building orientation.*
 - a. Individual buildings within a multifamily development shall be oriented to:
 - (1) Common open space, such as interior courtyards or on-site natural areas or features;
 - (2) Perimeter streets;
 - (3) Other residential buildings; or
 - (4) Through-access drives.
 - b. Multifamily buildings in a single development shall be clustered or grouped to form neighborhoods.
3. *Common space.*
 - a. Developments with at least four (4) units shall provide one hundred fifty (150) square feet of private common open space for each multifamily dwelling unit. A minimum of

forty percent (40%) of the open space shall be usable for recreation, including swimming pools, sport courts, or playgrounds with equipment. Required landscaping is excluded from open space calculations.

- b. To the maximum extent practicable, common open spaces, such as gardens, courtyards, recreation or play areas, shall contain a minimum of three (3) of these features:

- (1) Seasonal planting areas;
- (2) Trees;
- (3) Pedestrian-scaled lighting;
- (4) Gazebos or other decorative shelters;
- (5) Seating;
- (6) Play structures for children; or
- (7) Natural features or areas, unless the City determines that for preservation reasons the buildings should avoid the feature or area.

4. *Pedestrian circulation.*

- a. *Circulation patterns.* Sidewalks shall be provided as necessary for efficient pedestrian circulation within the project and to neighboring properties pursuant to Section 405.080, Mobility and Connectivity Development Standards.

- b. *Walkway location and design.*

- (1) Sidewalks shall be separated from vehicular traffic where possible.
- (2) Sidewalks shall be constructed of attractive, durable materials, such as decorative concrete or brick pavers.
- (3) Sidewalk widths shall be compatible with anticipated uses, but in no instance shall be less than five (5) feet wide as a minimum standard.

- 5. *Stormwater management.* The requirements of Section 405.070, Stormwater Management and Natural Area Protection Standards shall be incorporated during site design.

D. *Building Design.*

- 1. *Maximum building length.* The maximum length of any multifamily building shall be one hundred fifty-six (156) feet or six (6) townhouse units, whichever is less.
- 2. *Facade design.* Multifamily buildings with a facade length of greater than forty (40) linear feet shall incorporate a variety of different wall planes and roof planes and shall feature a minimum of two (2) of the following design elements in the design of the front facade (See Figure 405.100-C.):

- a. Bay windows;

- b. Covered porches or balconies;
 - c. Structural offsets of a minimum of four (4) feet from the principal plane of the facade;
 - d. Accent materials, such as brick, stone, or stucco with banding highlights; or
 - e. Window grills and shutters.
3. *Patio.* All ground floor units shall be provided with a minimum six-foot-by- ten-foot patio or balcony directly accessible from the unit. At least fifty percent (50%) of all units above ground-floor level shall be provided with a minimum four-foot-by-ten-foot balcony directly accessible from the unit.
4. *Building materials.* All construction shall be of durable high-quality materials and shall meet the following standards:
- a. If vinyl exterior siding is used, it shall have a manufacturer's warranty of a minimum of fifteen (15) years.
 - b. Metal is not permitted as a primary facade material. This Section does not prohibit the use of metal siding designed to look like clapboard siding.
 - c. Architectural aluminum or steel panels (designed to ensure absence of any deformation or oil canning) are permitted, but use of architectural aluminum or steel panels should be limited to specific architectural elements or features.
5. *Transparency.* At least twenty-five percent (25%) of all walls facing a public street shall contain windows or doorways.
6. *Roof.*
- a. Minimum roof pitch on all townhouses, duplexes and multifamily dwellings is 4/12. No flat roofs are permitted.
 - b. Multifamily residential buildings shall be designed to avoid any continuous roofline longer than fifty (50) feet. Rooflines longer than fifty (50) feet shall include at least one (1) vertical elevation change of at least two (2) feet.
 - c. The incorporation of a variety of roof forms is strongly encouraged. Upper-level residential floors may be incorporated into the roof form to reduce the apparent height and mass of buildings.
 - d. The height of each multifamily building taller than thirty-five (35) feet shall be stepped down from its highest roofline at least one (1) full story on any end of the building located within fifty (50) feet of a street right- of-way or an adjacent area zoned or used for single-family residential.
7. *Building access.* Multifamily buildings shall provide concentrated unit access points. Monotonous access balconies and corridors running the length of the exterior of a building are prohibited.

E. *Parking Location And Layout.*

1. *Parking internal to development.*

- a. To the maximum extent feasible, garage entries, carports, parking areas and parking structures shall be internalized in building groupings or oriented away from street frontage.
- b. Parking areas and freestanding parking structures (detached garages or carports) shall not occupy more than thirty percent (30%) of each perimeter public street frontage of a multifamily development.
- c. To the maximum extent practicable, freestanding parking structures that are visible from perimeter public streets shall be sited so that the narrow end of the parking structure is perpendicular to the perimeter street.

2. *Covered parking.*

- a. Multifamily development shall provide covered parking to meet a minimum of fifty percent (50%) of the required parking identified in Table 405.110-1, Off-Street Parking. The Director may reduce or waive this requirement for low-income housing.
- b. Carports and common garages shall be limited to sixty (60) feet in length.
- c. Detached garages and carports shall incorporate compatible materials, scale, colors, architectural details and roof slopes similar to those of the primary multifamily buildings.

F. *Storage Space.*

1. *Intent.*

- a. To ensure multifamily developments provide sufficient storage for residents so that balconies and garages may be used for their original purpose.
- b. To reduce parking impacts resulting from undersized garage spaces and a lack of storage.
- c. To ensure parking is used for parking and not for storage.

2. *Design standards.* Multifamily developments shall provide a minimum of thirty-two (32) feet of exterior storage space per unit. Storage may be provided through one (1) or more of the following:

- a. Increased garage dimensions that allow for storage in front of parked vehicles;
- b. Storage units incorporated above detached garage structures or within the multifamily building;
- c. Storage closets within units, aside from bedroom closets; or
- d. Detached storage buildings or sheds.

§ 405.120. Landscaping and Screening.

A. Landscaping.

1. *Purpose.* The purpose of the landscaping standards is to ensure that landscaping in Warsaw:
 - a. Integrates building sites with both natural topography and existing vegetation;
 - b. Minimizes disturbed and impervious areas;
 - c. Respects the limitations and best uses of water resources;
 - d. Reduces the amount of reflected glare and heat absorbed in and around developments;
 - e. Breaks up large expanses of parking lots; and
 - f. Preserves residential neighborhoods by lessening the impacts of potentially incompatible uses.
2. *Applicability.* This landscaping section shall apply to all new development and redevelopment as provided in Section 405.120(A)(3). Applicability of the provisions of this Section shall be as indicated in Table 405.120-1, below.

Table 405.120-1 Applicability of Landscaping Standard by Development Type						
Standard	Section	Single-Family/ Duplex	Multifamily	Mixed Use	Commercial	Industrial
Landscaped area	405.120(A)(3)(a)	♦	♦	♦	♦	♦
Landscape buffer	405.120(A)(3)(b)		♦	♦	♦	♦
Parking lot landscaping	405.120(A)(3)(d)		♦	♦	♦	♦

3. Required landscaping.

- a. *Landscaped areas.* All exposed ground areas surrounding or within a principal or accessory use, including adjacent, unpaved street rights-of-way, that are not devoted to drives, parking lots, sidewalks, patios or similar uses shall be landscaped.
 - (1) All residential lots shall have a minimum of one (1) tree planted between the sidewalk and the front of each house at the time the house is constructed.
 - (2) All multifamily and commercial uses shall provide at least four (4) feet in depth of site perimeter landscaping along all public streets, planted at a minimum of thirty hundredths (0.30) landscape unit per linear feet, fifteen percent (15%) of which shall be trees.
- b. *Landscape buffer.* The following regulations apply to properties where a multifamily, mixed-use or nonresidential district or use abuts a single-family residential district or use.

(1) *Buffer required.*

- (a) A minimum fifteen-foot wide buffer space shall be provided.
- (b) The buffer shall be landscaped with sixty hundredths (0.60) landscape unit per linear foot, twenty-five percent (25%) of which shall be trees.
- (c) New trees and shrubs shall be evenly spaced at planting.
- (d) A solid masonry wall, a minimum of six (6) feet in height, may be substituted for required shrubs.
- (e) Where a natural buffer exists, as determined by the Director, it shall remain undisturbed.
- (f) If used in addition to a landscape screen, fences shall have additional evergreen shrubs planted on the residential side of the fence.
- (g) Green stormwater infrastructure (GSI)/stormwater best management practices (BMPs) are encouraged in landscape buffers to meet both landscaping requirements and stormwater retention requirements per the City's stormwater management design criteria.

(2) *Uses and easements.*

- (a) Mechanical equipment and permanent detention facilities are prohibited in the buffer area. This restriction does not apply to GSI/stormwater BMPs with native vegetation.
- (b) Utility easements may cross but not be placed in the long dimension of a buffer yard except for drainage easements when GSI/stormwater BMPs are implemented within the landscape buffer.
- (c) Wherever practical, pedestrian access shall be placed through the buffer yard.

- c. *Landscaping units.* Required landscaping is calculated in landscaping units. Table 405.120-3 indicates the landscape units awarded for various preserved or planted landscape materials:

Table 405.120-3 Landscape Units Awarded		
Landscape Material	Landscape Units Awarded	
	Newly Installed	Existing Retained
Evergreen tree, more than 10 feet high	8	14
Evergreen tree, more than 8 feet to 10 feet high	8	11
Evergreen tree 6 feet to 8 feet high	6	9
Deciduous tree, more than 8 inches in caliper	n/a	14
Deciduous tree, more than 4 inches to 8 inches in caliper	n/a	11

Table 405.120-3 Landscape Units Awarded		
Landscape Material	Landscape Units Awarded	
	Newly Installed	Existing Retained
Deciduous tree, more than 2.5 inches to 4 inches in caliper	7	9
Deciduous tree, 1.5 inches to 2.5 inches in caliper or multistem	4	4
Shrubs, 36 inches high	1	1.2
Shrubs, 24 inches high	0.8	0.9
Shrubs, 18 inches high	0.5	0.6
Perennials/ground cover	1 per 400 square feet	
Annual flower bed	1 per 400 square feet	
Lawn grass	1 per 800 square feet	
Flower basket support	0.2 per basket	
Earthen berm, minimum 18 inches high	0.05 per linear foot	

Hardscape Material	Units Awarded
Split rail fence	0.20 per linear foot
Screening (opaque) fence	0.40 per linear foot
Shredded bark or 3 inches plus rock mulch, such as river rock	1 per 500 square feet
Ornamental pavers	1 per 250 square feet
Landscape boulders, 3 feet or greater in height	1 per boulder
Seating	0.40 per linear foot
Landscape lighting, sculpture, art, water feature, and/or sheltering structure/landmark	As determined by Director

Retained Existing Vegetation Mass ¹	Bonus Landscaping Units Awarded
300 or more square feet with a minimum of 3 deciduous trees (4 inches in caliper or greater), 3 evergreen trees (minimum 6 feet high) or any combination thereof	15%
500 or more square feet with a minimum of 5 deciduous trees (4 inches in caliper or greater), 5 evergreen trees (minimum 6 feet high) or any combination thereof	20%
800 or more square feet with a minimum of 8 deciduous trees (4 inches in caliper or greater), 8 evergreen trees (minimum 6 feet high) or any combination thereof	25%

NOTES:

¹ Points awarded for retained vegetation in perimeter buffers may only be applied in the buffer area along the same lot line or street frontage where the vegetation is found.

- d. *Parking Lot Landscaping.* The following landscaping requirements shall be met for all off-street surface parking lots. Figure 405.120-A identifies the three (3) required types of parking lot landscaping.

(1) Parking lot perimeter landscaping is required around the entire perimeter of a parking lot as follows:

- (a) Perimeter parking lot landscaping of a minimum width of ten (10) feet shall be required for all parking lots having more than three (3) spaces where the parking lot is adjacent to a public street or a nonretail or industrial use such as a residential area, institutional use (e.g., hospital) or office.
- (b) The parking lot perimeter landscaping shall achieve a minimum of one and two-tenths (1.2) landscape units per linear foot.
- (c) Where lots are being developed in a mixed-use district, the parking lot perimeter landscaping requirement may be reduced along an interior lot line, at the discretion of the Director, provided that interior parking lot landscaping applies to both parking lots.

(2) Internal landscaping shall be provided as follows:

- (a) Landscape strips shall be installed between the parking rows of every other double row of parking when parking rows exceed fifty (50) parking spaces. Landscape strips shall be designed as follows:
 - i. Be a minimum of twelve (12) feet in width and shall extend the length of the parking row.
 - ii. Include a five-foot wide sidewalk and a seven-foot wide planting strip.
 - iii. Meet planting requirements for interior landscape islands, as outlined below.
- (b) Landscape islands shall be installed for every ten (10) parking spaces contained in a parking row, either within the parking row or at the end of the parking row and shall be designed as follows:
 - i. Be a minimum of six (6) feet in width and at least two hundred (200) square feet in total area.
 - ii. Be sunken below the level of the parking lot surface to allow for runoff capture.
 - iii. Have a minimum of four (4) five-gallon deciduous shrubs and one (1) deciduous tree, a minimum of two and one-half inches in caliper, per two hundred (200) square feet.
 - iv. Incorporate perennials and grasses for seasonal color.
 - v. Contain a minimum of fifty percent (50%) living landscaping material, with a maximum of fifty percent (50%) nonliving landscaping material. Approved sidewalks are not counted toward the nonliving landscape material percentage.

(3) *Curbs*. Landscaped areas within parking lots or the along perimeter of the property

must be protected from vehicular traffic through the use of continuous concrete curbs, unless GSI/stormwater BMPs are used. At least one break per ten (10) linear feet of curb is required to allow for runoff inflows into the landscaped areas. If GSI/stormwater BMPs are implemented within the landscape area alternative edging may be used to allow for sheet flow of stormwater runoff into the facilities.

- e. *Site distance triangle.* A site distance triangle within the off-street parking area must be established at street intersections by maintaining a maximum height for shrubs and ground cover of thirty (30) inches. No obstructions are permitted in the site distance triangle, including tree branches that must be trimmed within eight (8) feet of the ground. All applicable sight distance requirements must be met for parking lot internal circulation and access points to the public right-of-way.
- 4. *Landscaping standards.* All landscaping elements, including but not limited to planters, retaining walls and berms, must be specifically approved and shall conform to the following standards:
 - a. *Preservation of existing vegetation.* Landscaping plans should be designed to preserve and protect existing native vegetation and mature trees. Bonus landscape credit shall be awarded for preserved vegetation as indicated in Table 405.120-3, Landscape Units Awarded, above, where the Director accepts the existing vegetation as being in good health and meets the intent of the landscaping requirements of this Chapter.
 - b. *Allowed plant materials.* Proposed materials must be specified on development plans. For a list of permissible plant species, refer to the resources found within the stormwater management design criteria. Materials not on the list may be approved if the Director determines that they are equally or more suitable for local soil conditions and local climate requirements, and that the requested materials would provide the same or better level of visual benefits and have desired growth habits. No noxious weeds, as defined by the State, are permitted for use in the City.
 - c. *Revegetation.*
 - (1) All disturbed areas must be adequately reseeded and restored on all projects. A revegetation bond, satisfactory to the Director, must be furnished as a condition of certificate of occupancy and shall remain in full force and effect until the landscaping plan is completed, vegetation is sufficiently established, and temporary erosion and sediment control, such as silt fence and straw bales, are removed from the site.
 - (2) In all disturbed areas, soil must be prepared with tilling and the addition of decomposed organic matter, such as, but not limited to, compost, composted horse manure, or composted chopped straw or hay. Straw tackifier or matting on steep slopes is required to prevent soil erosion. The addition of decomposed organic matter is also required prior to turf installation.
 - d. *Retaining walls.*
 - (1) Where retaining walls are used, they shall not exceed six (6) feet in height and shall either incorporate the use of native materials or be earth tone colors to match the

native soils and rocks. In instances where the topographic conditions justify additional retaining walls, there shall be a minimum planting area of five (5) feet between the walls.

- (2) In cases where the wall is split into multiple sections, a minimum of five (5) five-gallon shrubs for each twenty (20) feet of linear planting area shall be planted in the area between the walls and at the base of the lowest wall.
- e. *Stormwater management.* The requirements of Section 405.070 Stormwater Management and Natural Area Protection Standards should be considered when designing landscaping. Opportunities to meet both the requirements of this Section and Section 405.070 with vegetated GSI/stormwater BMPs are encouraged.

B. *Screening.*

1. *Single-family residential screening.* To the maximum extent practicable, utility equipment on residential lots shall be located behind the front building line of the house and screened from public view by an opaque wall, fence or landscaping screen. Alternative locations may be approved by the Director to allow for the retention of existing trees on wooded sites. Roof-mounted mechanical equipment, except solar energy collection systems, is prohibited on single-family residential dwellings.
2. *Multifamily, mixed-use and commercial screening.* For all developments other than single-family residential, the following mechanical equipment screening standard shall apply to the maximum extent practicable.
 - a. *Roof-mounted mechanical equipment.* Roof-mounted mechanical equipment shall be screened by a parapet wall or similar feature that is an integral part of the building's architectural design. The parapet wall or similar feature shall be of a height equal to or greater than the height of the mechanical equipment being screened. See Figure 405.120-B.
 - b. *Wall-mounted mechanical equipment.* Wall-mounted mechanical equipment, except air-conditioning equipment (e.g., window air-conditioning units), that protrudes more than six (6) inches from the outer building wall shall be screened from view by structural features that are compatible with the architecture and color of the subject building. Wall-mounted mechanical equipment that protrudes six (6) inches or less from the outer building wall shall be designed to blend with the color and architectural design of the subject building.
 - c. *Ground-mounted mechanical equipment.* Ground-mounted mechanical equipment shall be screened from view by landscaping or by a decorative wall that is compatible with the architecture and landscaping of the development site. The wall shall be of a height equal to or greater than the height of the mechanical equipment being screened.
 - d. *Utilities.*
 - (1) Utility poles (other than wooden poles erected by a public utility company) and supports shall be painted or be of materials neutral in color.

- (2) All transformers and other facilities and equipment, including telecommunications equipment, shall either be screened through the use of architectural materials compatible with the architectural materials present on the site or, alternatively, through landscape screening.
 - (3) Such screening shall be adequate to completely screen such facilities from all rights-of-way.
 - e. *Alternate screening.* Mechanical equipment that is not screened in full compliance with the screening standards of this Section shall be reviewed in accordance with the procedures of Section 405.030(H), Alternative Compliance. Alternate screening methods may include, but shall not be limited to, increased setbacks, increased landscaping, grouping the equipment on specific portions of a site and painting or otherwise camouflaging the equipment.
3. *Screening of service, loading and storage areas.*
- a. *Applicability.* These screening requirements are applicable to all service, loading and storage areas. Owners are encouraged to locate the types of features listed in this Subsection where they are not visible from off-site or from public areas of a site, so that screening is unnecessary.
 - b. *Placement.*
 - (1) All service areas shall be placed at the rear, on the side of, or inside buildings. See Figure 405.120-C.
 - (2) No service area shall be visible from a public right-of-way or from adjacent residential areas.
 - (3) Service areas and access drives shall be located so they do not interfere with the normal activities of building occupants or visitors on driveways, walkways, in parking areas or at entries.
 - c. *Outside storage areas and loading docks.*
 - (1) All storage areas, service areas and loading docks not screened by an intervening building shall be screened from view from any public street right-of-way. In addition, storage and loading areas must be screened from view from any adjoining property when that property requires a buffer. On property zoned or used industrial, all outside storage areas that are adjacent to nonindustrial zoned property must also be screened from view.
 - (2) An opaque screen consisting of one (1) or a combination of the following shall be used:
 - (a) Freestanding walls, wing walls or fences;
 - (b) Earthen berms in conjunction with trees and other landscaping; or
 - (c) Landscaping, that must be opaque and eight (8) feet in height within eighteen

(18) months of planting.

- (3) Screening shall be a minimum height of eight (8) feet to screen truck berths, loading docks, areas designated for permanent parking or storage of heavy vehicles and equipment or materials.
- (4) Screening shall be long enough to screen the maximum size trailer that can be accommodated on site. Sites that can accommodate a full-size tractor-trailer shall provide a forty-eight-foot wing wall, where wing walls are used.
- d. *Shopping cart storage.* All shopping carts shall be stored inside the building they serve. Shopping cart corrals shall be made of a material suitable for withstanding weathering and rusting. Plastic corrals are prohibited.
- e. *Refuse facility screened.* All refuse facilities, including new refuse facilities placed on an existing development, shall be large enough to accommodate a trash dumpster and shall be completely screened from view of public streets and adjoining nonindustrial zoned properties by:
 - (1) Meeting the requirements of the other sections of this Section; or
 - (2) Screening on three (3) sides by a minimum six-foot wall surrounded by evergreen landscaping. See Figure 405.120-D. An opening shall be situated so that the container is not visible from adjacent properties or public streets and the opening shall be a wood or metal clad opaque gate. Chain-link gates are not permitted. Gates must have tie backs to secure in the open position.
- f. *Design of screening.* All screening shall be complementary to the building served in landscaping approach and through the use of similar colors and material palette.

§ 405.130. Sustainability.**A. Wind Energy.**

1. *Purpose.* This Subsection is intended to promote the compatible use of small wind-energy systems. Wind energy is an abundant, renewable, and nonpolluting energy resource. When converted to electricity, it reduces our dependence on nonrenewable energy resources and reduces air and water pollution that result from conventional sources. Distributed wind-energy structures also enhance the reliability and power quality of the power grid, reduce peak power demands, and increase local electricity generation.
2. *Small wind-energy standards.* Small wind-energy systems shall be a permitted accessory use in all zoning districts subject to the following requirements:
 - a. *Tower system standards.*
 - (1) A wind tower for a small wind-energy system shall be set back a distance of one (1.0) times its total height from:
 - (a) Any public road right-of-way, unless written permission is granted by the governmental entity with jurisdiction over the road;
 - (b) Any overhead utility lines, unless written permission is granted by the affected utility; and
 - (c) All property lines.
 - (2) The maximum height of a small wind-energy system tower shall be seventy-five (75) feet. Systems taller than seventy-five (75) feet shall be required to obtain a conditional use permit.
 - b. *Vertical axis wind turbine standards.* A vertical axis wind turbine (VAWT) using vertical wind turbine technology shall be permitted in all zone districts as an accessory use, subject to the following requirements:
 - (1) *Residential district requirements.*
 - (a) A maximum of one (1) VAWT is permitted per lot or one (1) per acre, whichever is greater.
 - (b) Building-mounted VAWTs shall not exceed forty (40) feet in height measured from the base attached to the structure to the highest point on the VAWT.
 - (c) The maximum height for a VAWT shall not exceed seventy- five (75) feet measured from the base of the tower to the highest point on the VAWT.
 - (d) A VAWT shall be set back a distance of one (1.0) times its total height from:
 - i. Any public road right-of-way, unless written permission is granted by the governmental entity with jurisdiction over the road;
 - ii. Any overhead utility lines, unless written permission is granted by the

affected utility; and

- iii. All property lines, unless written permission is granted from the affected land owner or neighbor.

(2) *Nonresidential district requirements.* Multiple VAWTs are permitted on any nonresidential lot subject to the following requirements:

- (a) Building-mounted VAWTs shall not exceed forty (40) feet in height measured from the base attached to the structure to the highest point on the VAWT.
- (b) Light-pole-mounted VAWTs shall not exceed twenty-five (25) feet in height measured from the top of the light pole to the highest point on the VAWT.
- (c) The maximum height for a VAWT shall not exceed seventy- five (75) feet measured from the base of the tower to the highest point on the VAWT.
- (d) A VAWT shall be set back a distance of one (1.0) times its total height from:
 - i. Any public road right-of-way, unless written permission is granted by the governmental entity with jurisdiction over the road;
 - ii. Any overhead utility lines, unless written permission is granted by the affected utility; and
 - iii. All property lines, unless written permission is granted from the affected land owner or neighbor.

3. *General standards for tower and VAWT systems.*

- a. *Lighting.* A small wind-energy system or VAWT shall not be artificially lighted unless such lighting is required by the Federal Aviation Administration. A light temporarily used to inspect a turbine, tower and associated equipment is permissible, provided that said light is only used for inspection purposes and not left on for an extended period of time.
- b. *Decibel levels.* Decibel levels for a small wind-energy system or VAWT shall not exceed the lesser of sixty (60) decibels (dBa) as measured at the closest neighboring inhabited dwelling, except during short-term events, such as utility outages and severe wind storms.
- c. *Color.* The color of the small wind-energy system shall either be the stock color from the manufacturer or painted with a nonreflective, unobtrusive color that blends in with the surrounding environment. Approved colors include but are not limited to white, off-white or gray.
- d. *Signs.* All signs, other than the manufacturer's or installer's identification, appropriate warning signs, or owner identification on a wind generator, tower, building, or other structure associated with a small wind-energy system or VAWT visible from any public road shall be prohibited.
- e. *Code compliance.* A wind-energy structure including tower shall comply with all

applicable State construction and electrical codes, and the National Electrical Code as adopted by the City.

- f. *Screening.* Ground-level mechanical equipment associated with the wind-energy system shall conform to Section 405.120(B), Screening.

4. *Other standards.*

- a. The structure shall comply with all applicable Federal Aviation Administration requirements, including but not limited to Subpart B (commencing with Section 77.11) of Part 77 of Title 14 of the Code of Federal Regulations regarding installations in excess of two hundred

(1) (200) feet in height and installations close to airports. The system shall also comply with any and all Missouri aeronautics regulations.

- b. All electrical wires associated with a wind-energy system, other than wires necessary to connect the wind generator to the tower wiring, the tower wiring to the disconnect junction box, and the grounding wires shall be located underground.
- c. A VAWT tower shall be designed and installed so as to not provide step bolts or a ladder readily accessible to the public for a minimum height of eight (8) feet above the ground.
- d. No part of the system, including guy wire anchors, may be closer than five (5) feet from any property boundary.
- e. Temporary meteorological (Met) towers shall be permitted under the same standards as a small wind-energy system, except that the requirements shall be the same as those for a temporary structure. A permit for a temporary Met tower shall be valid for a maximum of three
 - (1) (3) years after which an extension may be granted. Permanent Met towers may be permitted under the same standards as a small wind energy system.
- f. All ground-mounted electrical and control equipment shall be labeled or secured to prevent unauthorized access.

- 5. *New technology.* The Director may waive the provisions of these requirements through the alternative compliance process in Section 405.030(H) where the availability of new technology alleviates the issues addressed by these regulations.

- 6. *Decommissioning.* A wind-energy system that has reached the end of its useful life shall be removed within six (6) months of such determination. A wind-energy system is considered to have reached the end of its useful life when it has been inoperable for twelve (12) consecutive months. Time extensions are allowed when good faith efforts to repair the turbine can be demonstrated.

B. *Solar Energy Systems.*

- 1. *Purpose.* This Subsection is intended to promote the compatible use of solar energy systems

and to assist in decreasing the City's dependence upon non- renewable energy systems through the encouragement of solar energy systems for the heating of buildings and water.

2. *Applicability.*

- a. Solar energy systems are permitted in all zoning districts as an accessory use.
- b. A solar energy system shall provide power for the principal use and/or accessory use of the property on which the solar energy system is located.

3. *Roof-mounted solar.* The installation and construction of a roof-mounted solar energy system shall be subject to the following development and design standards:

- a. A roof- or building-mounted solar energy system may be mounted on a principal or accessory building.
- b. A roof-mounted solar collection system shall not exceed by more than eighteen (18) inches above the roof on which it is located, nor shall it extend a minimum of one (1) foot below the ridge line.
- c. A solar collection system may be located on an accessory structure.
- d. The zone district height limitations of this Code shall not be applicable to solar collectors, provided that such structures are erected only to such height as is reasonably necessary to accomplish the purpose for which they are intended to serve, and that such structures do not obstruct solar access to neighboring properties.
- e. Placement of solar collectors on flat roofs shall be allowed by right, provided that panels do not extend horizontally past the roofline.
- f. A development proposed to have a solar collection system located on the roof or attached to a structure, or an application to establish a system on an existing structure, shall provide a structural certification as part of the building permit application.

4. *Ground- or pole-mounted solar.* The installation and construction of a ground- mounted or pole-mounted solar energy system shall be subject to the following development and design standards:

- a. The height of the solar collector and any mounts shall not exceed twenty (20) feet when oriented at maximum tilt.
- b. Any solar collector and any mounts, in a residential district, shall not exceed the greater of one-half (1/2) the footprint of the principal structure or six hundred (600) square feet, whichever is greater. The size of any solar collector and any mounts in mixed use and non-residential districts shall not exceed one-half (1/2) of the footprint of the principal structure.
- c. The surface area of a ground- or pole-mounted system, regardless of the mounted angle, shall be calculated as part of the overall coverage.
- d. The minimum solar energy system setback distance from the property lines shall be equivalent to the building setback or accessory building setback requirement of the

- underlying zoning district, and the system may not be located in the front yard.
- e. All power transmission lines from a ground-mounted solar energy system to any building or other structure shall be located underground and/or in accordance with the building electrical code, as appropriate.
 - f. All abandoned or unused freestanding solar energy systems shall be removed within twelve (12) months of the cessation of operations.
5. *Electrical equipment.* All electrical equipment associated with and necessary for the operation of solar energy systems shall comply with the setbacks specified for accessory structures in the underlying zoning district.
 6. *Solar panel orientation.* Solar panels are designed to absorb (not reflect) sunlight; and, as such, solar panels are generally less reflective than other varnished or glass exterior housing pieces. However, solar panel placement should be prioritized to minimize or negate any solar glare onto nearby properties or roadways, without unduly impacting the functionality or efficiency of the solar system.
 7. *Administrative review process.*
 - a. *In general.* The Director, in consultation with Code Enforcement, shall have up to fifteen (15) working days following the submittal of a complete application to approve or deny such application. The Director may impose such conditions and require such guarantees deemed reasonable and necessary to protect public interest and to ensure compliance with the standards and purposes of this Zoning Ordinance and policies of the land use.
 - b. All solar collection installations shall be performed by a qualified solar installer, and, prior to operation, the electrical connections shall be inspected by the Code Enforcement Director. In addition, any connection to the public utility grid must be inspected by the appropriate public utility.
 - c. *Submittal requirements.* An application for a solar energy system shall be filed on a form, approved by the Director, with any other required documentation he or she should deem necessary.
 8. *Conflict with other municipal policies and ordinances.* Nothing in this Subsection does, or is intended to, abrogate the owner's responsibility to meet all other requirements of this Code, including, but not limited to, the preservation of private and public views, the quality of architectural design, the preservation of historic landmark structures, or the like.

C. *Green Stormwater Infrastructure.*

1. *Purpose.* This Subsection is intended to promote the use of green stormwater infrastructure in both public improvement projects and private development projects. Green stormwater infrastructure is defined as stormwater management solutions designed to capture, filter, absorb, and/or re-use stormwater by mimicking natural hydrologic processes.
 - a. *Terminology.* Green stormwater infrastructure (GSI) may also be referred to as green infrastructure, stormwater control measures, or post-construction permanent

stormwater best management practices (stormwater BMPs).

b. *Distinguishing between Temporary Construction and Post-Construction BMPs.*

(1) Temporary construction BMPs, also known as erosion and sediment control BMPs, are those designed and installed specifically to minimize the impacts of sediment carried in runoff from active construction sites.

(2) Post-construction stormwater BMPs are designed to capture and treat runoff on a long-term basis following completion of construction.

2. *Applicability.* All improvements defined in Section 405.030(O), Drainage Permit are encouraged to use green stormwater infrastructure to meet the City's stormwater management requirements, defined in Section 405.070, Stormwater Management and Natural Area Protection Standards.

3. *Principles.*

a. *Utilize and protect the natural stormwater system.* Natural drainage paths, streams, undisturbed green spaces, wetlands and riparian areas are all efficient low-cost natural stormwater management features. This is the existing natural stormwater management system and should be preserved and utilized where practical. Replacing the services provided by these natural systems with man-made systems requires significant capital investment and time, creates the need for ongoing operation and maintenance of these systems, and reduces the value of natural resources.

b. *Capture rain where it falls.* Managing rain with the use of green stormwater infrastructure in close proximity to where it hits the ground can reduce the need for stormwater pipes and can provide a more efficient means for infiltration and treatment of runoff. Green stormwater infrastructure can also help create a more aesthetically pleasing environment, provide improved pedestrian connectivity, maintain natural areas, reduce heat islands and improve air quality.

c. *Minimize impervious surfaces.* Impervious surfaces, such as roadways, parking lots and rooftops, reduce the available area for infiltration and increase the rate and volume of runoff. By minimizing impervious surfaces, stormwater volume and flow rates can be decreased, thereby reducing likelihood of flash flooding, stream channel erosion and impaired water quality. Development and redevelopment improvements are encouraged to minimize increased impervious areas through use of alternative permeable materials, or, remove un-used impervious areas to reduce the negative impacts of development on the City's stormwater management systems.

§ 405.140. Subdivision Design Standards.

A. *General Purpose And Intent.* The purpose and intent of these regulations is to provide for the harmonious development of the community and the surrounding area; to provide for the proper location and width of streets, building lines, open spaces, safety and recreation facilities, utilities, drainage, and for the avoidance of congestion of populations through requirements of minimum lot width, depth and area and the compatibility of design; to require and fix the extent to which and the manner in which streets shall be graded and improved and water, sewer, drainage, and other utility mains and piping or connections or other physical improvements shall be installed; and to provide for and secure the actual construction of such physical improvements.

B. *Blocks, Lots And Easements.*

1. *Block length.*¹

- a. Intersecting streets (which determine block length) shall be provided at such intervals as to serve cross traffic adequately and to meet existing streets in the neighborhood.
- b. In residential districts, where no existing plats are recorded, the blocks shall not exceed one thousand three hundred twenty (1,320) feet in length, except that a greater length may be permitted where topography or other conditions justify a departure from this maximum.
- c. In blocks longer than eight hundred (800) feet, pedestrianways and/or easements through the block may be required near the center of the block.
- d. Such pedestrianways or easements shall have a minimum width of ten (10) feet.

2. *Block width.*

- a. In residential development, the block width shall normally be sufficient to allow two (2) tiers of lots of appropriate depth.
- b. In certain instances, however, a different arrangement may be required in order to provide better circulation or to protect a major circulation route.
- c. Blocks intended for business or industrial use shall be of such width and depth as may be considered most suitable for the prospective use.

3. *Lots.*

- a. Minimum lot width shall be measured at the building setback line. In addition, corner lots should have a width fifteen (15) feet greater than the minimum width.
- b. Minimum lot depth should be one hundred (100) feet. This measurement shall be made through the center of the lot and shall be perpendicular to the property line or radial to the property line on curved streets.
- c. Minimum lot area shall be subject to the zoning regulations of the district in which the subdivision is located and the minimum design standards of this regulation. The more

restrictive of the regulations shall govern.

- d. All side lot lines shall bear between sixty degrees (60°) and ninety degrees (90°) from the street right-of-way line on a straight street or from the tangent of a curved street.
- e. Front building or setback shall be shown on the final plat for all lots in the subdivision and shall not be less than the setbacks established by the zoning regulations or any other regulations adopted by the Board of Aldermen; the most restrictive setback requirement shall govern.
- f. Double-frontage lots shall be avoided unless, in the opinion of the Planning and Zoning Commission, a variation to this rule will give better street alignment and lot arrangement.
- g. Every lot shall abut on a public street other than an alley.
- h. The subdivision or resubdivision of a tract or lot shall not be permitted where said subdivision or resubdivision places an existing permanent structure in violation of the requirements of the zoning regulations or the minimum design standards of these regulations.
- i. Where possible, residential lots should not be designed to face on arterial streets. The number of lots facing on collector streets shall be kept to a minimum. The street pattern shall be designed so that the side lines of lots abut arterial and collector streets wherever land shapes and topography permit.

4. *Easements.*

- a. Where alleys are not provided, permanent easements of not less than ten (10) feet in width shall be provided on each side of all rear lot lines and three (3) feet in width on side lot lines, where necessary, for utility poles, wires, conduits, underground conductors, storm and sanitary sewers, gas, water and heat mains, and other public utilities.
 - (1) These easements shall provide for a continuous right-of-way.
 - (2) Where the utility company or agency has the need for a wider easement than required above for a specific location, this easement shall be shown on the plat.
 - (3) Permanent easements shall not be obstructed by structures, retaining walls or trees.
 - (4) A property owner may install fences and landscape the easement with grass and shrubs at his/her own risk.
 - (5) A twelve-foot temporary construction easement shall be provided on each side of all lot lines for initial construction of water, sewer and other utility lines.
- b. *Drainage easements.* All stormwater management components, including stormwater drainage setbacks, shall be placed in a drainage easement following the requirements of Section 405.070, Stormwater Management and Natural Area Protection Standards and the City of Warsaw's stormwater management design criteria.

C. *Streets And Alleys.*

1. *Relationship to adjoining street systems.*

- a. The arrangement of streets in new subdivisions shall make provisions for the continuation of the principal existing streets in adjoining additions (or their proper projection where adjoining property is not subdivided) insofar as they may be necessary for public requirements.
- b. The width of such streets in new subdivisions shall be not less than the minimum street widths established herein.
- c. Alleys, when required, and street arrangements must cause no hardship to owners of adjoining property when they plat their land and seek to provide for convenient access to it.
- d. Whenever there exists a dedicated or platted half street or alley adjacent to the tract to be subdivided, the other half of the street or alley shall be platted and dedicated as a public way.

2. *Street names.* Streets that are obviously in alignment with other already existing and named streets shall bear the names of the existing streets. Street names should not be similar to already platted street names.

3. *Arterial streets.* Arterial streets through subdivisions shall conform to the major street plan of the Comprehensive Plan as adopted by the Planning and Zoning Commission and the governing body.

4. *Culs-de-sac.* An adequate turnaround of not less than a one-hundred-foot diameter right-of-way shall be provided at the closed end of a dead-end local street longer than one (1) lot in length. Such local street segment shall not exceed five hundred (500) feet in length from the center line of an intersection of a cross street to the center of the cul-de-sac.

5. *Right-angle intersections.* Under normal conditions, streets shall be laid out to intersect, as nearly as possible, at right angles. Where topography or other conditions justify a variation from the right-angle intersection, the minimum angle shall be sixty degrees (60°).

6. *Half streets.* Half streets shall be prohibited, except where no lots front on such half street.

7. *Alleys.*

- a. Alleys may be required in commercial, industrial and residential areas.
- b. Dead-end alleys shall be avoided, wherever possible, but if unavoidable, such alleys shall be provided with adequate turnaround facilities at the dead end.
- c. Alleys should be avoided in residential areas except where alleys of adjoining subdivisions would be closed or shutoff by failing to provide alleys in the adjoining subdivision.

8. *Street alignment.* On streets with reverse curves, a reasonable tangent shall be provided between curves to permit a smooth flow of traffic.

9. *Street layout.* Proposed streets shall conform to topography as nearly as possible to reduce drainage problems and grades.
 10. *Minimum requirements.* The right-of-way grades and widths for streets and alleys dedicated and accepted shall conform to the standardized regulations of the Kansas City Metropolitan Chapter APWA, 1997 Editions, as adopted in Section 500.050.
 11. *Curbing.* Curbing shall be placed on all streets within a subdivision. Curbing design shall be presented by developer for approval by the City Engineer.
- D. *Required Improvements.* The subdivider shall install, or provide for the installation of, the following improvements:
1. *Streets.* The subdivider shall provide for the installation of paved streets. All street construction shall conform to the specifications of the Board of Aldermen, and compliance therewith shall be confirmed by the City Engineer prior to release of surety by the Board of Aldermen.
 2. *Walks.* Sidewalks shall be installed on both sides of all arterial and collector streets, and sidewalks shall be required on both sides of the street in a commercial district. All sidewalks shall be not less than five (5) feet in width of Portland cement concrete and shall comply with the specifications of the City Engineer. Sidewalks shall be located in the platted street right-of-way six (6) inches from the property line.
 3. *Storm drainage.* The subdivider shall follow the stormwater standards as listed and referenced in Section 405.070, Stormwater Management and Natural Area Protection Standards. A drainage permit is required to demonstrate compliance with stormwater management standards per Section 405.030 (O), Drainage permit.
 4. *Sanitary sewers and other utilities.*
 - a. The subdivider shall be responsible to provide for and pay the full cost for the proper installation of all utilities, including sanitary sewer and connection to approved treatment facilities, and water supply, natural gas, electricity and telephone service. Such utilities shall be installed according to the specifications of the controlling utility company or public agency.
 - b. All structures within seven hundred fifty (750) feet of a public sewer system must utilize such public system for sewage disposal. Structures further than seven hundred fifty (750) feet from an existing sewer line may use a private sewage disposal system provided that the owner of such structure can demonstrate to the satisfaction of the Board of Aldermen that such private sewage system will function properly given its design, the anticipated volume of sewage and the characteristics of the site.
 5. *Street signs.* The City shall install street signs at all intersections within a subdivision.
 6. *Permanent monuments.* Permanent monuments shall be placed at all lot and block corners, angle points, point of curve in streets, and at intermediate points as required prior to the final acceptance of the plat by the City. Said permanent monuments shall be three-fourths-inch iron bars or pipe, eighteen (18) inches long, and shall be set with top of monument flush

with existing ground line.

7. *Exceptions for existing improvements.* Where the proposed subdivision is a resubdivision or concerns an area presently having any or all required improvements as previously set out, and where such improvements meet the requirements of this Section and are in good condition as determined by the Board of Aldermen upon its consideration of the opinion of the City Engineer, no further provision need be made by the subdivider to duplicate such improvements. However, where such existing improvements do not meet the requirements of this Code as determined by the Board of Aldermen upon its consideration of the opinion of the City Engineer, the subdivider shall provide for the repair, correction or replacement of such improvements so that all final improvements will then meet the requirements of this Code as determined by the Board of Aldermen upon its consideration of the opinion of the City Engineer.

Section 500.050. City of Warsaw Standards and Procedures for Design and Construction.

- A. The following shall be adopted and published on the City's website to establish standards and procedures for the construction of all public improvements, including: streets, sewers, flood control, stormwater management, street lighting, landscaping and irrigation systems.
1. American Public Works Association (APWA) standard specifications and design criteria of the Kansas City Metropolitan Chapter APWA as adopted and amended by the City of Warsaw.
 2. Street signs and traffic markings manual; the Federal Highway Administration Uniform Traffic Control Devices as adopted by the City of Warsaw.

APPENDIX A: CODE OF ORDINANCES REVISION REDLINES

§ 405.020. Common Development Review Procedures.

A. Purpose And Organization.

1. *Procedural requirements.* This Section describes the procedures for review of all applications for land use and development activity in Warsaw.
 - a. Section 405.020(A)(2), Table of Procedures, includes a summary table listing the land use and development procedures in this Code.
 - b. Section 405.020, Common Development Review Procedures, Subsections (B) through (J), describe standard procedures that are applicable to all or most types of specific applications based on the following review steps:
 - (1) Preapplication meeting.
 - (2) Neighborhood meeting.
 - (3) Application submissions, content and fees.
 - (4) Complete application and staff review.
 - (5) Public notice requirements.
 - (6) Action by review and decisionmaking authorities.
 - (7) Appeals.
2. *Table of procedures.* Section 405.030, Specific Procedures and Approval Criteria, Subsections (A) through (N), include additional provisions unique to each type of application, such as public hearing requirements and approval criteria. The specific procedures work in conjunction with the common procedures. The following procedures are included:

Table 405.020-1 Specific Procedures	
Section	Application Type
405.030(B)	Comprehensive Plan amendment
405.030(C)	Rezoning (Zoning Map amendment)
405.030(D)	Unified Development Code amendment (text amendment)
405.030(E)	Conditional use permit
405.030(F)	Site plan
405.030(G)	Planned development
405.030(H)	Alternative compliance
405.030(I)	Major subdivision
405.030(J)	Minor subdivision
405.030(K)	Variance
405.030(L)	Appeal
405.030(M)	Minor modification
405.030(N)	Grading permit
405.030(O)	Drainage permit

3. *Administrative Manual for additional materials.* The Director may compile the requirements for application contents, forms, fees, submission materials, and review schedule in an Administrative Manual, which shall be made available to the public. The Director may amend and update the Administrative Manual from time-to-time.

B. *Preapplication Meeting.*

1. *Purpose.* The purpose of the preapplication meeting is to provide an opportunity for the applicant and the City to discuss the development concept prior to the application submission for a project in order to:
 - a. Determine the required application(s) and, if necessary, the timing of multiple application submittals (i.e., whether they may be processed concurrently or must be processed sequentially);
 - b. Provide the applicant with application materials and inform the applicant of submittal requirements;
 - c. Provide the applicant with an estimated time frame for the review process;
 - d. Discuss generally compliance with the Code's zoning, use, density, development, and design standards, and attempt to identify potentially significant issues regarding compliance;
 - e. Discuss the need for any neighborhood meetings and public notice requirements; and
 - f. Refer the applicant to other departments or agencies to discuss potential significant issues prior to application submittal.
2. *Applicability.*
 - a. *Preapplication meeting recommended.* A preapplication meeting is recommended prior to submitting most development applications. The preapplication meeting is designed to help the applicant understand the Warsaw development approval process.
 - b. *Record of preapplication conference.* The City is not responsible for making or keeping a summary of the topics discussed at the preapplication conference.

C. *Neighborhood Meeting.*

1. *Purpose and intent.* The purpose of the neighborhood meeting is for applicants to educate residents, occupants, and owners of nearby lands about the proposed development and application, receive comments, address concerns about the development proposal, and resolve conflicts and outstanding issues, where possible. The intent is to have applicants take primary responsibility for the neighborhood meetings.
2. *Applicability.*
 - a. A neighborhood meeting is required for the following applications: Comprehensive Plan amendments, rezonings, planned developments, and major subdivisions.
 - b. The Director may require a neighborhood meeting for any application type if the Director determines the application may have significant adverse neighborhood

- impacts, including but not limited to traffic, noise, visual, or environmental impacts, or where substantial objections have been raised by neighbors. To the maximum extent practicable, the Director shall determine the necessity for a neighborhood meeting at the preapplication meeting.
- c. If either the Planning and Zoning Commission or Board of Aldermen find that the circumstances of an application justify a neighborhood meeting where a neighborhood meeting was not previously scheduled, or that an additional meeting is necessary as the application process is underway, they may continue the application and instruct the applicant to schedule a meeting following the procedure established in this Section.
3. *Procedure.* If a neighborhood meeting is held by the applicant, it shall be held at the applicant's expense and comply with the following procedures:
- a. *Time and place.* The neighborhood meeting shall be held at a place that is convenient and generally accessible to neighbors that reside in proximity to the land subject to the application. It shall be scheduled after 5:00 P.M. on a weekday unless the Director specifies another time that is more convenient under the circumstances.
- b. *Notification.*
- (1) The applicant shall provide notification of the neighborhood meeting a minimum of ten (10) calendar days in advance of the meeting by mail to:
- (a) All owners and occupants within two hundred (200) feet of the land subject to the application;
- (b) Any neighborhood organization registered with the City of Warsaw within such two-hundred-foot radius; and
- (c) Board of Aldermen or Planning and Zoning Commission, when the neighborhood meeting is required by either of those review boards as described in Subsection (C)(2)(c), above.
- (2) The notification shall State the time and place of the meeting, contain a vicinity map and short description of the project, and State the purpose of the meeting.
- c. *Conduct of meetings.* At the neighborhood meeting, the applicant shall explain the development proposal and application, answer any questions, and respond to concerns neighbors have about the application and proposed ways to resolve conflicts.
- d. *Staff attendance.* The applicant shall be responsible for scheduling the meeting, coordinating the meeting, and for retaining an independent facilitator if needed. The meeting shall be held prior to submittal of the subject development application. Attendance at the neighborhood meeting by City planning staff is not required, unless deemed necessary by the Director.
- e. *Written summary of neighborhood meeting.* The applicant shall provide the Director a written summary or transcript of the neighborhood meeting within ten (10) business days of its conclusion or with the completed application, whichever is sooner. The written summary shall include a list of those in attendance, a summary of the issues

related to the development proposal discussed, comments by those in attendance about the development proposal, and any other information the applicant deems appropriate. The written summary of the neighborhood meeting shall be included with the application materials and be made available to the public for inspection.

- f. *Response to summary.* Any person in attendance at the neighborhood meeting, within five (5) calendar days after the meeting summary has been made public, may submit a written response stating his or her understanding of the issues related to the development proposal discussed, comments by those in attendance about the development proposal, and any other information deemed appropriate. All written responses to a summary of the neighborhood meeting shall be included with the application materials and be made available for public inspection.
4. *Failure to hold meeting.* If an applicant fails to hold a neighborhood meeting or does not demonstrate a reasonable effort was made in the notification of such meeting, such failure shall not stop or delay the review process or create a legal cause of action. However, such omission may be just cause for denial of the application.

D. *Application Submission, Content And Fees.*

1. *Form of application.*
 - a. Application submittal requirements, contents and fees shall be established in the individual application forms provided by the City.
 - b. In addition to the information required by the application form, the Director may require applicants for rezoning, conditional use permit, preliminary or final development plan, or preliminary plat to submit any technical studies that the Director deems necessary to enable the Planning and Zoning Commission, Board of Aldermen, or Board of Adjustment to fully evaluate the application. Examples of technical studies include, but are not limited to: traffic studies, engineering studies, geologic or hydrogeologic studies, flood studies, environmental impact assessments, noise studies, photometric (lighting) studies, or surface water management/drainage studies.
2. *Authority to file application.* The person having legal authority to take action according to the approval sought shall file an application for development review or approval under this Code. The person is presumed to be the record owner, purchaser under a sale or option to purchase, or the duly authorized agent of the record owner. Agents may only submit applications where the owner indicates consent in writing, a copy of which consent shall be submitted with the application.
3. *Where to file applications.* All applications required by this Section shall be submitted to the City offices unless otherwise specified.
4. *Contact person designation.*
 - a. The applicant shall designate one (1) person on the application as the primary contact person who will be responsible for all notification, including meeting dates, deadlines and requirements. The City will communicate with the contact person about the application and review procedures. It is the contact person's responsibility to inform

the owners or applicant of such information.

- b. The applicant shall notify the Director in writing if there is to be a change in the contact person. The Director will continue to communicate with the designated contact person until the notice of change has been received.
5. *Concurrent applications.* Where an applicant seeks approval of two (2) different requests for the same parcel simultaneously, the applicant shall submit all necessary documents, plans, maps and other required information in accordance with the provisions relating to both of the submitted applications and pay all appropriate fees for both applications.
6. *Application content and fees.*
- a. *Application contents: general.* The Director is authorized to establish submittal requirements for all land use development applications required by this Section and to update and amend such requirements as necessary to ensure effective and efficient City review. Applicants shall refer to the individual application forms for submittal requirements for each type of land use development application. The applicant shall provide any additional information, documents, or other material relevant to the application that the Director reasonably believes is necessary in order for the City to evaluate, analyze and understand the subject matter of the application.
 - b. *Submittal waivers pursuant to preapplication meetings.* At or following a preapplication meeting, the Director may waive certain submittal requirements set forth in the application form, except for fees, in order to reduce the burden on the applicant and to tailor the requirements to the information necessary to review a particular application. The Director may waive such requirements where the Director finds that the projected size, complexity, anticipated impacts, or other factors associated with the proposed development or subdivision clearly justify such waiver. This discretion may only be exercised if a preapplication meeting is held.
 - c. *Fees.* Nonrefundable fees are required at the time of the filing of any development application and are payable to the City in accordance with the fee schedules adopted by City ordinance. The City may require, in addition to the fees above, that the applicant pay all or a portion of the reasonable fees charged by private consultants retained by the City for the purposes of reviewing the application and advising City officials and agencies with respect thereto. The Director will notify the applicant prior to retaining any such consultant.
 - d. *Authorization and payment required.* The City shall adopt and amend from time to time a fee schedule setting forth an assessment of fees to defray the cost of processing land development applications under this Section. At the time of submittal, all applications shall include payment of the processing fee, as well as any review fees charged by agencies which the City has agreed to collect.
 - e. *No required fees for City-initiated applications.* No fee shall be required for land development applications initiated by the City.

E. *Complete Application And Staff Review.*

- 1. *Complete application required for processing.* All application submissions must be

complete prior to any processing by the City of Warsaw. A complete application includes all of the submittal information identified on the application form and any items or exhibits requested by the Director that are consistent with the standards and requirements of this Code. A complete application is also accompanied by the applicable fee. Incomplete applications shall be denied.

2. *Official submission.* An application shall be officially submitted when it is presented to the Director, either through hand submitted copy of the application, or electronically submitted copy of the application filed pursuant to instructions for electronic filing identified on the City of Warsaw webpage or portal at such time as the City makes this technology available, filed on a business day during normal office hours.
3. *Determination of completeness.* The City's acceptance of an application for completeness review does not bind the City to accept an incomplete application.
 - a. *Completeness determination.* Staff shall determine whether an application is complete no later than ten (10) calendar days after the official submission of the application.
 - (1) Staff shall make its determination of an incomplete application in writing. An e-mail to the applicant or comment in the City's permit on-line tracking system, if one is established, shall be considered a determination in writing.
 - (2) Notice occurs upon dispatch or publication, not upon receipt.
 - (3) The determination shall identify the documents, studies, or other information needed to make the application complete.
 - b. *Incomplete applications rejected.* An incomplete application shall not be processed by the City. The City may retain the application fee paid for any submitted application. Following notice of an incomplete application, the applicant shall have thirty (30) days to submit the information required to make the application complete or the application shall be deemed rejected. After thirty (30) days the City shall require that any additional or further requests by the applicant be accompanied by a new application and fee.
4. *Staff review.*
 - a. *Review by other departments and divisions.*
 - (1) In addition to internal review, staff may distribute the complete application to other City departments and divisions and to any other appropriate governmental or quasi-governmental agencies and bodies to solicit comments and ensure that the proposal complies with all applicable standards, requirements and review criteria. The applicant shall be responsible for submitting any additional information or revised plans required by staff or the referral agencies in a timely manner. As applicable, the review and decisionmaking bodies shall consider the services and facilities provided by the referral agencies as a factor in approval of the complete application. The criteria for evaluating sufficiency of the services that must be satisfied for the approval of the application shall be provided to the review and decisionmaking bodies as a part of any referral response.
 - (2) Referral agencies shall comment in writing after receiving a complete application.

The failure of any agency to respond shall be considered no comment on the application by that agency. As applicable, referring agencies will provide the review and decisionmaking bodies with a summary of any capacity evaluation study that assesses the availability of City-provided facilities or services to the proposed development. The summary will include an explanation of the agency's assumptions regarding available capacity.

- b. *Subsequent requests for information.* Staff and referral agencies shall use best efforts to identify all major issues and to request additional information, data, or reports from the applicant during the review period described above. This provision shall not be interpreted to preclude staff or referral agencies from requesting revisions or corrections to previously submitted materials if such materials are subsequently found to be inaccurate, incomplete, or if subsequent plan revisions do not comply with this Section.
- F. *Public Notice Requirements.* Applications for development approval shall comply with the Missouri Statutes and the provisions of this Section with regard to public notification.
- 1. *General notice requirements and timing of notice.*
 - a. Unless otherwise stated in this Code, notice for all public hearings shall be given pursuant to this Section. Notice may be written (mailed), published or posted as further described in this Section. Agenda notice shall be posted and published on the City's website a minimum of seventy-two (72) hours prior to a meeting.
 - b. Table 405.020-2 sets forth the specific notice requirements for applications requiring any type of notification.

Table 405.020-2 Notice Requirements					
Procedure	Section	Type of Notice Required			
		Publish	Written/ Mailed	Posted	Agenda
Comprehensive Plan amendment	405.030(B)	♦		♦	♦
Rezoning (Zoning Map amendment)	405.030(C)	♦	♦	♦	♦
Unified Development Code amendment (text amendment)	405.030(D)	♦			♦
Conditional use permit	405.030(E)	♦	♦		♦
Site plan	405.030(F)				
Planned development	405.030(G)	♦	♦	♦	♦
Alternative compliance	405.030(H)				
Major subdivision	405.030(I)			♦	♦
Minor subdivision	405.030(J)				
Variance	405.030(K)	♦	♦		♦
Appeal	405.030(L)		♦		♦
Minor modification	405.030(M)				
Grading permit	405.030(N)				
Drainage permit	405.030(O)				

2. *Content.* Notices, whether by publication or written, shall at a minimum:
 - a. Identify the address or location of the property subject to the application and the name, address and telephone number of the applicant or the applicant's agent;
 - b. Specify the date, time and place of the public hearing;
 - c. Describe the nature, scope and purpose of the application or proposal;
 - d. Notify the public where to view the application; and
 - e. Include a statement that the public may appear at the public hearing or be heard, if any, and submit evidence and written comments with respect to the application.
3. *Published notice.* When the provisions of this Code require that notice be published, the City shall be responsible for preparing the content of the notice and publishing the notice in a newspaper of general circulation that has been selected by the City. The content and form of the published notice shall be consistent with Section 405.020(F)(2), Content, above and the requirements of Missouri Statutes. Unless otherwise specified in the specific procedure section, published notice shall be provided before the 15th day before the date of the hearing.
4. *Written (mailed) notice.*

- a. When the provisions of this Code require that written or mailed notice be provided, the Director shall be responsible for preparing and mailing notice to specific property owners of their opportunity to be heard.
 - (1) Written notice shall be sent via regular mail notice at least fifteen (15) days prior to the date of the hearing.
 - (2) Written notice of the public hearing on the application shall be provided to the owner of the property for which the approval is sought and all property owners within one hundred eighty-five (185) feet of the subject property.
 - (3) In cases of an application where a protest petition may be submitted, the notice shall also contain a statement explaining that property owners within an area determined by lines drawn parallel to and one hundred eighty-five (185) feet from the boundaries of the district to be changed shall have the opportunity to submit a protest petition.
- b. Written notice to property owners shall be required only for the initial presentation of the proposed development at a public hearing. Additional mailed notice shall not be required where the application is not decided at the initial public hearing unless otherwise directed by the City.
- c. If the hearing is deferred or continued at the applicant's request, the applicant shall be responsible for paying any additional fees for the purposes of renotifying adjacent property owners.

5. *Posted notice.*

- a. For applications where posted notice is required, it shall be posted on the property and maintained for at least fifteen (15) days prior to the date of the public hearing.
- b. Any posted notice shall be a minimum of twenty-four (24) inches by thirty-six (36) inches and printed so that the following information is visible from a distance of one hundred (100) feet from a public street or right-of-way:
 - (1) Current zoning classification;
 - (2) Proposed zoning classification/use;
 - (3) Proposed type of development review (e.g., rezoning, subdivision, variances); and
 - (4) Date and time of the hearing.
- c. Projects abutting more than one (1) right-of-way may be required to post additional notices.

6. *Constructive notice.*

- a. *Minor defects.*
 - (1) Minor defects in any notice shall not impair the notice or invalidate proceedings pursuant to the notice if a bona fide attempt has been made to comply with

applicable notice requirements. Minor defects in notice shall be limited to errors in a legal description, typographical or grammatical errors, or errors of actual acreage that do not impede communication of the notice to affected parties.

- (2) Failure of a party to receive written notice shall not invalidate subsequent action.
- (3) In all cases, however, the requirements for the timing of the notice and for specifying the time, date and place of a hearing shall be strictly construed.
- (4) If questions arise at a review hearing regarding the adequacy of notice, the decisionmaking authority shall direct the Director to make a formal finding as to whether there was substantial compliance with the notice requirements of this Code, and such finding shall be made available to the decisionmaking authority prior to final action on the request.
- b. *Presumption of notice.* When the City records of publication, mailing and posting of notices as required by this Section, it shall be presumed that notice of a public hearing was given as required by this Section.

G. Action By Review And Decisionmaking Authorities.

1. Recommendations by review authority.

- a. The proper review authority (Director, Planning and Zoning Commission, Board of Aldermen, or Board of Adjustment) is established for each type of procedure in the specific review procedures. The review authority shall evaluate the application, referral comments, staff report, and public testimony, if any, and make a recommendation to the decisionmaking authority to approve, approve with conditions, continue for additional information or for further study, or deny the application.
- b. The review authority's actions shall be based on the evidence presented and compliance with the general review criteria identified in Section 405.020(G)(7), below, and the specific review criteria for each application as identified in Section 405.030(B) through (N).

2. Review and action by decisionmaking authority.

- a. The proper decisionmaking authority (Director, Planning and Zoning Commission, Board of Aldermen, or Board of Adjustment) is established for each type of procedure in the specific review procedures. A decisionmaking authority may take action on an application or appeal by approving, approving with conditions, continuing, or remanding for additional information or for further study, or denying the application or appeal.
- b. In taking action, the decisionmaking authority shall evaluate the application, referral comments, staff report, public testimony, if any, and the review authority's recommendation. All final decision actions shall be based on the application or appeal's compliance with the general review criteria identified in Section 405.020(G)(7), below, and the specific review criteria for each application as identified in Section 405.030(B) through (N).

3. *Withdrawal of application by applicant.* An applicant shall have the right to withdraw an application, without prejudice, at any time prior to action on the application at a public hearing or meeting. The applicant shall submit in writing the withdrawal request to the Director, and after such withdrawal, the City will not take further action on the application. The application shall be considered terminated, and no rights shall vest based on the application. To reinstate review, the applicant may resubmit the application; in all respects it shall be treated as a new application for purposes of review, scheduling, and payment of application fees. Withdrawal of an application from a public hearing or meeting agenda is at the review or decisionmaking authority's discretion.
4. *Continuation of public hearings.* The review or decisionmaking authority may continue the public hearing for its consideration of the application for a definite time not to exceed sixty (60) days, unless a longer period is agreed to by the applicant in writing or at a public hearing. The continuance may be granted by the review or decisionmaking authority on its own initiative or at the request of the applicant or affected property owners. A review or decisionmaking body may also deny a request for continuation.
5. *Written findings of fact.*
 - a. Unless otherwise specifically required by this Code or other applicable laws, written findings are not required for a final decision on any application. However, any decision may be expressly made subject to the subsequent adoption of written findings and, in that case, the decision shall not be final until the findings are adopted.
 - b. Where an appeal of any quasi-judicial decision has been filed with the Circuit Court of Benton County, in cases where written findings have not been adopted, written findings shall be adopted by the approving authority within forty-five (45) days of service of the appeal on the City and thereafter shall be certified by the Circuit Court as part of the administrative record. The forty-five-day time period for adoption and certification of findings may be extended with the permission of the court.
6. *Conditions of approval.*
 - a. The review or decisionmaking authority may recommend or impose such conditions upon the subject development as is necessary to carry out the general purpose and intent of this Code. Conditions and additional information requirements shall be in written form and attached to the approved plan, plat, or permit.
 - b. Conditions of approval shall be reasonably related to the anticipated impacts of the proposed use or development and shall be based upon the review criteria specified in each procedure's adopted standards.
 - c. The decisionmaking authority may place specific time limits on the satisfaction of any condition of approval. If a time limit is not specified in the approval or in the specific provisions of this Code, then a one-year time limit shall apply.
 - d. The decisionmaking authority may require financial guaranties, as identified in Section 405.030, from the applicant where it finds such guaranties are necessary to ensure compliance with conditions of approval and to protect the public health, safety, or welfare. The City shall release such guaranties when the Director has determined that

all conditions attached to the approval have been or will be satisfied.

- e. Conditions of approval shall be met or financial guaranties provided prior to the issuance of a certificate of occupancy or the appropriate final permit required by the City.

7. *Generally applicable review criteria.* Unless otherwise specified in this Section or the specific procedure, City review and decisionmaking bodies shall review all development applications submitted pursuant to this Section for compliance with the general review criteria stated below. The application may also be subject to additional review criteria specific to the type of application. In case of conflict between the general review criteria set forth in this Section and the specific review criteria, the specific review criteria shall apply. A development application must be in compliance with these review criteria prior to the issuance of a certificate of occupancy or the appropriate final permit required by the City unless otherwise provided for in the development approval.

- a. *Consistent with prior approvals.* Where a preliminary plan or plat was submitted and approved, a subsequent application for the same development shall be consistent with the terms and conditions of such prior preliminary plan or plat approval for the project including, without limitation, an approved phasing plan for development and installation of public improvements and amenities.
- b. *Consistent with Comprehensive Plan.* The proposal is consistent with the City of Warsaw Comprehensive Plan and any applicable subarea, neighborhood, sector or district plan. The decisionmaking authority shall weigh competing plan goals, policies and strategies and may approve an application that provides a public benefit even if the development is contrary to some of the goals, policies or strategies in the Warsaw Comprehensive Plan or other applicable plans.
- c. *Compliance with use and development standards.* The proposal complies with all applicable use standards, site development standards, design standards, subdivision standards, public improvement standards, floodplain management standards and all other applicable substantive standards stated in this Code or other applicable City code. Such compliance shall be applied at the level of detail required for the subject submittal and those standards which are not otherwise modified, varied or waived as allowed by this Code.
- d. *Compliance with other applicable regulations.* As applicable, prior to final approval of the proposed development pursuant to this Code, the proposed development complies with all other City regulations and with all applicable regulations, standards, requirements or plans of the Federal or State governments and other relevant jurisdictions, including but not limited to wetlands, water quality, erosion control and wastewater regulations.
- e. *Minimizes adverse environmental impacts.* The proposed development meets or exceeds all environmental protection standards in this Code, is designed to minimize negative impacts, and does not cause significant adverse impacts on the natural environment, including but not limited to water, air, noise, stormwater management, scenic resources, wildlife habitat, soils, native vegetation and the natural functioning of the environment.

- f. *Minimizes adverse impacts on surrounding property.* The proposed development meets or exceeds all neighborhood protection standards in this Code and all other site development standards intended at least in part to protect the existing character of neighboring properties and uses and does not cause significant adverse impacts on surrounding properties.
- g. *Minimizes adverse fiscal or economic impacts.* The proposed use will not result in significant adverse fiscal or economic impacts on the community or the City.
- h. *Compliance with utility, service and improvement standards.* As applicable, the proposed development complies with Federal, State, county and/or service district standards and design/construction specifications for roads, access, drainage, water, sewer, schools and emergency/fire protection.
- i. *Provides adequate road systems.* There is adequate road capacity available to serve the proposed use, and the proposed use is designed to ensure safe ingress and egress onto the site and safe road conditions around the site, including adequate access onto the site for fire, public safety and EMS services.
- j. *Provides adequate public services and facilities.* There will be capacity to provide adequate public services and facilities to accommodate uses permitted under the proposed development at the time such needs or demands arise while maintaining adequate levels of service to existing development. Public services and facilities include, but are not limited to, roads, domestic water, sewer, schools, public safety, fire protection, libraries and vehicle/pedestrian connections and access within the site and to adjacent properties.
- k. *Rational phasing plan.* As applicable, the proposed phasing plan for development of the project is rational in terms of available infrastructure capacity. In addition, each phase of the development shall contain all of the required streets, utilities, landscaping, open space and other improvements that are necessary and desirable for the residents and users of that phase and shall not be dependent upon subsequent phases for those improvements.

H. *Appeals.*

- 1. *Procedures.* Appeal procedures depend on the type of application and the appropriate review and decisionmaking authority. The applicant should consult with the specific provisions of this Code for requirements. This Section refers only to appeals to be heard by a City decisionmaking authority. Certain decisions that may be appealed by State law to a court are not covered by this Section.
 - a. *Board of Adjustment.* Most appeals of administrative determinations shall be made to the Board of Adjustment as provided in Section 405.030(L).
 - b. *Planning and Zoning Commission.* As identified in the specific provisions, some decisions of the Director or other departments may be appealed to the Planning and Zoning Commission by filing a written notice of appeal with the Director within ten (10) calendar days after the rendering of the decision. Upon filing of a written notice of appeal, the matter shall be placed on the agenda of the next regularly scheduled

meeting of the Planning and Zoning Commission no later than thirty (30) calendar days after the notice of appeal has been filed. The Planning and Zoning Commission may hear the appeal at its regular meeting or set a special hearing date at its discretion.

- c. *Board of Aldermen.* As identified in the specific provisions, some decisions of the Planning and Zoning Commission or Director may be appealed to the Board of Aldermen by filing a written notice of appeal with the Director within ten (10) calendar days after the rendering of the decision by the Planning and Zoning Commission or Director. Upon filing of a written notice of appeal, the matter shall be placed on the agenda of the next regularly scheduled meeting of the Board of Aldermen, no later than thirty (30) calendar days after the notice of appeal has been filed. The Board of Aldermen may hear the appeal at its regular meeting or set a special hearing date at its discretion.
- d. *Board of Aldermen decisions.* A decision by the Board of Aldermen may be appealed to a Missouri court of record as permitted by Missouri Statutes.

2. *Effect.*

- a. *Stay of proceedings.* The appeal of any decision or administrative action stays all proceedings in furtherance of the decision or administrative action.
- b. *Abandoned appeal.* If an appeal is filed but not pursued (either withdrawn or continued at the applicant's request) for a period of ninety (90) days, the appeal shall be considered abandoned and the decision or administrative action shall be considered final.
- c. *Imminent peril.* Where a stay of proceedings would cause imminent peril to life or property, the official from whom the appeal is taken or the Director may certify in writing to the decisionmakers hearing the appeal that the stay would cause such harm. The stay will be lifted pending hearing on the appeal. In such case, the action may be stayed only by a restraining order granted by a decisionmaking body or court of record if due cause is shown following notice to the official or Director.

I. *Inactive Applications.*

- 1. *Criteria.* The Director may notify the applicant in writing that an application will be considered inactive unless corrective action is taken within forty-five (45) days, if at any point in a development review process the following have occurred:
 - a. The applicant fails to attend any scheduled mandatory neighborhood meeting, meeting with the Director, meeting or hearing before the Planning and Zoning Commission, Board of Adjustment or Board of Aldermen; or
 - b. The applicant has not responded to a staff report, has not agreed to a date for a meeting or hearing before the Planning and Zoning Commission or Board of Adjustment, has not given proper public notice as required by this Chapter, or has not taken some other affirmative step within a reasonable time frame that is within the applicant's control and is necessary to advance the application for a final determination. A reasonable time frame shall be determined by the Director taking into account average response times from similar applicants on similar applications; or
 - c. The applicant fails to submit an application for the next required permit for the

approved application within two (2) years.

2. *Application terminated.* No further processing of such application shall occur until the deficiencies are corrected. If the applicant does not correct the deficiencies within the forty-five-day correction period, the application shall be considered automatically withdrawn and terminated. Any resubmittal of the application thereafter by the applicant will be treated as a new application for purposes of review, scheduling and payment of application fees.

J. *Actions And Limitations Following Development Approval Or Denial.*

1. *Termination of approval.* Approvals granted under this Code terminate if unused by the applicant after a reasonable period of time.
 - a. *Lapse.* Except as otherwise specified in the specific procedures sections of this Code, an approval granted under these regulations shall lapse and shall become void one (1) year following the date of final approval unless, prior to the expiration date, a building permit based upon such approval is issued and construction is commenced and diligently pursued toward completion.
 - b. *Extension.*
 - (1) An approval may be extended by up to one (1) year by the body that issued the original approval. Requests for extensions of more than one (1) year must show good cause for the need for extension.
 - (2) All requests for extensions shall be submitted to the Director in writing at least thirty (30) days prior to the expiration of approval. An extension request shall include payment of required fees and a written description of the reasons for the applicant's inability to comply with the specified deadlines, listing any changes in the character of the neighborhood, any changes to the Comprehensive Plan or this Code that have occurred since approval of the permit/ plan as these changes affect the permit/plan, and the anticipated time schedule for completing the review project and/or the specific project. Additional review of the permit/plan may result in additional conditions.
 - (3) If the extension is denied, the applicant may resubmit a new application, subject to the fees and regulations in effect at the time of resubmittal, for the same project.
2. *Limitations on successive applications.*
 - a. *Limitations on resubmittals.* No application on the same request shall be permitted within one (1) year of an application denial unless the Commission determines that extenuating circumstances exist. A notation of "denied without prejudice" on the minutes of the prior action on an application shall be evidence of the existence of extenuating circumstances and resubmission shall be permitted.
 - b. *Amendments.*
 - (1) All substantial changes, modifications, removal or release of the provisions of an approved plan or plat that do not qualify as minor modifications under Section 405.030(M) shall be considered amendments. Amendments shall include, but are

not be limited to, changes in use, access, layout, any condition of approval, any change resulting in significant increased off-site impacts, and similar changes as determined by the Director.

- (2) For purposes of review and scheduling, proposed amendments are treated as new applications subject to the applicable procedures and review criteria set forth in this Chapter unless otherwise noted in the specific review procedures.
 - (3) All approved amendments to a recorded plan or plat shall be recorded within ninety (90) days of the amendment's approval.
- c. *Modification of conditional use permits.* A request to modify, expand, or otherwise change an approved conditional use permit not in substantial conformance with the approved permit shall be processed according to the provisions of this Section as a new application.

§ 405.030. Specific Procedures.

- A. *Summary Of Specific Procedures.* Table 405.030-1 summarizes the land use and development procedures in this Section and identifies the bodies that have review and decisionmaking responsibilities for each procedure. Exceptions to these general rules apply; see Subsections (B) through (~~O~~~~N~~) for details on each procedure. Other boards, commissions, government agencies, and nongovernmental agencies may be asked by staff, the Planning and Zoning Commission, or the Board of Aldermen to review some applications, including, but not limited to, rezoning and plat approvals.

Table 405.030-1 Summary of Administrative Review Procedures					
Procedure	Section 405.030.	Planning Director/ <u>City Engineer</u>	Planning and Zoning Commission	Board of Aldermen	Board of Adjustment
		Key: R = Review A = Approve PH = Public hearing X = Appeal			
Comprehensive Plan amendment	B	R	A	Adopt by resolution	
Rezoning	C	R	PH/R	A	
Unified Development Code amendment (text amendment)	D	R	PH/R	A	
Conditional use permit	E	R	R	A	
Site plan	F				X
Administrative		R A			X
PZC review		R	A	X	
Planned development	G				
Preliminary plan		R	PH/A		
Final plan		R	R	A	
Alternative compliance	H	R	R/X	A	
Major subdivision	I	R	R	A	
Preliminary plat		R	PH/A		
Final plat		R	R	A	
Minor subdivision	J	A	X		
Variance	K	R			PH/A
Appeal	L	R			PH/A
Minor modification	M	A			X
Grading permit	N	A			X
<u>Drainage permit</u>	<u>O</u>	<u>A</u>			<u>X</u>

B. *Comprehensive Plan Amendments.*

1. *Purpose.* The purpose of this Subsection is to provide standards and requirements for amending the Warsaw Comprehensive Plan and other adopted City plans. The amendment process is established in order to provide flexibility in response to changing circumstances, to reflect changes in public policy, and to advance the general welfare of the City.

2. *Applicability.* An application for plan amendment may be initiated by the Board of Aldermen, Planning and Zoning Commission or Director, or requested by a property owner in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* A plan amendment applicant is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Notice for a plan amendment shall be by publication, pursuant to Section 405.020(F).
 - c. *Action by review and decisionmaking bodies.* A plan amendment application is reviewed and approved by the Planning and Zoning Commission and certified to the Board of Aldermen. The Board of Aldermen may adopt the plan amendment by resolution.
 - d. *Planning and Zoning Commission hearing.* The Planning and Zoning Commission shall hold a public hearing and determine whether to approve, approve with revisions, postpone, or deny the application for plan amendment based on consideration of the following criteria:
 - (1) The existing plan and/or any related element of the plan is in need of the proposed amendment;
 - (2) The proposed amendment is compatible with the surrounding area and the goals and policies of the plan;
 - (3) The proposed amendment will have no major impact on transportation services and facilities;
 - (4) The proposed amendment will have minimal effect on service provision, including adequacy or availability of facilities and services, and is compatible with existing and planned service provision;
 - (5) The proposed amendment is consistent with the City's ability to annex the property (if applicable);
 - (6) The proposed amendment is consistent with the logical expansion of services (if applicable);
 - (7) Strict adherence to the current plan would result in a situation neither intended nor in keeping with other key elements and policies of the plan; and

- (8) The proposed plan amendment will promote the public welfare and will be consistent with the goals and policies of the Warsaw Comprehensive Plan and the major elements of the plan.
- (9) The following review criteria from Section 405.020(G)(7), Generally applicable review criteria, shall also be applicable:
 - (a) Minimizes adverse environmental impacts;
 - (b) Minimizes adverse impacts on surrounding property; and
 - (c) Minimizes adverse fiscal or economic impacts.

C. *Rezoning (Zoning Map Amendment).*

1. *Purpose.* The boundaries of any zone district may be changed or the zone classification of any parcel of land may be changed pursuant to this Subsection. The purpose of rezoning is to make adjustments to the official Zoning Map that are necessary in light of changed conditions, changes in public policy, to conform to the Warsaw Comprehensive Plan or other applicable plans, or to advance the general welfare of the City. Rezonings should not be used as a way to legitimize nonconforming uses or structures or when a conditional use, variance or minor administrative modification could be used to achieve the same result.
2. *Applicability.* An application for a rezoning may be initiated by the Board of Aldermen, Planning and Zoning Commission or the Director, or requested by a property owner in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant for rezoning is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Rezoning applications shall be submitted with a site plan pursuant to Section 405.030(F).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Published, written, and posted notice shall be provided before the 15th day prior to the Planning and Zoning Commission public hearing according to Section 405.020(F).
4. *Action by review and decisionmaking bodies.* A rezoning application is reviewed by the Planning and Zoning Commission and decided upon by the Board of Aldermen.
 - a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public meeting and make a recommendation to approve, approve with revisions, postpone, or deny the application for rezoning.

b. *Board of Aldermen review.*

- (1) The Board of Aldermen shall hold a public hearing to review the application and shall approve, approve with conditions, postpone, or deny the proposed rezoning.
- (2) If there is a valid protest against the change of zoning that is signed by the owners of at least thirty percent (30%) of either: the area of land (exclusive of street and alleys) included in the proposed change, or within an area determined by lines drawn parallel to and one hundred eighty-five (185) feet distant from the boundaries of the district proposed to be changed, a Zoning Map amendment will not become effective except upon the affirmative vote of two-thirds (2/3) of all members of the Board of Aldermen.

c. *Review criteria.* The application shall comply with all of the criteria in Section 405.020(G)(7) as well as the following specific criteria:

- (1) Whether the proposed rezoning corrects an error or meets the challenge of some changing condition, trend, or fact since the time that the original text or map designations were established;
- (2) Whether the proposed rezoning is consistent with the Warsaw Comprehensive Plan or other applicable City plans or policy guides;
- (3) Whether the proposed rezoning is consistent with the purpose and intent of this Code;
- (4) Whether and the extent to which the proposed rezoning addresses a demonstrated community need;
- (5) Whether the proposed rezoning will protect the health, safety, morals, and general welfare of the public;
- (6) Whether the proposed rezoning will contribute to mitigation of adverse impacts on the natural environment, including air, water, noise, stormwater management, wildlife, and vegetation;
- (7) Whether the proposed rezoning will ensure efficient development within the City;
- (8) Whether the proposed rezoning will result in a logical and orderly development pattern; and
- (9) Whether the property has remained unused or underutilized under the current zoning designation.

5. *Adoption by ordinance.* Amendments to the Zoning Map shall be approved in the form of an ordinance and shall be indicated on the official Zoning Map.

6. *Successive applications.*

- a. If the Board of Aldermen denies an application for rezoning, an application for the same or more intensive zoning shall not be refiled for one (1) year from the advertised public hearing date of the Board of Aldermen. An application for a less intensive zoning

classification may be submitted at any time.

- b. The Planning and Zoning Commission may, upon petition of the applicant, permit a filing of the application after six (6) months from the date of the original Board of Aldermen hearing when it determines that significant physical, economic, or land use changes have taken place on or in the immediate vicinity of the subject parcel.

D. *Unified Development Code Amendment (UDC Text Amendment).*

1. *Purpose.* The purpose of this Subsection is to provide standards and requirements for amending the text of this Code. The purpose of text amendments is to make adjustments to the text of this Code that are necessary in light of changed conditions, changes in public policy, or that are necessary to advance the general welfare of the City. Text amendments are not intended to relieve particular hardships or to confer special privileges or rights on any person.
2. *Applicability.* An application for a UDC text amendment may be initiated by the Board of Aldermen, Planning and Zoning Commission, or Director, or requested by an owner of land in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* A nonCity applicant for a UDC text amendment is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Published notice shall be provided before the 15th day prior to the Board of Aldermen public hearing according to Section 405.020(F).
4. *Action by review and decisionmaking bodies.* A UDC text amendment application is reviewed by the Planning and Zoning Commission and decided upon by the Board of Aldermen.
 - a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public hearing and make a recommendation to approve, approve with revisions, postpone, or deny the application for text amendment.
 - b. *Board of Aldermen public hearing.* The Board of Aldermen shall hold a public hearing and shall approve, approve with edits, postpone, or deny the proposed UDC text amendment.
 - c. *Review criteria.* Recommendations and decisions on UDC text amendments shall be based on consideration of the following criteria:

- (1) Whether the proposed amendment corrects an error or meets the challenge of some changing condition, trend, or fact since the time that the original text designations were established;
 - (2) Whether the proposed amendment is consistent with the Warsaw Comprehensive Plan or other applicable City plans and policy guides;
 - (3) Whether the proposed amendment is consistent with the purpose and intent of this Code;
 - (4) Whether the proposed amendment will result in a logical and orderly development pattern; and
 - (5) Whether the proposed amendment is in the best interests of the City as a whole.
5. *Adoption by ordinance.* UDC text amendments shall be approved in the form of an ordinance.

E. *Conditional Use Permit.*

1. *Purpose and applicability.*
 - a. The City of Warsaw recognizes certain uses that may be appropriate in a specific zoning district, but which may have characteristics that, depending upon the location, design, and manner of operation, may have a greater impact than permitted uses on adjoining properties, businesses, or residences. Such uses require more comprehensive review, including the ability of the City to establish specific conditions for the project in order to mitigate any potential adverse impacts.
 - b. All uses listed as "conditional" in Table 405.050-1 shall be required to follow the procedures set forth below.
2. *Applicability.* An application for a conditional use permit may be initiated by the Board of Aldermen, Planning and Zoning Commission, or the Director, or requested by a property owner in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant for a conditional use permit is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Conditional use permit applications shall be submitted with a site plan pursuant to Section 405.030(F).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Posted notice shall be provided before the 15th day prior to the Planning and Zoning

Commission public hearing according to Section 405.020(F).

4. *Action by review and decisionmaking bodies.* A conditional use application is reviewed by the Planning and Zoning Commission and decided upon by the Board of Aldermen.
 - a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public hearing and make a recommendation to approve, approve with revisions, postpone, or deny the application for conditional use permit.
 - b. *Board of Aldermen review.* The Board of Aldermen shall hold a public meeting to review the application and shall approve, approve with conditions, postpone, or deny the conditional use permit.
 - c. *Review criteria.* The conditional use permit application shall comply with all of the criteria in Section 405.020(G)(7) as well as the following specific criteria:
 - (1) The proposed conditional use is consistent with the Warsaw Comprehensive Plan;
 - (2) The proposed conditional use complies with all applicable provisions of the UDC;
 - (3) The proposed conditional use will not have a negative impact on the value of surrounding property or the general neighborhood;
 - (4) The location and size of the conditional use, the nature and intensity of the operation involved or conducted in connection with it, and the location of the site with respect to streets giving access to it are such that the conditional use will not dominate the immediate neighborhood so as to prevent the development and use of neighborhood property in accordance with the applicable zoning district regulations. In determining whether the conditional use will dominate the immediate neighborhood, consideration shall be given to:
 - (a) The location, nature, and height of buildings, structures, walls, and fences on the site; and
 - (b) The nature and extent of the proposed landscaping and buffering on the site.
 - (5) Whether adequate utility, drainage, and other necessary facilities have or will be provided; and
 - (6) Whether adequate access roads or entrance and exit drives will be provided and shall be designed to prevent traffic hazards and minimize traffic congestion.
5. *Special conditions.* The Planning and Zoning Commission may stipulate conditions and limitations on the approval of the conditional use permit in the interest of the public welfare and to assure that the intent of this Code is carried out.
 - a. *Conditions.* The approval of a conditional use permit may place reasonable stipulations or conditions on the operation, location, arrangement, or construction of a conditional use in order to assure the protection of adjacent properties and uses in the vicinity, and to safeguard the welfare of the citizenry as a whole as it may be affected by the use.
 - b. *Time limits and expiration.*

- (1) All conditional use permits expire upon any transfer of ownership of the property on which the conditional use is located.
 - (2) The Planning and Zoning Commission may impose any time limits on the duration of a conditional use permit use that the Commission finds appropriate for the circumstances of the use.
6. *Extension of time or amendment.* When a conditional use permit is set to expire due to an imposed time limit and the property owner wishes to continue the use, or when an applicant wishes to amend an approved conditional use permit, a new application for conditional use permit following the procedures established in this Subsection shall be submitted.
7. *Termination for failure to pursue the conditional use or abandonment.*
- a. All conditional use permits approved prior to the passage of this Section and all conditional use permits approved after the effective date of this Code shall automatically terminate if the conditions set out below occur.
 - (1) Approval of the conditional use permit shall automatically terminate one (1) year after the date of approval of the conditional use permit unless a building permit or a certificate of occupancy has been granted for the use.
 - (2) Approval of the conditional use permit shall automatically terminate if the use is abandoned or is discontinued for a period of six (6) months or more.
 - b. Extensions of the approval period may be requested at any time prior to termination or within sixty (60) days after termination. When it is determined that no significant changes affecting the conditional use permit have occurred, the Planning and Zoning Commission may extend the approval. All approvals and extensions shall be valid for one (1) year from the date of action, unless the Planning and Zoning Commission approves a greater or lesser period.

F. *Site Plan.*

1. *Purpose.* The purpose of the site plan review process is to ensure compliance with the development and design standards and provisions of this Code. It is designed to encourage quality development reflective of the goals, policies, and objectives of the Comprehensive Plan. For land uses requiring a site plan review, such uses may be established in the City, and building or land use permits may be issued only after a site plan showing the proposed development has been approved in accordance with the procedures and requirements of this Subsection.
2. *Types of site plan review.*
 - a. *Administrative site plan review.* The following types of projects or amendments to existing site plan approvals may be approved by the Director using the administrative site plan approval process:
 - (1) A single use proposed in a structure that is less than twenty-five thousand (25,000) square feet in building size for that use;

- (2) A combination of uses proposed in a single structure, such as a shopping center, that is less than twenty-five thousand (25,000) square feet in building size;
 - (3) Multiple buildings proposed where the combined total of all structures will not exceed twenty-five thousand (25,000) square feet in building size;
 - (4) Detached one-family dwellings and related accessory uses and buildings in approved subdivisions;
 - (5) Nonstructural remodeling of facade treatment in downtown Warsaw;
 - (6) Relocation of development pads, buildings, or dwelling units for some practical reasons such as topography, road alignment or easements, provided that the modification does not significantly alter the site design in terms of parking layouts, vehicular circulation, landscape design, and other similar components of the development plans;
 - (7) An increase or decrease in a proposed setback, provided that Code requirements are still met;
 - (8) A change in building design relating to items such as materials, colors, window, and door locations and mechanical units, provided that the design remains essentially the same as that previously approved by the Planning and Zoning Commission or Board of Aldermen;
 - (9) A modification to a recreation area or open space design, but not elimination or a significant reduction; or
 - (10) A change in landscape design/plant types or minor parking lot/site revisions.
- b. *Planning and Zoning Commission site plan review.* The following types of projects shall require approval by the Planning and Zoning Commission:
- (1) Any development, with the exception of single-family detached dwellings, that exceeds twenty-five thousand (25,000) square feet in building size;
 - (2) Any administrative site plan referred to the Planning and Zoning Commission by the Director;
 - (3) Any change that may affect an adjoining residential neighborhood;
 - (4) Any request that in the opinion of the Director would significantly alter the design of the site and/or building(s); or
 - (5) A request to change or delete a condition of approval established by the Planning and Zoning Commission or Board of Aldermen.
3. *Procedures.*
- a. *Preapplication meeting.* A preapplication meeting is not required.
 - b. *Application and notice.*

(1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Site plan applications shall include the following information unless waived by the City Administrator as part of a pre-application meeting. Items listed as “required” or “if required” may not be waived:

(a) Site Information (Required):

- i. North arrow and scale
- ii. Vicinity map
- iii. Name, address, phone number, and email address for site plan preparer, applicant, and owner
- iv. Property address, legal description, and parcel number
- v. Property boundaries, dimensions, and lot size(s), individual lots must be dimensioned
- vi. Existing and proposed road alignment, right-of-way lines, pavement width, and grade
- vii. Name of streets abutting and within 50 feet of the property

(b) Zoning Information (Required):

- i. Total lot coverage by lot, including building coverage and paved surfaces
- ii. Existing and proposed building(s): location and footprint dimensions, height, setbacks from all property lines and the road ROW along with identification of setbacks required by the applicable zone district; location and depth of riparian setback where applicable
- iii. Any changes to zone district dimensional standards with a reference to the UDC provision that permits the proposed change
- iv. Residential development: lot size per dwelling unit, total number of dwelling units, floor area of each dwelling unit, where applicable
- v. Proposed uses by building, structure, or site location
- vi. Compliance with any use-specific standards that affect site design, such as accessory structure dimensional standards or ADU minimum lot sizes
- vii. Existing and proposed site access locations

(c) Project Specific Information:

- i. Existing and proposed utilities on the site, including utility size, easement size, and culverts.
- ii. Location and type of existing and proposed wireless communication facilities.

- iii. Topographic lines at two-foot intervals and grades, both existing and proposed; spot grades of completed improvements.
- iv. Indication of prominent natural features, such as existing trees, streams, and ridgelines, the 100-year floodplain line and elevation above floodplain.
- v. Expected water consumption per day in gallons; required flow rate in GPM and/or peak instantaneous demand; proposed fire service line size if required; proposed water meter size.
- vi. Required Industrial uses: expected wastewater discharge flow per day and waste stream characteristics (i.e., TSS or BOD)
- vii. Site-specific utility service information such as on-site manholes, clean-outs, and connection points.
- viii. Location, type, and area of on-site sewage disposal systems, if applicable.
- ix. If required for the project, traffic impact analysis report.
- x. Sidewalk location and design.
- xi. Total number of required parking spaces and a detailed floor plan to calculate usable floor space for parking space requirements. Shared parking agreements must be included if used for parking allotments and shall be irrevocable to protect everyone's current and future interests.
- xii. Dimensions and design of parking and loading areas, including specifications for paving and striping.
- xiii. Location and dimensions of fire lanes and identification of adequate hydrant access.
- xiv. Dimensions and design of stacking spaces for drive-thru facilities.
- xv. A landscape plan that meets the requirements of Section xx. Plant materials, sizes, and quantities may be shown in a table on the side of the landscape sheet.
- xvi. Identification of screening materials, design, dimensions, and estimated time of maturity.
- xvii. Parking lot landscaping layout, materials.
- xviii. Where required, the location and dimensions of public and/or private open space.
- ~~i~~xix. Provide information on outdoor lighting indicating height, fixture type, and locations.

(d) Stormwater Management Information: If the project meets the applicability

requirements of 405.030(O), Drainage Permit, then a drainage permit shall be included with the site plan. Any application fees associated with the drainage permit may be waived when submitted with the site plan.

- (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
- (3) Notice is not required.
- c. *Multiple applications.* Where a site plan is submitted in conjunction with another application that requires a preapplication meeting and notice of public hearing, the site plan shall be included in the preapplication meeting discussion and shall be made available for public review with all related applications.
4. *Action by review and decisionmaking bodies.*
 - a. *Action by Director.* The Director shall review each administrative site plan application and, as deemed necessary, distribute the application to other reviewers. Taking into account the results of those reviews, the Director shall take final action on the application and approve, approve with conditions, deny, or defer decision on the application based on the applicable approval criteria below. The Director's review and decision, including referral to other agencies and bodies, shall be completed within thirty (30) working days of receipt of a complete application. Failure to complete such review in thirty (30) working days shall not constitute deemed approval of the site plan.
 - b. *Referral to Planning and Zoning Commission.* The Director may refer to the Planning and Zoning Commission any application involving any requested deviation, modification, or exemption from the requirements of this Code, and/or any application that in the Director's opinion presents issues that require Planning and Zoning Commission attention. Such applications shall State all reasons for requesting any deviation, modification, or exemption from the rules, requirements, and regulations of this Code.
 - c. *Action by Planning and Zoning Commission.* Where a site plan has been referred by the Director to the Planning and Zoning Commission or is identified for Planning and Zoning Commission review by this Code, the Planning and Zoning Commission shall hold a hearing on the proposed application and approve, approve with conditions, or deny the proposed site plan, based on the applicable approval criteria below.
 - d. *Approval criteria.* The Director may approve a site plan upon a finding that the application meets all of the following criteria:
 - (1) The site plan is consistent with the Warsaw Comprehensive Plan;
 - (2) The site plan is consistent with any previously approved subdivision plat, planned development, or any other precedent plan or land use approval as applicable;
 - (3) The site plan complies with all applicable development and design standards set forth in this Code;
 - ~~(3)~~(4) Stormwater management is provided in compliance with Section 405.070,

Stormwater Management and Natural Area Protection Standards, if applicable:

- ~~(4)~~(5) Any significant adverse impacts reasonably anticipated to result from the structure or use will be mitigated or offset to the maximum extent practicable;
 - ~~(5)~~(6) The development proposed in the plan and its general location is or will be compatible with the character of surrounding land uses; and
 - ~~(6)~~(7) The development can be adequately served by City services, including but not limited to roads, water and wastewater.
5. *Appeal.* Appeal of a Director's determination on a site plan may be made to the Board of Adjustment. Appeal of a Planning and Zoning Commission determination on a site plan may be made to the Board of Aldermen by filing an appeal within fourteen (14) days of the date of the Planning and Zoning Commission's determination.
 6. *Modifications to site plans.* The holder of an approved site plan may request a modification to the document or the conditions of approval by submitting amended documents to the Director. The amended documents shall be filed and processed in accordance with the procedures for an initial site plan submittal.

G. *Planned Development.*

1. *Purpose.*
 - a. Planned development district (PD) rezoning is appropriate for the purpose of providing design flexibility not normally available through standard zoning procedures. Planned development district rezoning is available in any zoning district classification except mixed use. Planned development rezoning is intended to encourage high-quality smart-growth development that provides:
 - (1) More efficient infrastructure;
 - (2) Reduced traffic demands;
 - (3) More usable public or private open space and pedestrian connectivity;
 - (4) Needed housing choices and affordability;
 - (5) Assurance of new quality development; and
 - (6) Protection of the quality and integrity of existing neighborhoods.
 - b. Planned development approval is a two-step process: approval of a preliminary site plan followed by approval of a final site plan. Preliminary plan approval may take place at the same time as rezoning if both applications are submitted together. The approved final development plan shall serve as a basis for use (permitted within the district), density, and design criteria.
 - c. The sale, subdivision or replatting of the lot after zoning approval does not exempt the project from complying with applicable development standards, architectural quality,

sign concepts, or other conditions that were committed to at the time of rezoning.

2. *Procedures.*

a. *Preapplication meeting.* An applicant for PD rezoning is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.

b. *Application and notice.*

(1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). PD rezoning applications shall be submitted with a preliminary site plan that meets the requirements identified in ~~the application form~~ [Section 405.030\(F\)](#).

(2) All applicants are required to submit complete applications as identified in Section 405.020(E).

(3) Published, written and posted notice shall be provided before the 15th day prior to the Planning and Zoning Commission public hearing according to Section 405.020(F).

3. *Planned development standards.* The design of the PD shall be shown on the preliminary site plan and may include the following changes to the base zone district standards:

a. *Revisions to site standards.* All applications for planned developments may propose to revise [site zone district dimensional](#) standards, such as setbacks or lot sizes, provided that they are reduced to not less than twenty-five percent (25%) of the underlying district standard and provided that the revisions are appropriate to the location and design of the development. For example, a front yard setback could be reduced from twenty-five (25) feet to six and twenty-five hundredths (6.25) feet to better suit a specific development layout.

b. *Density bonus.* A density bonus of up to ten percent (10%) over what is allowed by the underlying zoning district may be granted to projects that offer higher development standards and enhanced site amenities such as:

(1) Providing additional landscaping and buffering beyond the minimum amounts required under the standards in Section 405.120;

(2) Providing quality enhancements to the overall commercial architectural design for the site;

(3) Dedication of trails and open space, including on-site trail connections or preservation of riparian areas beyond that required by Section 405.070 Stormwater Management and Natural Area Protection Standards; and

(4) Maximizing traffic efficiency and connectivity while minimizing congestion by providing shared access to existing businesses and proposed land uses.

4. *Action by review and decisionmaking bodies.* A PD rezoning application is reviewed by

the Planning and Zoning Commission and decided upon by the Board of Aldermen.

- a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public hearing and make a recommendation to approve, approve with revisions, postpone, or deny the application for PD rezoning.
- b. *Board of Aldermen review.*
 - (1) The Board of Aldermen shall hold a public meeting to review the application and shall approve, approve with conditions, postpone, or deny the proposed PD rezoning.
 - (2) If there is a valid protest against the change of zoning that is signed by the owners of at least thirty percent (30%) of either: the area of land (exclusive of street and alleys) included in the proposed change, or within an area determined by lines drawn parallel to and one hundred eighty-five (185) feet distant from the boundaries of the district proposed to be changed, a zoning amendment will not become effective except upon the affirmative vote of two-thirds (2/3) of all members of the Board of Aldermen.
- c. *Approval criteria.* The Planning and Zoning Commission and Board of Aldermen shall consider the following criteria when reviewing a ~~PD~~-preliminary site plan:
 - (1) The development meets the terms of the underlying zoning district ~~and~~ except as modified by the planned development district standards;
 - (2) The site is capable of providing the required amount of open space (green space) for the buildings, parking and drive areas;
 - (3) The site plan provides for safe and easy ingress, egress and internal traffic circulation;
 - ~~(3)~~(4) Stormwater management is provided in compliance with Section 405.070, Stormwater Management and Natural Area Protection Standards, if applicable;
 - ~~(4)~~(5) All easements and utilities shall be at or above the engineering standards/service capacities of the approving departments and agencies;
 - ~~(5)~~(6) The plan is consistent with good land use planning and site engineering design principles, particularly with respect to safety and aesthetics;
 - ~~(6)~~(7) The architectural designs are consistent with Warsaw's policies and regulations and compatible with surrounding features;
 - ~~(7)~~(8) The plan represents an overall development pattern that is consistent with the Comprehensive Plan, Master Street Plan, Master Land Use Plan and other adopted planning policies;
 - ~~(8)~~(9) Right-of-way and easements; ~~as determined by the City's Public Works Department, has~~ have been identified by the City for dedication; and
 - ~~(9)~~(10) Recreational and aesthetic amenities associated with the planned

developments shall be of an equal or higher quality than what is required of normal (nonplanned) developments.

5. *Preliminary site plan amendment.* Once property has been rezoned to a planned development district, changes to the preliminary site plan may be made only after approval of a revised preliminary site plan. Minor revisions or changes that are not considered significant may be approved by the Director without a public hearing. If these revisions or changes are not approved, they may be appealed to the Planning and Zoning Commission. Significant changes may only be approved after a rehearing by the Planning and Zoning Commission, which shall be subject to the same procedural requirements of the original application.
 - a. *Determining significant changes.* For the purposes of this Subsection, whether the changes to the preliminary site plan are significant shall be determined by the Director and shall mean any of the following as compared to the approved preliminary site plan:
 - (1) Any changes that exceed any terms specified by the Planning and Zoning Commission and/or Board of Aldermen;
 - (2) Increases in density or intensity of residential uses by more than five percent (5%);
 - (3) Increases in total floor area (entire plan) of all nonresidential buildings by more than five percent (5%) or five thousand (5,000) square feet, whichever is less;
 - (4) Increases of lot coverage by more than five percent (5%);
 - (5) Changes in architectural style that make the project less compatible with surrounding land uses;
 - (6) Changes in ownership patterns or stages of construction that lead to a different development concept;
 - (7) Changes in ownership patterns or stages of construction that impose substantially greater traffic volumes on streets and load capacities on other public facilities;
 - (8) Decreases in any peripheral setback of more than five percent (5%);
 - (9) Decreases in areas devoted to open space of more than five percent (5%) or the substantial relocation of such areas;
 - (10) Changes to the traffic circulation patterns that may affect traffic outside of the project boundaries;
 - (11) Modification or removal of conditions and stipulations to the preliminary site plan approval; or
 - (12) Modifications that change, amend, or violate the terms of the Comprehensive Plan.
 - b. *Appeal.* Appeal of the Director's determination of significance may be made to the Planning and Zoning Commission, whose decision shall be final. No further action shall be taken to process the application pending the Planning and Zoning Commission's determination.

6. *Final site plan approval.*

- a. *Submission.* Following approval of a preliminary ~~PD~~ site plan, an applicant may submit a final ~~PD~~-site plan for approval. The final plan shall include the information specified on the ~~PD~~-final site plan application form.
- b. *Submitting preliminary and final plans.* The developer may submit preliminary and final development plans simultaneously at the developer's own risk.
- c. *Grading and construction.* Permits for grading or construction shall be issued only after final plans have been approved by the Director or Planning and Zoning Commission.
- d. *Conditions for approval.* Final plans shall be approved only after the following conditions have been met:
 - (1) Final plans conform to the approved preliminary site plan and meet any special amendments or requirements imposed at the time of rezoning. Significant changes, as determined by the Director, between the preliminary plan and the final plan shall be sufficient reason to require the resubmission of a preliminary plan.
 - (2) If the project is being constructed in phases, each phase shall be functional and shall be adequately served by access drives, parking, [storm drainage system\(s\)](#), and utilities as a freestanding project and shall not have adverse effects on the neighborhood if the later phases of development are not carried out.
- e. *Director action.*
 - (1) A final ~~PD~~-site plan that contains no modifications or additions from the approved preliminary plan shall be approved by the Director if the Director determines that all of the submission requirements have been satisfied.
 - (2) A final development plan that contains modifications from the approved preliminary development plan but which changes are not significant as measured against the original approved preliminary development plan may be approved by the Director if the Director determines that all of the submission requirements have been satisfied.
 - (3) If the final site plan has significant changes from the preliminary plan, the Director shall not be consider the final plan and shall return it to the applicant.
 - (4) Appeal of the Director's determination may be made to the Planning and Zoning Commission, whose determination shall be final. No further action shall be taken to process the application pending the Planning and Zoning Commission's determination.

H. *Alternative Compliance.*

1. *Purpose and scope.* To encourage creative and unique design, the alternative compliance process allows development to occur in a manner that meets the intent of this Code yet through an alternative design that does not strictly adhere to the Code's standards. This is not a general waiver of regulations. Rather, this Subsection authorizes a site-specific plan

that is equal to or better than the strict application of the standard.

2. *Applicability.* The alternative compliance procedure is available only for the following sections of this Code:
 - a. ~~Section 405.070, Natural Resource Area Protection;~~
 - b. Section 405.080, Mobility and Connectivity;
 - c. Section 405.090, Commercial and Mixed Use Design and Development Standards;
 - d. Section 405.100, Multifamily and Townhouse Residential Design Standards; and
 - e. Section 405.120, Landscaping and Screening.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant proposing alternative compliance shall request and attend a preapplication conference prior to submitting application materials for the applicable permit(s) to discuss the project, the applicable Code standards, and the proposed method of alternative compliance. The application should include sufficient explanation and justification, in both written and graphic form, for the requested alternative compliance.
 - b. *Application and notice.* An alternative compliance request shall be submitted as part of another application, such as with the landscaping portion of a site plan application or lot layout in a subdivision application. The alternative compliance request shall be clearly labeled on the application.
4. *Decisionmaking responsibility.* Final approval of any alternative compliance proposed under this Subsection shall be the responsibility of the decisionmaking body responsible for deciding upon the application. Administratively approved projects proposing alternative compliance shall receive written approval of the alternative compliance from the Director.
5. *Review criteria.* Alternative compliance requests may be approved if the applicant demonstrates that the following criteria have been met by the proposed alternative:
 - a. Achieves the intent of the subject standard to the same or better degree than the subject standard;
 - b. Advances the goals and policies of the Comprehensive Plan and this Code to the same or better degree than the subject standard;
 - c. Results in benefits to the community that are equivalent to or exceed benefits associated with the subject standard; and
 - d. Imposes no greater impacts on adjacent properties than would occur through compliance with the specific requirements of this Code.
6. *Effect of approval.* Alternative compliance approval shall apply only to the specific site for which it is requested and shall not establish a precedent for approval of other requests.

I. *Major Subdivision.*

1. *Purpose.* The purpose of the subdivision review procedures is to ensure compliance with the standards and requirements in Section 405.140, Subdivision Design Standards, and encourage quality development consistent with the goals, policies and objectives in the Comprehensive Plan.
2. *Applicability.* The procedures of this Subsection and the standards in Section 405.140, Subdivision Design Standards, shall apply to all subdivisions or resubdivisions that result in the portioning, dividing, combining or altering of any lot, parcel or tract of land into two (2) or more lots, tracts, parcels or other divisions of land, except any subdivisions that are specifically excluded by State law or are defined as minor subdivisions in Section 405.030(J), below. However, unless the method of disposition is adopted for the purpose of evading the requirements of this Code, this procedure shall not apply to any division of land that:
 - a. Is created by any transfer by operation of law;
 - b. Creates cemetery lots;
 - c. Creates an interest or interests in oil, gas, minerals or water that are severed from the surface ownership of real property;
 - d. Is created by the acquisition of an interest in land in the name of a husband and wife or other persons in joint tenancy, or as tenants in common of such interest. For the purpose of this Subsection, any interest in common owned in joint tenancy shall be considered a single interest; or
 - e. Creates a leasehold interest with a term of less than twenty (20) years and involves no change in use or degree of use of the leasehold estate.
3. *Preliminary plat: procedures.*
 - a. *Generally.* All major subdivisions are processed in two stages: the preliminary plat, and the final plat. The final plat can only be filed with the City for review and processing after the preliminary plat has been approved or conditionally approved by the Board of Aldermen. Specific procedures for preliminary and final plats are outlined below.
 - b. *Preliminary plat preapplication meeting.* An applicant for a preliminary plat approval is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - c. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Preliminary plats shall include, at a minimum:
 - (a) Site information (Required):
 - i. Name of the proposed subdivision

- ii. North arrow and scale (not less than 1" = 100')
- iii. Vicinity map
- iv. Name, address, phone number, and email address for site plan preparer, applicant, and owner
- v. Property address and legal description for all of the land to be platted as well as any platted or unplatted adjacent properties in the same ownership
- vi. Property boundaries, dimensions, and lot size(s), individual lots must be dimensioned
- vii. Name of streets abutting and within 50 feet of the property

(b) Lot and Zoning Information (Required)

- i. Existing and proposed building(s): (a) location and footprint dimensions, (b) height, (c) building setbacks from all property lines and the road ROW along with setbacks required by the applicable zone district
- ii. Total lot coverage by lot, including building coverage, accessory structures with a roof, and paved surfaces
- iii. Residential development: lot size per dwelling unit, total number of dwelling units, floor area of each dwelling unit, where applicable
- iv. Any changes to zone district dimensional standards with a reference to the UDC provision that permits the proposed change
- v. Compliance with any use-specific standards that affect site design, such as accessory structure dimensional standards or ADU minimum lot sizes

(c) Project Specific Information:

- i. Topographic lines at two-foot intervals and grades, both existing and proposed; spot grades of completed improvements.
- ii. Existing environmental features such as significant trees, streams, and ridgelines; location and direction of drainage channels; identification of areas subject to 100-year flood; proposed riparian buffers
- iii. Location and design of any proposed low impact development features.
- iv. Existing and proposed road alignments, rights-of-way lines, pavement width, and appropriate grades
- v. Existing and proposed utilities on the site, including utility size, easement size, and culverts.
- vi. Location and type of existing and proposed wireless communication facilities.

vii. Expected water consumption per day in gallons; required flow rate in GPM and/or peak instantaneous demand; proposed fire service line size if required; proposed water meter size.

viii. Required: Industrial uses: expected wastewater discharge flow per day and waste stream characteristics (i.e., TSS or BOD)

ix. Site-specific utility service information such as on-site manholes, clean-outs, and connection points.

x. If required for the project, traffic impact analysis report.

xi. Location, type, and area of on-site sewage disposal systems, if applicable.

~~(a)~~(d) Stormwater Management Information: If the project meets the applicability requirements of 405.030(O), Drainage Permit, then a drainage permit shall be included with the preliminary plat application. Any application fees associated with the drainage permit will be waived when submitted with the preliminary plat.

(2) All applicants are required to submit complete applications as identified in Section 405.020(E).

(3) No notice is required for preliminary plat consideration.

4. *Preliminary plat: action by review and decisionmaking bodies.*

a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public meeting and approve, approve with revisions, postpone, or deny the application for preliminary plat. The Planning and Zoning Commission shall act on the application within sixty (60) days of the opening of the public meeting to consider the application or the application shall be deemed approved. The sixty-day time frame may be extended with the applicant's consent.

b. *Board of Aldermen action.* The Board of Aldermen shall review the Planning and Zoning Commission's action on the preliminary plat and take action by resolution. If the Planning and Zoning Commission has denied the preliminary plat, the Board may, by a vote of not less than three-fourths (3/4) of its full membership, overrule the disapproval.

c. *Review criteria.* Recommendations and decisions on preliminary plat approvals shall be based on consideration of the following criteria:

(1) ~~Evidence of substantial~~e Compliance with the purpose and intent provisions of this Code.

(2) Consistency with the Warsaw Comprehensive Plan.

(3) Physical suitability of the land for the proposed development or subdivision.

(4) Compatibility of the subdivision design and development intensity with surrounding land uses.

- (5) Whether there are adequate facilities available to serve the development as designed.
 - ~~(5)~~(6) Stormwater management is provided in compliance with Section 405.070, Stormwater Management and Natural Area Protection Standards, if applicable;
 - (7) Evidence of approval by the appropriate utilities, including water and sewer utilities.
 - ~~(6)~~(8) Right-of-way and easements, ~~as determined by the City's Public Works Department,~~ have been identified by the City for dedication.
 - ~~(7)~~(9) Compliance with all applicable use, density, development, and design standards set forth in this Code that have not otherwise been modified or waived pursuant to this Chapter and that would affect or influence the layout of lots, blocks and streets. Applicants shall avoid creating lots or patterns of lots in the subdivision that will make compliance with such development and design standards difficult or infeasible.
 - ~~(8)~~(10) That the general layout of lots, roads, driveways, sidewalks, utilities, drainage facilities, and other services within the proposed subdivision is designed in a way that minimizes the amount of land disturbance, maximizes the amount of open space in the development, preserves existing trees/vegetation and riparian areas, protects critical wildlife habitat, and otherwise accomplishes the purposes and intent of this Code.
 - ~~(9)~~(11) Evidence that provision has been made for a public sewage disposal system or, if other methods of sewage disposal are proposed, adequate evidence that such system shall comply with State and local laws and regulations.
 - ~~(10)~~(12) Evidence that all areas of the proposed subdivision that may involve soil or topographical conditions presenting hazards or requiring special precautions have been identified by the applicant and that the proposed use of these areas is compatible with such conditions.
 - ~~(11)~~(13) Provision has been made for assumption of responsibility for maintaining all roads, open spaces and other public and common facilities in the subdivision.
 - ~~(12)~~(14) As applicable, the proposed phasing for development of the subdivision is rational in terms of available infrastructure capacity and financing.
5. *Preliminary plat: effect of approval.* Approval of the preliminary plat does not constitute acceptance of the subdivision but is merely an authorization to proceed with preparation of the final plat for record. No grading of streets or construction shall be done in the subdivision before the final plat is approved by the Planning Commission and by the Board of Alderman except by special permission of the Board of Aldermen. Upon refusal of the Planning and Zoning Commission to approve a preliminary plat, the applicant may make such changes as are required for approval and resubmit the plat or he/she may appeal the decision to the Board of Aldermen who may reverse the decision of the Planning

Commission and approve said preliminary plat. The approval of the preliminary plat shall be effective for a period of two (2) years; such period may be extended by the Planning Commission upon the request of the property owner.

6. *Preliminary plat: termination.* An approved preliminary plat terminates after two (2) years without further notice unless a final plat has been filed. Final plats may be filed for less than the entire preliminary plat; however, any portions of the preliminary plat that are not subject to a final plat at the end of two (2) years shall be deemed terminated. A new preliminary plat application will be required for any areas of the development subject to a terminated preliminary plat.
7. *Engineering and construction plans.*
 - a. *Engineering and construction plans required.* Completed engineering and construction plans, prepared by an engineer licensed in the State of Missouri, shall be submitted to the ~~Director of Public Works~~City Engineer prior to or concurrently with the submission of a final plat application. The ~~Director of Public Works~~City Engineer shall determine whether the engineering and construction plans conform to the City's engineering specifications. If the engineering and construction plans do not comply, the ~~Director of Public Works~~City Engineer shall provide the applicant with information as necessary to modify the plans. Engineering and construction plans must be approved by the ~~Director of Public Works~~City Engineer prior to City approval of a final plat application.
 - b. *Submission requirements.*
 - (1) Upon the approval of the preliminary plat, the subdivider shall have prepared engineering drawings for proposed required improvements containing the data and information specified below:
 - (a) Plans, profiles, details, specifications and cost estimates for roadway and sidewalk construction, including plans and profiles for each street with a typical cross section of the roadway. The profiles of grade lines shall be shown to a scale of one (1) inch equals fifty (50) feet horizontal and one (1) inch equals five (5) feet vertical. This information shall be shown on standard plan and profile sheets unless otherwise required.
 - (b) Plans, profiles, details, specifications and cost estimates of proposed storm drainage improvements.
 - (c) Plans, profiles, details, specifications and cost estimates of proposed water distribution systems and proposed water supply facilities and hydrants, if any.
 - (d) Plans, profiles, details, specifications and cost estimates of sewage systems and of any required sewage treatment facilities.
 - (e) Grading plans for all lots and other sites in the subdivision.
 - (f) When unusual site conditions exist, the governing body may require such additional plans, specifications and drawings as may be necessary for an adequate review of the improvements to be installed.

(g) All plans shall be based on City or United States Geological Survey datum for vertical control.

- (2) Any or all of the required drawings may be waived or modified by the Board of Aldermen, after consideration of the City Engineer's opinion, upon a showing by the subdivider that such drawings are either unnecessary or create a substantial hardship.

8. *Final plat: procedures.*

- a. *Final plat preapplication meeting.* An applicant for a final plat approval is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
- b. *Application and notice.*
- (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).
- (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
- (3) No notice is required for final plat consideration.

9. *Final plat: action by review and decisionmaking bodies.*

- a. *Planning and Zoning Commission review.* The Planning and Zoning Commission shall hold a public meeting and recommend approval, approval with revisions or denial of the application for final plat. The Planning and Zoning Commission shall act on the application within sixty (60) days of the opening of the public meeting to consider the application or the application shall be deemed approved. The sixty-day time frame may be extended with the applicant's consent.
- b. *Board of Aldermen action.* The Board of Aldermen shall review the Planning and Zoning Commission's recommendation on the final plat and approve, approve with revisions or deny the final plat application. Approval of the final plat does not constitute acceptance of the public improvements identified on the plan; the Board of Aldermen shall take a separate action to review and determine whether to accept dedication of the public improvements.
- c. *Review criteria.* The Planning and Zoning Commission shall not recommend approval of and the Board of Aldermen shall not approve any final plat unless the final plat meets all of the following criteria:
- (1) The proposed final plat complies with the conditions of approval of the preliminary plat;
- (2) The layout and design of the proposed final plat is in substantial compliance with the approved preliminary plat, including but not limited to number of lots or parcels, street and block layout, and access; [and](#)

- (3) The improvement plans for any required on-site or off-site public or private improvements have been reviewed and approved by the City for construction; ~~and~~
- ~~(4) The applicant has constructed all the required public or private improvements that have been inspected and accepted by the City, or the applicant has filed with the City sufficient financial security for those improvements pursuant to Section 405.030(1)(11), below.~~
10. *Recordation.* The approved plat shall be recorded at the Benton County Recorder of Deeds office at the applicant's expense within one (1) year of approval. A final plat that is not recorded within one (1) year shall be considered void.
11. *Improvements.*
- a. *General.*
- (1) After the approval of the final plat and any required permits, the subdivider may do the grading and any drainage work that is required, all according to plans approved by the City Engineer.
- (2) Prior to the issuance of any building permits, all street paving, storm drainage, and utility lines must be installed in accordance with Section 405.140.
- ~~(3) In lieu of the actual construction of all physical improvements prior to the filing of the final plat, the Board of Aldermen may accept a bond, cash escrow, benefit district or other financial guaranty in an amount that will provide for the construction of the required improvements within a period of time to be specified by the Board of Aldermen. Such financial guaranty shall be properly executed prior to any grading or construction and may be released in segments upon written approval of the City.~~
- ~~(4) In order to encourage appropriate development, the City may, at the discretion of the Board of Aldermen, assist in the construction and financing of any of the required improvements. The extent and nature of such assistance, if any, shall be determined solely by the Board of Aldermen.~~
- ~~b. *Building permits.* Unless the required improvements have been installed or guaranteed by a bond for a lot or tract, no building permits shall be issued for that lot or tract.~~
- ~~e.b.~~ *Construction of improvements.* No improvements shall be constructed nor shall any work preliminary thereto be done until such time as a final plat and the engineering drawings accompanying it shall have been approved by the Board of Aldermen and there shall have been compliance with all of the requirements relating to an agreement, bond or deposit specified in these regulations.
- ~~d.c.~~ *Inspection.* All improvements constructed or erected shall be subject to inspection by the City or its designated representative responsible for setting and enforcing the applicable design and construction standards of the required improvement. The subdivider shall give at least twenty-four (24) hours' notice to such official prior to the performance of any work item which the City requests to inspect.

~~e.d.~~*Acceptance of improvements.* Upon the determination by the Board of Aldermen, after consideration of the opinion of the official, that there are no defects, deficiencies or deviations in the improvements, and that all improvements have been installed in conformance with the approved engineering drawings, and with the requirements of this Code, and all other applicable State and Federal statutes, ordinances and regulations, the Board of Aldermen and/or such appropriate utility shall thereupon by resolution or by letter, respectively, formally accept such improvements. The improvements shall become the property of the Board of Aldermen or appropriate utility company involved.

J. *Minor Subdivision And Administrative Lot Combination.*

1. *Purpose.* The purpose of the minor subdivision review procedure is to ensure compliance with the standards and requirements in Section 405.140, Subdivision Design and Improvements, and to encourage quality development consistent with the goals, policies and objectives in the Comprehensive Plan.
2. *Applicability.* The minor subdivision procedure is applicable for the following, provided that the proposed lots and resulting density are permitted under the existing zoning designation of the subject property:
 - a. A condominium, timesharing, or duplex subdivision as defined in this Code;
 - b. A subdivision that creates no more than three (3) lots where no new roads or public infrastructure is required, provided that parcels are eligible for minor subdivision only once, and further subdivision of the original or newly created parcels shall be processed as a major subdivision;
 - c. Consolidation of two (2) or more lots into a single lot in a previously recorded subdivision plan; and
 - d. Lot line adjustments where the resulting number of lots does not change.
3. *Minor subdivision plat: procedures.*
 - a. *Minor subdivision plat preapplication meeting.* An applicant for a minor subdivision plat approval is required to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). Minor subdivision applications shall be submitted with a plat pursuant to Section 405.030(I)(3)(c).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020.(E).
 - (3) No notice is required for minor subdivision plat consideration.
4. *Action by review and decisionmaker.*

a. *Authority.* The Director shall have decisionmaking authority for minor subdivisions.

b. *Review and approval criteria.*

(1) ~~Evidence of substantial e~~Compliance with the purpose and intent provisions of this Code;

(2) Consistency with the Warsaw Comprehensive Plan;

(3) Physical suitability of the land for the proposed development or subdivision;

(4) Compatibility with surrounding land uses;

(5) Whether there are adequate facilities available to serve development for the type and scope suggested by the proposed minor subdivision;

~~(5)~~(6) Stormwater management is provided in compliance with Section 405.070, Stormwater Management and Natural Area Protection Standards, if applicable;

~~(6)~~(7) Evidence of adequate sewage treatment for each lot; and

~~(7)~~(8) Evidence that the subdivision will not create any hazards due to geology, soil, topography, drainage, fire protection, or any other condition, and that all lots will contain safe, adequate building sites.

5. *Recordation.* The applicant shall cause the minor plat to be recorded within ninety (90) days from the date of approval and acceptance of the Director. In the event that the plat is not recorded, the approval of the Director shall be deemed to be void.

6. *Administrative lot combination.* The Director has the authority to approve lot combinations in which the configuration of the property is created by the assembly or combination of existing tracts of record where the Director finds that the proposed lot combination does not substantially increase demands on public infrastructure serving existing and proposed tracts, parcels or lots, and the following conditions are satisfied:

a. The proposed lot combination is in compliance with all other provisions of this Code;

b. The proposed lot combination will not create any tract, parcel, or lot that does not meet the minimum lot standards of the zoning district in which it is located;

c. The proposed lot combination shall not cause any construction over a public sanitary sewer line or sewer easement; and

d. The proposed lot combination is consistent with the surrounding area. In determining consistency, the size and dimensions of lots previously developed, the layout and design of existing subdivisions and the degree of deviation from previous development shall be considered.

K. *Variance.*

1. *Purpose and applicability.* In order to prevent or to lessen such practical difficulties and unnecessary physical hardships inconsistent with the objectives of the Code as would result

from strict or literal interpretation and enforcement, variances from certain regulations may be granted.

2. *Applicability.* An application for a variance may be requested by a property owner in the City.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant for a variance is encouraged to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). All variance applications shall be accompanied by a site plan.
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) Published, mailed, and posted notice shall be provided before the 15th day prior to the Board of Zoning Adjustment public hearing according to Section 405.020(F).
4. *Action by review and decisionmaking bodies.*
 - a. *Review by Board of Adjustment.* A variance application is reviewed by the Board of Adjustment at a public hearing.
 - b. *Review criteria.* In exercising the power to grant variances from the specific requirements of these regulations, the Board of Adjustment shall find each of the following factors to exist:
 - (1) The variance requested arises for such condition which is unique to the property in question and which is not ordinarily found in the same zone or district and is not created by an action or actions of the property owner or applicant.
 - (2) The granting of the permit for the variance will not adversely affect the rights of adjacent property owners represented in the application.
 - (3) The strict application of the provisions of the zoning regulations for which the variance is requested will constitute unnecessary hardship upon the property owners represented in the application.
 - (4) The variance desired will not adversely affect the public health, safety, morals, order, convenience, prosperity or general welfare.
 - (5) The granting of the variance desired will not be opposed to the general spirit and intent of the zoning regulations.
 - c. *Conditions of approval.*
 - (1) In granting a variance, the Board of Adjustment may impose such conditions,

safeguards and restrictions upon the premises benefitted by the variance as may be necessary to reduce or minimize any potentially injurious effect of such variance upon other property in the neighborhood and to carry out the general purpose and intent of this Code.

- (2) The Board of Adjustment may require a performance bond to guarantee the installation of improvements. The amount of the bond shall be based on a general estimate of cost for the improvements as determined by the Board of Adjustment and shall be enforceable by or payable to the City in the sum equal to the cost of constructing the required improvements.
 - (3) In lieu of performance bonds or other conditions, the Board of Adjustment may specify a time limit for the completion of such required improvements, and in the event the improvements are not completed within the specified time, the Board of Adjustment may, after reconsideration, declare the granting of the application null and void, or the variance may be made contingent on the performance of certain actions.
- d. *Action on approval.* If an application for variance is granted by the Board of Adjustment, it shall be signed by the Chairman of the Board and shall state on the application the conditions of the approval established by the Board. A copy of the approved variance application shall be forwarded to the Director who shall issue a permit setting out the terms of the variance

L. *Appeal.*

1. *Purpose.* The Board of Adjustment shall be authorized to hear and decide appeals where it is alleged there is an error in any order, requirement, decision or determination made by an administrative official of the City in the administration or enforcement of this Code.
2. *Applicability.* Appeals to the Board of Adjustment may be taken by any person aggrieved, by any neighborhood organization as defined in Section 32.105, RSMo., representing such person or by any officer, department, board or bureau of the municipality affected by any decision of the administrative officer.
3. *Procedures.*
 - a. *Preapplication meeting.* An applicant for an appeal is encouraged to attend a preapplication meeting according to Section 405.020(B). The schedule for preapplication meetings is available from the City.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D). The application shall specify all grounds for the appeal. All grounds not specified in the application shall be deemed waived by the applicant.
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).
 - (3) No notice is required for an appeal.

- c. *Timing of application.* An appeal shall be taken within thirty (30) days of the date of the decision. The officer whose decision is being appealed shall immediately, after being served with the notice of appeal, transmit all the papers constituting the record upon which the action appealed from was taken to the Secretary of the Board of Adjustment.
- 4. *Action by review and decisionmaking bodies.*
 - a. *Review by Board of Adjustment.*
 - (1) An appeal is reviewed by the Board of Adjustment at a regular meeting.
 - (2) The Board of Adjustment shall grant to the administrative official's decision a presumption of correctness, placing the burden of persuasion of error on the appellant. An appeal shall be sustained only if the Board of Adjustment finds that the administrative official erred.
 - (3) In exercising the appeal power, the Board of Adjustment shall have all the powers of the official from whom the appeal is taken, and the Board of Adjustment may reverse or affirm wholly or partly or may modify the decision being appealed.
 - (4) If the Board of Adjustment determines that it is necessary to obtain additional evidence in order to resolve the matter, it shall remand the appeal to the official from whom the appeal is taken, with directions to obtain such evidence and to reconsider the decision in light of such evidence.
 - b. *Time frame for action.* The Board of Adjustment shall take action on an appeal within a reasonable period of time after application submittal, but in no case more than sixty (60) days after receipt of a complete application.
 - c. *Vote to reverse administrative determination.* A concurring vote of four (4) members of the Board of Adjustment shall be necessary to reverse any order, requirement, decision or determination of an administrative official. Every decision of the Board of Adjustment shall be accompanied by a written finding of fact specifying the reason for the decision.
- 5. *Effect of appeal.* An appeal stays all proceedings in furtherance of the action appealed from, unless the officer from whom the appeal is taken certifies to the Board of Adjustment, after the notice of appeal has been filed, that by reason of facts stated in the certificate a stay would, in his/her opinion, cause immediate peril to life or property. In such case, proceedings shall not be stayed otherwise than by a restraining order which may be granted by the Board of Adjustment or by a court of record on application or notice to the officer from whom the appeal is taken and on due cause shown.

M. *Minor Modification.*

- 1. *Purpose.* Applications for minor modification may be submitted along with an application for development permit for the purpose of making a minor amendment to a development standard applicable to the proposed project. Minor modifications may also be made to approved site plans that conform to the requirements of this Section. A minor modification

allows a change of up to ten percent (10%) to the applicable standard.

2. *Standards subject to minor modification.*

- a. Up to four (4) minor modifications may be provided for a pending development application. No more than two (2) minor modifications may be permitted to correct measurement errors on an approved application through the submission of a site plan.
- b. The following standards may be subject to minor modifications of up to a maximum of ten percent (10%) from the general development and zoning district standards, provided that the applicable approval criteria below are met.

- (1) Minimum lot area requirements;

- (2) Setback requirements; and

- (3) Quantitative development standards (e.g., percentage of site landscaping, number of parking spaces, etc.).

- c. Stormwater standards cannot be modified.

- 3. *Measurement.* The modification is calculated by applying the ten-percent modification to the required development standard or measurement, rounded to the nearest whole number. For example, a required ten-foot side yard setback may be modified by ten percent (10%) or one (1) foot, allowing a nine- foot setback.
- 4. *Approval criteria.* Minor modifications may be approved only upon a finding that all of the following criteria have been met:
 - a. The requested adjustment is consistent with the stated purposes of this Code.
 - b. The adjustment will not substantially interfere with the convenient and enjoyable use of adjacent lands and will not pose a danger to the public health or safety.
 - c. Any adverse impacts resulting from the administrative adjustment will be mitigated to the maximum practical extent.
 - d. The administrative adjustment is of a technical nature (i.e., relief from a dimensional or design standard), and is either:
 - (1) Required to compensate for some unusual aspect of the site or the proposed development that is not shared by landowners in general;
 - (2) Supporting an objective or goal from the purpose and intent statements of the zoning district where located; or
 - (3) Proposed to protect sensitive natural resources or better integrate development with the surrounding environment.
- 5. *Review process.* Final approval of any proposed minor modification shall be the responsibility of the decisionmaker of the application to whom the minor modification request has been submitted. Minor modifications to approved site plans may be made by the

Director.

N. *Grading Permit.*

1. *Purpose.* The purpose of this Subsection is to provide procedures for grading permits. ~~The intent of the requirement for such Grading permits are required is~~ to review the extent of grading activity proposed to minimize and mitigate the disturbance of land, vegetation, ~~drainage patterns~~, and any existing or potential hazards ~~arising from site disturbance prior to City review.~~
2. *Applicability.*
 - a. It shall be unlawful for any person to conduct any activity resulting in any of the following total disturbed areas without first obtaining a grading permit pursuant to this Subsection. A grading permit shall be required for disturbed areas of:
 - (1) One (1) acre or more.
 - (2) Less than one (1) acre if such activities are part of a larger common plan of development, even though multiple, separate and distinct land development activities may take place at different times on different schedules.
 - b. The City may also require a grading permit regardless of the size of the total disturbed area in conjunction with approval of a final subdivision plat, conditional use permit, or site development plan, or if the construction activities are adjacent to a floodplain boundary or wetlands.
 - c. Grading not relating to a development application shall be prohibited, except as exempted below.
 - d. *Exemptions.* The following activities are exempt from this Subsection:
 - (1) Agricultural cropping and land management activities, not including construction activities.
 - (2) Maintenance and repair of any stormwater facility, utilities, irrigation ditch, watercourse, or related practice deemed necessary by the City Engineer.
 - (3) Emergency repairs to streets, utilities and other similar facilities deemed necessary by the City Engineer.
3. *Procedures.*
 - a. *Preapplication meeting.* A preapplication meeting is not required.
 - b. *Application and notice.*
 - (1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).
 - (2) All applicants are required to submit complete applications as identified in Section 405.020(E).

- (3) Notice is not required.
4. *Action by review and decisionmaking bodies.*
- a. ~~Director of Public Works~~City Engineer.
- (1) The grading plan and statement shall be reviewed for consistency with applicable regulations and standards and approval criteria below, and if approved by the ~~Director of Public Works~~City Engineer, a permit shall be issued within ten (10) working days of application.
 - (2) If determined inadequate by the ~~Director of Public Works~~City Engineer, the application shall be returned within ten (10) working days, and the owner may resubmit, without additional fees, an amended grading plan or statement.
- b. *Approval criteria.* The ~~Director of Public Works~~City Engineer shall approve a grading permit application if it meets the following criteria:
- (1) The grading proposed will have adequate on- and off-site sedimentation and erosion control measures;
 - (2) The grading proposed is the minimum amount necessary to carry out development plans;
 - (3) The grading proposed avoids any adverse impact on natural drainage patterns on- and off-site; and
 - (4) To the maximum extent practicable, the grading proposed avoids any disturbance of ridgelines, streams or existing trees and vegetation.

O. Drainage Permit.

1. *Purpose.* The purpose of this Subsection is to provide procedures for drainage permits. Drainage permits are required to minimize and mitigate the impact of stormwater runoff from development and increase in impervious area.
2. *Applicability.*
 - a. A drainage permit shall be required for all new development and redevelopment, including subdivision development and construction. It shall be unlawful for any person to alter the surface of the land to create additional impervious surfaces, including, but not limited to, pavement, buildings, and structures without first obtaining a drainage permit pursuant to this Subsection.
 - b. *Exemptions.* The following activities are exempt from this Subsection:
 - (1) *Existing Development.* Improvements that cause an increased area of impervious surface on the site less than 1,000 square feet.
 - (2) *New Development.* Construction of any one new single family or duplex dwelling unit provided the total impervious area of the site is less than 5,000 square feet.

3. Procedures.

a. Preapplication meeting. A preapplication meeting is not required.

b. Application and notice.

(1) All applicants shall submit an application in the correct form as authorized in Section 405.020(D).

~~(5)~~(2) All applicants are required to submit complete applications as identified in Section 405.020(E).

(3) All applicants shall submit the drainage permit at the beginning stages of the project so that the City may verify that proper stormwater management is incorporated into the design and that any drainage easements will be dedicated on the plat, if applicable. As design progresses, any major changes that result in a change in stormwater management shall require a resubmittal/update of the drainage permit.

(4) Notice is not required.

4. Action by review and decisionmaking bodies.

a. City Engineer.

(1) The drainage permit shall be reviewed for consistency with applicable regulations, standards and approval criteria below, and if approved by the City Engineer, a permit shall be issued within fifteen (15) working days of application.

(2) If determined inadequate by the City Engineer, the application shall be returned within fifteen (15) working days, and the owner or applicant may resubmit, without additional fees, an amended drainage permit.

b. Approval criteria. The City Engineer shall approve a drainage permit application if it meets the following criteria:

(1) The drainage system is designed in accordance with Section 405.070, Stormwater Management and Natural Area Protection Standards;

(2) The improvements proposed avoid any adverse impact on natural drainage patterns on- and off-site, including but not limited to flooding, erosion, loss of property, etc.;

(3) Drainage easements for all stormwater management components including stormwater drainage setbacks for natural overland drainage paths are dedicated to the City ;

(4) Maps and calculation tables per the City's stormwater management design criteria are included with the permit application; and

(5) Permit application meets design requirements for retention, detention, collection, and conveyance.

~~O.P.~~ Permits.

1. *Permit required.*
 - a. No building or other structure shall be erected, constructed, reconstructed, or moved, nor shall it be altered without first obtaining a building permit in accordance with the terms of this Subsection.
 - b. No open, vacant or unimproved land shall be used for any purpose other than agriculture without first obtaining a land use permit from the Director to be issued in accordance with the terms of this Subsection.
2. *Uses subject to permit.* The following uses shall be required to obtain a land use permit:
 - a. Salvage yards and junkyards.
 - b. Used car or auto storage lots.
 - c. Machinery, equipment or materials storage.
 - d. Mines, quarries or soil stripping.
 - e. Skeet shoots or target ranges.
 - f. Refuse dump or sanitary fill.
 - g. Railroad yards.
 - h. Picnic groves; fishing lakes.
 - i. Golf courses, baseball field and other privately owned recreation areas.
 - j. Nurseries.
3. *Application.* Applications for permits shall be filed with the Zoning Administrator upon forms prescribed, setting forth, among other things, the legal description of the lot, tract or parcel of land, together with a general description of the building or structure to be constructed, erected or altered thereon, including the approximate size and shape, location of the building or structure upon the lot, tract or parcel and the intended use.
4. *Conformity with Code.* No such permit shall be issued for any building, structure, construction or use of land unless the same is in conformity in every respect with all the provisions of this Code.
5. *Issuance.*
 - a. The Director shall be empowered to act within the provisions of this Chapter, upon all applications for building permits, and the same shall be approved or denied not later than the fifth business day succeeding as herein provided. The applicant may appeal to the Board of Adjustment.
 - b. For each building permit issued there shall be charged and collected from the applicant a fee as set out in Section 500.020.
 - c. For radio tower, trailer court, sign, or other use of land of a type not providing floor

- space to which the above schedule is applicable, there shall be charged a fee of ten cents (\$0.10) for each one hundred dollars (\$100.00) of the total cost of the work to be performed, provided that the minimum fee shall be two dollars (\$2.00).
- d. There shall be a separate permit for each building or structure to be constructed, erected or altered, except accessory buildings and appurtenances which may be included in the permit for the main building when construction is simultaneous.
6. *Revocation.* A permit may be revoked by the Director at any time prior to the completion of the building or structure for which the same was issued when it shall appear that there is departure from the plans, specifications or conditions as required under terms of the permit, that the same was procured by false representation or was issued by mistake, or that any of the provisions of this Code are being violated. Upon the failure, refusal or neglect of any owner, his/ her agent, contractor or duly authorized representative to secure such permit and pay the prescribed fee therefore as herein provided, the Building Inspector may issue a stop order; provided, however, that twenty-four (24) hours' written notice of such revocation or order to stop shall be served upon the owner, his/ her agent or contractor or upon any person employed upon the building or structure for which such permit was issued, and thereafter no such construction shall proceed.

§ 405.040. Zoning Districts.**A. General Provisions.**

1. *Purpose.* This Section establishes the zoning districts and contains basic information pertaining to the districts, including statements of purpose and dimensional standards.

- a. *Residential district purposes.* The residential zoning districts are intended to:

- (1) Provide appropriately located areas for residential development that are consistent with the Warsaw Comprehensive Plan and with the public health, safety and general welfare;
- (2) Ensure adequate light, air and privacy for all dwelling units;
- (3) Protect the scale and character of existing residential neighborhoods and the community;
- (4) Discourage any use that would generate traffic or create congestion on neighborhood streets other than the normal traffic that serves the residents of the district; and
- (5) Discourage any use that, because of its character or size, would create additional requirements and costs for public services that are in excess of such requirements and costs if the district were developed solely for the intended type of residential uses.

- b. *Mixed-use district purposes.* Mixed-use districts are intended to:

- (1) Promote higher-density residential development near and within downtown Warsaw;
- (2) Concentrate higher-intensity commercial and office employment growth efficiently in and around the downtown and other centers of community activity;
- (3) Encourage mixed-use redevelopment, conversion and reuse of aging and underutilized areas, and increase the efficient use of available commercial land in the City;
- (4) Create pedestrian-oriented environments that encourage pedestrian access, bicycle use, and more sustainable land use patterns; and
- (5) Ensure that the appearance and function of residential and nonresidential uses are of high and unique aesthetic character and quality and are integrated with one another and the character of the area in which they are located.

- c. *Commercial and industrial district purposes.* Commercial and industrial districts are intended to:

- (1) Help implement the Warsaw Comprehensive Plan by accommodating a full range of office, retail, commercial, service, and mixed uses needed by Warsaw's residents, businesses, visitors and workers;

- (2) Encourage site planning, land use planning, and architectural design that create an interesting, pedestrian-friendly environment where appropriate;
 - (3) Maintain and enhance the City's economic base and provide shopping, entertainment and employment opportunities close to where people live and work;
 - (4) Preserve, protect and promote employment-generating uses;
 - (5) Create suitable environments for various types of commercial and industrial uses and protect them from the adverse effects of incompatible uses;
 - (6) Allow flexibility to encourage redevelopment and positive improvements to existing businesses and residences;
 - (7) Minimize potential negative impacts of heavy-impact nonresidential development on adjacent residential areas; and
 - (8) Provide suitable locations for public and semipublic uses needed to complement nonresidential development.
2. *Zoning districts established.* For the purpose of regulating and restricting the use of land and the erection, construction, reconstruction, alteration, moving or use of buildings, structures or land, all lands within the corporate limits of Warsaw are hereby divided into the following districts:

Table 405.040-1 Zoning Districts		
Classification	District	Abbreviation
Base Districts		
Residential Districts	Single-Family Dwelling District	R-1
	Two-Family Dwelling District	R-2
	Multiple-Family Dwelling District	R-3
	Mobile Home District	R-4 (Retired)
Commercial Districts	Local Business District	C-1
	Central Business District	C-2
	Commercial District	C-3
Industrial Districts	Light Industrial District	M-1
	Heavy Industrial District	M-2
Open Space District	Open Space District	O
Overlay Districts		
	Waterfront Overlay District	WOD

3. *Zoning Map.*
- a. *Official Zoning Map.* The location and boundaries of the zoning districts are established as shown on a map prepared for that purpose designated as the "Zoning District Map." The Zoning Map, along with all of the notations, references and information shown on the Map are incorporated into and made part of this UDO.
 - (1) If changes are made in district boundaries or other items portrayed on the official Zoning District Map in accordance with the procedures established in this UDO, the changes shall be entered on the Map.

- (2) The official Map shall be located in the office of the City Clerk and shall be the final authority as to the current zoning status of land, buildings and other structures in the City.
- b. Zoning Map interpretation.
- (1) When definite distances in feet are not shown on the Zoning District Map, the district boundaries are intended to be along existing street, alley or platted lot lines or extensions of the same, and if the exact location of such lines is not clear, it shall be determined by the Zoning Administrator, due consideration being given to location as indicated by the scale of the Zoning District Map.
- (2) When streets or alleys on the ground differ from the streets or alleys as shown on the Zoning District Map, the Zoning Administrator may apply the district designations on the Map to the streets or alleys on the ground in such a manner as to conform to the intent and purpose of this Chapter.
4. *Annexation.* All territory hereafter annexed to the City of Warsaw shall be classified as Residential Holding - Open (RH-O) until other zoning, where appropriate, is approved in accordance with required procedures. No permit for use of property or erection of structures shall be issued unless such use and structure is permitted in the RH-O District.

B. *Single-Family Residential (R-1).*

1. *Purpose.* The purpose of this district is to provide for low-density, single-family detached residential development in a traditional neighborhood setting. This district implements the Low-Density Residential classification in the Warsaw Comprehensive Plan and should be located along a local road with most homes taking access from a secondary connector.
2. *Uses.* Uses permitted in the R-1 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the R-1 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-2 R-1 Single-Family Residential District Dimensions								
Lot Dimensions		Maximum Density (units/lot)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
6,000 ¹	80	1	50%	25	7	25	30	35

NOTES:

¹ Minimum lot size for all structures other than single-family detached units is 10,000 square feet.

4. *Building Area.* The minimum floor area for dwellings shall be a minimum of six hundred

fifty (650) square feet in "R-1" District. [Ord. No. 385, 10-7-2019]

C. *Two-Family Residential (R-2).*

1. *Purpose.* The purpose of this district is to provide for single-family and two-family medium-density residential development, either as a neighborhood of similar units or in a development with a mix of unit types. This district implements the Low-Density Residential classification of the Warsaw Comprehensive Plan and should be located along a local road with most homes taking access from a secondary connector.
2. *Uses.* Uses permitted in the R-2 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the R-2 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-3 Two-Family Residential District Dimensions									
Dwelling Type	Lot Dimensions		Maximum Density (units/lot)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Single-family	6,000	80	1	50%	25	7	25	30	35
Two-family	8,000 (4,000 per dwelling unit)								

NOTES:

¹ Minimum lot size for all structures other than single-family detached or two-family units is 10,000 square feet.

4. *Building Area.* The minimum floor area for dwellings shall be a minimum of six hundred fifty (650) square feet in "R-2" District. [Ord. No. 385, 10-7-2019]

D. *Multifamily Residential (R-3).*

1. *Purpose.* The purpose of this district is to provide sites for single-family, two-family, and multifamily dwellings in either traditional neighborhoods or in a setting with a mix of dwelling unit types. The R-3 District implements the Medium- and High-Density Residential classification of the Warsaw Comprehensive Plan and can be located as a transitional use between lower-density single-family development and mixed-use development or commercial development. R-3 development should be located along a local road with most homes taking access from a secondary connector.
2. *Uses.* Uses permitted in the R-3 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the R-3 District along

with any supplemental regulations provided in Section 405.040(M):

Table 405.040-4 R-3 Multifamily Residential District Dimensions									
Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Single-family detached	4,000	40	10	50%	15	7	15	10	35
Two-family	5,500 (2,250 per dwelling unit)	40	10	50%	15	7	15	10	45
Townhouse/ multifamily	n/a ¹	40	10	60%	15	7	15	10	45
Group living facilities	n/a ¹	40	n/a ¹	60%	15	7	15	10	35
Nonresidential	n/a ¹	40	n/a ¹	60%	10	7	10	10	35

NOTES:

¹ Must meet setback, height, and lot coverage requirements.

4. Building Area. The minimum floor area for dwellings shall be a minimum of six hundred fifty (650) square feet in "R-3" District. [Ord. No. 385, 10-7-2019]

E. *Mobile Home (R-4) Retired.* The R-4 District is retired as of the adoption date of this Code. Property can no longer be rezoned to R-4. The lawful use of property for parking mobile homes may be continued only to the extent that it exists as of the effective date of this Code. No mobile home may be replaced on any lot within the City after the effective date of this Code.

1. *Purpose.* The purpose of this district is to provide regulations for the continued use of moderate-density mobile home developments in a residential atmosphere as they existed as of the effective date of this Code. All land in this district shall be subject to the following requirements except as may be modified by Section 405.050(B)(1)(b).

2. *Uses.* Uses permitted in the R-4 District are identified in Table 405.050-1, Use Table.

3. *Dimensions.* The following dimensions shall apply to development in the R-4 District:

Table 405.040-5 Mobile Home District Dimensions				
	Lot Dimensions	M a x	M a x	Setbacks

Dwelling Type	Minimum Lot Size (acres or square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Mobile home	1 acre per park	150	n/a	n/a	25	7	n/a	30	35
Single-family dwelling	8,000	80	n/a	n/a	25	7	n/a	30	35
All other uses	10,000	80	n/a	n/a	25	7	n/a	30	35

4. *Use limitations.*

- a. All mobile homes shall be connected to public water and sewer systems.
- b. Mobile homes in mobile home parks shall be blocked at a maximum of ten-foot centers around the perimeter of each mobile home and each blocking shall provide two hundred fifty-six (256) square inches bearing upon the ground or pad. All mobile homes shall be secured to the ground by tie downs and ground anchors in conformance with the standards of the State of Missouri.
- c. All electrical, gas or propane hookups shall be in conformance with the requirement of the supplier.
- d. All spaces in mobile home parks shall front on either a public street or a private street constructed to the City's standards for public streets.
- e. Mobile homes in mobile home parks shall not be closer than twenty (20) feet to another mobile home or to the boundary of the mobile home park.
- f. Mobile homes on individual residential lots shall be limited to one (1) per lot and shall be required to meet the minimum lot requirements of this district. Accessory structures, as defined under Section 405.180, Definitions, shall be placed in conformance with the setback and dimensional requirements established for this district.
- g. Preowned manufactured homes are allowed as provided in under Chapter 405, Section 405.050.

5. *Nonconformity.* All existing occupied mobile homes located on an individual lot shall be permitted to remain in place so long as occupied, but provided that they may not be replaced unless made to conform to the requirements of this Chapter. Any such existing mobile home shall be removed when unoccupied for a period in excess of twelve (12) months.

F. *Local Business Mixed-Use (C-1).*

1. *Purpose.* The purpose of this district is to provide for a compatible mix of residential and small-scale neighborhood serving commercial and civic uses. This district is intended to be placed in a neighborhood setting providing a comfortable and safe pedestrian

environment and further enhancing the character of the neighborhood. The C-1 District implements the Commercial/ Office and Medium- and High-Density Residential classification of the Warsaw Comprehensive Plan and should be located along a primary collector street.

2. *Uses.* Uses permitted in the C-1 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the C-1 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-6 Local Business District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Maximum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Single-family detached	4,000	0	10	60%	15	0, 15 ²	15	0 ²	35
Two-family	5,500 (2,250 per dwelling unit)	0	10	60%	15	0, 15 ²	15	0 ²	35
Townhouse/ multifamily	¹	0	10	70%	15	0, 15 ²	15	0 ²	45
Nonresidential	¹	0	n/a	70%	15	0, 15 ²	15	0 ²	35

NOTES:

¹ Must meet setback, height and lot coverage requirements.

² Fifteen-foot setback is required where C-1 abuts a residential district or use.

4. *Use limitations.* Retail and service uses shall conduct all business within an enclosed structure; no drive-in, drive-through or curb service.
5. *Building Area.* The minimum floor area for dwellings shall be a minimum of six hundred fifty (650) square feet in "C-1" District. [Ord. No. 385, 10-7-2019]

G. *Central Business Mixed-Use (C-2).*

1. *Purpose.* The purpose of this district is to accommodate the broad range of retail shopping activities, office uses, lodging and vacation destinations, and some residential options that are normally found in downtown Warsaw. The Central Business District should be distinguished from other areas in the City and serve as the focal point for social, business, and cultural activities. This district contains the highest intensity of uses and should serve as the hub of pedestrian accessibility. The C-2 District implements the Medium- and High-Density Residential, Public/Institutional, and Commercial/Office classifications of the Warsaw Comprehensive Plan and should only be located in downtown Warsaw and along Main Street.

2. *Uses.* Uses permitted in the C-2 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.*
 - a. *Dimensional table.* The following dimensions shall apply to development in the C-2 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-7 Central Business District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density(units/acre)	Maximum Lot Coverage(percent)	Setbacks				Maximum Building Height(feet)
	Minimum Lot Size(square feet)	Minimum Lot Width(feet)			Maximum Front(feet)	Minimum Interior Side(feet)	Minimum Corner Side(feet)	Minimum Rear(feet)	
Single-family detached	3,000	0	7.5	60%	15	0 ²	15	0 ²	35
Two-family	4,000	0	15	60%	15	0 ²	15	0 ²	35
Townhouse/multifamily	0 ¹	0	15	80%	15	0 ²	15	0 ²	60
Nonresidential	0 ¹	0	n/a	80%	0	0 ²	15	0 ²	60

NOTES:

¹ Must meet setback, height and lot coverage requirements.

² Fifteen-foot setback is required where C-2 abuts a residential district or use.

b. *Additional standards.*

(1) *Commercial floor-to-ceiling heights and floor area of ground floor space.*

- (a) All commercial floor space must have a minimum floor-to- ceiling height of eleven (11) feet.
- (b) All commercial floor space provided on the ground floor must contain the following minimum floor area:
 - i. At least eight hundred (800) square feet or twenty-five percent (25%) of the buildable lot area, whichever is greater, on lots with street frontage of less than fifty (50) feet; or
 - ii. At least twenty percent (20%) of the buildable lot area on lots with fifty (50) feet or more of street frontage.

H. *Mixed-Use Commercial (C-3).*

1. *Purpose.* The C-3 District is established to group and link places used for working, shopping, educating and recreating with residential uses thereby creating a compact community form. This district allows commercial, office, civic, townhouse and apartment uses. The siting and architectural design and scale of structures in this district should be compatible with surrounding neighborhoods while contributing to the image and character

of the area. C-3 implements the Medium- and High-Density Residential and Commercial/Office land use classifications of the Warsaw Comprehensive Plan.

2. *Uses.* Uses permitted in the C-3 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the C-3 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-8 Mixed-Use Commercial District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Maximum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Single-family detached and two-family	3,000	40	12	60%	15	0 ²	15	0 ²	35
Townhouse/multifamily/lodging	n/a ¹	40	18	80%	15	0 ²	15	0 ²	60
Office/commercial/mixed use	n/a ¹	40 ³	n/a ¹	80%	0	0 ²	15	0 ²	60

NOTES:

¹ Must meet setback, height and lot coverage requirements.

² Fifteen-foot setback is required where C-3 abuts a residential district or use.

³ No minimum lot width for nonresidential structures in downtown Warsaw.

4. **Building Area.** The minimum floor area for dwellings shall be a minimum of six hundred fifty (650) square feet in "C-3" District. **[Ord. No. 385, 10-7-2019]**

I. *Waterfront Overlay District (WOD).*

1. *Purpose.* The purpose of the Waterfront Overlay District is to allow additional protections to all waterfront districts when an alteration to existing conditions occurs. The Waterfront Overlay District provisions have the following purposes:
 - a. To preserve natural, recreational, scenic and historic values along the City of Warsaw's waterfronts on the Osage River and Truman Lake.
 - b. To preserve, provide and enhance recreation areas and other green space.
 - c. To provide a continuous bicycle/pedestrian trail along the Osage River.
 - d. To strengthen the vitality of the district and capitalize on the asset of the waterfronts.
 - e. To promote the Osage River waterfront district as a unique destination place that brings

- pedestrian traffic to downtown Warsaw.
- f. To maximize the potential utility and enjoyment of the Osage River waterfront through active and passive uses, such as waterfront dining, public walkways and seating areas.
 - g. To protect the public health and safety.
 - h. To regulate uses and structures along the waterfront to avoid increased erosion and sedimentation.
 - i. To recognize areas of significant environmental sensitivity that should not be intensely developed.
 - j. To allow reasonable uses of land on the waterfront while directing more intensive and non-water-related development to the most appropriate areas of the community and region.
2. *Definitions.* The following definitions apply to this Chapter:

ENCROACH — To permanently occupy space within the physical boundaries of (such as a wetland).

FLOODPLAIN — Flood hazard areas as determined by the National Flood Insurance Agency.

~~**FLOOD-RELATED** — Any condition that can be attributed to the damage or occurrence of a flood or accidental inundation of water.~~

IMPERVIOUS SURFACE — Any nonporous area covered by a substance that does not, by its physical qualities, permit ~~inundation~~ infiltration by water, including but not limited to asphalt, slate, brick, aluminum, and concrete.

NONPOINT POLLUTION — Waterborne substances that can have adverse impacts on fish, wildlife, habitats and water quality, and that enter the groundwater via a diffuse number of points, possibly from the same source, as opposed to one particular point of entrance.

PHYSICAL OBSTACLE — Any structure or piece of structure that prevents visual or physical contact.

PIER — A structure that encroaches on a body of water specifically for the purpose of providing the general public with access for recreational fishing.

~~**SHORELINE** — The point at which land and water meet as determined by the mean high-water mark of a body of water.~~

STORMWATER MANAGEMENT — The intentional containment, ~~chemical~~ treatment or alteration of flow of water that results from precipitation specifically for the purpose of preventing flooding, erosion or nonpoint pollution.

~~**SUBSTANTIAL REHABILITATION** — The investment of more than fifty percent (50%) of a structure's assessed value in repairs or improvements other than physical~~

~~expansion.~~

WATER-DEPENDENT USES — Activities which require a location in, on, over or adjacent to the water because the activities require direct access to water and the use of water is an integral part of the activity. Examples of water-dependent uses include public and private marinas, yacht clubs, boat yards, commercial and recreational fishing facilities, tour boat and charter boat facilities, unloading and aggregate transshipping facilities, waterborne commerce, ferries, marine educational or laboratory facilities, and water-related public and quasi-public utilities.

~~**WATER-ENHANCED USES** — Activities that do not require a location on or adjacent to the water to function, but whose location on the waterfront could add to the public enjoyment and use of the water's edge, if properly designed and sited. Water-enhanced uses are generally of a recreational, cultural, commercial or retail nature.~~

3. *Applicability.* The Waterfront Overlay District is applicable where shown on the Warsaw Zoning Map.
4. *Uses.* Uses permitted in the WOD District are identified in Table 405.050-1, Use Table.
5. *Dimensions.* Development in the WOD shall conform to the dimensions applicable in the underlying base zone district along with any supplemental regulations provided in Section 405.040(M), except as follows:
 - a. *Visual and physical access.* Any new development that creates a visual or physical obstacle to public access on land that was previously accessible to the public shall mitigate the impact to ensure that physical and visual access is provided in another form.
 - b. *Waterfront setback.* Properties adjacent to the Osage River shall have a setback of fifty (50) feet from the top of the riverbank, as defined by the Director of Public Works on a site-by-site basis.
6. *District regulations.* Development otherwise permitted in the underlying zone shall meet the following standards:
 - a. *Docks and piers.* Access to the water from lots in any proposed subdivision shall be from a single common dock unless a single dock is considered infeasible, as determined by the Director.
 - b. *Water-dependent uses.* Any applicant proposing development adjacent to a water-dependent use will be required to notify the owner of the water-dependent use and submit his/her comments with the site plan, if comments were received. New development that permanently interferes with existing use of the water or will permanently inhibit the continued operation of a water-dependent use is prohibited.
 - c. *Residential uses.* All habitable space within dwelling units in the WOD shall be located above the one-hundred-year floodplain.
 - d. *Water-enhanced uses.* Any proposed water-enhanced use that will have a significant negative environmental or economic impact on existing water-dependent uses [more

- than one (1)] will not be permitted.
- e. *Marinas.* All site plans for new marinas or expansion of existing ones must include a stormwater management plan signed and prepared by a Missouri licensed engineer and must include a pump out.
 - f. *Hazards to water quality.* No structure or building shall be used in such a way as to significantly threaten or cause significant pollution to the water quality of the Osage River or Truman Lake.
 - g. *Relation to water.* Any use encroaching on water or that will exist permanently above water that is not water-dependent will not be permitted.
 - h. *Building orientation.* Primary structures shall be oriented toward the Osage River as well as the street by providing windows, doorways and other architectural features on the riverfront side of buildings.
 - i. *Natural features.* Destruction of natural features that serve to protect from floods or erosion shall not be permitted. [Development shall comply with requirements of Section 405.070 Stormwater Management and Natural Area Protection Standards.](#) ~~Such features could include the riverbank, vegetation, and natural slopes.~~ Any party responsible for the illegal or unauthorized destruction of such features will be compelled to replace them or compensate the City for their replacement.
 - j. *Pedestrian trails.* A continuous publicly accessible municipally owned pedestrian trailway, the Osage Trail, shall be created along the Osage River waterfront in the Waterfront Overlay District. An applicant for site plan approval of a lot or parcel which contains land along the Osage River waterfront shall be required to reserve a continuous right-of-way having a minimum width of twenty five (25) feet measured laterally from the riverbank of the Osage River in which a minimum twelve-foot-wide paved public trailway shall be developed on that lot or parcel in accordance with City's Master Trail Plan.
- J. *Light Industrial (M-1).*
- 1. *Purpose.* This district is intended to provide for a variety of businesses, including warehouses, research and development firms, repair shops, wholesale distributors, and light manufacturing. This district may include supporting office and commercial uses where appropriate. Uses permitted in this district are intended to serve community and regional needs. This district is intended to be located away from low- and medium-density residential development. The M-1 District implements the Industrial and Transportation/Utilities classifications of the Warsaw Comprehensive Plan and should take access from a primary connector or principal arterial street.
 - 2. *Uses.* Uses permitted in the M-1 District are identified in Table 405.050-1, Use Table.
 - 3. *Dimensions.* The following dimensions shall apply to development in the M-1 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-9
Light Industrial District Dimensions

Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks				Maximum Building Height (feet)
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)	
Office/ Commercial/ Industrial	8,000	80			25	7		20	45

K. *Heavy Industrial (M-2).*

1. *Purpose.* The purpose of this district is to accommodate a broad range of manufacturing, warehousing and wholesaling uses. This district is intended to be located away from residential development. The M-2 District implements the Industrial and Transportation/Utilities classifications of the Warsaw Comprehensive Plan and should take access from a primary connector or principal arterial street.
2. *Uses.* Uses permitted in the M-2 District are identified in Table 405.050-1, Use Table.
3. *Dimensions.* The following dimensions shall apply to development in the M-2 District along with any supplemental regulations provided in Section 405.040(M):

Table 405.040-10 Heavy Industrial District Dimensions									
Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks			Maximum Building Height (feet)	
	Minimum Lot Size (square feet)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)		Minimum Rear (feet)
Office/ Commercial/ Industrial	15,000	100			25	15		20	45

L. *Rural Holding And Open Space (RH-O).*

1. *Purpose.* The purpose of this district is to conserve and protect open land uses, accommodate low-intensity uses on land which is either unsuited for intensive development or which is not yet served by public utilities. Nonagricultural uses must be rezoned to a different classification prior to subdivision or development.
2. *Uses.* Uses permitted in the RH-O District are identified in Table 405.050-1, Use Table.

3. *Dimensions.* The following dimensions shall apply to development in the RH- O District along with any supplemental regulations provided in Section 405.040(M).

Table 405.040-11 Open Space District Dimensions								
Structure or Dwelling Type	Lot Dimensions		Maximum Density (units/acre)	Maximum Lot Coverage (percent)	Setbacks			
	Minimum Lot Size (acres)	Minimum Lot Width (feet)			Minimum Front (feet)	Minimum Interior Side (feet)	Minimum Corner Side (feet)	Minimum Rear (feet)
	5	100			25	15		20
								35

- M. *Supplementary Dimensional Standards.* No lot or yard shall be established in any district that does not meet the minimum requirements of that district along with any applicable regulations in this Section.

1. *Maximum height.* Chimneys, cooling towers, elevator headhouses, grain elevators, stage towers, scenery lofts, water towers, ornamental towers, church steeples, radio and television towers, antennas and mechanical equipment usually required to be placed above the roof level and not intended for human occupancy are not subject to any height limitations.
2. *Double-frontage lots.* Lots with two (2) nonadjoining frontages (double- frontage lots) shall maintain the required front yard setback along both frontages.
3. *Accessory buildings.*
 - a. No accessory building shall be erected in any required front or side yard, and no detached accessory building shall be erected closer than five (5) feet to any other building.
 - b. Accessory buildings may be located in the rear yard but shall not be closer than five (5) feet to the rear lot line and shall not be closer to the side lot line than the required side yard setback.
 - c. No accessory building shall cover more than thirty percent (30%) of the required rear yard.
4. *Number of structures and uses per lot.* Where a lot or tract is used for other than a single-family dwelling, more than one (1) principal use and structure may be located upon the lot or tract, provided that all structures and uses conform to all requirements for the district in which the lot or tract is located.
5. *Sight triangle.* On a corner lot in any district except C-2, development and landscaping shall not obstruct the sight triangle as defined by these regulations.

§ 405.060. Purpose and Applicability of Development Standards.

A. *Purpose And General Provisions.* The development and design standards set forth in Sections 405.070 through 405.120 shall apply to the physical layout and design of development in Warsaw. These provisions address the physical relationship between development and adjacent properties, public streets, neighborhoods, and the natural environment, in order to implement the Comprehensive Plan vision for a more attractive, efficient and livable community. The specific purposes of these Sections include:

1. To implement the Warsaw Comprehensive Plan through the creation and application of development standards that reflect Warsaw's community character and development choices;
2. To encourage the proper use of the land by promoting an appropriate balance between the built environment and the preservation and protection of open space and natural resources;
3. To protect public and private investment through preservation of open spaces, protection of natural resources, including existing trees, providing buffers between incompatible uses and along roadways, and encouraging the planting of new trees and vegetation as deemed appropriate;
4. To promote sound management of water quality and quantity through preservation of natural areas and their functions and by encouraging soil management and the use of native plant materials;
5. To provide appropriate standards to ensure a high-quality appearance for Warsaw and promote good design while also allowing flexibility, individuality, creativity and artistic expression;
6. To strengthen and protect the image, identity and unique character of Warsaw and thereby enhance its business economy;
7. To protect and enhance residential neighborhoods, downtown Warsaw, commercial districts and other areas by encouraging physical development that is of high quality and is compatible with the character, scale and function of its surrounding area;
8. To encourage developments that relate to adjoining public streets, open spaces and neighborhoods with building orientation and physical connections that contribute to the surrounding network of streets and walkways; and
9. To provide road connectivity for the movement of people, goods and services

B. *Applicability.* The development standards in Sections 405.070 through 405.120 are fully applicable to new development. In order to promote redevelopment and balance the costs of development in compliance with these standards on an existing structure against the benefits to the community of bringing all development into compliance with community development standards, the some exemptions from Section 405.110, Parking and Loading, and Section 405.120, Landscaping and Screening development standards are ~~applicable to~~ allowed for redevelopment on a sliding scale based on the amount of redevelopment taking place on the site as described in Table 405.060-1, Applicability of Development Standards, and more

completely described below:

Table 405.060-1 Applicability of Development Standards				
	Percent Compliance with Development Standards			
	Multifamily	Commercial	Mixed-Use	Industrial
New development				
New development	100%	100%	100%	100%
Existing development				
Less than 10%	n/a	n/a	n/a	n/a
Between 10% and 75%	Per Section 405.060(B)(2)(a)(2), below			
Greater than 75%	100%	100%	100%	100%
Interior changes	n/a	Off-street parking standards apply		
Nonconformities [Section 405.050(F)]				
Nonconforming lots	Applicable to structures only, not lots			
Nonconforming uses	Nonconforming uses are not permitted to be altered			
Nonconforming structures				
Enlargement, alteration, movement	100%	100%	100%	100%
Damage or destruction	100%	100%	100%	100%

NOTES:

¹ If there is more than one (1) structure on a lot, this is based on the individual structure subject to the addition, not the total for the lot.

1. *New development.* The development standards in this Section shall apply to all new development ~~except single family and two family residential~~ unless otherwise specified in the Section. Single and two-family residential development may be exempt from some requirements as identified in the specific development standards section.
2. *Existing development.*
 - a. *External additions.* The development standards in this Section shall apply to all external additions as follows:
 - (1) External additions that increase the assessed valuation of the existing structure by less than ten percent (10%), as determined by the ~~most recent county assessed value~~building permit valuation, shall not be required to comply with these development standards.
 - (2) External additions that increase the assessed valuation of the existing structure by more than ten percent (10%) but less than seventy-five percent (75%), as determined by the most recent ~~county assessed value~~building permit valuation, shall require a corresponding percent increase in compliance with these development standards or until the site reaches compliance, whichever is less. ~~For standards without specifically measurable requirements, the Director shall determine what compliance is required. The Director's determination may be appealed to the Planning and Zoning Commission.~~
 - (3) External additions that increase the ~~assessed valuation~~building permit valuation of

an existing structure by seventy-five percent (75%) or greater, as determined by the most recent county assessed value, shall be required to fully comply with these standards.

- b. *Interior changes.* Where development changes are wholly internal to the existing structure, only the off-street parking requirements included in Section 405.110 are applicable. This requirement may be waived by the Director where the applicant can show that there is sufficient existing parking to service the interior changes.
- c. *Ten-year time frame.* Any application by property owners to expand structures shall remain on record for ten (10) years from the date of said work completion. Any subsequent application to expand structures shall be cumulative to any requests made within the previous ten (10) years. The total shall be used by the City to determine the property owner's necessary level of compliance

§ 405.070. ~~Natural Resource Area Protection Development Standards~~ Stormwater Management and Natural Area Protection Standards.

A. Purpose. The City contains many natural amenities, including stream corridors, river corridors, natural drainage paths, significant viewsheds and hillsides, as well as tree cover, and open space, all of which contribute to stormwater management and flood risk reduction as well as the City's character, quality of life and property values. The regulations of this ~~S~~section are intended to implement the Warsaw Comprehensive Plan and stormwater management design criteria to ensure that the natural character of the City is reflected in patterns of development and redevelopment, and significant natural features are protected and incorporated into open space areas. This sectionArticle regulates stormwater management for development and redevelopment, as well as uses and activities within identified stormwater drainage setbacks, to preserve, conserve and manage disturbance to the City's stream corridors so that the following objectives may be achieved:

1. Encourage sustainable and healthy development practices that benefit the community as a whole;
2. Protect the public by preventing or regulating development in hazardous areas, such as locations within natural drainage paths or on steep slopes;
3. Mitigate impacts to the public from stream erosion and degradation;
4. Encourage only minimal grading that relates to the natural contour of the land;
5. Discourage mass grading activities, excessive tree and vegetation removal, and excessive terracing;
6. Improve surface and ground water quality by reducing the amount of nutrients, sediment, organic matter, pesticides, and other harmful substances that reach watercourses, wetlands, subsurface and surface water bodies;
7. Recognize that natural features contribute to the welfare and quality of life of the City's residents;
- ~~1.~~8. Provide natural, scenic, and recreation areas within and adjacent to stormwater drainage setbacks for community's benefit, thereby creating added value to lands adjacent to natural drainage paths and streams.

~~—Applicability. These development standards apply to all development and redevelopment types across the City that are located outside of the City's downtown waterfront.~~

B. Definitions.

1. Best Management Practice (stormwater BMP): post-construction, permanent stormwater BMPs designed to manage stormwater runoff. Stormwater BMPs may also be referred to as green stormwater infrastructure practices.
2. Drainage Easement: Authorization by the property owner to the public, a corporation or persons of the use of an area of land for stormwater management purposes.

3. Green Stormwater Infrastructure (GSI): Stormwater management solutions designed to capture, filter, absorb, and/or re-use stormwater by mimicking natural hydrologic processes. GSI may also be referred to as stormwater BMPs.
4. Natural Drainage Path: The overland route in which water concentrates based on the natural topography of the land. Natural drainage paths function as the surface drainage component of a stormwater drainage system and represent the path stormwater will take when the design capacity is exceeded in the enclosed system. Natural drainage paths typically begin with approximately 2 acres of drainage area. -
5. Stream Corridor: Perennial or intermittent waters included within a channel of land, and its adjacent riparian zones, which serve as a transitional zone between the aquatic and terrestrial upland ecosystems.
6. Storm Drainage System: All of the natural and man-made facilities and appurtenances such as natural drainage paths, streams, pipes, culverts, bridges, open channels, swales, street gutters, inlets, retention/detention facilities, and stormwater BMPs/GSI which serve to convey and control surface drainage.
7. Stormwater Drainage Setbacks: preservation of vegetated areas adjacent to a natural drainage path or stream defined by the drainage easement with limitations on allowable development and uses. Stormwater drainage setbacks consist of preservation, protection, and limited-use setback zones.
- ~~2.~~8. Top of Bank: The vertical point along a stream bank where an abrupt change in slope is evident, typically representative of the bank-full or channel-forming flow caused by approximately the two-year design storm as defined by the City's stormwater management design criteria.

C. Stormwater Management Requirements. All improvements shall be in compliance with the City's stormwater management design criteria, per Section 500.050, City of Warsaw Standards and Procedures for Design and Construction. Applicability standards are set forth in 405.030(O), Drainage Permit. The applicant shall follow the procedures established in Section 405.030 to demonstrate compliance with the design criteria.

D. Natural Drainage Path Preservation. Natural drainage paths and stream corridors shall be preserved and protected by limiting development activity in and adjacent to these areas to reduce risk of property damage from flooding and stream bank erosion, and to protect the safety of the public.

1. Natural drainage path requirements. Site design shall not change natural drainage paths. Natural drainage path preservation shall be as follows:
 - a. All final grading and drainage shall comply with applicable City and State requirements.
 - b. To the maximum extent feasible, development shall preserve the natural drainage paths unique to each site as a result of topography and vegetation. Natural drainage paths may be modified on site only if outside of the stormwater drainage setback. If natural drainage paths are modified, appropriate stabilization techniques shall be employed.

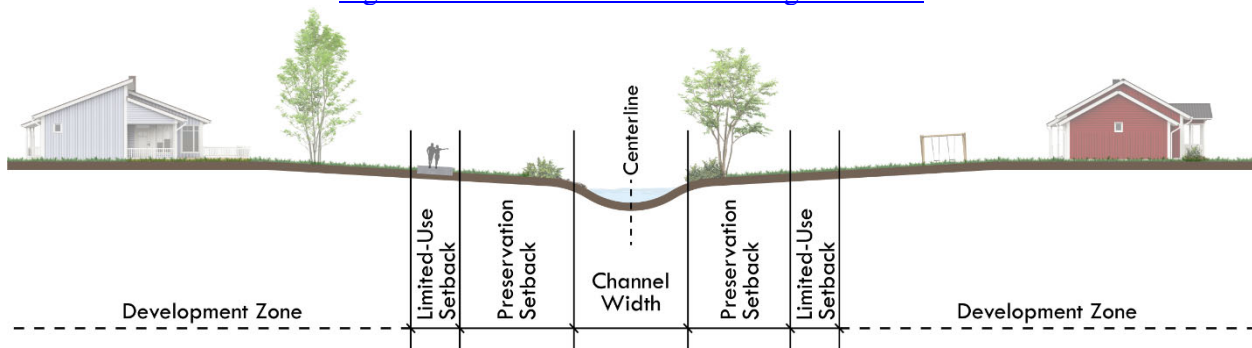
- c. Streets, roads, private access roads and other vehicular routes shall, to the maximum extent feasible, not be constructed within a natural drainage path.
 - d. Grading shall be designed such that drainage flows away from all structures and heavily used areas.
 - e. Development shall be designed to mitigate all negative or adverse drainage impacts, such as flooding and erosion, on adjacent and surrounding properties.
2. Stormwater drainage setbacks. Stormwater drainage setbacks shall apply to all land or development that includes natural drainage paths as defined herein and identified in the stormwater management design criteria. The requirements for stormwater drainage setbacks are as follows:
- a. The stormwater drainage setback shall start at the top of bank of the natural drainage path/stream, to be determined by topographic survey, and move outward on either side of the channel. If a top of bank cannot be determined, one of the following methods may be applied to define the top of bank for the stormwater drainage setback:
 - (1) Apply the assumed channel width to the centerline of the natural drainage path.
 - (2) Delineate the bank-full or channel-forming flow caused by approximately the two-year rainfall event as defined by the City's stormwater management design criteria.
 - b. Stormwater drainage setbacks shall be identified on the site plan and dedicated on the preliminary and final plats as a Drainage Easement.
 - c. Stormwater drainage setback widths have been determined based on tributary drainage area, as shown in Table 405.070-1 and Figure 405.070-1, with the following defined setback widths:
 - (1) Channel Width: centered on the natural drainage path is preserved for frequent stormwater flows with no other allowable uses.
 - (2) Preservation Setback Width: begins at the top of bank of the natural drainage path/stream and is preserved for vegetation or other forms of bank stabilization with no other allowable uses.
 - (3) Limited-Use Setback Width: extends a predetermined distance from the preservation setback or to the extents of the 100-year effective FEMA floodplain, whichever is greater. Allowable uses within the limited-use setback include community amenities such as trails and greenways, as well as utility rights-of-way.

Table 405.070-1 Stormwater Drainage Setbacks

<u>Drainage Area (acre)</u>	<u>Assumed Channel Width (feet)*</u>	<u>Preservation Setback Width (feet)</u>	<u>Limited-Use Setback Width (feet)</u>	<u>Total Setback Width (feet)</u>
<u>2 to < 10</u>	<u>5</u>	<u>5</u>	<u>-</u>	<u>15</u>

<u>Drainage Area (acre)</u>	<u>Assumed Channel Width (feet)*</u>	<u>Preservation Setback Width (feet)</u>	<u>Limited-Use Setback Width (feet)</u>	<u>Total Setback Width (feet)</u>
<u>10 to < 40</u>	<u>10</u>	<u>10</u>	<u>10</u>	<u>50</u>
<u>40 to < 160</u>	<u>30</u>	<u>30</u>	<u>10</u>	<u>110</u>
<u>160 to < 640</u>	<u>60</u>	<u>60</u>	<u>20</u>	<u>220</u>
<u>640+</u>	<u>80</u>	<u>80</u>	<u>20</u>	<u>280</u>
*Actual channel width may differ from Assumed Channel Width values presented in table based on results of topographic survey.				

Figure 405-070-1: Stormwater Drainage Setbacks



- d. No construction or disturbance of any type, including clearing, grubbing, stripping, fill, excavation, linear grading, paving, or building is allowed in the setback zones except as falls within the allowable setback uses or by permission of the City Engineer. Dense stands of native vegetation shall be maintained, particularly in the preservation setback.
 - e. Unless otherwise accepted by the Director, any maintenance of stormwater drainage setbacks shall be the responsibility of the property owner.
 - f. For work on existing facilities already located closer to the stream than allowed above, the improvements shall not increase the encroachment any closer to the stream. Bank stability concerns shall be addressed for improvements to existing land within the setback zones. Formal designation of a stormwater drainage setback is not required.
 - g. The application of stormwater drainage setbacks shall not operate to deprive any landowner of substantially all of the market value of their property or otherwise constitute an unconstitutional taking without compensation. If application of the stormwater drainage setbacks to a specific project would create a taking, then the Board of Aldermen may allow a variance, but only to the extent necessary to avoid a taking.
- E. Drainage easements. All storm drainage systems shall be placed in a drainage easement, per the City of Warsaw's stormwater management design criteria. If a subdivision is traversed by a natural drainage path or stream, a stormwater drainage setback shall be applied per Table 405.070-1. The entirety of the stormwater drainage setback shall be placed in a drainage

easement to provide adequate stormwater drainage and for access for maintenance thereof.

F. Maintenance agreements. Any person engaged in work of development or redevelopment that requires a drainage easement shall enter into a stormwater management operations and maintenance agreement assuring the continued operation and maintenance of such stormwater management components by the property owner and allowing access and inspection by the City. The agreement shall be recorded in the office of the Register of Deeds and be binding upon all owners of the property.

~~B.G.~~ Grading plan; revegetation of disturbed sites. A grading plan, submitted pursuant to Section 405.030(N), Grading Permit, and demonstrating compliance with the above standards is required. The grading plan shall include a section outlining the type and extent of revegetation proposed to accomplish the following requirements:

1. Following construction, the site shall be reclaimed and revegetated following the standards of Section 405.120, Landscaping and Screening.

2. In areas of subdivisions and large lot development sites, phased grading and revegetation is preferred.

~~2.3.~~ In areas of subdivisions and development sites where landscaping is not required or not anticipated by the Director, the developer shall reclaim all disturbed property and replant the entire area with native vegetation as described in Section 405.120, Landscaping and Screening.

~~3. Topsoil shall be stockpiled, and placed, and then redistributed on disturbed areas.~~

4. Temporary or permanent Irrigation shall be provided to the revegetated areas if the ~~Director~~ City Engineer determines that it is necessary ~~to ensure survival of native species planted.~~

~~C. Erosion Prevention And Sediment Control.~~

~~D.H. Standards.~~ Erosion control methods shall be used during construction to protect water quality, control drainage, and reduce soil erosion in accordance with Section 500.050 City of Warsaw Standards and Procedures for Design and Construction. ~~City of Warsaw Stormwater Management Criteria.~~ All new development shall be subject to the following erosion prevention and sediment control standards:

1. Compliance with applicable City and State requirements.

2. Water shall be ~~carried off the~~ managed within the site ~~to a predevelopment~~ pre-project conditions. ~~Stormwater management~~ Site disturbance shall cause no adverse impacts downstream. Erosion and sediment control shall contain erosion and sediment on the site, and protect stormwater management infrastructure within the site during construction. ~~without damage to downhill public or private properties and/or improvements.~~

~~3. Water shall be directed away from buildings and other heavily used areas.~~

~~4. Post-development discharge of stormwater shall not exceed predevelopment discharge for a one-hundred-year storm event.~~

~~5. Unnecessary ponding not intended for detention or retention purposes should be avoided.~~

~~6.3.~~ Erosion control measures as necessary to control erosion and sedimentation during site development and construction shall be implemented. ~~These may include, but are not limited to, the placement of hay bales and siltation fences.~~

~~— If a disturbed slope is not stabilized by October 15, then the developer/builder shall install an erosion blanket (or some equivalent) when finished working to protect the site during the winter season.~~

~~E.1.~~ Steep Slope And Ridgeline Development.

1. *Purpose.* The purpose of this ~~S~~ubsection is to:

- a. Prevent soil erosion and landslides;
- b. Protect the public by preventing or regulating development in hazardous areas, such as locations with steep slopes;
- c. Provide safe circulation of vehicular and pedestrian traffic to and within hillside areas and provide access for emergency vehicles necessary to serve the hillside areas;
- ~~d. Encourage only minimal grading that relates to the natural contour of the land;~~
- ~~e.d.~~ Preserve the most visually significant slope banks and ridgelines in their natural ~~S~~tate;
- ~~f.e.~~ Preserve visually significant rock outcroppings, native plant materials, natural hydrology and other areas of visual significance;
- ~~g.f.~~ Encourage variety in building types, grading techniques, lot sizes, site design, density, arrangement and spacing of buildings in developments;
- ~~h.g.~~ Encourage innovative architectural, landscaping, circulation and site design; and
- ~~i. Discourage mass grading of large pads and excessive terracing; and~~
- ~~j.h.~~ Require revegetation and reclamation of slopes disturbed during development.

2. *Applicability.* This Subsection shall apply to any development or subdivision proposal or lot created after December 21, 2015 ~~the effective date of this Code~~ for properties with an average slope of fifteen percent (15%) or greater, or where adverse conditions associated with slope stability, erosion or sedimentation are present as determined by the City Engineer. Determinations of adverse conditions shall be identified by the City Engineer within ten (10) days of applicable application filing.

3. *Development on slopes greater than twenty percent (20%).* Site areas with slopes greater than twenty percent (20%) shall remain undisturbed except as follows:

- a. This requirement shall not apply to small, isolated steep slope areas within a site that do not exceed two thousand five hundred (2,500) square feet.
- b. Slope areas of twenty percent (20%) or greater shall count toward minimum lot size, as defined in Section 405.040 Zoning Districts.

- c. Development is permitted outside of the slope area of twenty percent (20%) if the Director determines that there is sufficient buildable area on the lot for the proposed structure ~~or where buildable area can be made available through the minor modification process.~~
- 4. *Development on slopes between fifteen percent (15%) and twenty percent (20%).* The following standards apply to [site design for](#) all proposed development on sites where the average slope of the site measures between fifteen percent (15%) and twenty percent (20%).
 - ~~a. Site design.~~
 - ~~b.a.~~ Roads and building sites shall be oriented to minimize grading.
 - ~~e.b.~~ Buildings shall be oriented to consider views from the site as well as the aesthetic impact of views of the site from surrounding properties.
 - ~~d.c.~~ Hilltops, if graded, should be rounded to blend with natural slopes rather than leveled.
 - ~~e.d.~~ Slopes providing a transition from graded areas into natural areas should be varied in percent grade both up-slope and across the slope, in the undulating pattern of surrounding natural slopes so that the top or the toe (or both) of the cut or fill slope will vary from a straight line in plan view.
 - ~~f.e.~~ Parking areas should be constructed on multiple levels and follow natural contours as necessary to minimize cut and fill.
 - ~~g.f.~~ Roads should follow natural topography to the extent feasible, to minimize cut and fill. Necessary grading should be constant half-cut and half-fill along the length of the road (versus all cut or all fill at points) unless other arrangements would result in less severe alteration of natural terrain.
 - ~~h.g.~~ Typical design should utilize full split pads (separate level for a down-slope lower story), a split foundation (adapting a single story to a slope), setting the building into a cut in the hillside, or a combination of techniques. Repetitive padding or terracing of a series of lots (stair-stepping up a slope) is discouraged. Creation of a single large pad or terrace (especially creating a single pad or terrace of an entire lot) should be an exception to typical design to deal with circumstances that cannot be managed with other techniques.
 - ~~i. Natural drainage patterns. Site design shall not change natural drainage patterns, except as provided below:~~
 - ~~(1) All final grading and drainage shall comply with applicable City and State requirements.~~
 - ~~(2) To the maximum extent feasible, development shall preserve the natural surface drainage pattern unique to each site as a result of topography and vegetation. Grading shall be designed to ensure that drainage flows away from all structures, especially structures that are cut into hillsides. Natural drainage patterns may be modified on site only if the applicant shows that there will be no significant adverse~~

~~environmental impacts on site or on adjacent properties outside of the Stormwater Drainage Setback. If natural drainage patterns are modified, appropriate stabilization techniques shall be employed.~~

~~(3) Development shall be designed to mitigate all negative or adverse drainage impacts on adjacent and surrounding sites per City of Warsaw Stormwater Management Design Criteria.~~

~~(4) Standard erosion control methods shall be used during construction to protect water quality, control drainage and reduce soil erosion in accordance with City of Warsaw Stormwater Management Criteria. Sediment traps, small dams, barriers of straw bales or other methods acceptable to the City shall be located wherever there are grade changes to slow the velocity of runoff.~~

~~5. Winter erosion blanket. If a disturbed slope is not stabilized by October 15, then the developer/builder shall install an erosion blanket (or some equivalent) when finished working to protect the site during the winter season.~~

~~6. Utilities on slopes.~~

~~7. Utility easements are not permitted to follow slope lines and may only cross slope lines at ninety-degree angles.~~

~~8.~~ 5. Where buried utilities are placed on side slopes and where the utility corridor runs transverse to the side slope, the side slope portion of the corridor shall be no more than ten percent (10%).

~~9.~~ 6. Cutting, grading and filling.

- a. Cutting and grading to create benches or pads for buildings or structures shall be avoided to the maximum extent feasible.
- b. Except for driveways, cut and fill slopes shall be entirely contained within a lot (i.e., natural grade at the lot lines shall be maintained).
- c. Sharp angles shall be rounded off in a natural manner at the top and ends of cut and fill slopes [within approximately five (5) feet of the sharp angle] unless steep angles are a natural character of the site. Where this would damage tree root systems, the amount of rounding off may be reduced and shrubs used instead to hide the transition.

~~10.~~ 7. Raising or lowering of natural grade. The original, natural grade of a lot shall not be raised or lowered more than four (4) feet at any point for construction of any structure or improvement, except:

- a. The site's original grade may be raised or lowered a maximum of six (6) feet if retaining walls are used to reduce the steepness of man-made slopes, ~~provided that the retaining walls comply with the requirements set forth in this Subsection.~~
- b. As necessary to construct a driveway from the street to a garage or parking area, grade changes or retaining walls up to six (6) feet may be allowed.

- c. For the purposes of this Subsection, basements and buildings set into a slope are not considered to lower the natural grade within their footprint.

~~11.8.~~ 8. *Vehicular routes.* The following regulations apply to vehicular routes on slopes of fifteen percent (15%) or greater.

- a. No street, road, private access road, driveway or other vehicular route shall cross slopes greater than fifty percent (50%).
- b. Streets, roads, private access roads, driveways and other vehicular routes shall not be allowed to cross slopes between thirty percent (30%) and fifty percent (50%), except that a short run of no more than one hundred (100) feet or ten percent (10%) of the road/street's entire length, whichever is less, may be allowed by the Director upon finding that:
 - (1) Such street or road will not have significant adverse safety or environmental impacts, or appropriate engineering or other measures will be taken by the developer to substantially mitigate any such adverse impact; and
 - (2) No alternate location for access is feasible or available.
- c. Streets, roads, private access roads and other vehicular routes shall, to the maximum extent feasible, follow natural contour lines and not be within a natural drainage path.
- d. Grading for streets, roads, private access roads and other vehicular routes shall be limited to the paved portion of the right-of-way, plus up to an additional ten (10) feet on either side of the paved portion as needed, except that when developing access on slopes in excess of twenty-five percent (25%) only the paved right-of-way shall be graded, plus the minimum area required for any necessary curb, gutter or sidewalk improvements. The remainder of the access right-of-way shall be left undisturbed to the maximum extent feasible.

~~12.9.~~ 9. *Trails.* Public trails are permitted on all slopes provided proper safety buffers are in place. Private trails may be allowed if the Director determines that there will be no significant adverse impacts, ~~such as increased erosion potential~~.

~~Stormwater Management; Redevelopment Of Existing Lot Or Parcel. All redevelopment shall conform to the following stormwater management requirements:~~

~~Redevelopment of the site shall not have adverse effects on the City stormwater drainage system.~~

~~As determined by the City Engineer, redevelopment of the site shall not have detrimental effects on any applicable City approved drainage basin area.~~

~~Stormwater management shall be designed to meet current KC APWA standards as adopted by the City of Warsaw.~~

§ 405.080. Mobility and Connectivity Development Standards.

A. *Purpose.* These standards attempt to avoid the creation of large, isolated tracts without routes for through traffic or pedestrian and bicycle connections. The purpose of this Section is to:

1. Support the creation of a highly connected transportation system within Warsaw in order to provide choices for drivers, bicyclists and pedestrians;
2. Increase effectiveness of local service delivery; promote walking and bicycling; connect neighborhoods to each other and to local destinations, such as employment, schools, parks and shopping centers;
3. Reduce vehicle miles of travel and travel times, improve air quality, reduce emergency response times; and
4. Mitigate the traffic impacts of new development and free up arterial capacity to better serve regional long-distance travel needs.

B. *Traffic Impact Mitigation.*

1. *Applicability of traffic impact analysis requirement.* The transportation system for new development shall be capable of supporting the proposed development in addition to the existing and future uses in the area. Evaluation of system capacity shall be undertaken through a Traffic Impact Analysis (TIA) that should consider the following factors without limitation: street capacity and level of service; vehicle access and loading; on-street parking impacts; the availability of transit service and connections to transit; impacts on adjacent neighborhoods; and traffic safety, including pedestrian safety. A TIA shall be required with applications for development review and approval when:
 - a. Trip generation during any peak hour is expected to exceed two hundred fifty (250) trips per day or more than one hundred (100) trips during any one-hour peak period, based on traffic generation estimates of the Institute of Transportation Engineers' Trip Generation Manual (or any successor publication); or
 - b. A TIA is required by the Planning and Zoning Commission or Board of Aldermen as a condition of any land use application approved pursuant to the requirements of this Code; or
 - c. The Director, in his or her sole discretion, requires a TIA for:
 - (1) Any project that proposes access to a street with Level of Service D or below;
 - (2) Any application for a rezoning or specific plan review;
 - (3) Any case where the previous TIA for the property is more than two (2) years old;
 - (4) Any case where increased land use intensity will result in increased traffic generation; or
 - (5) Any case in which the Director determines that a TIA should be required because of other traffic concerns that may be affected by the proposed development.

2. *Traffic impact analysis and development review process.*

- a. A scoping meeting between the developer and the Director shall be required prior to the start of the TIA in order to determine the parameters of the study. This may be conducted as part of a preapplication meeting. The Director shall define the vicinity of the TIA study in as limited a geographic area as is feasible to make adequate traffic determinations for the project. Where a larger boundary is necessary to make adequate traffic determinations, the City shall work with the applicant to provide traffic information and perform such modeling as is necessary to study the area outside of the project vicinity.
- b. The TIA shall be submitted with the applicable development application.
- c. When access points are not defined or a site plan is not available at the time the TIA is prepared, additional studies may be required when a site plan becomes available or the access points are defined.

3. *Traffic mitigation measures.*

- a. The applicant shall, as part of the TIA, recommend measures to minimize and mitigate the anticipated impacts and determine the adequacy of the development's planned access points. Mitigation measures shall be acceptable to the Director and may include, without limitation: an access management plan; transportation demand management measures; street improvements on or off the site; placement of proportionate pedestrian, bicycle or transit facilities on or off the site; or other capital improvement projects, such as traffic calming infrastructure or capacity improvements.
- b. Following City approval of the TIA, the developer and the City shall enter into an agreement specifying the implementation program and time frame for the required traffic improvements and identifying mitigation requirements where the project construction time frame varies from the anticipated traffic improvement time frame.

C. *Streets And Vehicular Circulation.*

- 1. *Street standards.* All streets shall meet the standards of [Section 500.050, City of Warsaw Standards and Procedures for Design and Construction](#), [Section 405.070, Stormwater Management and Natural Area Protection Standards](#), and [Section 405.140, Subdivision Design Standards](#), and shall be consistent with the transportation element of the Warsaw Comprehensive Plan.
- 2. *Street connectivity.*
 - a. *Purpose.* Street and block patterns should include a clear hierarchy of well-connected streets that distributes traffic over multiple streets and avoids traffic congestion on principal routes. Within each development, the access and circulation system should accommodate the safe, efficient and convenient movement of vehicles, bicycles and pedestrians through the development and provide ample opportunities for linking adjacent neighborhoods, properties and land uses. Local neighborhood street systems are intended to provide multiple direct connections to and between local destinations, such as parks, schools and shopping. These connections should knit separate

developments together rather than forming barriers between them.

b. *Residential streets.*

- (1) Residential streets shall be laid out so that use by through traffic will be discouraged. Traffic-calming techniques, such as diverters, neck-downs, street gardens and curvilinear alignments, are encouraged to reduce speeds and cut-through traffic.
- (2) Should topography or other constraints require the use of straight streets that extend more than six hundred (600) feet without being punctuated by cross streets, an oblong median, traffic-calming device or similar feature shall be used to slow traffic and break-up the runway appearance. (See Figure 405.080-A.)
- (3) To the maximum extent practicable, streets shall be arranged to follow the natural contours of the site.

c. *Vehicular access to public streets and adjacent land.*

- (1) All development shall provide public street connections to all existing, proposed or preliminary platted adjacent public streets.
- (2) If there are no adjacent public streets, subdivisions and/or site plans shall provide for connections along each boundary abutting adjacent vacant land for future connections spaced at intervals not to exceed one thousand (1,000) feet for arterials, or six hundred sixty (660) feet for other street types, or as otherwise approved by the Director.
- (3) When connections to surrounding streets are required, public right-of-way shall be dedicated and streets developed pursuant to Section
 - (a) 405.140 to existing paved rights-of-way. The City may also require temporary turnarounds to be constructed and paved for temporary culs-de-sac between development phases.

d. *Culs-de-sac and dead-end streets discouraged.*

- (1) The design of street systems shall use through streets. Permanent culs-de-sac and dead-end streets shall only be used when topography, the presence of natural features, and/or vehicular safety factors make a vehicular connection impractical.
- (2) All permanent dead-end streets shall be developed as culs-de-sac and extend no further than six hundred sixty (660) feet.
- (3) All culs-de-sac shall conform to the requirements of the present adopted International Fire Code.
- (4) Half streets (i.e., streets of less than the full right-of-way and pavement width) shall not be permitted except where such streets, when combined with a similar street (developed previously or simultaneously) on property adjacent to the development, creates or comprises a street that meets the right-of-way and pavement requirements.

- (5) Whenever cul-de-sac streets are created, at least one (1) eight-foot wide pedestrian access easement shall be provided, to the maximum extent practicable, between each cul-de-sac head or street turnaround and the sidewalk system of the closest adjacent street or pedestrian pathway. This requirement shall not apply where it would result in damage to or intrusion into significant natural areas, such as stream corridors, wetlands and steep slope areas. The pedestrian access easement will be dedicated to the City and maintained as part of the sidewalk system. (See Figure 405.080-B.)

D. Driveways And Access.

1. General.

- a. Every lot shall have access that is sufficient to afford a reasonable means of ingress and egress for emergency vehicles, as well as for those needing access to the property in its intended use.
- b. Private driveways and parking lots that provide access from residential lots and districts to businesses in nonresidential districts shall not be permitted.
- c. All driveway entrances and other openings onto streets shall be constructed so that:
 - (1) Vehicles may safely enter and exit from the lot in question;
 - (2) Interference with the free and convenient flow of traffic in abutting or surrounding streets is minimized; and
 - (3) The driveway is not less than twenty (20) feet in length from the face of the garage to the nearest street improvement.
- d. Each driveway shall be not more than thirty (30) feet in width, measured at right angles to the center line of the driveway, except as that distance may be increased by permissible curb return radii.
- e. Joint driveways are desirable whenever possible in order to minimize the number of access points to streets and access easements. (See Figure 504.080-C.)
- f. One (1) curb cut is allowed for each legal lot. Curb cuts should be spaced at intervals of one hundred fifty (150) feet along the street frontage, unless the Director determines that a lesser amount is appropriate. A second curb cut may be requested for residential lots with more than two hundred (200) feet of frontage through Section 405.030(M), Minor Modification.
- g. Unless no other practicable alternative is available, all driveways and other openings shall be located a minimum of:
 - (1) Seventy-five (75) feet from a street intersection;
 - (2) Forty (40) feet from another access driveway; and
 - (3) Ten (10) feet from an interior property line for single-family development and twenty (20) feet from an interior property line for multifamily and nonresidential

development.

2. *Residential.* In addition to the above general requirements, all residential development shall be subject to the following:
 - a. Direct driveway access (ingress or egress) from any single-family residential lots to any arterial street or highway shall be prohibited on any lot platted after the effective date of this Code.
 - b. In order to prevent sidewalk obstructions caused by parked cars, garages shall be set back either three (3) feet from the right-of-way line or a minimum of twenty (20) feet from the right-of-way line. No garage may be setback a distance between three (3) feet and twenty (20) feet from the right-of-way.
 - c. Multifamily development sites greater than five (5) acres shall include a minimum of two (2) through-access drives. An exception may be made by the Director where a site is landlocked by existing development or other physical constraints, or where existing natural features on the site require the use of protective measures that would otherwise make a second access drive infeasible.
3. *Nonresidential.* In addition to the above general requirements, all nonresidential development shall be subject to the following unless otherwise provided for in the downtown Warsaw design standards:
 - a. All uses shall have access limited to the collector or arterial streets.
 - b. All nonresidential buildings, structures and parking and loading areas shall be physically separated from all nonarterial or collector streets by vertical curbs and other suitable barriers and landscaping to prevent unchanneled motor vehicle access. Each property shall not have more than two (2) accessways to any one street unless unusual circumstances demonstrate the need for additional access points. In addition, each accessway shall comply with the following:
 - (1) To the maximum extent possible, unless prohibited by existing site constraints, the width of any accessway leading to the arterial street shall be median-divided to provide separation from incoming and outgoing traffic. (See Figure 504.080-E.)
 - (2) Curb returns shall have a minimum radius of thirty (30) feet.
 - (3) On corner lots for nonresidential development, no part of any accessway shall be nearer than one hundred (100) feet to the intersection of any two (2) street rights-of-way.
4. *Visibility at intersections.* On all lots or parcels of land on which a front setback is required, no obstruction that will obscure the view of motor vehicle drivers shall be placed within the triangular area formed by the adjoining street property lines and a line connecting them at points of forty-five (45) feet from the intersection of said street property lines. (See Figure 504.080-F.)

E. *Pedestrian Circulation.*

1. *Sidewalks required.* Sidewalks shall be installed on both sides of all arterials, collector streets and local streets (including loop streets and culs-de-sac) as identified within the Warsaw Transportation Improvement Plan and within and along the frontage of all new development or redevelopment. Sidewalk entries shall be provided to all buildings and individual units that front on the sidewalk.
2. *On-site pedestrian connections.*
 - a. All commercial, multifamily, mixed-use, and attached residential development shall provide a network of on-site, paved, pedestrian walkways with a minimum width of five (5) feet to and between the following areas (See Figure 504.080-G.):
 - (1) Entrances to each commercial, multifamily, mixed-use and/or attached residential building on the site, including pad site buildings;
 - (2) Public sidewalks, walkways or trails on adjacent properties that extend to the boundaries shared with the subject development;
 - (3) Public sidewalks along the perimeter streets adjacent to the development;
 - (4) Adjacent land uses and developments; and
 - (5) Adjacent public park, greenway, trail or other public or civic use.
 - b. Internal pedestrian walkways shall be provided through parking areas in excess of fifty (50) spaces, constructed of materials distinguishable from the driving surface through the use of one (1) or more of the following methods:
 - (1) Changing paving material, patterns or paving color (See Figure 504.080-H.);
 - (2) Changing paving height;
 - (3) Decorative bollards;
 - (4) Painted crosswalks;
 - (5) Raised median walkways with landscaped buffers; or
 - (6) Stamped asphalt.

§ 405.090. Commercial and Mixed-Use Design and Development Standards.

A. *Purpose.* The commercial and mixed-use design standards are intended to protect and preserve the quality and character of the built environment in the City. More specifically, the purposes of this Section are to:

1. Encourage high-quality development as a strategy for investing in the City's future;
2. Emphasize Warsaw's unique community character while maintaining and enhancing the quality of life for its citizens;
3. Enhance the sense of place by shaping the appearance, aesthetic quality and spatial form of structures and developments;
4. Protect and enhance property values;
5. Minimize negative impacts of development on the natural environment;
6. Provide property owners, developers, architects, builders, business owners and others with a clear and equitable set of parameters for developing land;
7. Encourage a pedestrian- and bicyclist-friendly environment;
8. Ensure greater public safety, convenience, and accessibility through the physical design and location of land use activities; and
9. Promote both the sustainability of the structure and the overall community.

B. *Generally Applicable Design Standards.*

1. *Design intent.* It is the intent of these regulations to preserve and protect property values by creating an aesthetic quality throughout the built environment of Warsaw. Warsaw's design character is that of a vibrant, small- town lake resort, complementary to the natural landscape and unbuilt environs.
2. *Site design requirements.*
 - a. The location of structures and access shall complement the existing topography and views of the site. Excessive grading and/or the use of engineer-designed retaining walls shall be minimized when an alternate site layout would avoid such disturbances. Buildings on sloping lots with a grade differential in excess of ten (10) feet shall be designed with foundations that step with the existing (natural) grades.
 - b. All disturbed areas shall be revegetated within fourteen (14) days of disturbance using ~~recommended~~ native plant species ~~listed in Section 405.120~~. [For a list of permissible plant species, refer to the resources found within the stormwater management design criteria.](#) Where revegetation is not possible within fourteen (14) days, the applicant shall be required to provide a surety bond or enter into an agreement to complete the work as determined by the Director.
 - c. Where development has been proposed on a site, construction activity shall, at a minimum, avoid the following:

- (1) All drainage and utility easements;
 - (2) Any required development setbacks;
 - (3) All areas over thirty percent (30%) in slope; and
 - (4) Any unique and sensitive natural site features as identified by the Director.
- d. Continuous, linear strip development shall be discouraged.
- e. Transformers, switchgear and related utility service equipment shall not be located above ground in pedestrian access easements. Building service panels are to be located on the inside of all buildings.
- e.f. The requirements of Section 405.070, Stormwater Management and Natural Area Protection Standards shall be incorporated during site design.
3. *Building orientation and entrances.* Except as otherwise specified in these design standards, the following regulations shall apply.
- a. *Individual buildings.*
 - (1) The front building facade shall be oriented toward a public street and pedestrian walkways.
 - (2) In cases where the long axis of a building is perpendicular to the primary street, the portion of the structure facing the primary street shall be configured with at least one (1) operable entrance and one or more transparent windows.
 - b. *Corner lots.* Buildings on corner lots shall be oriented to the corner and to the street fronts and should make a strong tie to the building lines of each street unless the applicant can demonstrate that to do so would be infeasible. Parking and curb cuts shall be located away from corners.
 - c. *Multiple buildings.*
 - (1) Buildings within mixed-use and commercial developments shall be organized to promote a compact pattern of development, pedestrian- friendly spaces, streetscapes, areas of naturalized landscaping and screened parking areas.
 - (2) Buildings shall be arranged and grouped so that their primary orientation complements one another and adjacent, existing development by:
 - (a) Framing the corner of an adjacent street intersection or entry point to the development;
 - (b) Framing and enclosing a pedestrian and/or vehicle road or access corridor within or adjacent to the development site;
 - (c) Framing and enclosing on at least three (3) sides parking areas, public spaces or other site amenities;
 - (d) Framing and enclosing outdoor dining or gathering spaces for pedestrians

between buildings; or

(e) Framing one (1) or more areas of natural vegetation.

4. *Build-to-zone.*

a. *Intent:* to create a consistent and well-designed building edge that contributes to the overall character of the site and promotes a more pedestrian-oriented environment while allowing for flexibility to accommodate amenities such as outdoor seating and gathering spaces.

b. *Standards.*

(1) Except as otherwise specified in the Downtown Warsaw Design Standards, mixed-use and commercial buildings shall build a minimum of seventy percent (70%) of the building wall to the back of the sidewalk along primary street frontages. See Figure 405.090-B.

(2) Portions of the street frontage not occupied by the building wall shall be occupied by community amenities, such as plazas or streetscape or pedestrian walkways that provide access to rear parking.

5. *Building design.*

a. *Four-sided design.*

(1) All sides of a building shall be architecturally finished with equal levels of materials and detailing. Blank walls void of architectural details or other variation are prohibited. Except as otherwise provided in the Downtown Warsaw Design Standards, any wall that faces a street, connecting pedestrian walkway, or residential use, and that exceeds thirty (30) feet in length shall include a minimum of two (2) of the following within each successive thirty-foot section or fraction thereof:

(a) Change in wall plane, such as projections or recesses, having a depth of at least three percent (3%) of the length of the facade and extending at least twenty percent (20%) of the length of the facade;

(b) Change in texture or masonry pattern.

(c) Windows.

(d) Trellises with vines.

(e) Covered walkways.

(f) Structural canopies.

(g) An equivalent element that subdivides the wall into human scale proportions.

(2) Ground floor facades that face public streets shall have arcades, display windows, entry areas, awnings or other such features along no less than sixty percent (60%) of their horizontal length.

- (3) Rear facades of buildings shall either be screened from view of the public or be landscaped and incorporate architectural facade elements resembling the elements in the front facade.
- (4) Corporate or franchise architecture is discouraged in favor of architecturally compatible designs. The Director may require photographic examples of the more minimized corporate architecture in the designs and completed structure by the same company in other communities.

b. *Building materials and colors.*

- (1) Except as otherwise specified for downtown Warsaw, all primary exterior building materials shall be durable, economically maintained, and of a high quality that will retain its appearance over time, including but not limited to: brick; native or manufactured stone (Renaissance stone or similar masonry materials); integrally colored, burnished, textured, or glazed concrete masonry units; prefinished metal panel systems; quality metals, such as copper; high-quality prestressed concrete systems; tilt-up concrete panels with an architectural finish; and drainable (water managed) EIFS. Exceptions to these material requirements may be made by the Director for the M-1 and M-2 Districts.
- (2) The following exterior materials are prohibited: split shakes, rough- sawn wood; painted concrete block; tilt-up concrete panels without an architectural finish; field-painted or prefinished standard corrugated metal siding; standard single- or double-tee concrete systems; or barrier-type EIFS. The Director may permit the use of these materials on up to ten percent (10%) of any facade as an accent material.
- (3) Metal is not permitted as a primary facade material. Architectural aluminum or steel panels (designed to ensure absence of any "oil canning") are permitted, but use of architectural aluminum or steel panels should be limited to specific architectural elements or features. This Section does not prohibit the use of metal siding designed to look like clapboard siding.
- (4) Building materials, except glass, shall be of low reflectance and finished in subtle, neutral or earth tone colors (brown, tan, grey, green, blue, red in muted, flat colors) characteristic of the soil types and vegetation found in Warsaw.
- (5) Building trim and accent areas may feature brighter colors, but fluorescent colors and neon tubing accents are not permitted.

c. *Roofs.* Roofs shall be designed and constructed as follows:

- (1) Flat roofs shall include parapets concealing flat roofs and rooftop equipment, such as HVAC units, from public view. Parapet roofs should be of sufficient height to conceal HVAC units and other similar roof-mounted apparatus from public view from adjacent street levels. Parapet roofs shall have cornices or be stepped.
- (2) Sloping roofs shall have a vertical rise of not less than one (1) foot for every three (3) feet of horizontal run and no more than one (1) foot for every one (1) foot of horizontal run. Sloping roofs shall have three (3) or more roof slope planes where a

building exceeds three thousand (3,000) square feet. Two (2) or more roof slope planes shall be required for buildings of three thousand (3,000) square feet or less.

C. Highway Commercial And Big Box Design Standards.

1. *Applicability.* The standards in this Subsection apply to:

- a. All retail establishments with twenty-five thousand (25,000) square feet of gross leasable area or more; and
- b. All formula or chain retail, restaurant, or personal service businesses that have ten (10) or more substantially similar businesses in the United States at the time of application. This Subsection does not apply to gas stations, offices, hotels or banks.

2. *Site layout and design.*

- a. *Structures.* In order to develop and maintain a strong street edge, buildings for stand-alone projects or individual pad developments associated with a larger commercial center shall be located at the front of the site at the minimum setback line with the exception of a single drive- through lane or additional landscaping.
- b. *Pedestrian flow.*
 - (1) Sidewalks at least eight (8) feet in width shall be provided along all sides of the lot that abut a public street.
 - (2) Sidewalks at least eight (8) feet in width shall be provided along the full length of the building across any facade featuring a public entrance and along any facade abutting public parking areas. These sidewalks shall be located at least ten (10) feet from the front of the facade of the building to provide planting beds for foundation landscaping, except where features such as arcades or entryways are part of the facade.
 - (3) In parking lots with one hundred (100) spaces or more, sidewalks at least eight (8) feet in width shall be provided from all public entrances to the perimeter of the side to permit for the safe movement of pedestrians through the parking lot.

3. *Building facade.*

- a. *Small retail stores.* Where large retail establishments contain additional separately owned stores that occupy less than thirty thousand (30,000) square feet of gross floor area, with separate, exterior customer entrances, the street level facade of such stores shall be transparent above the walkway grade for no less than fifty percent (50%) of the horizontal length of the building facade of such additional stores.
- b. *Entrances.* All sides of a large retail establishment that directly face an abutting public street shall feature at least one (1) customer entrance. Where a large retail establishment directly faces more than two (2) abutting public streets, this requirement shall apply only to two (2) sides of the building, including the side of the building facing the primary street, and another side of the building facing a second street. Each entrance shall be prominent, visible from the street, connected by a walkway to the public

- sidewalk, and include human-scale elements. Movie theaters are exempt from this requirement.
- c. *Service functions.* Service functions like refuse collection, incidental storage and similar functions shall be integrated into the architecture of the building unless an alternate location places these functions farther from adjacent residential uses.
4. *Off-street parking location.*
- a. Outside of downtown Warsaw, no more than seventy percent (70%) of the off-street parking for the entire store shall be located in front of the building. Off-street parking shall be established in one (1) or more of the locations listed below. The locations are listed in priority order; the applicant shall select the highest feasible location from this list and shall demonstrate why that application was selected over other alternative locations.
 - (1) Adjacent to off-street parking lots serving nonresidential uses on abutting lots;
 - (2) Adjacent to lot lines abutting nonresidential development;
 - (3) Adjacent to lot lines abutting mixed-use development;
 - (4) Behind the building;
 - (5) In front of the building; or
 - (6) Adjacent to lot lines abutting residential uses.
 - b. In cases where an off-street parking lot serving a nonresidential use is located on an abutting lot, connection between the two (2) parking areas via a cross-accessway with a minimum width of twelve (12) feet and a maximum width of twenty-four (24) feet is strongly encouraged. A cross- access easement shall be recorded.
 - c. The property shall not be advertised or marketed as available for camping, long-term parking, or any use other than typical customer parking for shopping patrons. Parking lots shall not be used for short-term or long-term storage of motor homes, campers, trailers or recreational vehicles.
 - d. Except for the purpose of normal loading and unloading operations, no trailers, semitrailers and trucks, truck-tractors, or outdoor containers shall be stored on site.
5. *Relationship to surrounding uses.*
- a. Multibuilding developments shall be configured to locate the tallest and largest structures within the core of the site and provide a gradual decrease in building height and mass towards adjacent residential land uses.
 - b. Horizontally integrated mixed-use developments shall locate nonresidential uses away from lots in adjacent residential areas.
 - c. Medium- to high-density housing shall be incorporated to the maximum extent feasible, both within and around the development, to facilitate connections between residential

and nonresidential uses.

- d. Nonresidential structures taller or larger than adjacent residential uses shall be broken up into modules or wings with the smaller or shorter portions of the structure located adjacent to residential uses.

D. *Downtown Warsaw Design Standards.* The Downtown Warsaw Design Standards are applicable to property within the boundaries identified in Figure 405.090-C.

- 1. *General design considerations.* The following design considerations are applicable to all historic buildings in downtown Warsaw regardless of the style, age or location of the building.

- a. *Context.* The context of surrounding buildings should be a top consideration when designing changes to the physical environment. Changes to existing buildings should take into consideration the relationship to neighboring buildings. All buildings should relate to surrounding buildings in set back, size, shape, rhythm of window openings, regulating lines of traditional building features, materials, color, and ornamentation.
- b. *Style.* Downtown Warsaw does not have one, single architectural style. The majority of buildings are typical historic commercial buildings constructed in the late 1800s and early 1900s, commonly referred to as "early 20th Century commercial buildings." However, there are several post World War II buildings that have replaced original commercial buildings as well as some modern (post-1970) buildings, particularly on the outer edges of the downtown boundaries. Rehabilitation of all existing buildings should respect and relate to the historic commercial buildings.
- c. *Existing fabric.* All existing historic building materials and details should be retained. Care should be taken not to obscure the facade or details on the facade by covering it with metal, plastic, masonry or wood panels. Existing nonhistoric cover-up materials should be removed when possible. The original size and shape of masonry openings should be retained. Original openings should not be altered by blocking in or downsizing windows or storefronts.

- 2. *Streetscape design and character.*

- a. *Intent.* A distinguishing feature in most historic commercial districts is the consistent set back from the street and sidewalk. The wall of commercial buildings along the sidewalk forms a relationship with the street that is essential to the pedestrian as opposed to automobile orientation of the business district. The edge can be interrupted by unequal setbacks and/or the absence of buildings (parking lots or vacant lots). These interruptions are often a result of destination-oriented businesses and may be appropriate for the outer edges of the downtown district. Interruptions in the continuous wall of buildings can disrupt pedestrian flow. This condition is currently illustrated toward the north and south ends of Main Street. See Figure 405.090-D for the location streetscape elements.
- b. *Design standards.*

- (1) All existing buildings shall maintain a consistent setback from the street, flush with the facades of neighboring buildings. See Fig. 405.090-E.
 - (2) Curb cuts shall not be allowed off of Main Street in the core area of downtown between Polk Street and State Street.
 - (3) Where disruptions in the continuous street wall of buildings already exist, landscaping shall be used to recreate the edge to minimize the disruption.
 - (4) Demolition of existing buildings shall be permitted only when either a professionally prepared cost-benefit analysis or structural analysis finds that no other feasible alternative exists.
- c. *Building size and shape.* All commercial buildings shall maintain the overall size, scale, height and horizontal or vertical orientation of the original commercial buildings in the area which is approximately either twenty (20) feet to twenty-five (25) feet or forty (40) feet to fifty (50) feet wide and one (1) or two (2) stories tall, except for corner buildings in the core area where buildings are wider than fifty (50) feet; these buildings shall be composed of at least two (2) twenty- to twenty-five-foot bays. Structural design precedent shall be established by neighboring buildings.
- d. *Design rhythm.* The repetition of the storefront bays and the location and size of the door and window openings creates a pattern or rhythm along the street. The rhythm created by the traditional historic commercial buildings shall be maintained on all buildings.
- e. *Regulating lines.*
- (1) *Intent.* The majority of downtown buildings relate to some or all of the regulating lines on adjacent buildings: building height, cornice or building cap, upper level windows, distinction between upper facade and storefront, transom and display windows and bulkhead. Even when there are a variety of one- and two-story buildings in the same block, there are typically predominant regulating lines. See Figure 405.090-F for the location of regulating lines.
 - (2) *Design standards.* When regulating lines are prevalent, as determined by the Director, the following guidelines should be followed.
 - (a) Building heights shall be emphasized by the horizontal alignment of cornices or building caps. All building heights shall relate to neighboring buildings in the block, as addressed in Subsection (D)(2), above. Where a one-story building adjoins two-story buildings, the one-story building shall relate to the height of other one-story buildings in the block. Regulating lines are not always established by immediately adjacent buildings and may be established by the block as a whole.
 - (b) The alignment of upper level windows along the block shall be maintained to the maximum extent possible.
 - (c) The clear distinction between the storefront and upper facade shall be

maintained to the maximum extent possible.

- (d) The alignment of storefront elements (transom window, display windows, bulkhead) shall be maintained to the maximum extent possible with neighboring buildings.

f. *Building materials.*

(1) *Intent.*

- (a) Building materials are an important consideration in how buildings relate to each other and their surroundings. Materials can be indicative of architectural styles and often establish the basic color scheme on a building facade. Historic commercial buildings in downtown Warsaw are predominately red or blond brick; a few pressed metal upper facades and wood (Trader's Alley) are original to the area as well. Most buildings have a decorative, corbeled brick or applied pressed metal cornice. The majority of brick buildings have brick or limestone window lintels and sills. Upper floor windows in two-story buildings were typically double-hung windows with wood frames; some have been replaced with aluminum frames and single, fixed panes.
- (b) Most storefronts were originally wood, some with cast-iron columns and brick or limestone piers. Most buildings have a steel I-beam spanning the storefront bay that serves as the lower cornice (many have decorative rosettes). Alterations over the years have included the installation of aluminum, brick, stone and wood siding on several storefronts; in many instances, these materials altered the proportions and regulating lines of the original storefront. The bulkheads or base of the storefronts were originally brick or wood.

(2) *Design standards.*

- (a) All existing historic building materials shall be retained to the maximum extent possible.
- (b) Proposed building improvements shall use traditional materials or materials similar to the traditional ones. Questions about traditional materials shall be determined by the Director.
- (c) Contemporary materials may be appropriate if the design and composition relate to the context and other design standards are met. Aluminum or wood siding, wood or asphalt shingles and dark or mirrored glass is prohibited except as accent materials limited to use on twenty percent (20%) or less of the structure.

g. *Color.*

(1) *Intent.*

- (a) Color plays an important role in how well a building fits into its environment and should be considered when rehabilitating existing buildings. A good source for paint colors typical of and appropriate for historic commercial buildings are the

heritage or historic paint colors offered by many paint manufacturers. Although personal preference is a major factor in the selection of paint color, the following standards should be considered when selecting colors.

- (b) The brick facades have already been painted on a number of buildings in downtown Warsaw. Typically, when the facade of a brick building must be repainted, it should be painted a color similar to the natural color of the brick. Likewise, when brick or limestone trim, such as window lintels or sills, is painted, it should be painted a color to match the natural color of the material. Accent colors should be used primarily on wood trim, such as window frames, storefront frames and bulkheads. By introducing a new paint color on decorative brick, limestone or pressed metal details, the details are accented making the building appear more ornate than it was originally designed. It was very rare for masonry or components, such as window lintels or sills, or cornices to be painted on traditional historic commercial buildings in this area of the country.

(2) *Design standards.*

- (a) A paint scheme for historic commercial buildings shall consist of no more than three (3) colors: one (1) primary color for the body and no more than two (2) accent colors for the primary and secondary trim. The predominant building material (brick or pressed metal) shall be considered the primary body color. If the historic building material has been altered, a natural color, similar to the historic material, shall be used for the body. Questions about color appropriateness shall be resolved by the Director.
- (b) Accent colors should complement the natural colors that already exist in the downtown district.
- (c) Color schemes shall be modest or muted color schemes with bright colors limited to accents.
- (d) Masonry that has been previously painted may be repainted if it is not feasible to remove existing paint from the masonry surfaces. Masonry buildings or details that have not been painted previously shall not be painted.

- 3. *Building facade.* Building facades should relate to the surrounding buildings as described in this Section. Existing buildings should retain the traditional elements outlined below. See Figure 405.090-G for the location of building facade elements.

a. *Storefront.*

- (1) *Intent.* Storefronts were historically composed almost entirely of glass, creating visual openness. This openness creates an inviting relationship to the street, emphasizes the pedestrian orientation of the commercial district and should be retained.

(2) *Design standards.*

- (a) The storefront shall fit within its original opening. The original building

entrance(s) should be retained when possible.

- (b) Doors on the storefront shall use clear glass and shall not be made of solid metal or solid wood.
- (c) Storefront revisions shall retain the original elements: transom window, display windows, bulkhead and entrance (door), and use only appropriate materials as described here or in Subsection (D)(2)(f), Building materials. The size, proportions and alignment of windows, door and bulkhead shall relate to neighboring buildings.
- (d) Display and transom windows that have been downsized or covered shall, to the maximum extent possible, be reopened.
- (e) Display windows shall be clear glass and retain the size and proportion of the original opening.
- (f) Ideally, where transom windows have been altered, they shall be restored to their original appearance to the maximum extent possible.
 - i. When restoration of the transom window glass is not feasible, the size and proportion of the original opening shall be maintained.
 - ii. When ceiling heights have been lowered, opaque panels shall be framed in to resemble the form and profile of an historic transom window.
- (g) When installing new display or transom glass in a storefront, consideration should be given to reducing heat gain. There are a variety of glass products that minimize heat gain without affecting visibility. Examples of such products include thermal glazing with clear or Low E glass. The important aesthetic consideration is that it be clear glass.

b. *Upper facade.*

- (1) *Intent.* On two-story buildings, the upper windows are a predominant character-defining feature.
- (2) *Design standards.*
 - (a) The historic masonry window openings shall be maintained to the maximum extent possible. Windows that have been downsized or covered shall be reopened to maintain the size and proportion of the historic window openings.
 - (b) For fire safety purposes, window openings shall not be blocked in or covered with a solid material.
 - (c) When upper level windows are missing or are in need of replacement, the openings shall not be downsized to accept stock sizes; replacement windows shall be provided to fill the entire opening and resemble the style and profile of the original window.
 - (d) Windows shall be clear glass. Reflective or tinted glass is prohibited in

downtown Warsaw.

c. *Cornice or building cap.*

(1) *Intent.* The cornice defines the top of the building and emphasizes the relationship of the top of the building to adjacent buildings.

(2) *Design standards.*

(a) Existing cornices shall be retained to the maximum extent possible and repaired as needed.

(b) When cornices have been removed, they shall be replaced with an historic cornice to the maximum extent feasible. If replacement is not feasible, a simplified cornice shall be designed to define the top of the building and maintain the visual unity of building tops along the block.

d. *Rear facades.* Where rear or secondary public entrances are used for customer access or where rear facades are visible to the general public, the following standards shall apply:

(1) Rear facades that are visible from a public street should complement the main facade in their design and material usage.

(a) Materials selected for facades of buildings facing Harrison Street, including accessory uses, may differ from those approved for the Main Street facade, but general design treatment and color schemes shall be consistent around all sides of the building.

(b) The rear facades shall be constructed of the primary building material, such as brick or stone. When concrete or concrete block is the predominant material of an existing rear facade, it shall be painted to match the color of existing brick or stone.

(c) Rear facades that are covered with wood or metal siding shall be painted a neutral color to blend with the natural colors found in the predominant building materials.

(2) Architectural embellishments, awnings, landscaping and signs should be used to mark the secondary entrance.

(3) A minimum of twenty percent (20%) of the building's rear facade facing a public right-of-way, parking area, or open space shall consist of transparent materials.

(4) Shed additions and stairs that are not in use shall be removed where possible.

(5) Service necessities, including trash dumpsters, downspouts, gas tanks, satellite dishes and utility boxes shall be screened from public view with fencing or landscaping pursuant to Section 405.120.

(6) It is recommended that a coordinated effort be made to encourage businesses to share dumpsters.

(7) Rear customer entries shall be well maintained.

4. *Demolition controls for historic structures.*

- a. *Purpose.* This Subsection is intended to work in conjunction with Warsaw Municipal Code Chapter 500, Article III, Demolition, by establishing standards for the demolition of historic structures. The purpose of this Subsection is to:
 - (1) Effect and accomplish the protection, enhancement and perpetuation of such areas and improvements and of districts which represent or reflect elements of the City's cultural, social, economic, political and architectural history.
 - (2) Safeguard the City's historic, aesthetic and cultural heritage, as embodied and reflected in such areas, improvements and districts.
 - (3) Stabilize and improve property values in such districts.
 - (4) Foster civic pride in the beauty and accomplishments of the past.
 - (5) Protect and enhance the City's attractions to tourists and visitors and the support and stimulus to business and industry thereby provided.
 - (6) Strengthen the economy of the City.
 - (7) Promote the use of historic districts and landmarks for the education, pleasure, and welfare of the people of the City.
- b. *Applicability.* The standards of this Subsection are applicable to historic structures in downtown Warsaw, defined as those buildings that have some or all of the architectural features identified in this Section that were common to building design in the period generally from the late 1800s through the early 1900s and any other structure located in the downtown design standards area that is fifty (50) years of age or older.
- c. *Demolition restriction.* No historic structure shall be demolished unless the owner has first given the City at least six (6) months' notice of his or her intention to demolish the building. During that six-month period, the City will work with the owner to identify any alternative uses that would allow the existing building to produce a better economic return that would allow it to remain in active use, or that would allow it to be used for the purposes or land uses the owner wants to achieve, or to identify a purchaser for the building who would preserve it from demolition. In the event the owner does not accept the alternatives, if any, offered by the City during that six-month period, the demolition may proceed, but only after the owner has provided at least thirty (30) days' additional time for the City or other parties to document the building through photographs or other means. The owner is encouraged, but not required, to allow access to the building during the thirty-day period in order to allow documentation of the interior of the building as well.
- d. *Maintenance.* Property owners are required to maintain historic buildings and structures, as defined above, in a State of normal repair and not allow demolition by neglect. Demolition by neglect is the gradual deterioration of a building when routine maintenance is not performed. The City has the authority to impose enforcement

provisions on property owners who are found to have allowed an historic structure to fall into a state of neglect.

§ 405.100. Multifamily and Townhouse Design Standards.

A. *Purpose.* The purpose of the multifamily and townhouse residential design standards is to preserve the quality and character of the built environment in the City. More specifically, the purposes of this Section are to:

1. Encourage high-quality development as a strategy for investing in the City's future;
2. Emphasize the City's unique community character;
3. Maintain and enhance the quality of life for the City's citizens;
4. Shape the City's appearance, aesthetic quality, and spatial form;
5. Protect and enhance property values;
6. Provide property owners, developers, architects, builders, business owners, and others with a clear and equitable set of parameters for developing land; and
7. Promote the sustainability of both the structure and the overall community.

B. *Applicability.*

1. The design standards in this Section apply to all new dwellings intended or constructed to be occupied by three (3) or more households, including individually constructed buildings, townhomes, and multiple buildings constructed as parts of a larger development.
2. Section 405.060(B), Applicability, identifies how these provisions apply to redevelopment and infill development.

C. *Site Design.*

1. *Building separation.* The minimum separation between multifamily buildings, including accessory buildings, on the same lot or development parcel is fifteen (15) feet.
2. *Building orientation.*
 - a. Individual buildings within a multifamily development shall be oriented to:
 - (1) Common open space, such as interior courtyards or on-site natural areas or features;
 - (2) Perimeter streets;
 - (3) Other residential buildings; or
 - (4) Through-access drives.
 - b. Multifamily buildings in a single development shall be clustered or grouped to form neighborhoods.
3. *Common space.*
 - a. Developments with at least four (4) units shall provide one hundred fifty (150) square feet of private common open space for each multifamily dwelling unit. A minimum of

forty percent (40%) of the open space shall be usable for recreation, including swimming pools, sport courts, or playgrounds with equipment. Required landscaping is excluded from open space calculations.

- b. To the maximum extent practicable, common open spaces, such as gardens, courtyards, recreation or play areas, shall contain a minimum of three (3) of these features:

- (1) Seasonal planting areas;
- (2) Trees;
- (3) Pedestrian-scaled lighting;
- (4) Gazebos or other decorative shelters;
- (5) Seating;
- (6) Play structures for children; or
- (7) Natural features or areas, unless the City determines that for preservation reasons the buildings should avoid the feature or area.

4. *Pedestrian circulation.*

- a. *Circulation patterns.* Sidewalks shall be provided as necessary for efficient pedestrian circulation within the project and to neighboring properties pursuant to Section 405.080, Mobility and Connectivity Development Standards.

- b. *Walkway location and design.*

- (1) Sidewalks shall be separated from vehicular traffic where possible.
- (2) Sidewalks shall be constructed of attractive, durable materials, such as decorative concrete or brick pavers.
- (3) Sidewalk widths shall be compatible with anticipated uses, but in no instance shall be less than five (5) feet wide as a minimum standard.

- 5. *Stormwater management.* The requirements of Section 405.070, Stormwater Management and Natural Area Protection Standards shall be incorporated during site design.

D. *Building Design.*

- 1. *Maximum building length.* The maximum length of any multifamily building shall be one hundred fifty-six (156) feet or six (6) townhouse units, whichever is less.
- 2. *Facade design.* Multifamily buildings with a facade length of greater than forty (40) linear feet shall incorporate a variety of different wall planes and roof planes and shall feature a minimum of two (2) of the following design elements in the design of the front facade (See Figure 405.100-C.):
 - a. Bay windows;

- b. Covered porches or balconies;
 - c. Structural offsets of a minimum of four (4) feet from the principal plane of the facade;
 - d. Accent materials, such as brick, stone, or stucco with banding highlights; or
 - e. Window grills and shutters.
3. *Patio.* All ground floor units shall be provided with a minimum six-foot-by- ten-foot patio or balcony directly accessible from the unit. At least fifty percent (50%) of all units above ground-floor level shall be provided with a minimum four-foot-by-ten-foot balcony directly accessible from the unit.
4. *Building materials.* All construction shall be of durable high-quality materials and shall meet the following standards:
- a. If vinyl exterior siding is used, it shall have a manufacturer's warranty of a minimum of fifteen (15) years.
 - b. Metal is not permitted as a primary facade material. This Section does not prohibit the use of metal siding designed to look like clapboard siding.
 - c. Architectural aluminum or steel panels (designed to ensure absence of any deformation or oil canning) are permitted, but use of architectural aluminum or steel panels should be limited to specific architectural elements or features.
5. *Transparency.* At least twenty-five percent (25%) of all walls facing a public street shall contain windows or doorways.
6. *Roof.*
- a. Minimum roof pitch on all townhouses, duplexes and multifamily dwellings is 4/12. No flat roofs are permitted.
 - b. Multifamily residential buildings shall be designed to avoid any continuous roofline longer than fifty (50) feet. Rooflines longer than fifty (50) feet shall include at least one (1) vertical elevation change of at least two (2) feet.
 - c. The incorporation of a variety of roof forms is strongly encouraged. Upper-level residential floors may be incorporated into the roof form to reduce the apparent height and mass of buildings.
 - d. The height of each multifamily building taller than thirty-five (35) feet shall be stepped down from its highest roofline at least one (1) full story on any end of the building located within fifty (50) feet of a street right- of-way or an adjacent area zoned or used for single-family residential.
7. *Building access.* Multifamily buildings shall provide concentrated unit access points. Monotonous access balconies and corridors running the length of the exterior of a building are prohibited.

E. *Parking Location And Layout.*

1. *Parking internal to development.*

- a. To the maximum extent feasible, garage entries, carports, parking areas and parking structures shall be internalized in building groupings or oriented away from street frontage.
- b. Parking areas and freestanding parking structures (detached garages or carports) shall not occupy more than thirty percent (30%) of each perimeter public street frontage of a multifamily development.
- c. To the maximum extent practicable, freestanding parking structures that are visible from perimeter public streets shall be sited so that the narrow end of the parking structure is perpendicular to the perimeter street.

2. *Covered parking.*

- a. Multifamily development shall provide covered parking to meet a minimum of fifty percent (50%) of the required parking identified in Table 405.110-1, Off-Street Parking. The Director may reduce or waive this requirement for low-income housing.
- b. Carports and common garages shall be limited to sixty (60) feet in length.
- c. Detached garages and carports shall incorporate compatible materials, scale, colors, architectural details and roof slopes similar to those of the primary multifamily buildings.

F. *Storage Space.*

1. *Intent.*

- a. To ensure multifamily developments provide sufficient storage for residents so that balconies and garages may be used for their original purpose.
- b. To reduce parking impacts resulting from undersized garage spaces and a lack of storage.
- c. To ensure parking is used for parking and not for storage.

2. *Design standards.* Multifamily developments shall provide a minimum of thirty-two (32) feet of exterior storage space per unit. Storage may be provided through one (1) or more of the following:

- a. Increased garage dimensions that allow for storage in front of parked vehicles;
- b. Storage units incorporated above detached garage structures or within the multifamily building;
- c. Storage closets within units, aside from bedroom closets; or
- d. Detached storage buildings or sheds.

§ 405.120. Landscaping and Screening.

A. Landscaping.

1. *Purpose.* The purpose of the landscaping standards is to ensure that landscaping in Warsaw:
 - a. Integrates building sites with both natural topography and existing vegetation;
 - b. Minimizes disturbed and impervious areas;
 - c. Respects the limitations and best uses of water resources;
 - d. Reduces the amount of reflected glare and heat absorbed in and around developments;
 - e. Breaks up large expanses of parking lots; and
 - f. Preserves residential neighborhoods by lessening the impacts of potentially incompatible uses.
2. *Applicability.* This landscaping section shall apply to all new development and redevelopment as provided in Section 405.120(A)(3). Applicability of the provisions of this Section shall be as indicated in Table 405.120-1, below.

Table 405.120-1 Applicability of Landscaping Standard by Development Type						
Standard	Section	Single-Family/ Duplex	Multifamily	Mixed Use	Commercial	Industrial
Landscaped area	405.120(A)(3)(a)	♦	♦	♦	♦	♦
Landscape buffer	405.120(A)(3)(b)		♦	♦	♦	♦
Parking lot landscaping	405.120(A)(3)(d)		♦	♦	♦	♦

3. Required landscaping.

- a. *Landscaped areas.* All exposed ground areas surrounding or within a principal or accessory use, including adjacent, unpaved street rights-of-way, that are not devoted to drives, parking lots, sidewalks, patios or similar uses shall be landscaped.
 - (1) All residential lots shall have a minimum of one (1) tree planted between the sidewalk and the front of each house at the time the house is constructed.
 - (2) All multifamily and commercial uses shall provide at least four (4) feet in depth of site perimeter landscaping along all public streets, planted at a minimum of thirty hundredths (0.30) landscape unit per linear feet, fifteen percent (15%) of which shall be trees.
- b. *Landscape buffer.* The following regulations apply to properties where a multifamily, mixed-use or nonresidential district or use abuts a single-family residential district or use.

(1) *Buffer required.*

- (a) A minimum fifteen-foot wide buffer space shall be provided.
- (b) The buffer shall be landscaped with sixty hundredths (0.60) landscape unit per linear foot, twenty-five percent (25%) of which shall be trees.
- (c) New trees and shrubs shall be evenly spaced at planting.
- (d) A solid masonry wall, a minimum of six (6) feet in height, may be substituted for required shrubs.
- (e) Where a natural buffer exists, as determined by the Director, it shall remain undisturbed.
- (f) If used in addition to a landscape screen, fences shall have additional evergreen shrubs planted on the residential side of the fence.
- (g) Green stormwater infrastructure (GSI)/~~post-construction permanent stormwater best management practices~~ stormwater best management practices (BMPs) are encouraged in landscape buffers to meet both landscaping requirements and stormwater retention requirements per the City's stormwater management design criteria.

(2) *Uses and easements.*

- (a) Mechanical equipment and, permanent detention ~~and temporary erosion and sedimentation control basis~~ facilities are prohibited in the buffer area. This restriction does not apply to GSI/stormwater BMPs with native vegetation.
 - (b) Utility easements may cross but not be placed in the long dimension of a buffer yard except for drainage easements when GSI/stormwater BMPs are implemented within the landscape buffer.
 - (c) Wherever practical, pedestrian access shall be placed through the buffer yard.
- c. *Landscaping units.* Required landscaping is calculated in landscaping units. Table 405.120-3 indicates the landscape units awarded for various preserved or planted landscape materials:

Table 405.120-3 Landscape Units Awarded		
Landscape Material	Landscape Units Awarded	
	Newly Installed	Existing Retained
Evergreen tree, more than 10 feet high	8	14
Evergreen tree, more than 8 feet to 10 feet high	8	11
Evergreen tree 6 feet to 8 feet high	6	9
Deciduous tree, more than 8 inches in caliper	n/a	14

Deciduous tree, more than 4 inches to 8 inches in caliper	n/a	11
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Table 405.120-3 Landscape Units Awarded		
Landscape Material	Landscape Units Awarded	
	Newly Installed	Existing Retained
Deciduous tree, more than 2.5 inches to 4 inches in caliper	7	9
Deciduous tree, 1.5 inches to 2.5 inches in caliper or multistem	4	4
Shrubs, 36 inches high	1	1.2
Shrubs, 24 inches high	0.8	0.9
Shrubs, 18 inches high	0.5	0.6
Perennials/ground cover	1 per 400 square feet	
Annual flower bed	1 per 400 square feet	
Lawn grass	1 per 800 square feet	
Flower basket support	0.2 per basket	
Earthen berm, minimum 18 inches high	0.05 per linear foot	

Hardscape Material	Units Awarded
Split rail fence	0.20 per linear foot
Screening (opaque) fence	0.40 per linear foot
Shredded bark or 3 inches plus rock mulch, such as river rock	1 per 500 square feet
Ornamental pavers	1 per 250 square feet
Landscape boulders, 3 feet or greater in height	1 per boulder
Seating	0.40 per linear foot
Landscape lighting, sculpture, art, water feature, and/or sheltering structure/landmark	As determined by Director

Retained Existing Vegetation Mass ¹	Bonus Landscaping Units Awarded
300 or more square feet with a minimum of 3 deciduous trees (4 inches in caliper or greater), 3 evergreen trees (minimum 6 feet high) or any combination thereof	15%
500 or more square feet with a minimum of 5 deciduous trees (4 inches in caliper or greater), 5 evergreen trees (minimum 6 feet high) or any combination thereof	20%
800 or more square feet with a minimum of 8 deciduous trees (4 inches in caliper or greater), 8 evergreen trees (minimum 6 feet high) or any combination thereof	25%

NOTES:

¹ Points awarded for retained vegetation in perimeter buffers may only be applied in the buffer area along the same lot line or street frontage where the vegetation is found.

- d. *Parking Lot Landscaping.* The following landscaping requirements shall be met for all off-street surface parking lots. Figure 405.120-A identifies the three (3) required types

of parking lot landscaping.

(1) Parking lot perimeter landscaping is required around the entire perimeter of a parking lot as follows:

- (a) Perimeter parking lot landscaping of a minimum width of ten (10) feet shall be required for all parking lots having more than three (3) spaces where the parking lot is adjacent to a public street or a nonretail or industrial use such as a residential area, institutional use (e.g., hospital) or office.
- (b) The parking lot perimeter landscaping shall achieve a minimum of one and two-tenths (1.2) landscape units per linear foot.
- (c) Where lots are being developed in a mixed-use district, the parking lot perimeter landscaping requirement may be reduced along an interior lot line, at the discretion of the Director, provided that interior parking lot landscaping applies to both parking lots.

(2) Internal landscaping shall be provided as follows:

- (a) Landscape strips shall be installed between the parking rows of every other double row of parking when parking rows exceed fifty (50) parking spaces. Landscape strips shall be designed as follows:
 - i. Be a minimum of twelve (12) feet in width and shall extend the length of the parking row.
 - ii. Include a five-foot wide sidewalk and a seven-foot wide planting strip.
 - iii. Meet planting requirements for interior landscape islands, as outlined below.
- (b) Landscape islands shall be installed for every ten (10) parking spaces contained in a parking row, either within the parking row or at the end of the parking row and shall be designed as follows:
 - i. Be a minimum of six (6) feet in width and at least two hundred (200) square feet in total area.
 - ii. Be sunken below the level of the parking lot surface to allow for runoff capture.
 - iii. Have a minimum of four (4) five-gallon deciduous shrubs and one (1) deciduous tree, a minimum of two and one-half inches in caliper, per two hundred (200) square feet.
 - iv. Incorporate perennials and grasses for seasonal color.
 - v. Contain a minimum of fifty percent (50%) living landscaping material, with a maximum of fifty percent (50%) nonliving landscaping material. Approved sidewalks are not counted toward the nonliving landscape material percentage.

- (3) *Curbs.* Landscaped areas within parking lots or the along perimeter of the property must be protected from vehicular traffic through the use of continuous concrete curbs, unless GSI/stormwater BMPs are used. At least one break per ten (10) linear feet of curb is required to allow for runoff inflows into the landscaped areas. If GSI/stormwater BMPs are implemented within the landscape area alternative edging may be used to allow for sheet flow of stormwater runoff into the facilities.
- e. *Site distance triangle.* A site distance triangle within the off-street parking area must be established at street intersections by maintaining a maximum height for shrubs and ground cover of thirty (30) inches. No obstructions are permitted in the site distance triangle, including tree branches that must be trimmed within eight (8) feet of the ground. All applicable sight distance requirements must be met for parking lot internal circulation and access points to the public right-of-way.
4. *Landscaping standards.* All landscaping elements, including but not limited to planters, retaining walls and berms, must be specifically approved and shall conform to the following standards:
- a. *Preservation of existing vegetation.* Landscaping plans should be designed to preserve and protect existing native vegetation and mature trees. Bonus landscape credit shall be awarded for preserved vegetation as indicated in Table 405.120-3, Landscape Units Awarded, above, where the Director accepts the existing vegetation as being in good health and meets the intent of the landscaping requirements of this Chapter.
- b. *Allowed plant materials.* Proposed materials must be specified on development plans. A-For a list of permissible plant species, refer to the resources found within the stormwater management design criteria. ~~that are compatible with various climate zones found in the City shall be adopted by the Planning and Zoning Commission and may be amended from time to time.~~ Materials not on the list may be approved if the Director determines that they are equally or more suitable for local soil conditions and local climate requirements, and that the requested materials would provide the same or better level of visual benefits and have desired growth habits. No noxious weeds, as defined by the State, are permitted for use in the City.
- c. *Revegetation.*
- (1) All disturbed areas must be adequately reseeded and restored on all projects. A revegetation bond, satisfactory to the Director, must be furnished as a condition of certificate of occupancy and shall remain in full force and effect until the landscaping plan is completed, vegetation is sufficiently established, and ~~structural temporary erosion and sediment control~~ best management practices (BMPs), such as silt fence and straw bales, are removed from the site.
- (2) In all disturbed areas, soil must be prepared with tilling and the addition of decomposed organic matter, such as, but not limited to, compost, composted horse manure, or composted chopped straw or hay. Straw tackifier or matting on steep slopes is required to prevent soil erosion. The addition of decomposed organic matter is also required prior to turf installation.

d. *Retaining walls.*

(1) Where retaining walls are used, they shall not exceed six (6) feet in height and shall either incorporate the use of native materials or be earth tone colors to match the native soils and rocks. In instances where the topographic conditions justify additional retaining walls, there shall be a minimum planting area of five (5) feet between the walls.

(2) In cases where the wall is split into multiple sections, a minimum of five (5) five-gallon shrubs for each twenty (20) feet of linear planting area shall be planted in the area between the walls and at the base of the lowest wall.

e. *Stormwater management. The requirements of Section 405.070 Stormwater Management and Natural Area Protection Standards should be considered when designing landscaping. Opportunities to meet both the requirements of this Section and Section 405.070 with vegetated GSI/stormwater BMPs are encouraged.*

B. *Screening.*

1. *Single-family residential screening.* To the maximum extent practicable, utility equipment on residential lots shall be located behind the front building line of the house and screened from public view by an opaque wall, fence or landscaping screen. Alternative locations may be approved by the Director to allow for the retention of existing trees on wooded sites. Roof-mounted mechanical equipment, except solar energy collection systems, is prohibited on single-family residential dwellings.
2. *Multifamily, mixed-use and commercial screening.* For all developments other than single-family residential, the following mechanical equipment screening standard shall apply to the maximum extent practicable.
 - a. *Roof-mounted mechanical equipment.* Roof-mounted mechanical equipment shall be screened by a parapet wall or similar feature that is an integral part of the building's architectural design. The parapet wall or similar feature shall be of a height equal to or greater than the height of the mechanical equipment being screened. See Figure 405.120-B.
 - b. *Wall-mounted mechanical equipment.* Wall-mounted mechanical equipment, except air-conditioning equipment (e.g., window air-conditioning units), that protrudes more than six (6) inches from the outer building wall shall be screened from view by structural features that are compatible with the architecture and color of the subject building. Wall-mounted mechanical equipment that protrudes six (6) inches or less from the outer building wall shall be designed to blend with the color and architectural design of the subject building.
 - c. *Ground-mounted mechanical equipment.* Ground-mounted mechanical equipment shall be screened from view by landscaping or by a decorative wall that is compatible with the architecture and landscaping of the development site. The wall shall be of a height equal to or greater than the height of the mechanical equipment being screened.
 - d. *Utilities.*

- (1) Utility poles (other than wooden poles erected by a public utility company) and supports shall be painted or be of materials neutral in color.
 - (2) All transformers and other facilities and equipment, including telecommunications equipment, shall either be screened through the use of architectural materials compatible with the architectural materials present on the site or, alternatively, through landscape screening.
 - (3) Such screening shall be adequate to completely screen such facilities from all rights-of-way.
- e. *Alternate screening.* Mechanical equipment that is not screened in full compliance with the screening standards of this Section shall be reviewed in accordance with the procedures of Section 405.030(H), Alternative Compliance. Alternate screening methods may include, but shall not be limited to, increased setbacks, increased landscaping, grouping the equipment on specific portions of a site and painting or otherwise camouflaging the equipment.
3. *Screening of service, loading and storage areas.*
- a. *Applicability.* These screening requirements are applicable to all service, loading and storage areas. Owners are encouraged to locate the types of features listed in this Subsection where they are not visible from off-site or from public areas of a site, so that screening is unnecessary.
 - b. *Placement.*
 - (1) All service areas shall be placed at the rear, on the side of, or inside buildings. See Figure 405.120-C.
 - (2) No service area shall be visible from a public right-of-way or from adjacent residential areas.
 - (3) Service areas and access drives shall be located so they do not interfere with the normal activities of building occupants or visitors on driveways, walkways, in parking areas or at entries.
 - c. *Outside storage areas and loading docks.*
 - (1) All storage areas, service areas and loading docks not screened by an intervening building shall be screened from view from any public street right-of-way. In addition, storage and loading areas must be screened from view from any adjoining property when that property requires a buffer. On property zoned or used industrial, all outside storage areas that are adjacent to nonindustrial zoned property must also be screened from view.
 - (2) An opaque screen consisting of one (1) or a combination of the following shall be used:
 - (a) Freestanding walls, wing walls or fences;

- (b) Earthen berms in conjunction with trees and other landscaping; or
 - (c) Landscaping, that must be opaque and eight (8) feet in height within eighteen (18) months of planting.
- (3) Screening shall be a minimum height of eight (8) feet to screen truck berths, loading docks, areas designated for permanent parking or storage of heavy vehicles and equipment or materials.
- (4) Screening shall be long enough to screen the maximum size trailer that can be accommodated on site. Sites that can accommodate a full-size tractor-trailer shall provide a forty-eight-foot wing wall, where wing walls are used.
- d. *Shopping cart storage.* All shopping carts shall be stored inside the building they serve. Shopping cart corrals shall be made of a material suitable for withstanding weathering and rusting. Plastic corrals are prohibited.
- e. *Refuse facility screened.* All refuse facilities, including new refuse facilities placed on an existing development, shall be large enough to accommodate a trash dumpster and shall be completely screened from view of public streets and adjoining nonindustrial zoned properties by:
 - (1) Meeting the requirements of the other sections of this Section; or
 - (2) Screening on three (3) sides by a minimum six-foot wall surrounded by evergreen landscaping. See Figure 405.120-D. An opening shall be situated so that the container is not visible from adjacent properties or public streets and the opening shall be a wood or metal clad opaque gate. Chain-link gates are not permitted. Gates must have tie backs to secure in the open position.
- f. *Design of screening.* All screening shall be complementary to the building served in landscaping approach and through the use of similar colors and material palette.

§ 405.130. Sustainability.**A. Wind Energy.**

1. *Purpose.* This Subsection is intended to promote the compatible use of small wind-energy systems. Wind energy is an abundant, renewable, and nonpolluting energy resource. When converted to electricity, it reduces our dependence on nonrenewable energy resources and reduces air and water pollution that result from conventional sources. Distributed wind-energy structures also enhance the reliability and power quality of the power grid, reduce peak power demands, and increase local electricity generation.
2. *Small wind-energy standards.* Small wind-energy systems shall be a permitted accessory use in all zoning districts subject to the following requirements:
 - a. *Tower system standards.*
 - (1) A wind tower for a small wind-energy system shall be set back a distance of one (1.0) times its total height from:
 - (a) Any public road right-of-way, unless written permission is granted by the governmental entity with jurisdiction over the road;
 - (b) Any overhead utility lines, unless written permission is granted by the affected utility; and
 - (c) All property lines.
 - (2) The maximum height of a small wind-energy system tower shall be seventy-five (75) feet. Systems taller than seventy-five (75) feet shall be required to obtain a conditional use permit.
 - b. *Vertical axis wind turbine standards.* A vertical axis wind turbine (VAWT) using vertical wind turbine technology shall be permitted in all zone districts as an accessory use, subject to the following requirements:
 - (1) *Residential district requirements.*
 - (a) A maximum of one (1) VAWT is permitted per lot or one (1) per acre, whichever is greater.
 - (b) Building-mounted VAWTs shall not exceed forty (40) feet in height measured from the base attached to the structure to the highest point on the VAWT.
 - (c) The maximum height for a VAWT shall not exceed seventy- five (75) feet measured from the base of the tower to the highest point on the VAWT.
 - (d) A VAWT shall be set back a distance of one (1.0) times its total height from:
 - i. Any public road right-of-way, unless written permission is granted by the governmental entity with jurisdiction over the road;
 - ii. Any overhead utility lines, unless written permission is granted by the

affected utility; and

- iii. All property lines, unless written permission is granted from the affected land owner or neighbor.

(2) *Nonresidential district requirements.* Multiple VAWTs are permitted on any nonresidential lot subject to the following requirements:

- (a) Building-mounted VAWTs shall not exceed forty (40) feet in height measured from the base attached to the structure to the highest point on the VAWT.
- (b) Light-pole-mounted VAWTs shall not exceed twenty-five (25) feet in height measured from the top of the light pole to the highest point on the VAWT.
- (c) The maximum height for a VAWT shall not exceed seventy- five (75) feet measured from the base of the tower to the highest point on the VAWT.
- (d) A VAWT shall be set back a distance of one (1.0) times its total height from:
 - i. Any public road right-of-way, unless written permission is granted by the governmental entity with jurisdiction over the road;
 - ii. Any overhead utility lines, unless written permission is granted by the affected utility; and
 - iii. All property lines, unless written permission is granted from the affected land owner or neighbor.

3. *General standards for tower and VAWT systems.*

- a. *Lighting.* A small wind-energy system or VAWT shall not be artificially lighted unless such lighting is required by the Federal Aviation Administration. A light temporarily used to inspect a turbine, tower and associated equipment is permissible, provided that said light is only used for inspection purposes and not left on for an extended period of time.
- b. *Decibel levels.* Decibel levels for a small wind-energy system or VAWT shall not exceed the lesser of sixty (60) decibels (dBa) as measured at the closest neighboring inhabited dwelling, except during short-term events, such as utility outages and severe wind storms.
- c. *Color.* The color of the small wind-energy system shall either be the stock color from the manufacturer or painted with a nonreflective, unobtrusive color that blends in with the surrounding environment. Approved colors include but are not limited to white, off-white or gray.
- d. *Signs.* All signs, other than the manufacturer's or installer's identification, appropriate warning signs, or owner identification on a wind generator, tower, building, or other structure associated with a small wind-energy system or VAWT visible from any public road shall be prohibited.
- e. *Code compliance.* A wind-energy structure including tower shall comply with all

applicable State construction and electrical codes, and the National Electrical Code as adopted by the City.

- f. *Screening.* Ground-level mechanical equipment associated with the wind-energy system shall conform to Section 405.120(B), Screening.

4. *Other standards.*

- a. The structure shall comply with all applicable Federal Aviation Administration requirements, including but not limited to Subpart B (commencing with Section 77.11) of Part 77 of Title 14 of the Code of Federal Regulations regarding installations in excess of two hundred

(1) (200) feet in height and installations close to airports. The system shall also comply with any and all Missouri aeronautics regulations.

- b. All electrical wires associated with a wind-energy system, other than wires necessary to connect the wind generator to the tower wiring, the tower wiring to the disconnect junction box, and the grounding wires shall be located underground.
- c. A VAWT tower shall be designed and installed so as to not provide step bolts or a ladder readily accessible to the public for a minimum height of eight (8) feet above the ground.
- d. No part of the system, including guy wire anchors, may be closer than five (5) feet from any property boundary.
- e. Temporary meteorological (Met) towers shall be permitted under the same standards as a small wind-energy system, except that the requirements shall be the same as those for a temporary structure. A permit for a temporary Met tower shall be valid for a maximum of three
 - (1) (3) years after which an extension may be granted. Permanent Met towers may be permitted under the same standards as a small wind energy system.
- f. All ground-mounted electrical and control equipment shall be labeled or secured to prevent unauthorized access.

- 5. *New technology.* The Director may waive the provisions of these requirements through the alternative compliance process in Section 405.030(H) where the availability of new technology alleviates the issues addressed by these regulations.

- 6. *Decommissioning.* A wind-energy system that has reached the end of its useful life shall be removed within six (6) months of such determination. A wind-energy system is considered to have reached the end of its useful life when it has been inoperable for twelve (12) consecutive months. Time extensions are allowed when good faith efforts to repair the turbine can be demonstrated.

B. *Solar Energy Systems.*

- 1. *Purpose.* This Subsection is intended to promote the compatible use of solar energy systems

and to assist in decreasing the City's dependence upon non- renewable energy systems through the encouragement of solar energy systems for the heating of buildings and water.

2. *Applicability.*

- a. Solar energy systems are permitted in all zoning districts as an accessory use.
- b. A solar energy system shall provide power for the principal use and/or accessory use of the property on which the solar energy system is located.

3. *Roof-mounted solar.* The installation and construction of a roof-mounted solar energy system shall be subject to the following development and design standards:

- a. A roof- or building-mounted solar energy system may be mounted on a principal or accessory building.
- b. A roof-mounted solar collection system shall not exceed by more than eighteen (18) inches above the roof on which it is located, nor shall it extend a minimum of one (1) foot below the ridge line.
- c. A solar collection system may be located on an accessory structure.
- d. The zone district height limitations of this Code shall not be applicable to solar collectors, provided that such structures are erected only to such height as is reasonably necessary to accomplish the purpose for which they are intended to serve, and that such structures do not obstruct solar access to neighboring properties.
- e. Placement of solar collectors on flat roofs shall be allowed by right, provided that panels do not extend horizontally past the roofline.
- f. A development proposed to have a solar collection system located on the roof or attached to a structure, or an application to establish a system on an existing structure, shall provide a structural certification as part of the building permit application.

4. *Ground- or pole-mounted solar.* The installation and construction of a ground- mounted or pole-mounted solar energy system shall be subject to the following development and design standards:

- a. The height of the solar collector and any mounts shall not exceed twenty (20) feet when oriented at maximum tilt.
- b. Any solar collector and any mounts, in a residential district, shall not exceed the greater of one-half (1/2) the footprint of the principal structure or six hundred (600) square feet, whichever is greater. The size of any solar collector and any mounts in mixed use and non-residential districts shall not exceed one-half (1/2) of the footprint of the principal structure.
- c. The surface area of a ground- or pole-mounted system, regardless of the mounted angle, shall be calculated as part of the overall coverage.
- d. The minimum solar energy system setback distance from the property lines shall be equivalent to the building setback or accessory building setback requirement of the

- underlying zoning district, and the system may not be located in the front yard.
- e. All power transmission lines from a ground-mounted solar energy system to any building or other structure shall be located underground and/or in accordance with the building electrical code, as appropriate.
 - f. All abandoned or unused freestanding solar energy systems shall be removed within twelve (12) months of the cessation of operations.
5. *Electrical equipment.* All electrical equipment associated with and necessary for the operation of solar energy systems shall comply with the setbacks specified for accessory structures in the underlying zoning district.
 6. *Solar panel orientation.* Solar panels are designed to absorb (not reflect) sunlight; and, as such, solar panels are generally less reflective than other varnished or glass exterior housing pieces. However, solar panel placement should be prioritized to minimize or negate any solar glare onto nearby properties or roadways, without unduly impacting the functionality or efficiency of the solar system.
 7. *Administrative review process.*
 - a. *In general.* The Director, in consultation with Code Enforcement, shall have up to fifteen (15) working days following the submittal of a complete application to approve or deny such application. The Director may impose such conditions and require such guarantees deemed reasonable and necessary to protect public interest and to ensure compliance with the standards and purposes of this Zoning Ordinance and policies of the land use.
 - b. All solar collection installations shall be performed by a qualified solar installer, and, prior to operation, the electrical connections shall be inspected by the Code Enforcement Director. In addition, any connection to the public utility grid must be inspected by the appropriate public utility.
 - c. *Submittal requirements.* An application for a solar energy system shall be filed on a form, approved by the Director, with any other required documentation he or she should deem necessary.
 8. *Conflict with other municipal policies and ordinances.* Nothing in this Subsection does, or is intended to, abrogate the owner's responsibility to meet all other requirements of this Code, including, but not limited to, the preservation of private and public views, the quality of architectural design, the preservation of historic landmark structures, or the like.

C. Green Stormwater Infrastructure.

1. *Purpose.* This Subsection is intended to promote the use of green stormwater infrastructure in both public improvement projects and private development projects. Green stormwater infrastructure is defined as stormwater management solutions designed to capture, filter, absorb, and/or re-use stormwater by mimicking natural hydrologic processes.
 - a. *Terminology.* Green stormwater infrastructure (GSI) may also be referred to as green infrastructure, stormwater control measures, or post-construction permanent

stormwater best management practices (stormwater BMPs).

b. *Distinguishing between Temporary Construction and Post-Construction BMPs.*

(1) Temporary construction BMPs, also known as erosion and sediment control BMPs, are those designed and installed specifically to minimize the impacts of sediment carried in runoff from active construction sites.

(2) Post-construction stormwater BMPs are designed to capture and treat runoff on a long-term basis following completion of construction.

2. *Applicability.* All improvements defined in Section 405.030(O), Drainage Permit are encouraged to use green stormwater infrastructure to meet the City's stormwater management requirements, defined in Section 405.070, Stormwater Management and Natural Area Protection Standards.

3. *Principles.*

a. *Utilize and protect the natural stormwater system.* Natural drainage paths, streams, undisturbed green spaces, wetlands and riparian areas are all efficient low-cost natural stormwater management features. This is the existing natural stormwater management system and should be preserved and utilized where practical. Replacing the services provided by these natural systems with man-made systems requires significant capital investment and time, creates the need for ongoing operation and maintenance of these systems, and reduces the value of natural resources.

b. *Capture rain where it falls.* Managing rain with the use of green stormwater infrastructure in close proximity to where it hits the ground can reduce the need for stormwater pipes and can provide a more efficient means for infiltration and treatment of runoff. Green stormwater infrastructure can also help create a more aesthetically pleasing environment, provide improved pedestrian connectivity, maintain natural areas, reduce heat islands and improve air quality.

~~d.~~c. *Minimize impervious surfaces.* Impervious surfaces, such as roadways, parking lots and rooftops, reduce the available area for infiltration and increase the rate and volume of runoff. By minimizing impervious surfaces, stormwater volume and flow rates can be decreased, thereby reducing likelihood of flash flooding, stream channel erosion and impaired water quality. Development and redevelopment improvements are encouraged to minimize increased impervious areas through use of alternative permeable materials, or, remove un-used impervious areas to reduce the negative impacts of development on the City's stormwater management systems.

§ 405.140. Subdivision Design Standards.

A. *General Purpose And Intent.* The purpose and intent of these regulations is to provide for the harmonious development of the community and the surrounding area; to provide for the proper location and width of streets, building lines, open spaces, safety and recreation facilities, utilities, drainage, and for the avoidance of congestion of populations through requirements of minimum lot width, depth and area and the compatibility of design; to require and fix the extent to which and the manner in which streets shall be graded and improved and water, sewer, drainage, and other utility mains and piping or connections or other physical improvements shall be installed; and to provide for and secure the actual construction of such physical improvements.

~~B. *Submission Requirements.* The following information shall be submitted for subdivision plat applications:~~

~~1. *Preliminary plat.* Five (5) prints of a preliminary plat of any proposed subdivision shall be submitted to the Planning and Zoning Commission at least ten (10) days before the meeting at which approval is asked. The preliminary plat shall be drawn at a scale of one hundred (100) feet to the inch. The preliminary plat shall show or be accompanied by the following information:~~

- ~~a. The proposed name of the subdivision and names of adjacent subdivisions.~~
- ~~b. The names of the owner and the engineer, surveyor or landscape architect responsible for the survey and design.~~
- ~~c. The location of boundary lines and their relation to established section lines or fractional section lines.~~
- ~~d. The location and size of existing and proposed streets, roads, lots (approximate dimensions), alleys, water, sewer and drainage facilities, parks, school sites and other features of the proposed subdivision. The plan shall show the outline of adjacent properties for a distance of at least three hundred (300) feet, and how the streets, alleys or highways in the proposed subdivision may connect with those adjacent which are of record.~~
- ~~e. Survey showing physical features of the property, including watercourses, ravines, bridges, culverts, present structures and other features of importance of lot and street layout. The approximate acreage of the property shall be indicated. Topography of the tract shall be shown on the preliminary plan by means of contours of two-foot intervals.~~
- ~~f. Approximate gradients of streets. All grades shall be based on City datum.~~
- ~~g. The current zoning classification of land within the subdivision.~~
- ~~h. Center line profiles of proposed streets may be required by the Planning and Zoning Commission.~~
- ~~i. North point, scale and date.~~

~~2. *Final Plat.*~~

~~a. After the preliminary plat has been approved by the Planning and Zoning Commission or the Board of Aldermen on appeal, a final plat for record shall be prepared and submitted to the Planning and Zoning Commission for approval by that body and by the Board of Aldermen. Five (5) prints of the plat shall be filed in the office of the Planning and Zoning Commission at least ten (10) days prior to the meeting at which approval is asked. The original plat shall be drawn in India ink on linen or better and shall show or be accompanied by the following information:~~

- ~~(1) The name of the subdivision and subdivisions, the names of streets (to conform wherever possible to existing street names), and the number of lots and blocks in accordance with a systematic arrangement.~~
- ~~(2) An accurate boundary survey of the property, with bearings and distances, referenced to section or fractional section corners and showing (in dotted lines) the lines of immediately adjacent streets and alleys with their widths and names.~~
- ~~(3) Location of lots, streets, public highways, alleys, parks and other features, with accurate dimensions in feet and decimals of feet, with the length and radii of all curves, and with all other information necessary to duplicate the plat on the ground.~~
- ~~(4) The location of building setback lines on all streets and the location and dimension of utility and drainage easements and other public right-of-way or access.~~
- ~~(5) Dedication of all streets, public highways, alleys, parks and other land intended for public use signed by the owner or owners and by all other parties who have lease rights, mortgage or lien interest in the property, together with any restrictions which are to apply to the lots.~~
- ~~(6) Certification by a registered land surveyor to the effect that the plat represents a survey made by him/her and that all the necessary boundary survey monuments are correctly shown thereon.~~
- ~~(7) North point, scale and date.~~

~~b. All figures and letters shown must be plain, distinct and of sufficient size to be easily read and must be of sufficient density to make a lasting and permanent record. When more than one (1) sheet is used, a key map, showing the entire subdivision at smaller scale with block numbers and street names, shall be shown on one (1) of the sheets or on a sheet of the same size. A copy of such restrictions as may be filed in connection with the property shall be submitted with the final plat.~~

~~C.B.~~ *Blocks, Lots And Easements.*

1. *Block length.*¹

- a. Intersecting streets (which determine block length) shall be provided at such intervals as to serve cross traffic adequately and to meet existing streets in the neighborhood.
- b. In residential districts, where no existing plats are recorded, the blocks shall not exceed

- one thousand three hundred twenty (1,320) feet in length, except that a greater length may be permitted where topography or other conditions justify a departure from this maximum.
- c. In blocks longer than eight hundred (800) feet, pedestrianways and/or easements through the block may be required near the center of the block.
 - d. Such pedestrianways or easements shall have a minimum width of ten (10) feet.
2. *Block width.*
- a. In residential development, the block width shall normally be sufficient to allow two (2) tiers of lots of appropriate depth.
 - b. In certain instances, however, a different arrangement may be required in order to provide better circulation or to protect a major circulation route.
 - c. Blocks intended for business or industrial use shall be of such width and depth as may be considered most suitable for the prospective use.
3. *Lots.*
- a. Minimum lot width shall be measured at the building setback line. In addition, corner lots should have a width fifteen (15) feet greater than the minimum width.
 - b. Minimum lot depth should be one hundred (100) feet. This measurement shall be made through the center of the lot and shall be perpendicular to the property line or radial to the property line on curved streets.
 - c. Minimum lot area shall be subject to the zoning regulations of the district in which the subdivision is located and the minimum design standards of this regulation. The more restrictive of the regulations shall govern.
 - d. All side lot lines shall bear between sixty degrees (60°) and ninety degrees (90°) from the street right-of-way line on a straight street or from the tangent of a curved street.
 - e. Front building or setback shall be shown on the final plat for all lots in the subdivision and shall not be less than the setbacks established by the zoning regulations or any other regulations adopted by the Board of Aldermen; the most restrictive setback requirement shall govern.
 - f. Double-frontage lots shall be avoided unless, in the opinion of the Planning and Zoning Commission, a variation to this rule will give better street alignment and lot arrangement.
 - g. Every lot shall abut on a public street other than an alley.
 - h. The subdivision or resubdivision of a tract or lot shall not be permitted where said subdivision or resubdivision places an existing permanent structure in violation of the requirements of the zoning regulations or the minimum design standards of these regulations.

- i. Where possible, residential lots should not be designed to face on arterial streets. The number of lots facing on collector streets shall be kept to a minimum. The street pattern shall be designed so that the side lines of lots abut arterial and collector streets wherever land shapes and topography permit.

4. *Easements.*

- a. Where alleys are not provided, permanent easements of not less than ten (10) feet in width shall be provided on each side of all rear lot lines and three (3) feet in width on side lot lines, where necessary, for utility poles, wires, conduits, underground conductors, storm and sanitary sewers, gas, water and heat mains, and other public utilities.

(1) These easements shall provide for a continuous right-of-way.

(2) Where the utility company or agency has the need for a wider easement than required above for a specific location, this easement shall be shown on the plat.

(3) Permanent easements shall not be obstructed by structures, retaining walls or trees.

(4) A property owner may install fences and landscape the easement with grass and shrubs at his/her own risk.

(5) A twelve-foot temporary construction easement shall be provided on each side of all lot lines for initial construction of water, sewer and other utility lines.

b. *Drainage easements.* All stormwater management components, including stormwater drainage setbacks, shall be placed in a drainage easement following the requirements of Section 405.070, Stormwater Management and Natural Area Protection Standards and the City of Warsaw's stormwater management design criteria. ~~If a subdivision is traversed by a watercourse, drainageway or channel, then a stormwater easement shall be provided. Such easement or right of way shall conform substantially to the lines of such watercourse and shall be of such width or construction, or both, as may be necessary to provide adequate stormwater drainage and for access for maintenance thereof.~~

D.C. *Streets And Alleys.*

1. *Relationship to adjoining street systems.*

- a. The arrangement of streets in new subdivisions shall make provisions for the continuation of the principal existing streets in adjoining additions (or their proper projection where adjoining property is not subdivided) insofar as they may be necessary for public requirements.
- b. The width of such streets in new subdivisions shall be not less than the minimum street widths established herein.
- c. Alleys, when required, and street arrangements must cause no hardship to owners of adjoining property when they plat their land and seek to provide for convenient access to it.

- d. Whenever there exists a dedicated or platted half street or alley adjacent to the tract to be subdivided, the other half of the street or alley shall be platted and dedicated as a public way.
2. *Street names.* Streets that are obviously in alignment with other already existing and named streets shall bear the names of the existing streets. Street names should not be similar to already platted street names.
3. *Arterial streets.* Arterial streets through subdivisions shall conform to the major street plan of the Comprehensive Plan as adopted by the Planning and Zoning Commission and the governing body.
4. *Culs-de-sac.* An adequate turnaround of not less than a one-hundred-foot diameter right-of-way shall be provided at the closed end of a dead-end local street longer than one (1) lot in length. Such local street segment shall not exceed five hundred (500) feet in length from the center line of an intersection of a cross street to the center of the cul-de-sac.
5. *Right-angle intersections.* Under normal conditions, streets shall be laid out to intersect, as nearly as possible, at right angles. Where topography or other conditions justify a variation from the right-angle intersection, the minimum angle shall be sixty degrees (60°).
6. *Half streets.* Half streets shall be prohibited, except where no lots front on such half street.
7. *Alleys.*
 - a. Alleys may be required in commercial, industrial and residential areas.
 - b. Dead-end alleys shall be avoided, wherever possible, but if unavoidable, such alleys shall be provided with adequate turnaround facilities at the dead end.
 - c. Alleys should be avoided in residential areas except where alleys of adjoining subdivisions would be closed or shutoff by failing to provide alleys in the adjoining subdivision.
8. *Street alignment.* On streets with reverse curves, a reasonable tangent shall be provided between curves to permit a smooth flow of traffic.
9. *Street layout.* Proposed streets shall conform to topography as nearly as possible to reduce drainage problems and grades.
10. *Minimum requirements.* The right-of-way grades and widths for streets and alleys dedicated and accepted shall conform to the standardized regulations of the Kansas City Metropolitan Chapter APWA, 1997 Editions, as adopted in Section 500.050.
11. *Curbing.* Curbing shall be placed on all streets within a subdivision. Curbing design shall be presented by developer for approval by the City Engineer.

~~E.D.~~ Required Improvements. The subdivider shall install, or provide for the installation of, the following improvements:

1. *Streets.* The subdivider shall provide for the installation of paved streets. All street construction shall conform to the specifications of the Board of Aldermen, and compliance

therewith shall be confirmed by the City Engineer prior to release of surety by the Board of Aldermen.

2. *Walks.* Sidewalks shall be installed on both sides of all arterial and collector streets, and sidewalks shall be required on both sides of the street in a commercial district. All sidewalks shall be not less than five (5) feet in width of Portland cement concrete and shall comply with the specifications of the City Engineer. Sidewalks shall be located in the platted street right-of-way six (6) inches from the property line.
3. *Storm drainage.* The subdivider shall follow the stormwater standards as listed and referenced in Section 405.070, Stormwater Management and Natural Area Protection Standards. A drainage permit is required to demonstrate compliance with stormwater management standards per Section 405.030 (O), Drainage permit.~~install culverts, storm sewers, riprap slopes, stabilized ditches, and these and other improvements shall comply with the minimum standards of the Board of Aldermen as such plans shall be examined by the City Engineer and approved prior to construction.~~
4. *Sanitary sewers and other utilities.*
 - a. The subdivider shall be responsible to provide for and pay the full cost for the proper installation of all utilities, including sanitary sewer and connection to approved treatment facilities, and water supply, natural gas, electricity and telephone service. Such utilities shall be installed according to the specifications of the controlling utility company or public agency.
 - b. All structures within seven hundred fifty (750) feet of a public sewer system must utilize such public system for sewage disposal. Structures further than seven hundred fifty (750) feet from an existing sewer line may use a private sewage disposal system provided that the owner of such structure can demonstrate to the satisfaction of the Board of Aldermen that such private sewage system will function properly given its design, the anticipated volume of sewage and the characteristics of the site.
5. *Street signs.* The City shall install street signs at all intersections within a subdivision.
6. *Permanent monuments.* Permanent monuments shall be placed at all lot and block corners, angle points, point of curve in streets, and at intermediate points as required prior to the final acceptance of the plat by the City. Said permanent monuments shall be three-fourths-inch iron bars or pipe, eighteen (18) inches long, and shall be set with top of monument flush with existing ground line.
7. *Exceptions for existing improvements.* Where the proposed subdivision is a resubdivision or concerns an area presently having any or all required improvements as previously set out, and where such improvements meet the requirements of this Section and are in good condition as determined by the Board of Aldermen upon its consideration of the opinion of the City Engineer, no further provision need be made by the subdivider to duplicate such improvements. However, where such existing improvements do not meet the requirements of this Code as determined by the Board of Aldermen upon its consideration of the opinion of the City Engineer, the subdivider shall provide for the repair, correction or replacement of such improvements so that all final improvements will then meet the requirements of

this Code as determined by the Board of Aldermen upon its consideration of the opinion of the City Engineer.

**Section 500.050. City of Warsaw Standards and Procedures for Design and
Construction of All Public Works Projects.**

- A. The following ~~documents~~ shall be adopted and published on the City's website to establish standards and procedures for the construction of all public improvements, including works projects: streets, sewers, flood control, ~~and~~ storm water management ~~drain facilities~~, street lighting, landscaping and irrigation systems.
1. ~~The standard specification and design within the 1997 Edition,~~ American Public Works Association (APWA) ~~and the~~ standard specifications and design criteria of the Kansas City Metropolitan Chapter APWA as adopted and amended by the City of Warsaw.
 2. ~~The construction and material specification within the Water Division II Section 2900 of the American Water Works Association.~~
 3. 2. Street signs and traffic markings manual; the Federal Highway Administration Uniform Traffic Control Devices as adopted by the City of Warsaw. ~~Uniform Traffic Control Devices 2003 Edition.~~

APPENDIX B: STORMWATER MANAGEMENT DESIGN CRITERIA (APWA 5600) CLEAN FOR PUBLISH

**CITY OF WARSAW,
MISSOURI
STORMWATER
MANAGEMENT DESIGN
CRITERIA**

**DIVISION V
SECTION 5600
STORM DRAINAGE SYSTEMS &
FACILITIES**

September 2022

DIVISION V

DESIGN CRITERIA

5600 STORM DRAINAGE SYSTEMS & FACILITIES

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Division V
Design Criteria
SECTION 5600 STORM DRAINAGE SYSTEMS & FACILITIES

SECTION 5601 ADMINISTRATIVE

5601.1 Introduction

These criteria provide uniform procedures for designing and checking the design of storm drainage systems under the rainfall and land characteristics typical of the Kansas City Metropolitan Area. This manual generally focuses on water quantity concerns including: conveyance, flow rates, and construction design parameters of stormwater systems. For an in-depth discussion of water quality design standards and Best Management Practices (BMPs) for the Kansas City Metropolitan area see the “Mid-America Regional Council and American Public Works Association; Manual for Best Management Practices for Stormwater Quality”.

Federal law requires that “Waters of the United States may be disturbed only after permission is received from the City/County and permitted by the U.S. Army Corps of Engineers, if applicable. A jurisdictional determination by the Army Corps of Engineers shall be obtained prior to beginning design.” Besides federal guidelines, specific criteria have been developed and are applicable to the types of drainage systems and facilities ordinarily encountered in local urban and suburban areas. Other special situations may be encountered that require added criteria or more complex technology than included herein such as maintaining or improving water quality. Any design procedure conforming to current accepted engineering practice may be used for the design of storm drainage systems in lieu of the computation methods presented in this manual, providing equivalent results are obtained and have been approved by the City/County Engineer. Drainage systems for all developments shall be designed assuming ultimate or built-out land-use conditions. The decision flowchart in Figure 5601-1, “Guide to Stormwater Management for Site Development”, shall be used to determine the appropriate runoff controls (see end of this section).

5601.2 Definitions

Best Management Practice (BMP): Stormwater management practice used to prevent or control the discharge of pollutants to water of the U.S. BMPs may include structural or non-structural solutions, a schedule of activities, prohibition of practices, maintenance procedures, or other management practices. For a comprehensive discussion on BMPs refer to the “Mid-America Regional Council and American Public Works Association; Manual for Best Management Practices for Stormwater Quality”.

City/County: The municipality or body having jurisdiction and authority to govern.

City/County Engineer: The municipal or county public works official or body having jurisdiction and authority to review and approve plans and designs for storm drainage systems.

Channel Lining: Includes any type of material used to stabilize the banks or bed of an engineered channel.

Design Storm: The combination of rainfall depth, duration, and distribution of a hypothetical rainfall event with a given likelihood of occurring in any year.

Detention Facility: A storm water management facility controlling storm water runoff from a site or watershed. The allowable runoff specified for detention facilities in Section 5608 is intended to manage maximum storm water release rates to minimize flooding and downstream erosion.

Detention Storage: The volume occupied by water above the level of the principal spillway crest during operation of a stormwater detention facility.

Development: Any activity, including subdivision, that alters the surface of the land to create additional impervious surfaces, including, but not limited to, pavement, buildings, and structures. Refer to Section 5601.3 for applicability.

Dry Detention: A detention facility that is designed for the temporary storage of water to control discharge rates from the facility and is normally dry between rainfall events.

Easement: Authorization by a property owner for the use by another for a specified purpose, of any designated part of the property.

Emergency Spillway: A device or devices used to discharge water under conditions of inflow that exceed the design outflow from the primary spillway detention facility. The emergency spillway functions primarily to prevent damage to the detention facility that would permit the sudden release of impounded water.

Engineer: See 'Registered Professional Engineer'.

Engineered Channel: An open drainage channel that has been explicitly designed to convey stormwater runoff in accordance with Section 5607 or as approved by the City/County engineer.

FHWA: Federal Highway Administration.

Floodplain: A relatively level surface of stratified alluvial soils on either side of a watercourse that is inundated during flood events.

Freeboard: The difference in elevation between the top of a structure such as a dam or open channel and the maximum design water surface elevation or high water mark. It is an allowance against overtopping by waves or other transient disturbances.

Impact Stilling Basin: A device that dissipates energy by allowing flowing water to strike a stationary surface therefore producing turbulence and energy loss. .

Impervious Surface: A surface that prevents the infiltration of stormwater.

Improved Channel: Any channel changed by grading or the construction of lining materials as approved by the City/County Engineer.

Incision: Adjustment of the channel bed elevation downwards, typically in response to some type of disturbance.

Increased Runoff: Increase in volume or peak flow of stormwater runoff.

Meander Amplitude: The linear distance between the apex of one meander and the apex of the next meander in a naturally curving stream.

Meander Length: The length measured along the thalweg of one complete waveform.

Meander Wavelength: The length of one complete waveform, measured as the straight-line linear distance along the valley between two analogous points on a waveform.

Low-Drop Structures: A step pool energy dissipation structure typically constructed out of rock or concrete with a design vertical drop of 2 feet or less per step.

Natural Channel: Any waterway with the ability to self-form by virtue of having at least one unfixed boundary. This includes drainage ways that may have been previously disturbed but through inactivity over time have begun to reform one or more characteristics of undisturbed streams.

Open Channel: A maintained earthen or lined waterway with an open water surface as approved by the City/County engineer.

Ordinary High Water Mark: A line on the bank established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Owner: The owner of record of real property.

Point Bars: Depositional features generally occurring on the inside of stream bends and opposite cut banks.

Pools: A deep reach of a stream. The reach of a stream between two riffles; a small and relatively deep body of quiet water in a stream or river.

Primary Outlet Works: A device such as an inlet, pipe, weir, etc., used to discharge water during operation of a storage facility.

Principal Stream: Stream Segments included in FEMA Flood Insurance Studies where the limits of the 1% floodplain and 1% base flood elevations have been determined.

Redevelopment: Remodeling, repair, replacement, or other improvements to any existing structure, facility, or site.

Registered Professional Engineer: A licensed engineer who is registered with and authorized to practice engineering within the state of registration.

Riffles: Shallow rapids in an open stream, where the water surface is broken into waves by obstructions such as stream armoring or bedrock outcrop wholly or partly submerged beneath the water surface.

Sediment Storage: The volume allocated to contain accumulated sediments within a detention facility.

Site: A tract or contiguous tracts of land owned and/or controlled by a developer or owner. Platted subdivisions, industrial and/or office commercial parks, and other planned unit developments shall be considered a single site. This shall include phased development where construction at a tract or contiguous tracts of land may occur in increments.

Storm Drainage System: All of the natural and man-made facilities and appurtenances such as natural drainage paths, streams, pipes, culverts, bridges, open channels, swales, street gutters, inlets, retention/detention facilities, and stormwater BMPs/GSI which serve to convey and control surface drainage.

Stormwater Drainage Setback: preservation of vegetated areas adjacent to a natural drainage path or stream defined by a drainage easement with limitations on allowable development and

uses. Stormwater drainage setbacks consist of preservation, protection, and limited-use setback widths.

Swale: An engineered channel conveying stormwater from more than two lots; often the swale is maintained by the property owner but an easement is required when requested by the City/County.

Thalweg: The deepest part of a channel cross-section. The dominant thread of stream flow creates the thalweg.

Top of Bank: The vertical point along a stream bank where an abrupt change in slope is evident, typically representative of the bank-full or channel-forming flow caused by approximately the 2-year design storm.

Tributary Area: All land draining to the point of consideration, regardless of ownership. Tributary area may also be referred to as watershed.

Waveform: A complete cycle of two channel bends in opposite directions.

Wet Detention: A detention facility that is designed to include permanent storage of water in addition to the temporary storage used to control discharge rates from the facility.

5601.3 General Requirements and Applicability

The design shall be accomplished under the direction of a Registered Professional Engineer qualified in the field of stormwater design. The design shall be based on land use in the tributary area as zoned, actually developed, or indicated by an adopted future land use plan, whichever basis produces the greatest runoff. Compliance with criteria shall be demonstrated through application and approval of a Stormwater Drainage Permit per Paragraph 5601.5, A.

This design criterion shall apply to all new development and redevelopment, including subdivision development and construction, which alters the surface of the land to create additional impervious surfaces, including, but not limited to, pavement, buildings, and structures with the following exceptions:

- A. **Exceptions for Existing Development:** Improvements that cause an increased area of impervious surface on the site less than 1,000 square feet.
- B. **Exceptions for New Development:**
 - 1. Construction of any one new single family or duplex dwelling unit provided the total impervious area of the site is less than 5,000 square feet.
 - 2. Construction on a site having previously provided stormwater management per the stormwater criteria adopted herein as part of a larger unit of development assuming fully developed conditions. If previously provided stormwater management for the project predates these standards, stormwater management shall be re-evaluated for compliance with the current requirements.

5601.4 Existing Drainage System

Existing drainage system component pipes, structures, and appurtenances within the project limits may be retained as elements of an improved system providing:

- They are in sound structural condition.
- Their hydraulic capacity, including surcharge, is equal to or greater than the capacity required by these criteria.

- Easements exist or are dedicated to allow operation and maintenance.

Discharge from an existing upstream storm drainage system shall be computed assuming its capacity is adequate to meet the performance criteria listed in Paragraph 5601.5. The computed discharge shall be used to design the new downstream system even if the actual capacity of the existing upstream system is less.

5601.5 Stormwater Management Requirements

Natural drainage paths and streams are to be preserved to the maximum extent practicable as site conditions permit. Requirements for preservation of natural drainage paths and streams are addressed in Section 5605. Engineered channels, the next highest priority system component, shall be designated and coordinated with the design of building lots and streets in accordance with the design criteria and performance standards addressed in Section 5607.

To the maximum extent possible, drainage systems, street layout and grades, lot patterns and placement of curbs, inlets and site drainage, and overflow swales shall be concurrently designed in accordance with the design criteria and performance standards set forth in this document. Curb and gutter may be omitted or modified where feasible in conjunction with other stormwater management practices including green stormwater infrastructure.

All improvements defined in Paragraph 5601.3 shall incorporate stormwater management measures to control runoff from the site. Allowable runoff from a site may be limited by the need to minimize downstream flood damage, prevent erosion, and/or minimize impacts to the ecology and water quality of the downstream drainage system. A layered approach to stormwater management level of service is applied to distribute the stormwater risk created from improvements throughout the watershed and provide protection for the community as a whole.

A. Stormwater Drainage Permit: A stormwater Drainage Permit per the City of Warsaw Code of Ordinances Chapter §405.020 is required to demonstrate compliance with this design criteria, as detailed in Section 5609.

B. Protection of Property

1. Property not reserved or designed for conveying storm water shall be protected from frequent inundation:
 - a. When the total drainage area including all upstream tributary area is less than 2 acres, protection may be provided by following the following lot-to-lot grading practices or by one of the conveyances described as follows.
 - 1) Maintain natural drainage path preservation/overflow system per Paragraph 5601.5,C, 1. such that the freeboard requirements for protection of buildings are met.
 - 2) When swales (engineered channels) are required for overflow systems, swales shall be approximately centered on the rear and/or side lot line with a minimum 15-foot drainage easement.
 - 3) Lawn grading shall maintain slopes between 1% and 33% (3 horizontal : 1 vertical) graded to drain away from buildings. Grading shall be designed to avoid localized sumps with potential to create ponding or flooding issues within the property or between multiple properties. If localized sumps are unavoidable, a drainage system shall be required. Drainage system may include collection and conveyance. Retention designs using GSI/stormwater BMP are also encouraged, as defined in Section 8 of the MARC BMP

Manual. See the KCMO GSI Manual for detailed design and construction guidance of GSI/stormwater BMPs.

- b. When the total drainage area is 2 acres or more, one or a combination of the following conveyances must be used to meeting the conveyance system requirements specified in Paragraph 5601.5 B
 - 1) Enclosed pipe system
 - 2) Engineered channel
 - 3) Street gutter
 - 4) Natural drainage path or stream
 - 2. Buildings shall be protected from infrequent flooding by:
 - a. Providing a minimum of one-foot freeboard above the 100-year design storm stage based on a 10% temporal distribution, at any point along the drainage system, for openings in a building. For dry and wet detention facilities the 100-year design storm stage will be the water surface elevation of flow through the primary spillway.
 - b. Flood-proofing a building below the 100-year design storm with 10% temporal distribution water surface elevation plus one foot of freeboard, in accordance with the current edition of the International Building Code or as required by the City/County.
 - c. Non habitable accessory buildings are sometimes provided less protection by local City/County ordinances or policies. Consult the local authority for exceptions.
- C. **Retention:** Stormwater retention shall be provided for the 0.5-inch design event over the tributary impervious area from the site. Retention-based facilities are designed to either capture and infiltrate or re-use the required retention volume with no discharge from the site for the minimum design event. Retention shall be provided in the form of GSI/stormwater BMPs, as defined in Section 8 of the MARC BMP Manual. See the KCMO GSI Manual for detailed design and construction guidance of GSI/stormwater BMPs. Retention requirements may be achieved in conjunction with detention storage, or independently.
- D. **Detention:** Detention storage shall be maximized for the smaller, more frequent events while allowing larger, less frequent events to pass through the facility without overtopping the facility. Peak runoff control shall be provided for the 2-, 10-, and 100-year design storms for broad protection of the receiving system, including channel erosion protection and flood peak reductions over a range of design storm average recurrence intervals (ARI). Post-improvement peak discharge rates from the site shall not exceed the allowable release rates expressed in discharge rate per tributary area as follows:
 - a. 2-year design storm with median (50%) temporal distribution shall have a maximum release rate of 0.1 cfs/acre of drainage area without overtopping of the primary spillway
 - b. 10-year design storm with median (50%) temporal distribution shall have a maximum release rate of 0.2 cfs/acre of drainage area without overtopping of the primary spillway
 - c. 10-year design storm with 10% temporal distribution shall have a maximum release rate of 2.0 cfs/acre of drainage area with allowable discharge through the primary spillway without overtopping the facility
 - d. 100-year design storm with 10% temporal distribution shall have a maximum release rate of 3.0 cfs/acre of drainage area with allowable discharge through the primary spillway without overtopping the facility.

E. Conveyance: Generally, a stormwater drainage system is defined when the drainage area is 2 acres or more. As defined in Paragraph 5601.2, the stormwater drainage system may consist of natural drainage paths in combination with engineered channels and enclosed systems. A storm drainage system shall incorporate an overflow system that is capable of conveying flows in excess of the designed system capacity. Overflow systems can consist of natural drainage path preservation. Enclosed conveyance systems consisting of inlets, conduits, and manholes may be used to convey stormwater runoff where site conditions and open space requirements will not permit the use of natural drainage paths or engineered channels. Where used, such systems must be designed in accordance with design criteria and performance standards addressed herein.

- 1. Natural Drainage Path Preservation and Overflow Systems:** Natural drainage paths shall be preserved to reduce the risk for property damage by designating space for the overland conveyance of stormwater for rainfall events exceeding the capacity of the engineered system. Natural drainage paths delineated from 2016 LiDAR data for the City of Warsaw are shown in Appendix A, for reference. Stormwater drainage setback requirements are defined in Section 5605. Each element of the stormwater drainage system (whether open, enclosed, retention, or detention) shall include an overflow element to a preserved natural drainage path. Overflow systems shall:
 - a. Be designed to route downstream flows in excess of the engineered system design capacity.
 - b. May include streets, natural drainage paths, engineered channels, redundant piping, spillways, parking lots, drives or combinations thereof.
 - c. Limit the maximum water surface elevation generated by the 100-year design storm with the 10% temporal distribution to meet protection of property requirements.
 - d. Conform to Paragraph 5605.2 Easements regarding easements and restricted uses for overflow systems within stormwater drainage setbacks.
- 2. Open Systems:** Engineered channels, ditches, and swales shall be designed to convey the 10-year design storm with the 10% temporal distribution, as defined in Section 5602. Where feasible, open systems consisting of open or engineered channels shall be used if all of the following are met:
 - a. The channel slope is less than or equal to 5 percent or where appropriate armoring techniques are used to prevent erosion.
 - b. The 2-year design storm velocity is less than or equal to 5 feet per second (fps) or where appropriate armoring techniques are used to prevent erosion.
 - c. When required stormwater drainage setbacks can be maintained.
- 3. Enclosed Systems:** Enclosed systems consisting of underground pipes, culverts, and similar underground structures shall be used to convey stormwater at all locations where natural drainage paths or engineered channels are not feasible. Enclosed pipe systems shall convey the 10-year design storm assuming the temporal distributions per Section 5602, and be designed per Section 5603, as follows:
 - a. **Gravity Flow Conditions:** 10-year design storm with median (50%) temporal distribution gravity flow conditions within the pipe system (e.g. no surcharging)

- b. **Pressure Flow Conditions:** 10-year design storm with 10% temporal distribution pressure flow conditions with surcharging less than 0.5 feet below the lowest opening to the surface or structure rim elevation.
- 4. **Street Crossings:** Concentrated flow for open systems shall be conveyed under streets to prevent vehicles from being swept from the roadway during infrequent storms. These crossings may be bridges or culverts. Crossings shall be designed to completely convey flows without street overtopping in accordance with the design storms listed in Table 5601-1 based the 10% temporal distribution. Roadway classifications are defined per the Warsaw Livable Community Transportation Improvement Plan.

Table 5601-1: Level of Service for Street Crossings

Street Classification	Min. Design Storm
Principal Arterial	50-Year
Primary Connectors	25-Year
Minor Streets ⁽¹⁾	10-Year
⁽¹⁾ Secondary connectors also fall into the category of minor streets	

Further, concentrated flow in excess of the minimum design storm may only overtop the roadway if the following conditions are met:

- a. The span of the structure opening is less than 20 feet.
- b. The peak stormwater runoff from the 100-year design storm with 10% temporal distribution is 250 cfs or less unless a guard fence is installed on the downstream side of the roadway. Such overflow depths at low points in roadways during the 100-year design storm with 10% temporal distribution will be limited to 7 inches measured at the high point in the roadway cross section, typically at the upstream face of culvert headwall or roadway curb; except that it also shall not exceed 14 inches at the deepest point in the roadway cross section.

- F. **Collection:** Inlet placement in roadway sections shall limit the allowable gutter spread to maintain one lane width for emergency vehicle access during the 10-year design storm with the median (50%) temporal distribution, as defined in Section 5602. Water spread may exceed these limits within 50 feet of a sump location, however, protection of property shall be maintained per Paragraph 5601.5, A. by limited overtopping of curb and/or flooding beyond the right-of-way.

5601.6 Waivers

The Developer may submit a stormwater Drainage Permit by a registered professional engineer that quantifies the problems and demonstrates that a waiver (exemption) of the requirement to provide stormwater management is appropriate. The City/County Engineer may waive requirements to address *unique* conditions or constraints:

- A. **Stormwater Management Requirements:** Stormwater management requirements may be waived when supported by a Stormwater Drainage Permit performed in accordance with Section 5609 and approved by the City/County Engineer.
- B. **Overflow Channels:** In previously developed areas, requirements to provide for 100-year design storm with 10% temporal distribution conveyance may be reduced by the City/County Engineer in circumstances where flood protection for the 100-year design storm is not reasonably attainable due to the location of damageable improvements with respect to the drainage system and where non-attainment is supported by an approved Drainage Permit.

5601.7 Other Requirements

Rules and regulations of other agencies also pertain to drainage systems which may or may not complement these criteria. When conflicts are encountered, the more stringent criteria shall govern.

The following agencies have jurisdiction over streams and/or drainage systems and often require permits. Other regulations, permits and requirements may not be limited to these agencies.

- Federal Emergency Management Agency.
- U.S. Army Corps of Engineers.
- Missouri Department of Natural Resources.
- Municipal Ordinances.

State and Federal regulations often establish requirements for a storm drainage project that impacts adjoining property, especially when a project causes a rise in water surface elevations. In addition to all Federal and State regulations the following shall be met:

- **Drainageways not designated a Special Flood Hazard Area (FEMA 1% Floodplain):** Construction of a storm drainage system, including grading and filling within a stormwater drainage setback is not permitted unless approved by the City/County.
- **Drainageways designated a Special Flood Hazard Areas (FEMA 1% Floodplain) and City/County participates in the National Flood Insurance Program:** When impacting adjoining properties, refer to the adopted Floodplain Management Ordinance for any requirements, in addition to all current FEMA regulations.

SECTION 5602 HYDROLOGY

5602.1 Scope

This section sets forth the hydrologic parameters to be used for computations involving the definition of runoff mass and peak rates to be accommodated by the storm drainage system. The methods to be used for calculating runoff mass and peak rates are intended for the design of drainage systems. The hydrologic calculations included are based on the *NOAA Atlas 14 Volume 8 Precipitation Frequency Atlas of the United States for Midwestern States* (NOAA, 2013), herein referred to as NOAA Atlas 14. The 6-hour temporal rainfall distributions were applied to the location of Warsaw, Missouri based on point precipitation frequency data from the NOAA Precipitation Frequency Data Server. Documentation of this data analysis can be found in the *Warsaw Stormwater Study: Hydrologic Analysis & Hydraulic Review* (Burns & McDonnell, September 2020).

5602.2 Computation Methods for Runoff

Runoff rates to be accommodated by each element of the proposed storm drainage system shall be calculated using the criteria of this section for land use runoff factors, rainfall, and system time. The following methods of computations are allowed:

- A. Watersheds Less than 200 Acres:** The Rational Method may be used to calculate peak rates of runoff to elements of enclosed and open channel systems, including inlets, when the total upstream area tributary to the point of consideration is less than 200 acres. The Rational Method is defined as follows:

$$Q = C \cdot i \cdot A$$

Where:

Q = Peak rate of runoff to system in cfs

C = Runoff coefficient as determined in accordance with Paragraph 5602.3

i = Rainfall intensity in inches per hour as determined in accordance with Paragraph 5602.6

A = Tributary drainage area (acres)

- B. Baseline Unit Hydrograph Method:** The following computer implementations of the unit hydrograph method are acceptable for all watersheds:

- SCS Technical Release No. 55 "Urban Hydrology for Small Watersheds", 2nd Edition, June 1986.
- SCS Technical Release No. 20 "Project Formulation - Hydrology", 2nd Edition, May 1983.
- U.S. Army Corps of Engineers, Hydrologic Engineering Center - "HEC-1Flood Hydrograph Package".
- U.S. Army Corps of Engineers, Hydrologic Engineering Center - "HEC-HMS Hydrologic Modeling System", current version.
- Other industry standard practices as approved by City/County Engineer.

Inputs for unit hydrograph procedures shall conform to the requirements of Paragraph 5602.3 through 5602.8.

- C. Other Alternative Design Methods:** Alternative design methods, including computer models may be employed so long as they produce runoff hydrographs to the system that are substantially the same as those calculated by the baseline method. To assess the equivalence of such methods, the Engineer shall prepare estimates using both the alternate design method and the baseline unit hydrograph method, and shall report for every sub-basin the following data from both: peak flow rate, lag time, runoff volume, and equivalent curve number based on total storm precipitation and direct runoff. Any discrepancy greater than

5% between the two models shall be clearly identified. Testing of equivalence is not required if the alternative method has been proven to the City/County to be consistently more conservative than the baseline unit hydrograph method or if the City/County has determined that the alternative method is reliably more accurate or appropriate for the design condition.

- D. Regression Equations:** Rural and urban regression equations prepared by the U.S. Geological Survey (USGS) for Missouri shall not be used as the sole input for project design, but are useful tools for evaluating design models. USGS StreamStats web application provides access to Geographic Information System analytical tools that are useful for stormwater planning. Rural regression formulas shall be used only to represent rural or pre-development conditions when significant basin storage does not exist. For urban watersheds a pre-development scenario of the basin model can be developed to compare to the rural regression, and then physically realistic adjustments can then be made to impervious percentages, ground cover, basin lag times, and channel routing to produce the urban scenario. Engineers shall use caution in interpreting regression equation results and acknowledge the range of standard error and uncertainty of both the regression formulas and the underlying gauge estimates.

5602.3 Runoff Coefficients

- A. Rational Method “C”:** A composite runoff coefficient based on the actual percentages of pervious and impervious surfaces shall be used when feasible. The “C” value can be calculated from any type of land use and known percent impervious surface from the following equation:

$$C = 0.3 + 0.6 \cdot I$$

Where:

I = percent impervious divided by 100

- B. SCS Runoff Curve Number Method “CN”:** SCS Curve Numbers shall be determined per SCS Technical Release No. 55. No soil disturbed by construction shall be assigned a Hydrologic Group classification of ‘A’ or ‘B’.
- C. Standard Land Use/Zoning Classifications:** Runoff Coefficients relative to development, undeveloped land and land use may use the values indicated in Table 5602-1 for preliminary planning purposes. Drainage Permit shall reflect actual percent imperviousness for the site.

Table 5602-1: Runoff Parameters

Land Use / Zoning	Average Percent Impervious	Average Percent Pervious	Rational Method “C” ¹	SCS Curve Number by Hydrologic Soil Group ²			
				A	B	C	D
Commercial & Business							
Local, Central and Commercial Business Districts (C-1, C-2, and C-3)	85	15	0.81	89	92	94	95
Residential							
Single Family and Two-Family Dwelling District (R-1 and R-2)	35	65	0.51	60	74	82	87
Multifamily Dwelling District (R-3)	60	40	0.66	74	83	88	91
Mobile Home District (R-4)	25	75	0.45	54	70	80	85
Churches & Schools	75	25	0.75	83	89	92	94
Industrial							
Light Industrial District (M-1)	60	40	0.66	74	83	88	91
Heavy Industrial District (M-2)	80	20	0.78	86	91	93	94
Parks, Cemeteries	10	90	0.36	45	64	76	82
Railroad Yard Areas	25	75	0.45	54	70	80	85
Open Space District (O) and Undeveloped Areas	0	100	0.3	39	61	74	80
All Surfaces							
Impervious: Asphalt, Concrete, Roofs, etc.	100	0	0.9	98	98	98	98
Turfed	0	100	0.3	39	61	74	80
Ponds/Permanent Water Surface	100	0	0.9	98	98	98	98
¹ Rational C is calculated based on average percent impervious per Paragraph 5602.3 A. ² SCS Curve Number calculated based on average percent impervious area (Purdue University, 2011)							

D. Un-zoned, but Master Planned Areas: Areas whose future land use is defined by an adopted land use plan shall be assigned runoff coefficients for the land use indicated on such plan.

E. Agricultural and Unplanned Areas

1. Existing Conditions: For purposes of determination of development impact, undeveloped areas whose current land use is agriculture (crops, pasture, meadow, brush, woods) shall have an assumed maximum of 0% impervious area or a maximum Curve Number based on good hydrologic condition.
2. Proposed Conditions: Undeveloped areas designated as agricultural or those areas for which no specific land use is indicated shall be assigned a minimum of 35% impervious area based on good hydrologic condition with Hydrologic Soil Group 'C' for purposes of the design of storm drainage systems. Existing undeveloped land with a Hydrologic Soil Group of 'A' or 'B' shall be assigned a Hydrologic Soil Group of 'C' for the proposed (developed) condition if the

undeveloped land would be disturbed as a result of the development (e.g. Pasture with good hydrologic condition and Hydrologic Soil Group 'B' that will be open space for a park would be assign a Hydrologic Soil Group 'C').

5602.4 Rainfall Mass

The NOAA Atlas 14 Volume 8, 6-hour duration, median and 10% first-quartile rainfall distributions for Region 3 shall be used for all computations that employ the use of rainfall mass. The rainfall distribution for the median (50%) and 10% temporal distributions are reproduced in Table 5602-2.

Time (hours)	Accumulated Percentage of Total Precipitation (%)	
	Median (50%) Temporal Distribution	10% Temporal Distribution
0	0	0
0.5	19.52	39.62
1.0	38.51	73.03
1.5	57.82	90.42
2.0	74.88	97.12
2.5	84.23	99.38
3.0	88.12	99.89
3.5	91.8	99.91
4.0	95.37	99.96
4.5	97.28	99.97
5.0	98.96	99.99
5.5	99.82	100
6.0	100	100

5602.5 Unit Hydrographs

The SCS Dimensionless Unit Hydrograph (either curvilinear or triangular) shall be the basis for computation of runoff hydrographs.

5602.6 Rainfall Intensity

Rainfall intensity shall be determined from Table 5602-3 per NOAA Atlas 14 Volume 8, 6-hour duration, median and 10% first quartile rainfall distributions for Region 3.

Table 5602-3: Rainfall Intensity (in/hr) for Warsaw, Missouri

Average Recurrence Interval (ARI)	Median (50%) Temporal Distribution	10% Temporal Distribution
1-Year	0.90	1.82
2-Year	1.04	2.12
5-Year	1.29	2.62
10-Year	1.51	3.07
25-Year	1.83	3.71
50-Year	2.08	4.22
100-Year	2.35	4.76

5602.7 Time of Concentration and Lag Time

Time of Concentration (T_C) is equal to the overland flow time to the most upstream inlet or other point of entry to the system, Inlet Time (T_I), plus the time for flow in the system to travel to the point under consideration, Travel Time (T_T).

$$T_C = T_I + T_T$$

- A. Inlet Time:** T_I shall be calculated by the following formula or determined graphically from Figure 5602-1, but shall not be less than 5.0 minutes nor greater than 15.0 minutes:

$$T_I = 1.8 \cdot (1.1 - C) \cdot \frac{D^{1/2}}{S^{1/3}}$$

Where:

T_I = Inlet time in minutes

C = Rational Method Runoff Coefficient as determined in accordance with Paragraph 5602.3

D = Overland flow distance parallel to slope in feet (100 feet shall be the maximum distance used for overland flow)

S = Slope of tributary area surface perpendicular to contour in percent

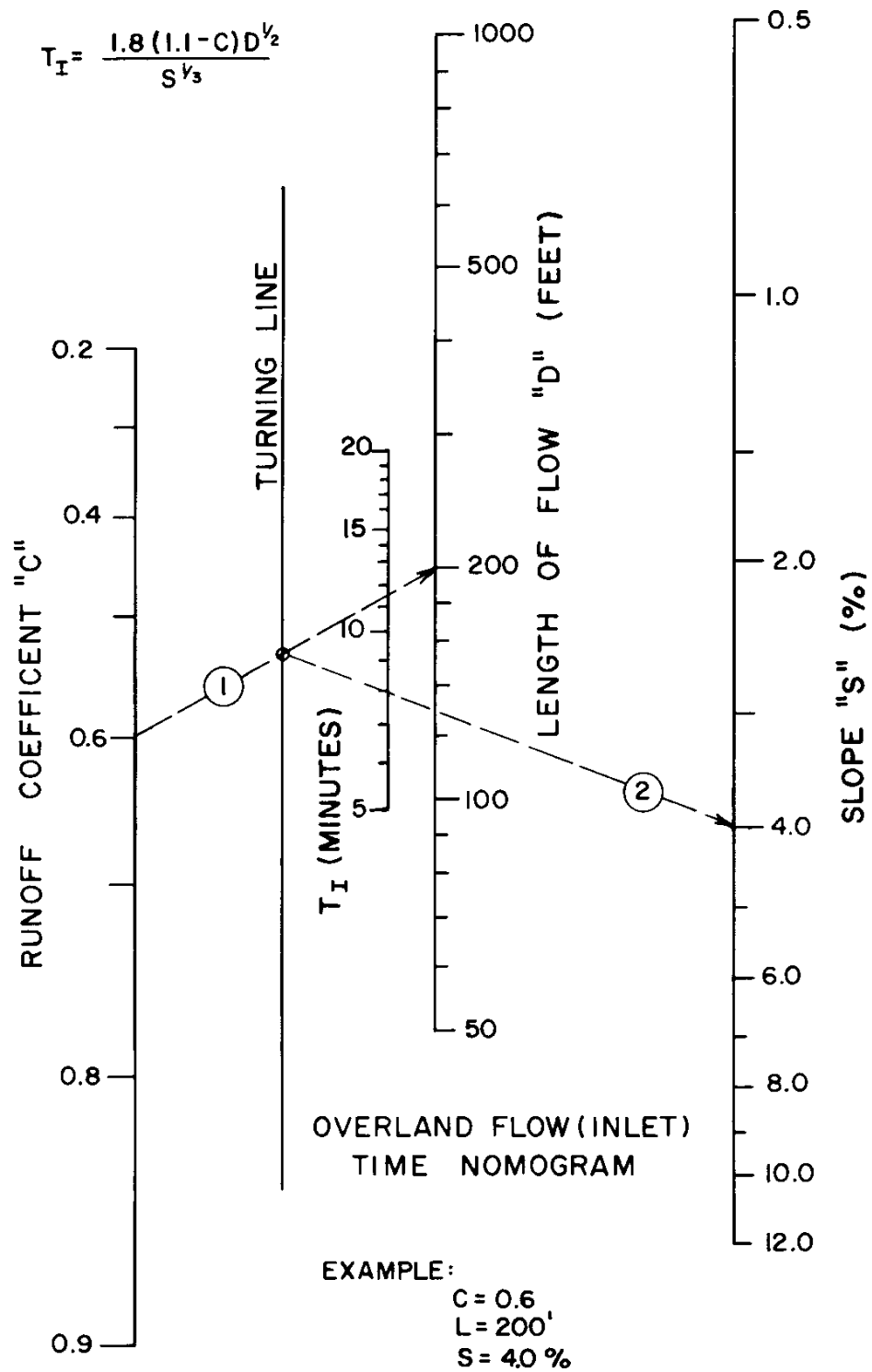
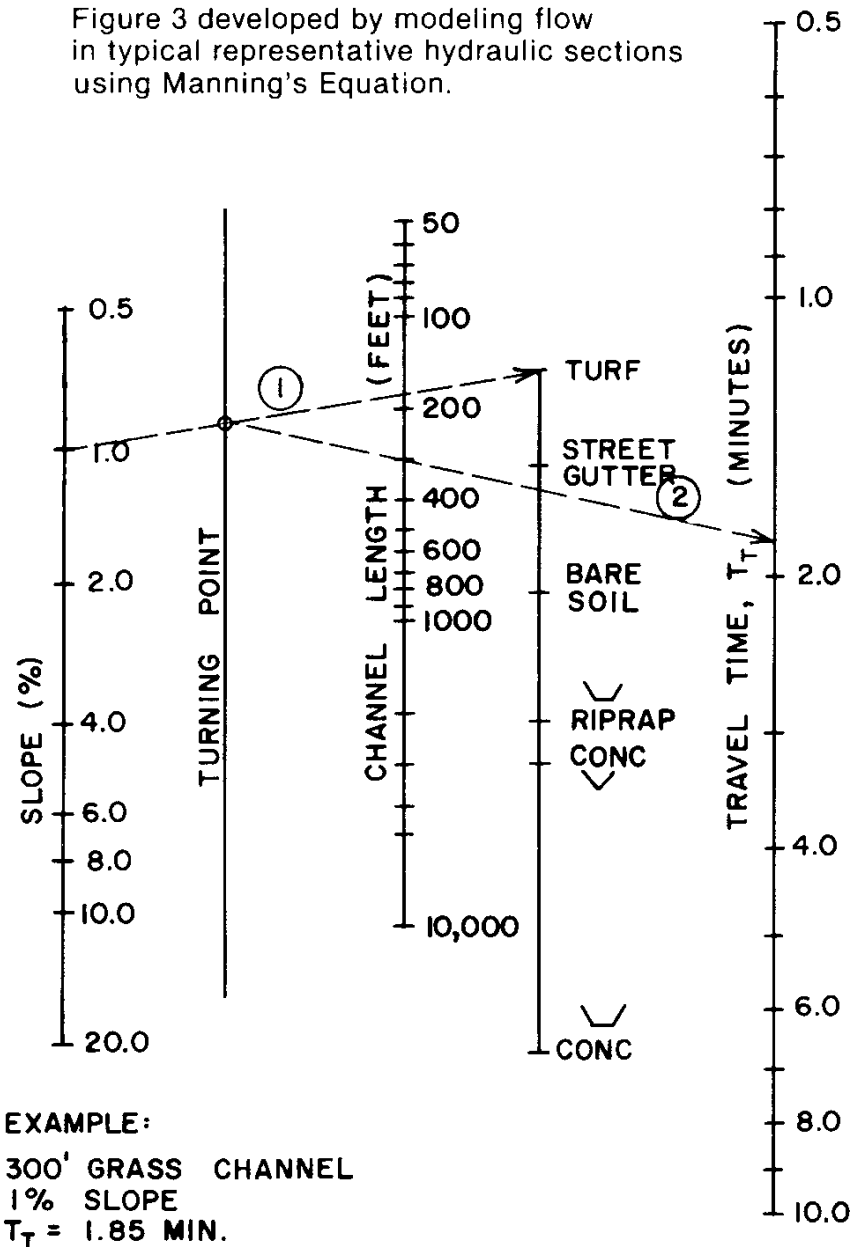


Figure 5602-1: Overland Flow (Inlet) Time Nomograph

Figure 3 developed by modeling flow in typical representative hydraulic sections using Manning's Equation.



- ① Connect Slope & Channel Condition to locate point on Turning Line
- ② Extend line from Turning Line through Channel Length, Read T_T

Figure 5602-2: Channel Flow Time Nomograph

- B. Travel Time:** T_T shall be calculated as the length of travel in the channelized system divided by the velocity of flow. Velocity shall be calculated by Manning's equation assuming all system elements are flowing full without surcharge. Travel time may be determined graphically from Figure 5602-2 in lieu of calculation.

To provide for future development when the upstream channel is unimproved, the Table 5602-4 shall be used for calculating T_T .

Table 5602-4: Travel Time Estimates for Future Development

Average Channel Slope (%)	Velocity (ft/sec)
< 2	7
2 to 5	10
> 5	15

- C. Lag Time:** Lag Time (T_L) is the calculated time between the maximum rainfall intensity of a storm and the point of maximum discharge on the outlet hydrograph. Lag Time is used instead of time of concentration for unit hydrograph models. It shall be calculated as 3/5th the time of concentration (T_c) given by Paragraph 5602.7 (A and B).

5602.8 Hydrograph Routing

Routing of hydrographs through storage elements or reservoirs shall be by modified-Puls level pool routing. Routing through channels shall be by the Muskingum-Cunge method. If the detention effect of significant storage in channels behind roadway embankments or culverts is to be modeled, the area impacted by the storage shall be modeled as a reservoir, and the remainder of the channel modeled using Muskingum-Cunge. Such incidental detention shall not be used for design discharge estimates unless allowed by the City/County and it can be reliably demonstrated that such storage will be maintained over the useful life of the proposed improvements.

5602.9 Calibration and Model Verification

All design discharge estimates should be calibrated to the extent possible using reliable gauge data, high water marks, or historical accounts. Model results should be evaluated to verify that they are reasonable as compared to observed data and standard practice. Engineers shall recognize the significant uncertainty associated with design discharge estimates and provide estimates that are protective of the public interest. To permit model verification, discharge rates (expressed as absolute discharge or discharge per acre of tributary area) relative to tributary area may be compared to regression equation results, gauge estimates, and/or known historical extremes.

SECTION 5603 HYDRAULICS

5603.1 Hydraulic Calculations for Pipes, Culverts, and Open Channels

- A. Gravity versus Pressure Flow for Enclosed Systems:** Two design philosophies exist for sizing storm drains under the steady uniform flow assumption. The first is referred to as open channel, or gravity flow design, in which the water surface within the conduit remains open to atmospheric pressure. Pressure flow design, on the other hand, requires that the flow in the conduit be at a pressure greater than atmospheric. For a given flow rate, design based on open channel flow requires larger conduit sizes than those sized based on pressure flow. Paragraph 5601.5 specifies hydraulic grade requirements associated with both gravity and pressure flow conditions. As hydraulic calculations are performed, frequent verification of the existence of the desired flow condition should be made.

Storm drainage systems can often alternate between pressure and open channel flow conditions from one section to another.

- B. Gravity flow conditions,** use Manning's formula shall be used as described below.

$$Q = \frac{1.486}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$$

Where:

Q = Discharge, cubic feet per second

A = Cross sectional area of flow, square feet

n = Manning's roughness coefficient (see Table 5603-1)

R = Hydraulic radius, feet

$$R = \frac{A}{P}$$

S = Slope in feet per foot

P = Wetted perimeter in feet

- C. Closed conduits flowing under pressure flow,** the energy grade line (EGL) will be above the crown of the pipe. In this case, the Bernoulli equation shall be used to calculate pipe capacity:

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_f + h_m$$

Where:

$\frac{p_1}{\gamma}$ = pressure head in the upstream system segment, feet

$\frac{V_1^2}{2g}$ = velocity head in the upstream system segment, feet

z₁ = elevation of the system invert in the upstream system segment, feet

$\frac{p_2}{\gamma}$ = pressure head in the downstream system segment, feet

$\frac{V_2^2}{2g}$ = velocity head in the downstream system segment, feet

z₂ = elevation of the system invert in the downstream system segment, feet

h_f = friction loss in the downstream system segment in feet

h_m = minor system losses in the downstream segment in feet

Pipe friction losses, h_f , may be calculated using the friction slope method, using the following derivation of Manning's equation from (FHWA, 1996).

$$h_f = S_f \cdot L$$
$$S_f = \frac{(Q \cdot n)^2}{\left(1.486 \cdot A \cdot R^{\frac{2}{3}}\right)^2}$$

Where:

S_f = friction slope, feet/foot (which is also the slope of the HGL)

Minor losses, h_m , shall be calculated by:

$$h_m = k \cdot \frac{v^2}{2g}$$

Where:

k = Coefficient as shown in Table 5603-2

A step-by-step procedure for manual calculation of the EGL using the energy loss method is presented in Hydraulic Engineering Circular No. 22 (HEC-22) Urban Drainage Manual (FHWA, 2013). For most drainage systems, computer evaluation utilizing continuous dynamic hydraulic modeling software are the most efficient means of evaluating the EGL and designing the system elements.

Table 5603-1: Manning's Roughness Coefficient
Type of Channel

	n
Closed Conduits	
Reinforced Concrete Pipe (RCPs)	0.013
Reinforced Concrete Elliptical Pipe	0.013
Corrugated Metal Pipe (CMPs):	
2 $\frac{2}{3}$ x $\frac{1}{2}$ in. Annular or Helical Corrugations unpaved - plain	0.024
2 $\frac{2}{3}$ x $\frac{1}{2}$ in. Annular or Helical Corrugations paved invert	0.021
3x1 in. Annular or Helical Corrugations unpaved - plain	0.027
3x1 in. Annular or Helical Corrugations paved invert	0.023
6x2 in. Corrugations unpaved - plain	0.033
6x2 in. Corrugations paved invert	0.028
24" diameter and smaller with Helical Corrugations.*	0.02
Vitrified Clay Pipe	0.013
Asbestos Cement Pipe	0.012
Open Channels (Lined)	
Gabions	0.025
Concrete	
Trowel Finish	0.013
Float Finish	0.015
Unfinished	0.017
Concrete, bottom float finished, with sides of	
Dressed Stone	0.017
Random Stone	0.02
Cement Rubble masonry	0.025
Dry Rubble or Riprap	0.03
Gravel bottom, side of	
Random Stone	0.023
Riprap	0.033
Grass (Sod)	0.03
Riprap	0.035
Grouted Riprap	0.03
Open Channels (Unlined) Excavated or Dredged	
Earth, straight and uniform	0.027
Earth, winding and sluggish	0.035
Channels, not maintained, weeds & brush uncut	0.09
Stream	
Clean stream, straight	0.03
Stream with pools, sluggish reaches, heavy underbrush	0.1
Flood Plains	
Grass, no brush	0.03
With some brush	0.09
Street Curbing	
*Allowed only when the pipe length between structures is at least 20 pipe diameters	0.014

Table 5603-2: Head Loss Coefficients

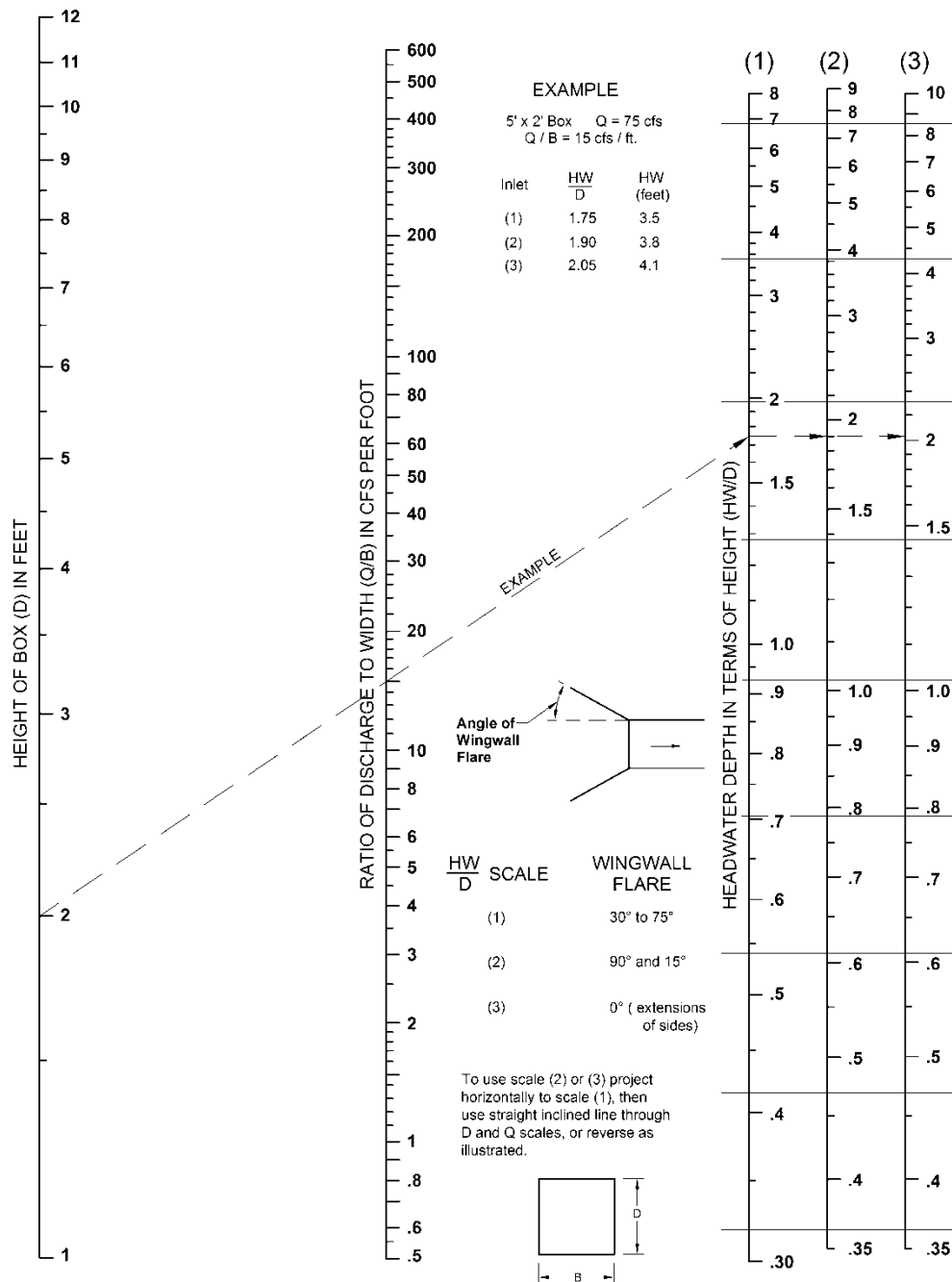
Condition	k
Manhole, junction boxes and inlets with shaped inverts:	
Thru flow	0.15
Junction	0.4
Contraction transition	0.1
Expansion transition	0.2
90 degree bend	0.4
45 degree and less bends	0.3
Culvert Inlets:	
Pipe, Concrete	
Projecting from fill, socket end (groove end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove end)	0.2
Square edge	0.5
Round (radius=1/12D)	0.2
Mitered to conform to fill slope	0.7
Standard end section	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
Standard end section	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dim. or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension or beveled top edge	0.2
Wingwalls at 10° to 25° to barrel - square edged at crown	0.5
Wingwalls parallel (extension of sides) - square edged at crown	0.7
Side or slope-tapered inlet	0.2

Note: When 50 percent or more of the discharge enters the structure from the surface, "k" shall be 1.0.

- D. Culverts:** Classified as having either entrance or outlet control. Either the inlet opening (entrance control), or friction loss within the culvert or backwater from the downstream system (outlet control) will control the discharge capacity.
- 1. Entrance Control:** Entrance control occurs when the culvert is hydraulically short (when the culvert is not flowing full) and steep. Flow at the entrance would be critical as the water falls over the brink. If the tailwater covers the culvert completely (i.e., a submerged exit), the culvert will be full at that point, even though the inlet control forces the culvert to be only partially full at the inlet. The transition from partially full to full occurs in a hydraulic jump, the location of which depends on the flow resistance and water levels. If the flow resistance is very high, or if the headwater and tailwater levels are high enough, the jump will occur close to or at the entrance. Design variables for culverts operating under entrance control may be determined from Figure 5603-1 through Figure 5603-7.
 - 2. Outlet Control:** If the flow in a culvert is full for its entire length, then the flow is said to be under outlet control. The discharge will be a function of the differences in tailwater and headwater levels, as well as the flow resistance along the barrel length. Design variables for culverts operating under outlet control may be determined from Figure 5603-8 through Figure 5603-14.
- Alternatively, refer to the Federal Highway Administration website for these charts (www.fhwa.dot.gov/bridge/hec05.pdf). Download applicable design manuals, reports, and FHWA hydraulics engineering such as Bridge Waterways Analysis Model (WSPRO), FHWA Culvert Analysis, and HDS 5 Hydraulic Design of Highway Culverts from www.fhwa.dot.gov/bridge/hydrsoft.htm. These are applicable when flow in the upstream channel is subcritical.
- E. Open Channels/Bridges:** Proper evaluation of the velocity, depth, and width of flow requires analyses of the structures and conditions that impact the flow. Boundary flow conditions upstream and downstream from the open channel system must be established. The standard-step backwater method, using the energy equation, can be used to determine the depth, velocity, and width of flow. Major stream obstructions, changes in slope, changes in cross-section, and other flow controls can cause significant energy loss. In these cases, the energy equation does not apply and the momentum equation must be used to determine the depth, velocity, and width of flow.

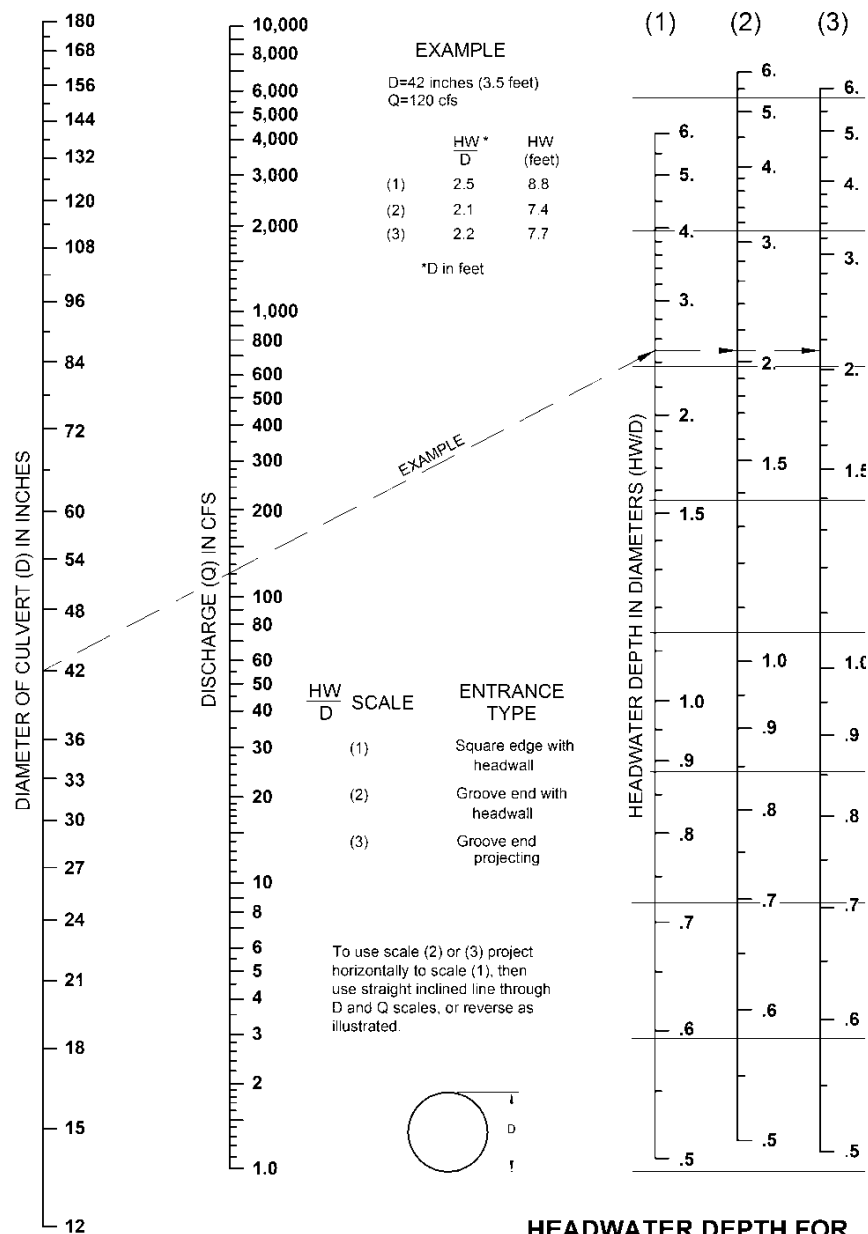
5603.2 Analysis of Systems by Computer Models

Hydraulic calculations may also be made using industry standard continuous simulation hydraulic modeling software that dynamically routes stormwater flows.



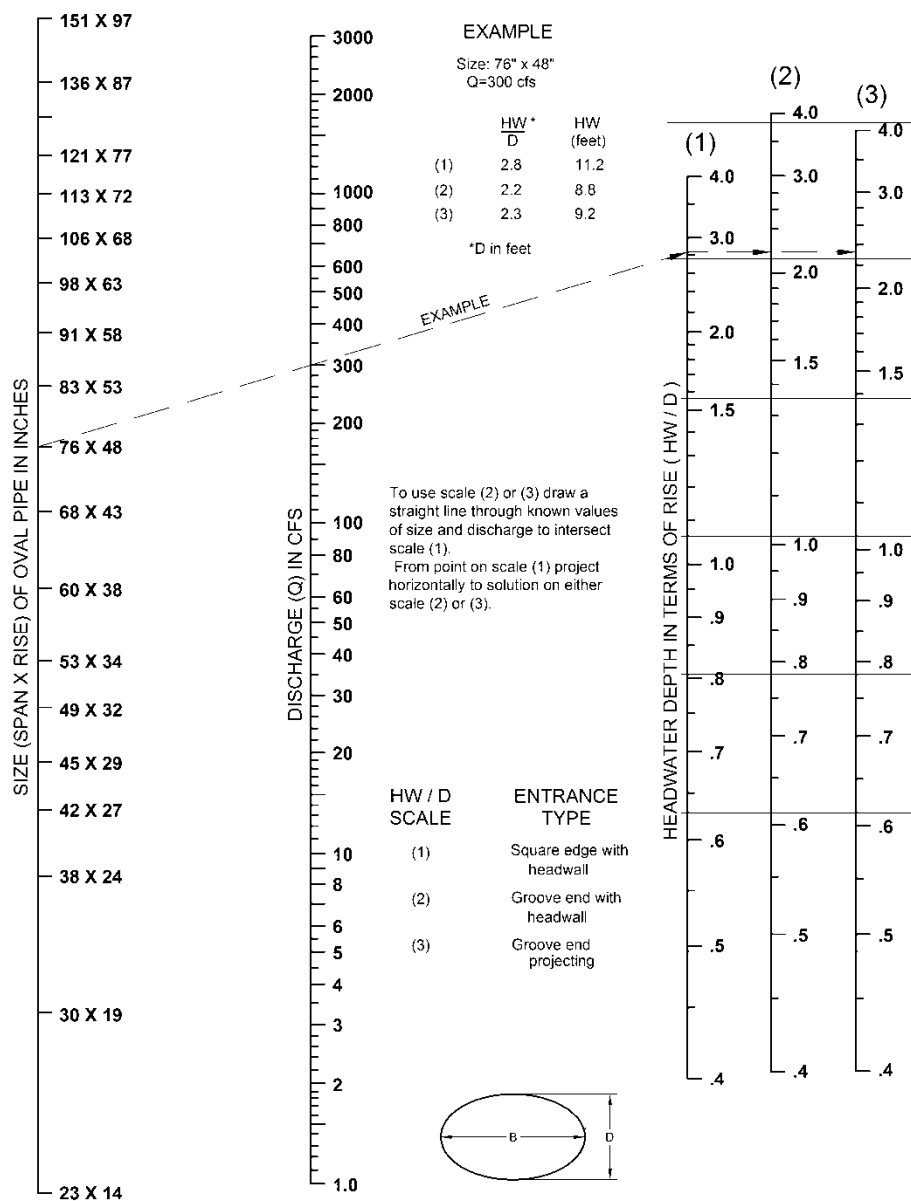
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Figure 5603-1: Headwater Depth for Box Culverts with Inlet Control



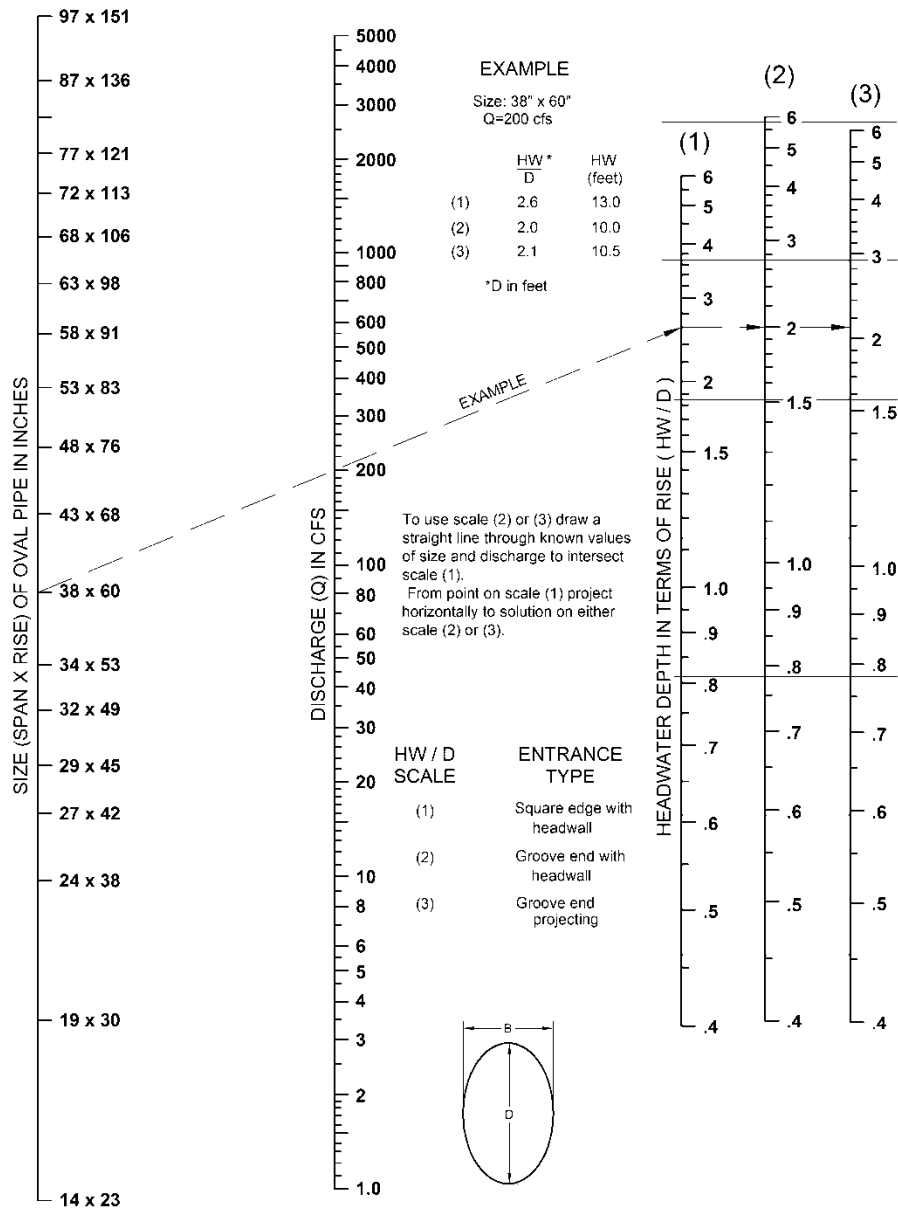
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HEADWATER SCALES 2 & 3 REVISED MAY 1964

Figure 5603-2: Headwater Depth for Concrete Pipe Culverts with Inlet Control



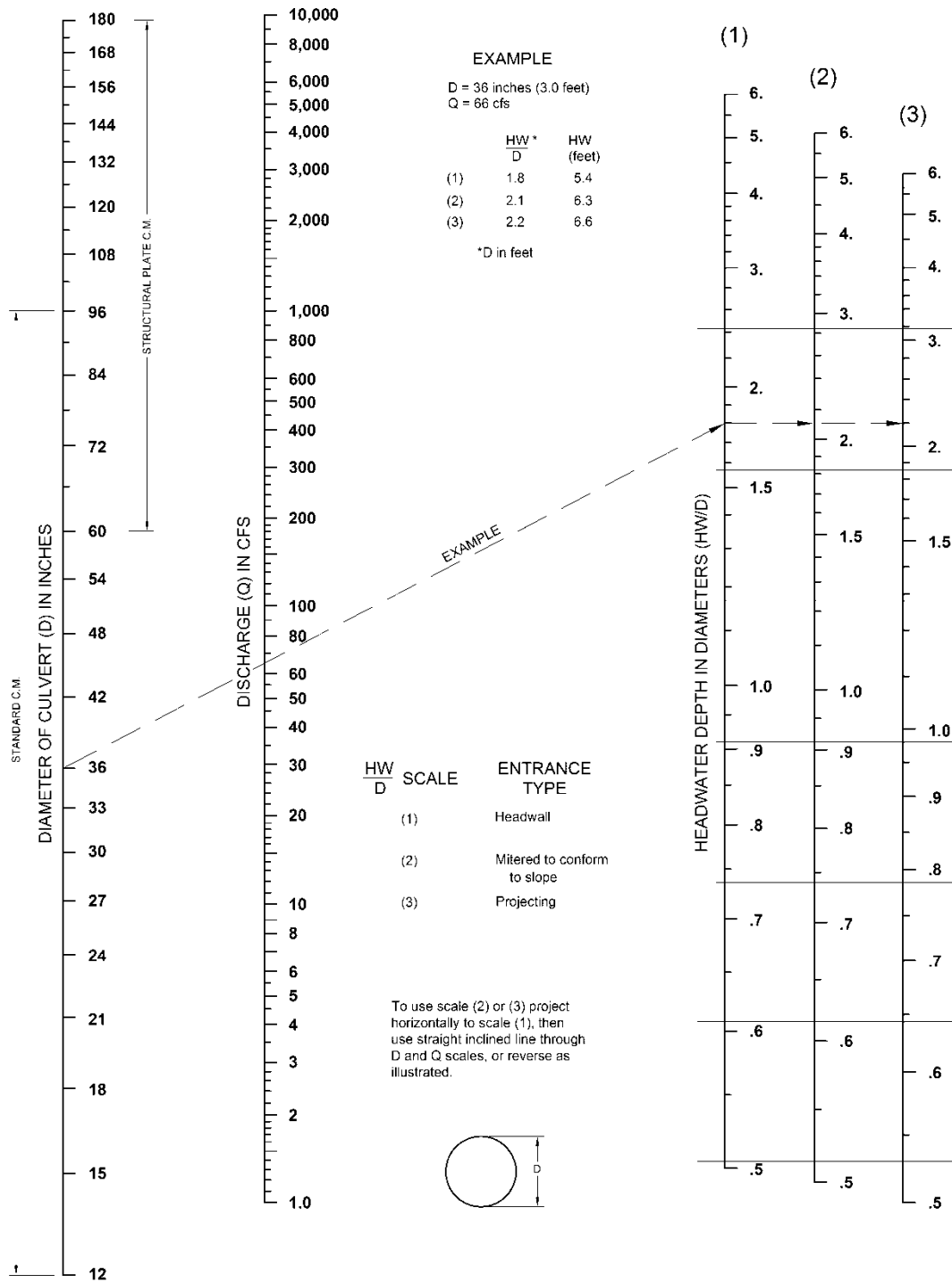
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Figure 5603-3: Headwater Depth for Oval Concrete Pipe Culverts, Long Axis Horizontal with Inlet Control



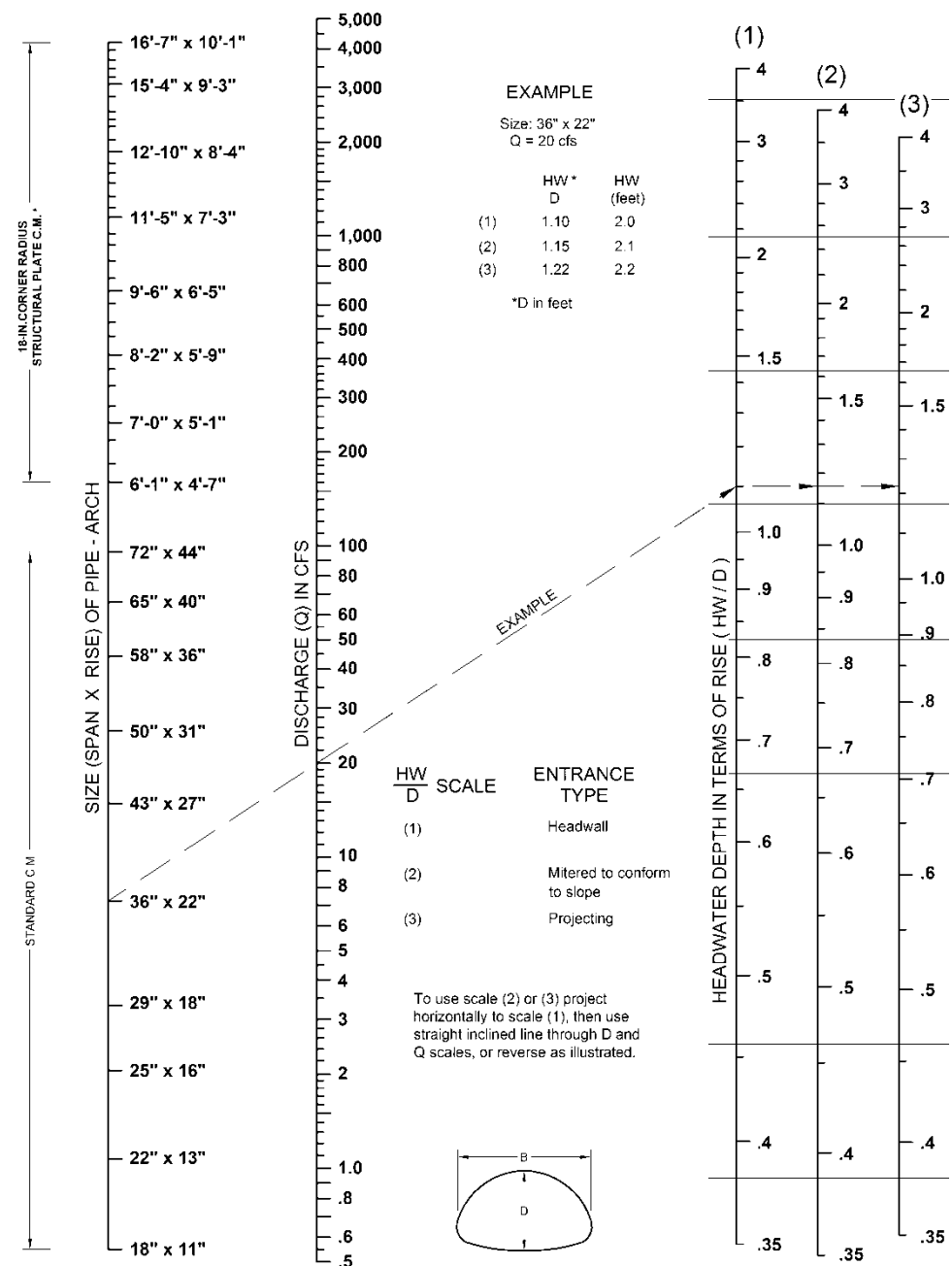
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Figure 5603-4: Headwater Depth for Oval Concrete Pipe Culverts, Long Axis Vertical with Inlet Control



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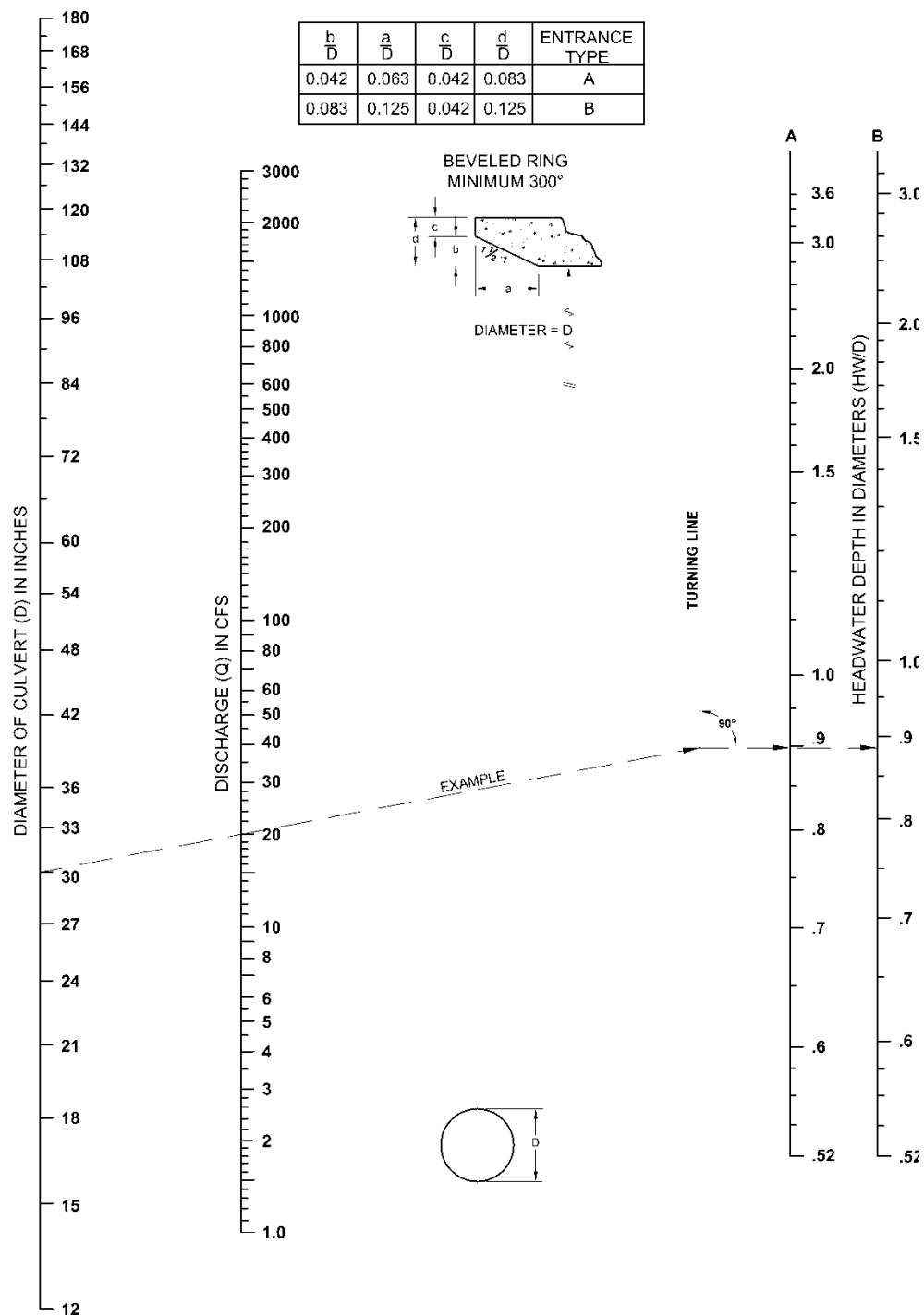
Figure 5603-5: Headwater Depth for Corrugated Metal Pipe Culverts with Inlet Control



* ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

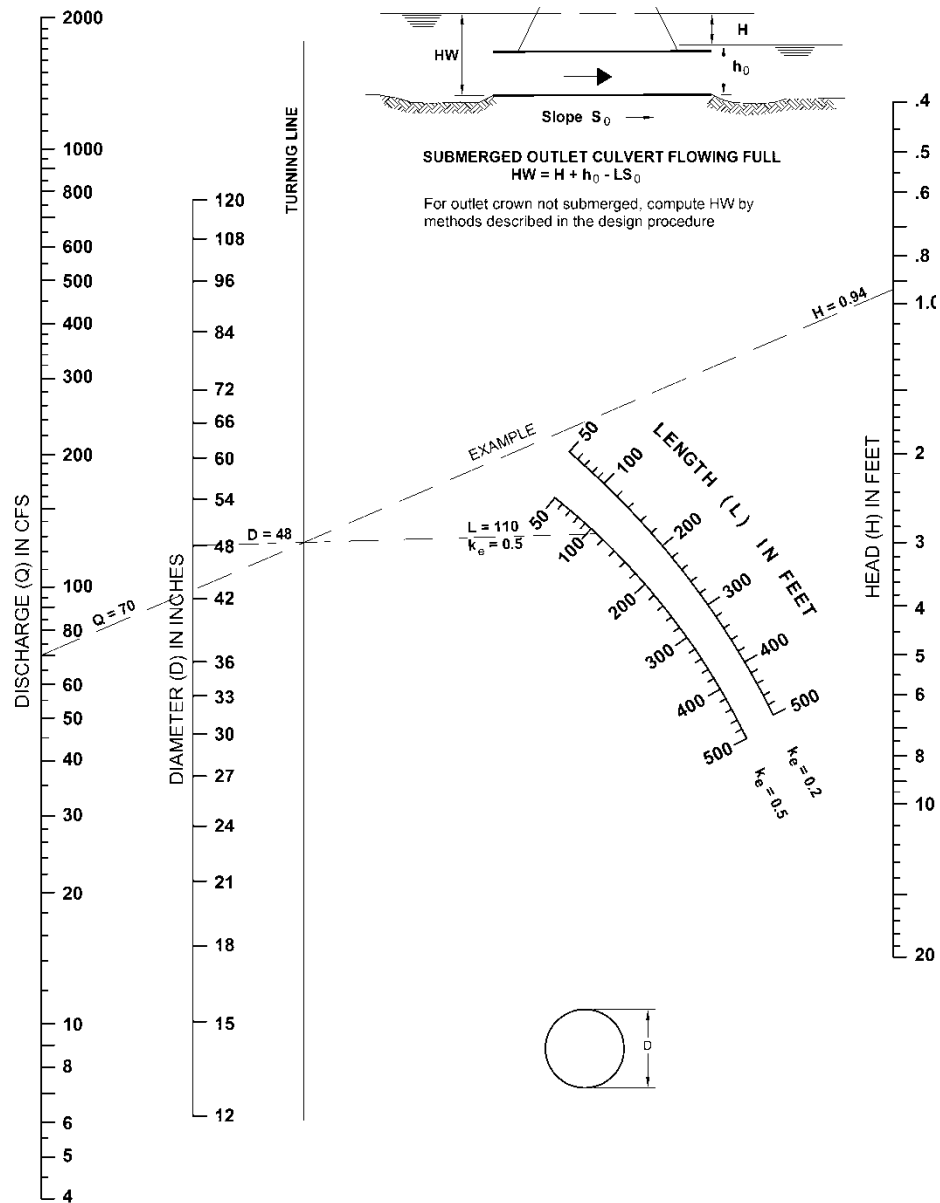
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Figure 5603-6: Headwater Depth for Corrugate Metal Pipe – Arch Culvert with Inlet Control



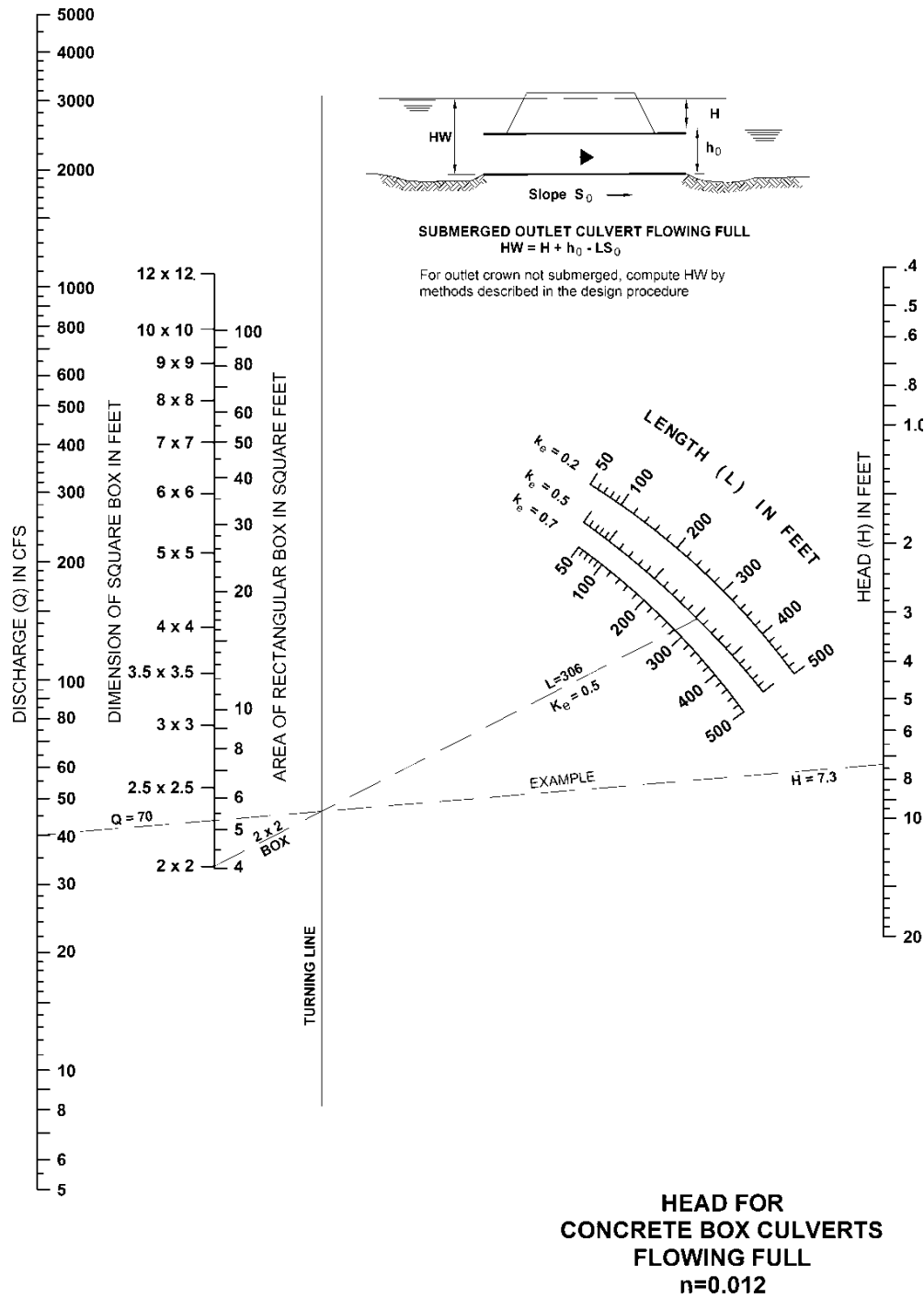
FEDERAL HIGHWAY ADMINISTRATION
MAY 1973

Figure 5603-7: Headwater Depth for Circular Pipe Culverts with Beveled Ring Inlet Control



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Figure 5603-8: Head for Concrete Pipe Culverts Flowing Full ($n=0.12$)



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Figure 5603-9: Head for Concrete Box Culverts Flowing Full ($n=0.012$)

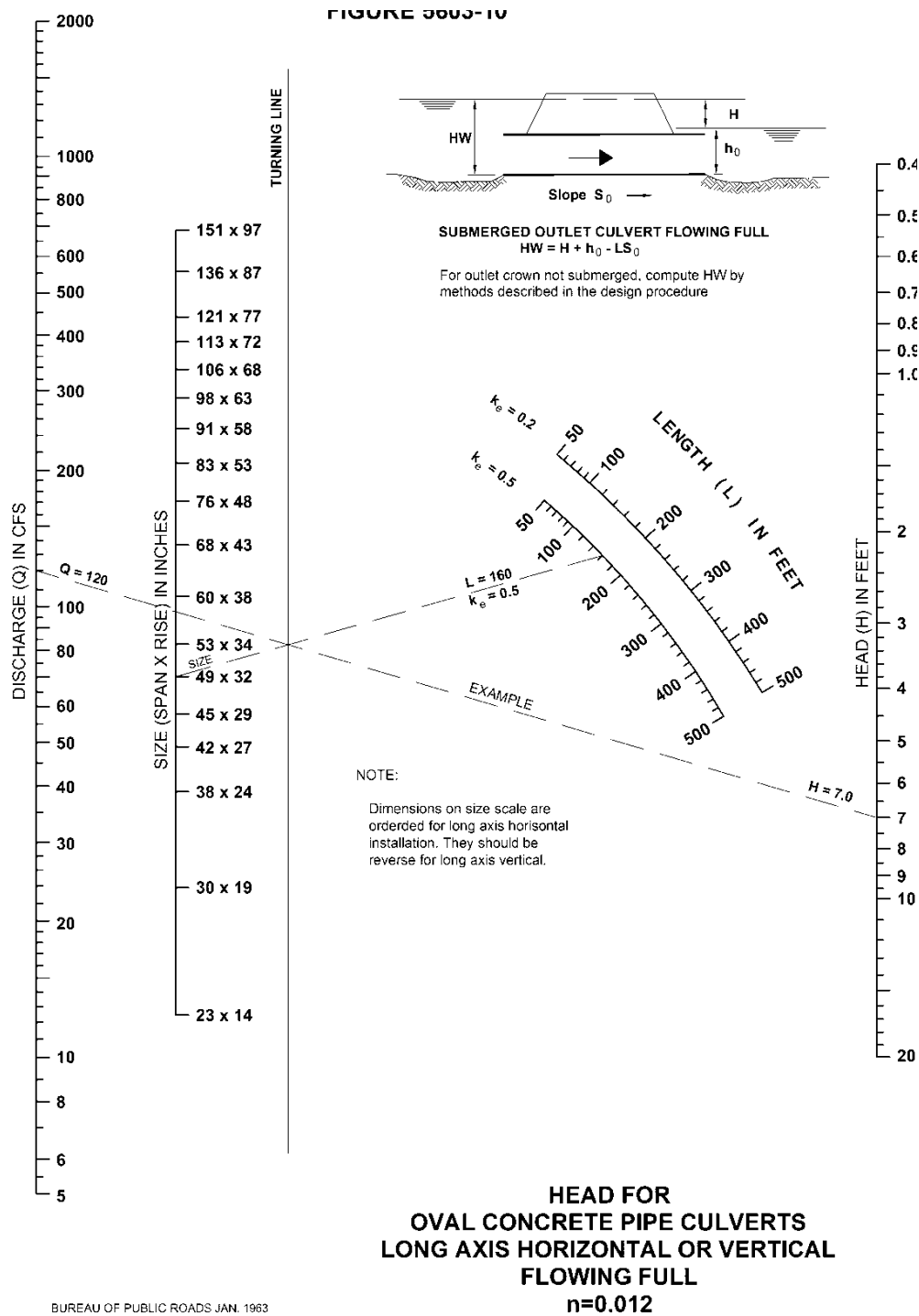
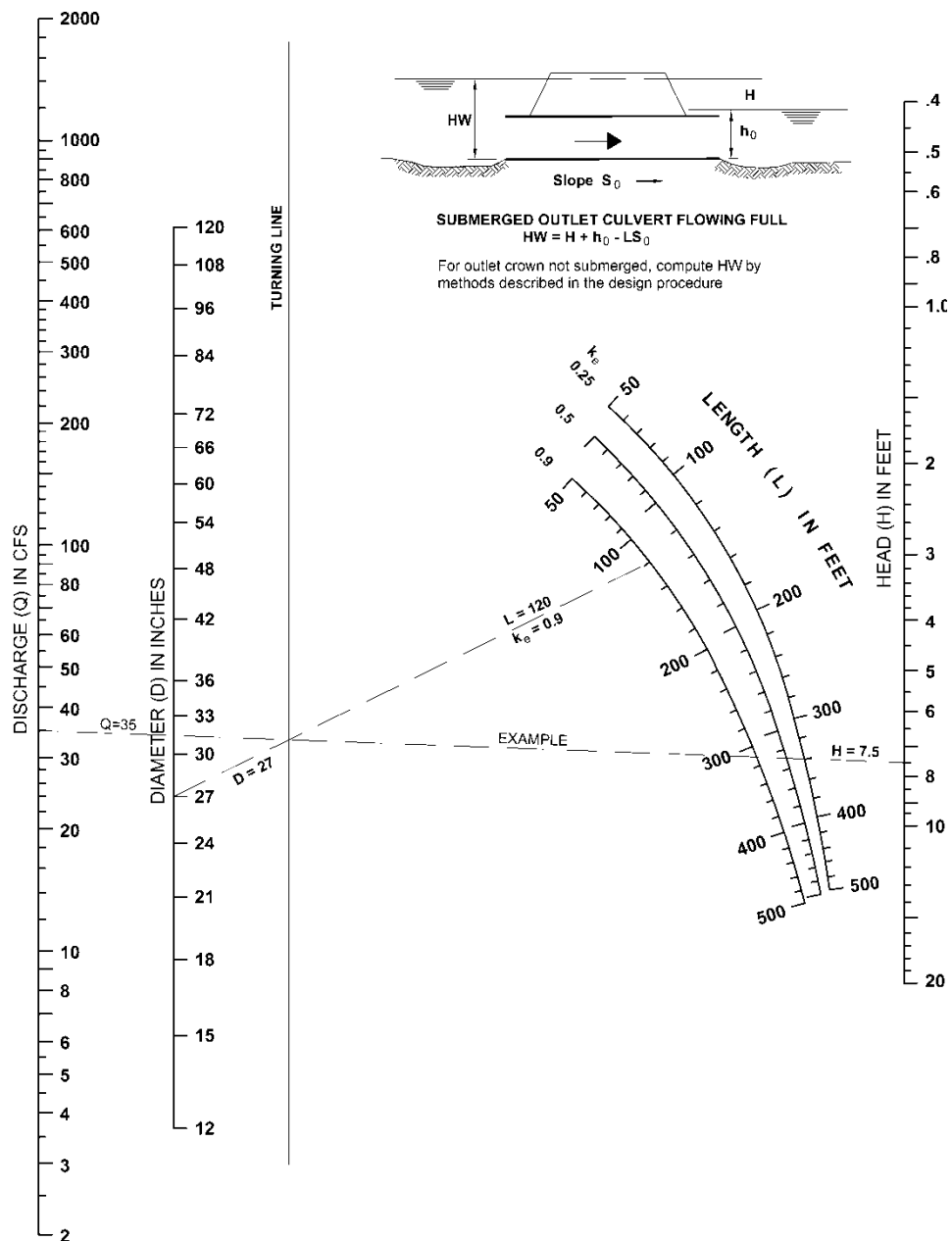
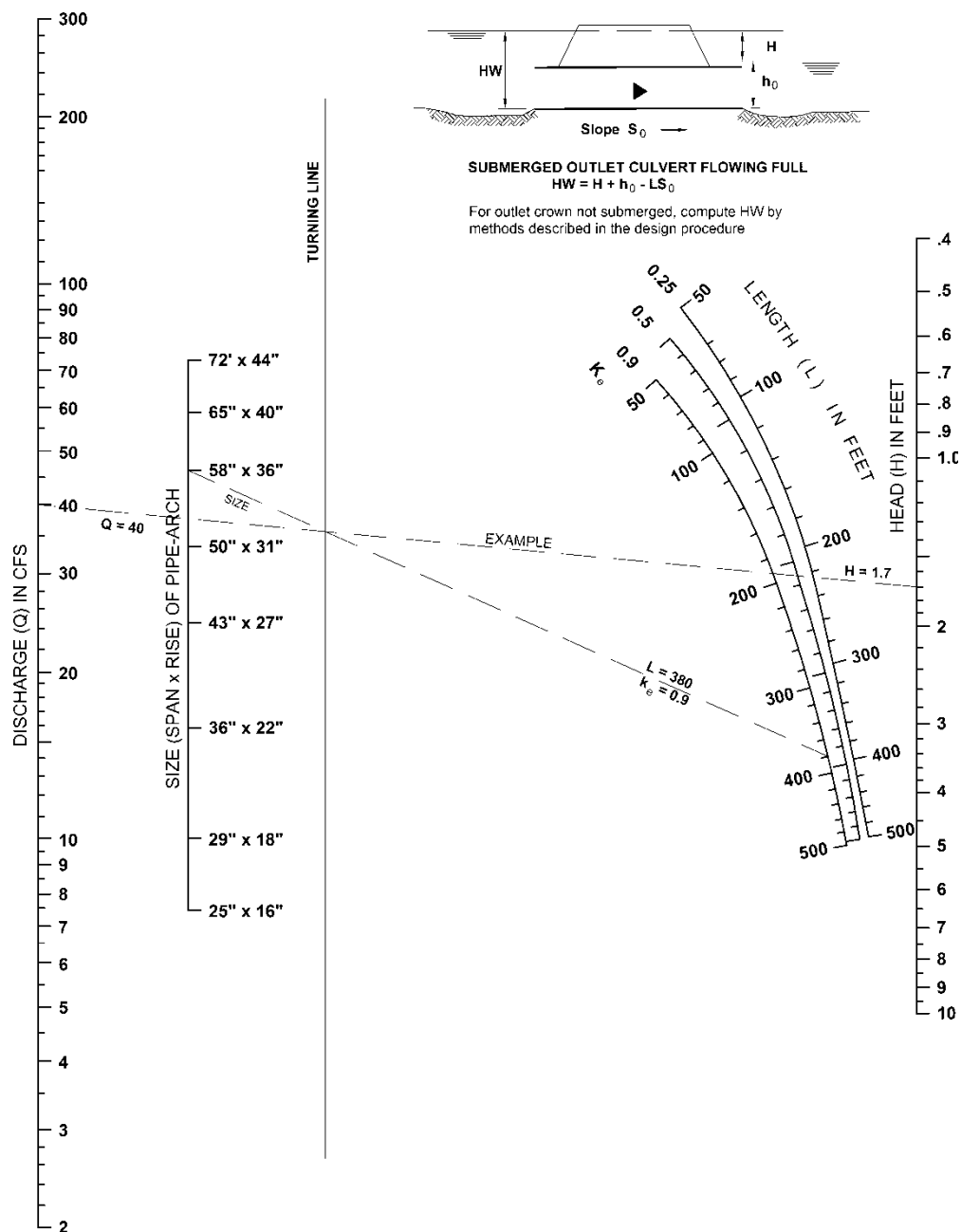


Figure 5603-10: Head for Oval Concrete Pipe Culverts, Long Axis Horizontal or Vertical Flowing Full (n=0.12)



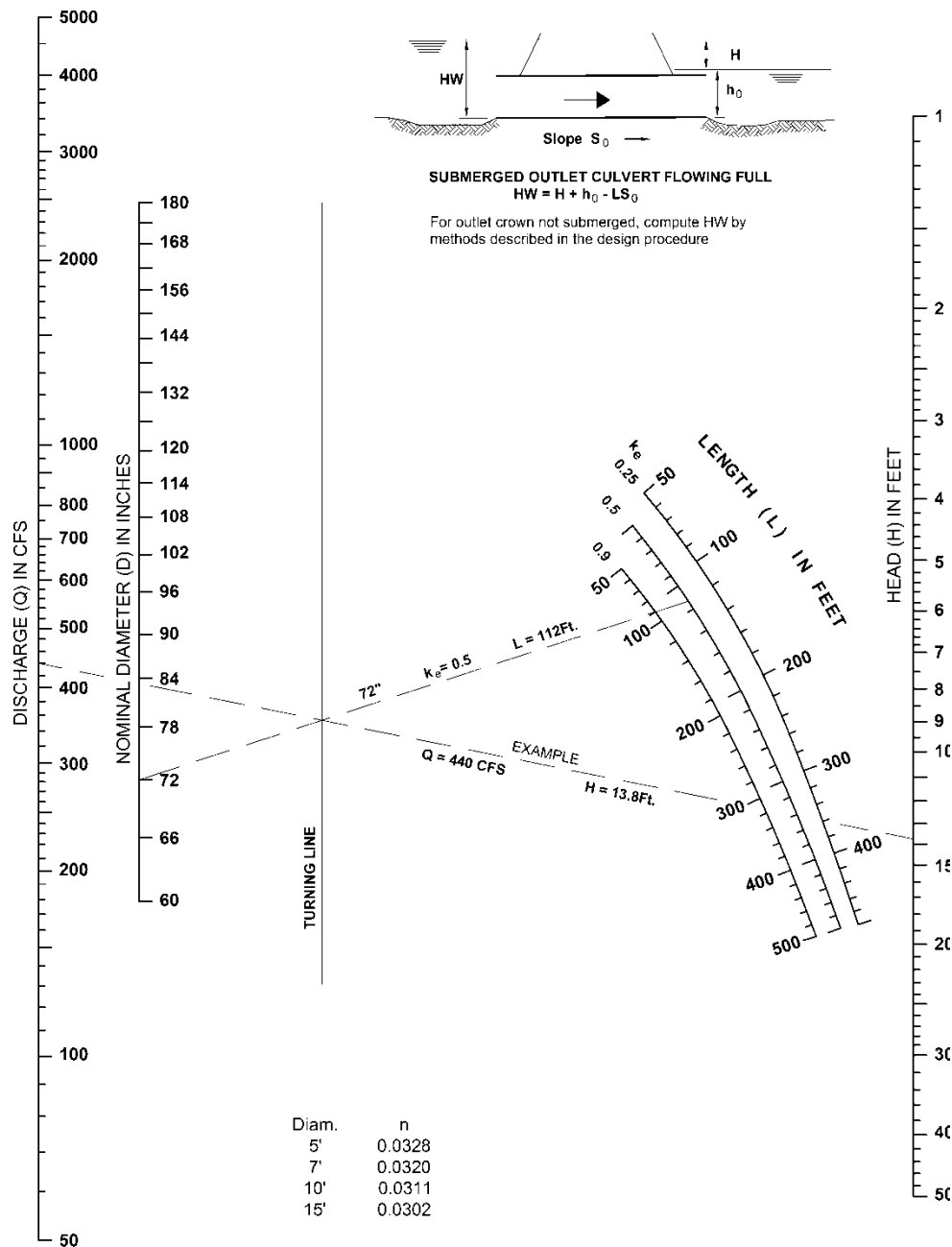
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Figure 5603-11: Head for Standard Corrugate Metal Pipe Culverts Flowing Full ($n=0.024$)



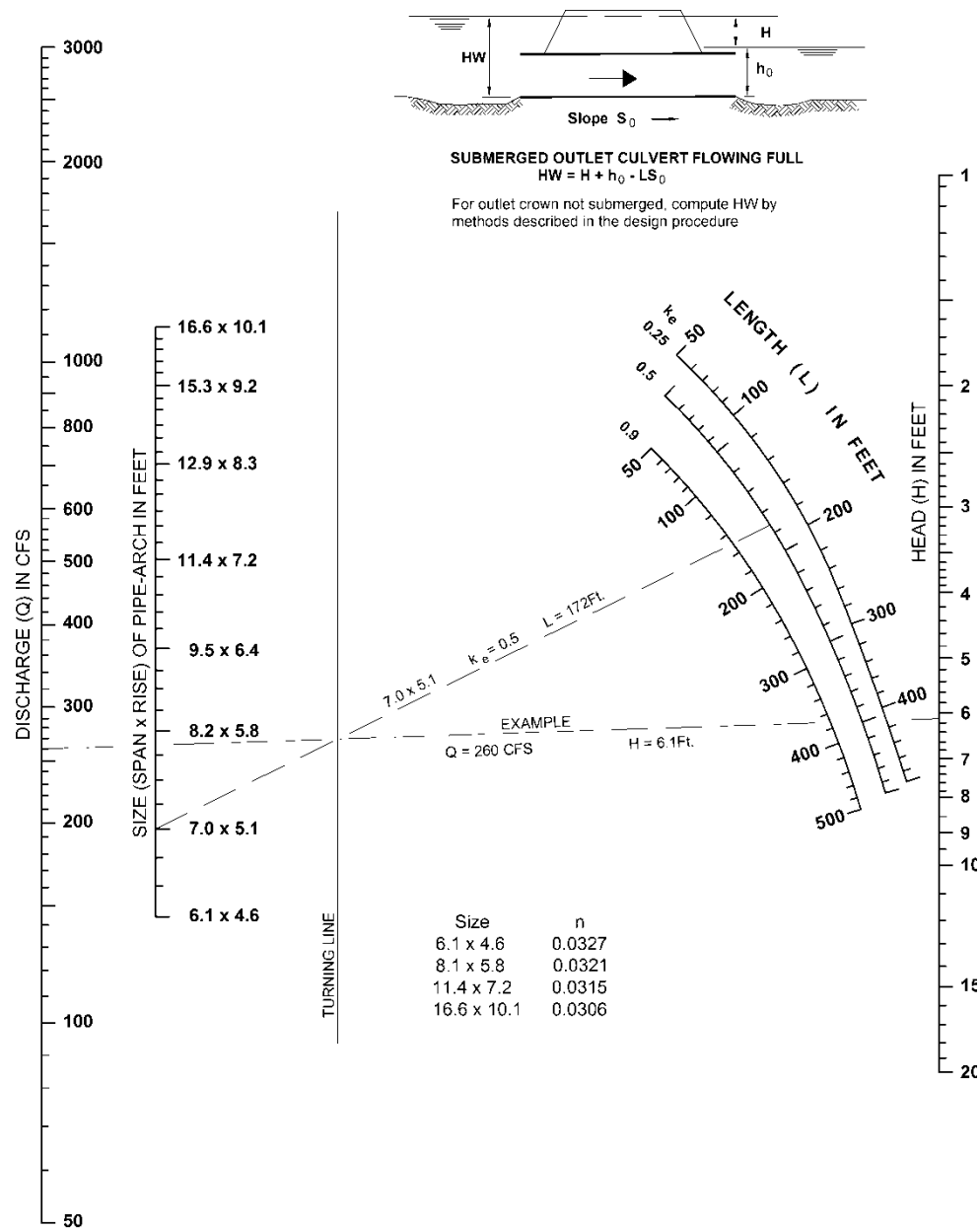
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Figure 5603-12: Head for Standard Corrugated Metal Pipe-Arch Culverts Flowing Full ($n=0.024$)



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Figure 5603-13: Head for Structural Plate Corrugated Metal Pipe Culverts Flowing Full ($n=0.0328$ to 0.0302)



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Figure 5603-14: Head for Structural Plate Corrugated Metal Pipe Arch Culverts, 18 inch Corner Radius, Flowing Full ($n=0.0328$ to 0.0302)

SECTION 5604 INLETS, MANHOLES AND JUNCTION BOXES

5604.1 Design Criteria

Stormwater inlet, manhole and junction box criteria is related to collection of stormwater from the surface and allowable hydraulic grade within the enclosed system. Collection design criteria focuses on inlet requirements in roadway applications within the public right-of-way and allowable spread of water in the street. Freeboard requirements focus on hydraulic grade elevations within the structures during the design storm.

- A. **Gutter Spread:** Inlet placement in roadway sections shall limit the allowable gutter spread to maintain one lane width for emergency vehicle access during the 10-year design storm with the median (50%) temporal distribution, as defined in Section 5602. Water spread may exceed these limits within 50 feet of a sump location, however, protection of property shall be maintained per Paragraph 5601.5, A. by limited overtopping of curb and/or flooding beyond the right-of-way.
- B. **Freeboard:** At all drainage structures and points of surface water entry into the enclosed drainage system, a minimum of 0.5-feet of freeboard shall be provided as measured from the lowest elevation of the inlet opening or structure rim elevation to the maximum water surface elevation in the inlet structure for the 10-year design storm with 10% temporal distribution, as defined in Paragraph 5601.5 and Section 5602.

5604.2 Inlet Design

Stormwater collection is the interception of stormwater runoff at specific locations. Stormwater collection is most often associated with stormwater inlets, which collect stormwater from roadways, parking lots, and other runoff generating surfaces and discharge the collected stormwater to the drainage system.

- A. **Inlet Placement:** inlets should be placed at sump locations along the project corridor. On-grade inlets shall be placed at suitable intervals that are governed by the allowable gutter spread. Inlets should also be considered for the following geometric controls:
 - 1. Immediately upstream of intersections, cross walks, and median breaks
 - 2. Immediately upstream and downstream of bridges
 - 3. Immediately upstream of superelevated sections of roadway
- B. **Gutter Spread:** Gutter spread in roadway sections shall be calculated using the methods prescribed in Hydraulic Engineering Circular No. 22 (HEC-22) Urban Drainage Manual (FHWA, 2013) based on a composite curb and gutter section, as shown in Figure 5604-1 and parameters shown in Table 5604-1.

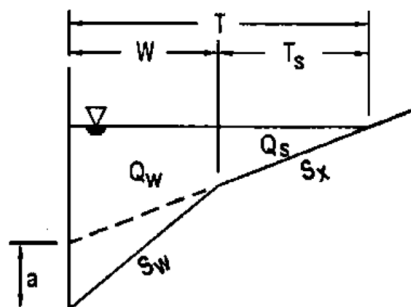


Figure 5604-1: Composite Curb and Gutter Section (Figure 4-1 of HEC-22, 2013)

- C. **Inlet Type:** Curb opening inlets are preferred for use on public streets. Grate and combination inlets may be used as approved by the City/County Engineer.
- D. **Inlet Design:** Inlets should be designed using the methods prescribed in Hydraulic Engineering Circular No. 22 (HEC-22) Urban Drainage Manual (FHWA, 2013), following the general procedures listed in this paragraph. HEC-22 parameters for APWA standard inlets are shown in Table 5604-1. Industry standard computer software models that follow HEC-22 may also be used for inlet design and gutter spread calculations.

Table 5604-1: Inlet Parameters for Curb Opening Inlets

Parameter	Curb Inlet Type 1 with C-1 Curb ⁽⁶⁾	Curb Inlet Type 1	Curb Inlet Type 2	Curb Inlet Type 3
Inlet Location ⁽¹⁾	Designer Specified based on roadway geometry			
Units Conversion Factor, K_u (ft/ft)	0.6	0.6	0.6	0.6
Gutter Cross-Slope ⁽²⁾ , S_w (ft/ft)	0.50	0.21	0.28	0.28
Curb Opening Height ⁽²⁾ , H (in)	6	6	10	10
Width of Gutter ⁽²⁾⁽³⁾ , W (ft)	1	2.3	3	3
Local Depression ⁽⁴⁾ , a (in)	$12 * W * (S_w - S_x)$			
Street Cross-Slope, S_x (ft/ft)	Designer Specified based on roadway geometry			
Street Longitudinal Slope, S_L (ft/ft)	Designer Specified based on roadway geometry			
Curb Opening Length, L (ft)	Designer Specified based on required inlet length, intercept, and gutter spread relationship			
Manning's Coefficient ⁽⁵⁾ , n	Designer Specified based on pavement type			
<div>(1) Specify Inlet on Grade or Inlet in Sag based on location of inlet in roadway alignment (FHWA, 2013)</div> <div>(2) APWA Division III Standard Drawings (Revised April 2019)</div> <div>(3) As measured from edge of street to front face of inlet</div> <div>(4) Local depression calculated per HEC-22 equation 4-6 (FHWA, 2013)</div> <div>(5) Defined by pavement type per HEC-22 Table 4-3 (FHWA, 2013)</div> <div>(6) Straight curb type C-1 directly abuts pavement without a gutter section. Unless designated in the table header as using type C-1 curb, all other parameters assume a standard CG-1 or CG-2 curb and gutter section.</div>				

- E. **Configuration:** These minimum dimensions (shown in Table 5604-2 and illustrated by Figure 5604-2) apply to either the roll back or straight type curbs:

Table 5604-2: Minimum Inlet Configuration Dimensions

Description	Dimension
Opening length, inside	4.0 ft (min)
Width, perpendicular to curb line, inside	3.0 ft (min)
Setback curb line to face	1.0 ft (min)
Opening, clear height	6.0 in. (min)
Gutter transition length	
(a) Both sides in sump and upstream side on slopes	5.0 ft (min)
(b) Downstream on slopes	3.0 ft (min)

5604.3 Inverts and Pipes

The inverts of pipe(s) entering a drainage structure shall be at or above the invert of the pipe exiting from the structure and provide a minimum fall of the invert in the structure of 0.1 feet through the structure. The desirable fall across the invert is a minimum of 0.2 feet.

5604.4 Manholes and Junction Structures

The maximum spacing between manholes shall be 500 feet. A manhole or junction structure shall be located at any change in alignment of the pipe system and/or connection with other pipe systems.

5604.5 Loading Conditions for Structures

Loading shall be in accordance with Paragraph 5710.3.

5604.6 Street Grade on Vertical Curves

The following formula shall be used to determine the street grade (S_x) at any point on a vertical curve using plus for grades ascending forward and minus for grades descending forward, in feet per foot.

$$S_x = S_1 + \frac{x \cdot (S_2 - S_1)}{L}$$

Where:

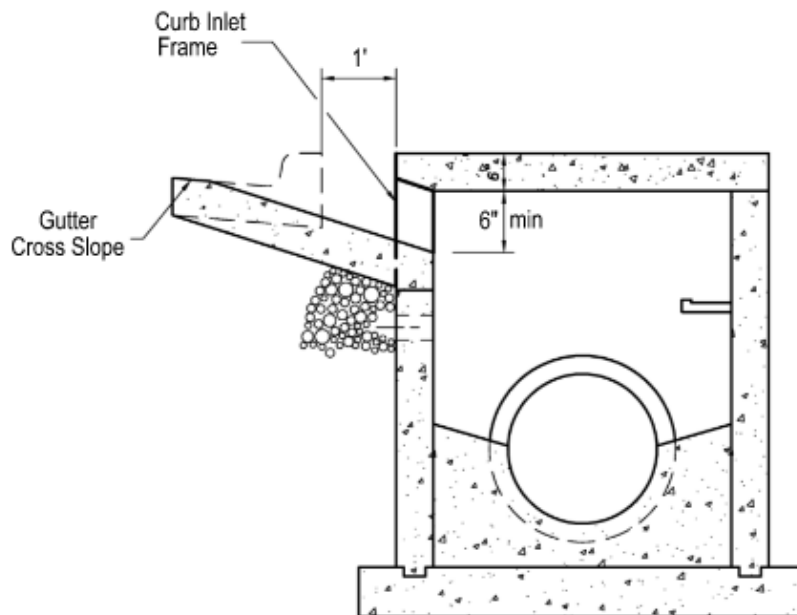
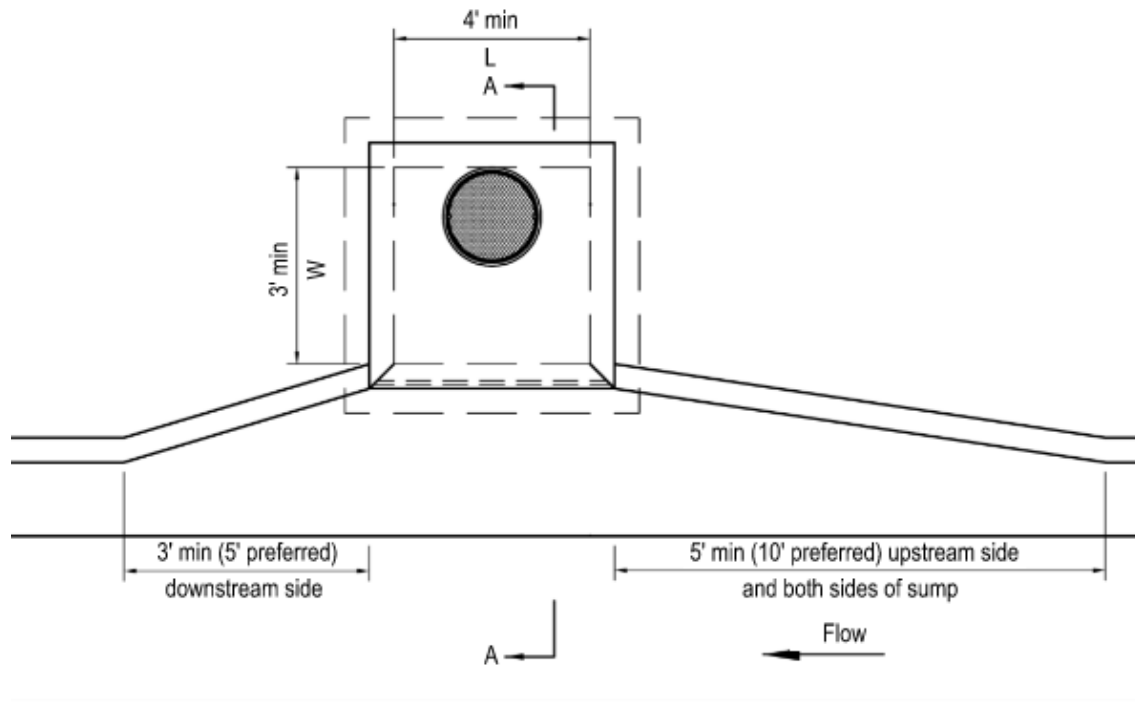
S_x = the street grade on a vertical curve at point x, in feet per foot

S_1 = the street grade at the PC of a vertical curve, in feet per foot

S_2 = the street grade at the PT of a vertical curve, in feet per foot

x = the distance measured from the PC to point x on a vertical curve, in feet

L = the total length of a vertical curve, in feet



SECTION A-A
Not to Scale

Figure 5604-2: Curb Inlet (10' Throat) Minimum Hydraulic Dimension

SECTION 5605 NATURAL DRAINAGE PATHS & STREAMS

5605.1 Design Criteria

This section sets forth requirements for the protection of natural drainage paths and streams as a conveyance for stormwater. Unless otherwise provided for by City, State, or Federal ordinance, regulation, or standards, existing streams shall be preserved and protected in accordance with this section. The City of Warsaw Code of Ordinances Chapter §405.070 Stormwater Management and Natural Area Protection Standards adopts requirements to preserve natural drainage paths through Stormwater Drainage Setbacks to protect the community's natural amenities. These policies are enforced during the planning phase of land development through requirement of a Stormwater Drainage Permit, as required by Chapter §405.020 and detailed in §405.030.

Natural drainage paths shall be preserved to reduce the risk for property damage by designating space for the overland conveyance of stormwater for rainfall events exceeding the capacity of the engineered system. Natural drainage paths delineated from 2016 LiDAR data for the City of Warsaw are shown in Appendix A, for reference. Stormwater drainage setback requirements are defined in Paragraph 5605.2. Each element of the stormwater drainage system (whether open, enclosed, retention, or detention) shall include an overflow element to a preserved natural drainage path. Overflow systems shall:

- A. Be designed to route downstream flows in excess of the engineered system design capacity.
- B. May include streets, natural drainage paths, engineered channels, redundant piping, spillways, parking lots, drives or combinations thereof.
- C. Limit the maximum water surface elevation generated by the 100-year design storm with the 10% temporal distribution to meet protection of property requirements.
- D. Conform to Paragraph 5605.2 Easements regarding easements and restricted uses for overflow systems within stormwater drainage setbacks.

5605.2 Easements

- A. **Natural Drainage Path Requirements:** Natural drainage paths and stream corridors shall be preserved and protected by limiting development activity in and adjacent to these areas to reduce risk of property damage from flooding and stream bank erosion, and to protect the safety of the public. Natural drainage paths delineated from 2016 LiDAR data for the City of Warsaw are shown in Appendix A, for reference.
 - 1. All final grading and drainage shall comply with applicable City/County and State requirements.
 - 2. To the maximum extent feasible, development shall preserve the natural drainage paths unique to each site as a result of topography and vegetation. Natural drainage paths may be modified on site only if outside of the stormwater drainage setback. If natural drainage paths are modified, appropriate stabilization techniques shall be employed.
 - 3. Streets, roads, private access roads and other vehicular routes shall, to the maximum extent feasible, not be within a natural drainage path.
 - 4. Grading shall be designed to ensure that drainage flows away from all structures and heavily used areas.
 - 5. Development shall be designed to mitigate all negative or adverse drainage impacts on adjacent and surrounding sites.

- B. Stormwater Drainage Setbacks:** Stormwater drainage setbacks shall be dedicated as a drainage easement to the City and apply to all land or development that includes natural drainage paths. The requirements for stormwater drainage setbacks are as follows:
1. The stormwater drainage setback shall start at the top of bank of the natural drainage path or stream, to be determined by topographic survey, and move outward on either side of the channel. If a top of bank cannot be determined, one of the following methods may be applied to define the top of bank for the stormwater drainage setback:
 - a. Apply the assumed channel width to the centerline of the natural drainage path.
 - b. Delineate the bank-full or channel-forming flow caused by approximately the 2-year design storm with the median (50%) temporal distribution.
 2. Stormwater drainage setbacks shall be identified on the site plan and dedicated on the preliminary and final plats as a Drainage Easement.
 3. Stormwater drainage setback widths have been determined based on tributary drainage area, as shown in Table 5605-1 and Figure 5605-1, with the following defined setback widths:
 - a. **Channel Width:** centered on the natural drainage path is preserved for frequent stormwater flows with no other allowable uses.
 - b. **Preservation Setback Width:** begins at the top of bank of the natural drainage path/stream and is preserved for vegetation or other forms of bank stabilization with no other allowable uses.
 - c. **Protection Setback Width:** extends a predetermined distance from the preservation setback or to the extents of the 100-year effective FEMA floodplain, whichever is greater. Allowable uses within the protection setback include community amenities such as trails and greenways, as well as utility rights-of-way.

Table 5605-1: Stormwater Drainage Setbacks

Drainage Area (acre)	Assumed Channel Width (feet)*	Preservation Setback Width (feet)	Limited-Use Setback Width (feet)	Total Setback Width (feet)
2 to < 10	5	5	-	15
10 to < 40	10	10	10	50
40 to < 160	30	30	10	110
160 to < 640	60	60	20	220
640+	80	80	20	280
*Actual channel width may differ from Assumed Channel Width values presented in table based on results of topographic survey.				

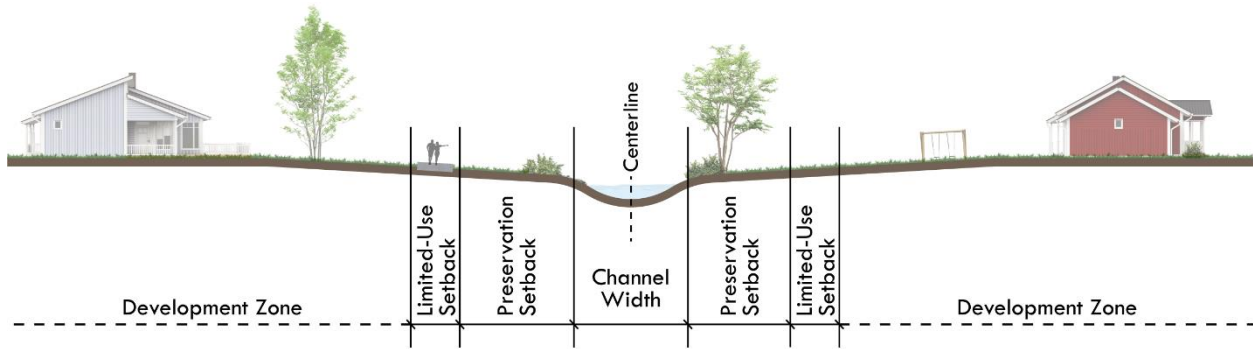


Figure 5605-1: Stormwater Drainage Setbacks

4. No construction or disturbance of any type, including clearing, grubbing, stripping, fill, excavation, linear grading, paving, or building is allowed in the setback widths except as falls within the allowable setback uses or by permission of the City/County Engineer. Dense stands of native vegetation shall be maintained, particularly in the preservation setback.
5. Unless otherwise accepted by the City/County, any maintenance of stormwater drainage setbacks shall be the responsibility of the property owner.
6. For work on existing facilities already located closer to the natural drainage path than allowed per these standards, the new construction shall not encroach closer to the drainage path. Bank stability concerns shall be addressed for improvements to existing land within the setback width.

5605.3 Natural Stream Benefits and Characteristics:

Natural streams provide numerous water quality, ecological, and quality of life benefits. Protection and preservation of natural streams is a national environmental objective, as set forth in the Clean Water Act. Streams and their associated wetlands provide critical habitat for plants and wildlife, water quality treatment, and improved infiltration of rainfall which lessens flood impacts, recharges groundwater, and preserves base flow. Streams provide recreational and open space in communities, improve aesthetics, provide natural landscapes, and enhance adjacent property values.

Stable streams in nature maintain a shape in plan, profile, and section that most efficiently transports the water and sediment supplied to them. The geometry and processes of streams involve unique terminology and concepts not common to engineered channels or pipe systems. Common features of stream geometry and characteristics are presented in Figure 5605-2 and Figure 5605-3. Certain definitions are contained in Section 5601. More complete information regarding the character and function of streams is given in Interagency (2001).

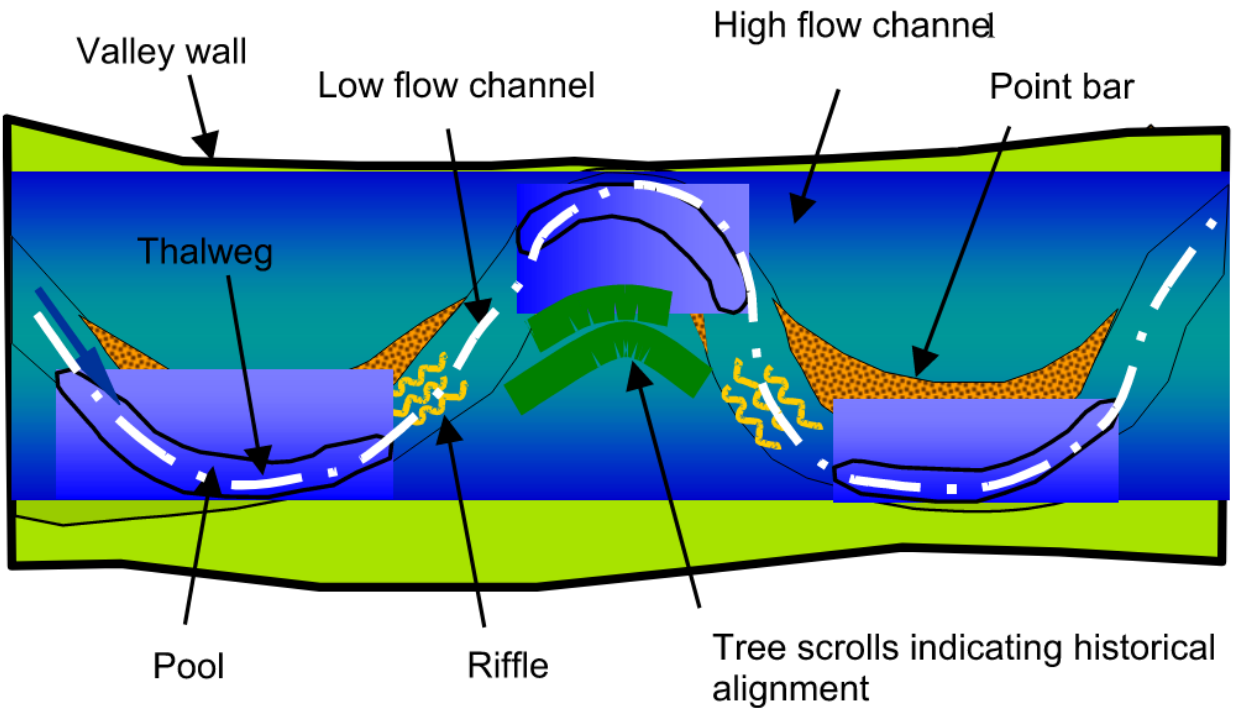


Figure 5605-2: Typical Stream Characteristics (1 of 2)

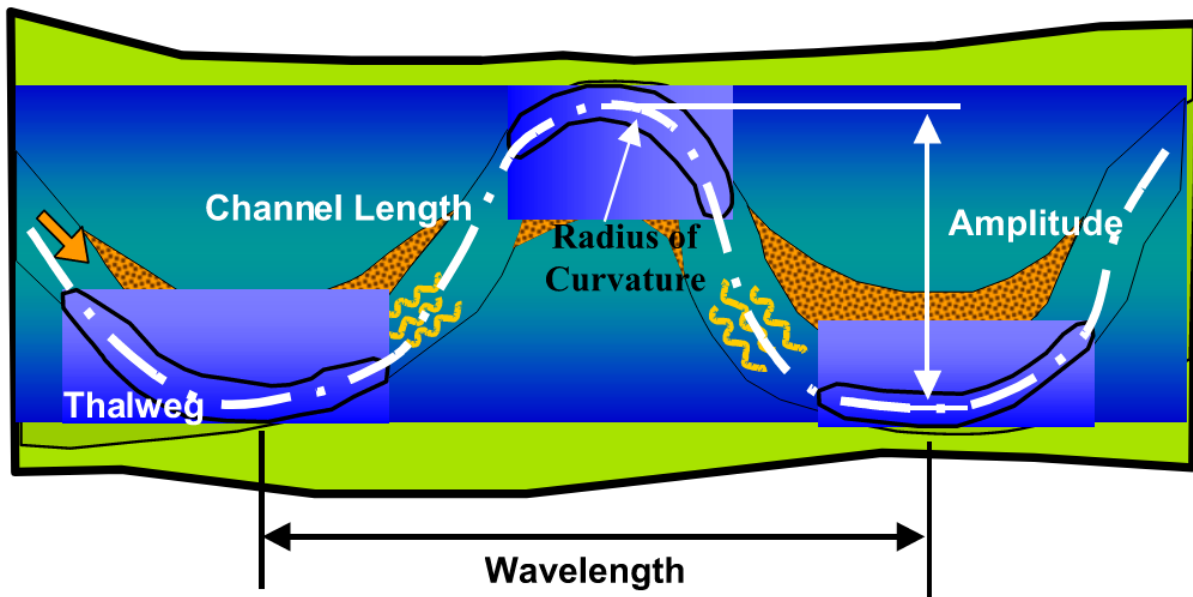


Figure 5605-3: Typical Stream Characteristics (2 of 2)

5605.4 In Stream Construction - General Requirements

Construction in natural drainage paths, streams or their setback widths shall conform to the general requirements of this subsection and to the appropriate specific requirements of the subsections following:

- A. **Stream Assessment:** A stream assessment shall be conducted in accordance with Paragraph 5605.5 for all construction within the setback widths except for discharge outfalls, unless otherwise directed by the City/County Engineer.

- B. Energy Management:** The pre-project and post-project hydraulic and energy grade lines for the 2-year, 10-year, and 100-year design storm with 10% temporal distribution flows shall be plotted. The region of a stream where in-stream construction causes a change in these grade lines is considered the zone of influence. The extent of the zone of influence downstream shall be generally limited by energy dissipation and grade control. The upstream limit of the zone may extend a distance beyond the construction as a drawdown or backwater curve. Within the zone of influence, the energy of the flow on the channel will be evaluated for the potential of excessive scour, deposition, initiation of head cuts, or other instability. Use of vegetation to increase bank resistance and minimize increases or abrupt changes in velocities is recommended. Bank or bed stabilization may be required in areas of unavoidable velocity or depth increase.
- C. Sediment Transport Continuity:** The minimum post-project applied shear to the bed of the channel in the zone of influence at the 2-year, 10-year, and 25-year storm flow shall not be less than 90% of the minimum pre-project applied shear in the zone, so as to maintain the ability of the channel to transport sediment. If such shear stresses cannot be maintained, the engineer will evaluate the potential for future sediment removal or maintenance.
- D. Transitions:** In-stream structures shall be designed to gradually blend into the natural stream and provide a smooth transition of both geometry and roughness.
- E. Repair of Disturbed Banks:** The side slopes of banks where construction occurs shall be restored with vegetation in accordance with Paragraph 5605.13 as quickly as possible.
- F. Professional Judgment:** Streams are complex, variable, and strongly governed by local geology and climate. These standards are based on general guidelines of good practice on typical local streams and may not be optimal or sufficient in all cases. Specific requirements may be increased or waived by the City/County Engineer if conditions warrant and decisions should be guided by prudent engineering judgment.

5605.5 Stream Assessment

When conducted, a stream assessment will extend a minimum of one wavelength up and downstream of the area to be impacted by construction. It shall include the components listed below, except modified by the City/County Engineer to better fit project needs. An example submittal is shown in Figure 5605-4 and Figure 5605-5.

- A. Plan Form Analyses and Inventory:** The plan-view of the stream using aerial photographs or planning-level aerial survey shall be plotted to an appropriate scale. Field surveys of the entire reach study area are not required. The following items shall be shown:
- Ordinary high water mark.
 - Top of bank.
 - Ground contours (if available).
 - Hydraulic grade line for "bank-full" conditions (see Paragraph 5605.5.B) and 100-year design storm with 10% temporal distribution .
 - Thalweg, locations of riffles and pools, and spacing between riffles (see Paragraph 5605.5.C).
 - Exposed bedrock, areas of differing bed and bank soil or rock materials, and the D_{50} and shear stress ratio at each riffle (see Paragraph 5605.5D)
 - Active scour and depositional areas, point bars, and islands.
 - Vegetation within the stormwater drainage setback widths, called out as mowed grass, mowed with trees, unmowed grass and plants, wooded, and bare. Trees greater than 6" diameter within 25 feet of the top of bank shall be located individually or by group. The species of dominant trees should be noted.

- Meander length, wavelength, meander amplitude, bank-full width, and radius of curvature for each bend.
- Total meander and valley length and sinuosity for the reach.
- Photographs of main channel, streamside vegetation, and each riffle, appropriately referenced to plan-view location.

B. Bank-full Width, Depth and Discharge: If directed by the City/County Engineer, the geomorphic "bank-full" width, depth, and discharge shall be estimated using field indicators as detailed in Chapter 7 of USDA (1994). If field indicators are not used, "bank-full" flow shall be estimated as the rural-conditions 2-year design storm with the median (50%) temporal distribution flow, and the bank-full width and depth estimated based on the dimensions of that flow through the existing channel. This assumption is intended to provide a rough upper estimate of the bank-full flow.

C. Longitudinal Profile and Sections: The elevations of the profile along the thalweg shall be field surveyed to the nearest 0.1 ft. and the following features noted: riffles, pools, exposed bed rock, and advancing head cuts (areas of bed elevation change that appear to be actively migrating upstream). The top of left and right bank and any field indicators of bank-full flow such as limits of woody vegetation or top of point bars shall be plotted at correct elevation along the profile. The bank-full flow and 100-year design storm with 10% temporal distribution flow profiles shall be plotted.

One field cross section shall be surveyed through each pool and riffle, and the depth and width of bank-full flow and floodplain for the 100-year design storm with 10% temporal distribution shall be shown on each section.

D. Bed and Bank Materials Analyses: The type of rock exposed in the bed and banks shall be identified. Bank soils shall be reported by Uniform Soil Classification using the visual-manual procedures (ASTM D 2488-00). The median (D_{50}) particle size shall be determined using the Wolman Pebble Count Method (USDA, 1994, Chapter 11). A shear stress ratio shall be calculated for each riffle based on the applied shear at bank-full flow divided by the critical shear of the D_{50} particle in the riffle, using methods and tables described below.

E. Critical Shear Stress Analysis: The shear stress ratio must be less than one at the extreme downstream point of any development in accordance with the guidelines below:

1. The average applied shear stress (τ_0) may be calculated from the hydraulic data as follows:

$$\tau_0 = \gamma \cdot R \cdot S$$

Where:

γ = the specific weight of water (62.4 lbs/ft³)

R = hydraulic radius at bank-full flow (feet)

S = the water surface slope along the main channel bank full flow, averaged over several bends in the area of the intervention

Effective flow may be calculated using methods described in detail in USACE 2001 or may be assumed to be equivalent to the 2-year storm.

2. The critical shear stress (τ_c) is that at which particles in the bed or bank are entrained and scour ensues. Shield's method is used for calculating the critical shear stress of spherical, non-cohesive particles, as follows:

$$\tau_c = \theta \cdot (\gamma_s - \gamma) \cdot D_{50}$$

Where

γ_s = the specific weight of sediment

γ = specific weight of water (62.4 lb/ft³)

D_{50} = the median particle size in the surface layer of bed or banks

θ = the Shield's parameter (0.06 for gravel to cobble, 0.044 for sand)

There are limited methods for calculating τ_c for fine-grained material. Field or laboratory testing generally determines the critical shear stress for these materials. The most widely available source is Chow (1988). Table 7-3, p. 165 is particularly relevant. More recently, the USDA Agricultural Research Service National Sedimentation Laboratory has developed computer software for calculating toe scour (ARS Bank-Toe Erosion Model, Prototype, August 2001). As part of that software, there are look-up tables.

The combination of these two sources is presented in Table 5605-2 Critical shear stress may also be determined from Urban Water Resources Research Council (1992), Figure 9.6, p. 335.

In lieu of calculated values, the critical shear stress from Table 5605-2 may be used. Table 5605-2 presents critical shear for sediment-laden water and where noted, clear water. The user must exercise judgment as to future conditions. Clear water values may be used below a heavily piped area, concrete channels designed to contain the future flows or immediately below a managed detention pond.

3. The ratio of average boundary stress to critical stress is the shear stress ratio:

$$\text{shear stress ratio} = \frac{\tau_o}{\tau_c}$$

If bed and bank materials are distinct, then the shear stress ratio should be calculated for each. If the shear stress ratio of either stream bed or bank is greater than one, the channel is prone to near-term adjustment and any interventions should be designed to prevent accelerated erosion. If the bed consists of rock, then the shear stress ratio is not applicable, unless the rock is prone to fracturing, slaking, or break-up, in which case the median size of particle should be used for calculation of the ratio.

Table 5605-2: Critical Shear Stresses for Channel Materials

Material	Shear Stress (psf)
Granular Material	
Boulders (100 cm)	20.295
Boulders (75 cm)	15.222
Boulders (50 cm)	10.148
Boulders (25.6 cm)	5.196
Rip Rap	3.132
Cobbles (6.4 cm)	1.299
Cobbles and shingles	1.1
Cobbles and shingles, clear water	0.91
Coarse sand (1mm)	0.015
Coarse sand (1mm)	0.015
Coarse gravel, noncolloidal (GW), clear water	0.3
Coarse gravel, noncolloidal, (GW)	0.67
Gravel (2cm)	0.406
Fine gravel	0.32
Fine gravel, clear water	0.075
Fine sand (0.125 mm)	0.002
Fine sand (0.125 mm) (SP)	0.002
Fine sand (SW), (SP), colloidal	0.075
Fine sand, colloidal, (SW), (SP), clear water	0.027
Graded loam to cobbles, noncolloidal (GM)	0.66
Graded loam to cobbles, noncolloidal, (GM), clear water	0.38
Graded silts to cobbles, colloidal (GC)	0.8
Graded silts to cobbles, colloidal, (GC), clear water	0.43
Fine Grained	
Resistant cohesive (CL), (CH)	1.044
Stiff clay, very colloidal, (CL)	0.46
Stiff clay, very colloidal, (CL), clear water	0.26
Moderate cohesive (ML-CL)	0.104
Ordinary firm loam (CL-ML)	0.15
Ordinary firm loam, (CL-ML), clear water	0.075
Alluvial silts, colloidal (CL-ML)	0.46
Alluvial silts, colloidal, (CL-ML), clear water	0.26
Alluvial silts, noncolloidal (ML)	0.15
Alluvial silts, noncolloidal, (ML), clear water	0.048
Sandy loam, noncolloidal (ML)	0.075
Sandy loam, noncolloidal (ML), clear water	0.037
Silt loam, noncolloidal (ML)	0.11
Silt loam, noncolloidal, (ML), clear water	0.048
Shales and hardpans	0.67
Others	
Jute net	0.46
Plant cuttings	2.09
Well established dense vegetation to the normal low water	2.16
Geotextile (synthetic)	3.01
Large Woody Debris	3.13

Note: For non-cohesive soils, the table values are based on spherical particles and Shield equation, as follows: $\tau_c = \Theta(\gamma_s - \gamma) D$ where γ_s is the specific weight of sediment (165 pcf), γ is specific weight of water, D is the reference particle size, and Θ is the Shield's parameter (0.06 for gravel to cobble, 0.044 for sand). For cohesive soils the values are based on limited testing as reported in Chow (1988) and USDA (2001).

- F. **Plan-Form Ratios:** The following ratios shall be calculated, and those that lie outside the typical range shall be noted. Streams are highly variable and ratios outside these ranges do not necessarily indicate problems.

Table 5605-3: Plan-Form Ratios

Ratio	Typical Range
Meander length / Wavelength (sinuosity)	1.1 to 1.5
Meander length / Bank-full width	10 to 14
Radius of curvature / Bank-full width	2 to 5
Riffle Spacing / Bank-full width	5 to 7

- G. **Channel Condition Scoring Matrix:** Using information summarized above, the channel condition scoring matrix given in Table 5605-4 shall be completed. A rating of 12 indicates a stream of moderate stability that will likely require only standard levels of protection during construction. A rating between 12 and 18 indicates that special measures may be necessary address those issues rated as poor in the assessment. Streams with a rating greater than 18 may exhibit significant system-wide instability. These streams should be studied in more detail by experts in river engineering and fluvial geomorphology. (This scoring system is newly developed and its results shall be considered provisional.)



Figure 5605-4: Stream Assessment

5605.6 Discharge Outfalls

Discharge points for inflows from enclosed systems or constructed channels shall be designed as one of the following. Energy management and sediment continuity checks are not required; however, energy dissipation shall be provided to reduce post development shear stress to pre-development shear stress at the outfall:

- A. Primary outfalls are those where the entire upstream channel is replaced by an enclosed system or engineered channel which discharges flow in line with the direction of the downstream segment. Energy dissipation should be provided at the outlet to reduce velocities per Paragraph 5606.4. Grade control downstream of the outlet and an energy dissipater should be provided to prevent undermining of the outfall by future head cuts per Paragraph 5605.10. The alignment and location of the outfall and associated energy dissipater and grade control should make a smooth transition into the downstream channel. Primary outfalls shall be used whenever the contributing drainage area of the outfalls is greater than 80% of the downstream channel.
- B. Tributary outfalls are primary outfalls located on a tributary to a larger downstream segment. Energy dissipation and transition to natural stream flow should take place in the tributary at least one channel width upstream of the confluence per Paragraph 5606.4. Grade control in the tributary upstream of the confluence shall be provided if the tributary flow line is higher than the adjoining channel or if future incision of the adjoining channel is anticipated. Tributary outfalls may be used in all situations of tributary flow.
- C. Lateral outfalls are small outfalls that discharge from the banks of a stream. Outfalls shall be located to enter on a riffle or from the outside of a bend, but should generally not enter from the inside of a bend. Outfall pipes shall be oriented to discharge with the direction of flow at a minimum of 10-15 degrees from a line perpendicular to the stream alignment. The invert shall be at or slightly below the top of the next downstream riffle. Outfalls shall be flush with or setback from the bank. The bank shall be shaped to provide a smooth transition and protected with reinforced vegetation (preferred) or rip- rap. If the outfall is in a bend, it shall be set back from the existing bank a sufficient distance to account for future meander migration, and the transition shall be graded and reinforced with vegetation. Riprap or hard armor protection should not be used in a bend. Perpendicular outfalls may only be used when the contributing drainage area of the outfall is less than 40% of that in the downstream channel.
- D. Edge-of-buffer outfalls are discharge points in the outer half of the riparian buffer that return the discharge to diffused overland flow. Outfalls shall be designed to spread flow and allow overland flow and infiltration to occur. Overland flow shall be directed to run in the outer portion of the buffer parallel to the channel direction to increase length of flow and prevent short-circuiting directly into the stream. Low weirs and berms may be graded to direct flow and encourage short-term ponding. The buffer zone utilized for infiltration shall be maintained in dense, erosion-resistant grasses or grasses reinforced with turf- reinforcing mats designed to withstand the shear stresses of a 10-year design storm with 10% temporal distribution. Edge-of-buffer outfalls that are part of a system of upland drainage using multiple small, distributed overland swales and ditches instead of pipes may provide significant infiltration and water quality treatment. Edge-of-buffer outfalls shall only be used if each individual outfall can be designed to operate without scour or the formation of gullies.

5605.7 Culverts, Bridges, and Above Grade Crossings

- A. Crossings should generally be located on a riffle. If the width of the crossing is large relative to the length of the riffle, then grade control structures shall be provided at the riffles upstream and downstream to isolate the impact of the crossings. If a crossing cannot be made at a riffle, avoid armoring a pool and place at-grade control structures at the riffle immediately upstream and downstream of the crossing. Maintain sediment transport continuity and avoid altering the channel cross-section.

- B. Realignment of channels to accommodate crossings and their approach should be avoided and minimized as much as possible. Any areas relocated shall have the banks stabilized in accordance with 5605.13 and shall be included in the reach isolated by upstream and downstream grade control.
- C. For bridges the multi-stage channel shape should be maintained and additional area to convey the design flow shall be above the elevation of the bank-full discharge.
- D. For multi-cell pipe and culvert crossings that have a cumulative width larger than the bank-full width, those cells wider than the bank-full width shall have a flow line located at the lowest estimated bank-full depth, or a weir wall or other structure upstream of the culvert opening shall be installed with a height to prevent access to the cell during flows less than bank-full flow. The weir wall shall be designed so that the hydraulic efficiency at the 100-year design storm with 10% temporal distribution is not reduced. Without these features, the culvert may have a tendency to build up deposits and lose capacity or require frequent maintenance, particularly when crossings are located in sharp bends or streams with high sediment loads.
- E. Culverts shall be designed so that there is minimal backwater effect at all flows up to the 25-year storm discharge. Energy management and sediment transport continuity shall be checked.

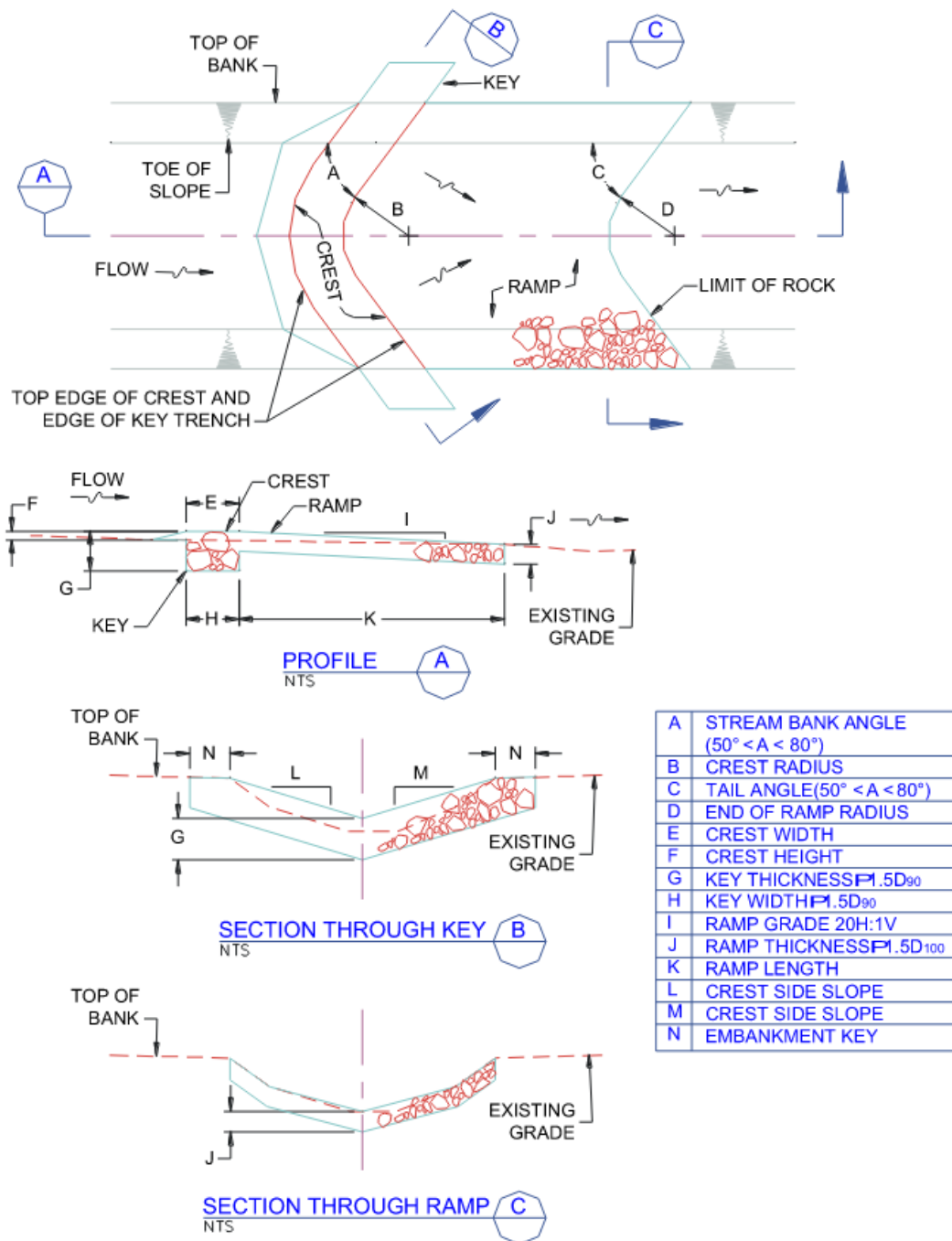
5605.8 Below Grade Stream Crossings

- A. Below grade stream crossings primarily include utility pipelines. Crossings should generally be at riffles and grade control structures constructed at the riffle, in addition to or constructed integrally with any encasement of the line the utility may require. Utility encasements shall extend a minimum of five (5) feet into the stream bank on both the upstream and downstream sides of the crossing to account for the natural stream morphology. If a crossing is at a bend in the stream this minimum shall extend ten (10) feet into the stream bank.
- B. If riffle crossing is not feasible, the crossing should be in a pool that is protected by a downstream grade control structure. The top of crossing elevation should be at least two feet below the top of grade control. Crossings under pools should not be armored directly, but are protected by downstream grade control.
- C. Below grade crossings shall be perpendicular to and along a straight section of the stream whenever possible. If a perpendicular crossing is not feasible, the grade control protecting the crossing shall be perpendicular.
- D. Constriction or alteration of the pre-existing channel shape shall be avoided. If alteration occurs, sediment transport continuity and energy management shall be verified. Stream banks shall be repaired using vegetative methods whenever possible and the hydraulic roughness of the repaired stream bank should match that of the undisturbed stream banks.
- E. Utility structures or manholes should not be placed within the stream cross section, when possible. Consider stream morphology when placing structures. Generally avoid placement of structures on the outside bend of a stream.
- F. Avoid utility crossings immediately downstream of a stormwater outfall.

5605.9 Grade Control

- A. Where grade control structures are required, they shall be placed in locations where the stream bed profile will support the creation or continuance of a riffle. The flow line of the grade control shall match the existing riffle.
- B. Where stream slope is less than 2%, the Newberry-style grade control structure detailed in Figure 5605-6 is recommended. Structures shall be constructed from durable stone sized using USACE methodology for steep channels (USACE EM 1110-2-1601, page 3-8, Equation 3-5). Rock shall generally comply with USACE gradations as given in (USACE EM 1110-2-1601, Hydraulic Design of Flood Control Channels, Chapter 3). Shotrock with sufficient fines to fill voids may be used. The use of filter fabric and uniform gradations of stone are discouraged in stream beds.

- C. Where grades are in excess of 2%, low-drop step structures should be used.
- D. Alternate styles of grade control may be approved by the City/County Engineer. Guidance for grade control design is given in Thomas et.al.
- E. Construction of new grade controls structures may be waived by the City/County Engineer if it is determined that existing riffles are adequate to prevent or retard advancing head cuts, or if it is preferable to accept the risk of future head cut than to further disturb the channel.
- F. When grade control is not part of a larger project, energy management and sediment continuity checks are not required.



Notes

1. The depth of key trench shall be a minimum of 1.5 D₉₀. The crest shall slope downward from the stream bank to the center of the structure to focus the flow to the channel center. The tail ramp is generally sloped at 20 horizontal to 1 vertical and dissipates energy gradually over its length. The upstream face is not perpendicular to the flow but has an upstream oriented "V" or arch shape in plan form.
2. For item A, Stream Bank Angle, and item C Tail Angle, the lower end of the range should be used for softer soils.
3. For items L and M, crest angle, the typical range is 5 to 1 to 10 to 1.

Figure 5605-6: Grade Control Structure

5605.10 Floodplain Fills

No fill shall be placed within the effective FEMA floodplain and/or floodway. Fill placed outside these limits shall not cause a rise in the FEMA effective floodplain beyond the limits of the property controlled by the developer. Fills placed within floodplain designated as a special flood hazard area by FEMA shall conform to FEMA and community floodplain management requirements. Energy management and sediment transport continuity shall be checked.

5605.11 Flood Control Projects

- A. The flood control projects that increase conveyance capacity in streams should generally be limited to cases where existing buildings or infrastructure face significant damage or life and safety issues. Projects to lower floodplain elevations to facilitate new development near streams at lowered elevations should be avoided.
- B. The portion of the channel within the effective floodplain should be left undisturbed if possible, with conveyance increases primarily from excavation of a larger cross sectional area in the over-bank. Excavated areas within the stormwater drainage setbacks should be revegetated with dense, native-type vegetation. Reducing roughness in the over-bank by paving or mowing to increase velocities should be avoided.
- C. Flood control projects should be evaluated on a project by project basis, and abide by current, effective floodplain management regulations..

5605.12 Bank Stabilization Projects

- A. Bank stabilization projects should generally be limited to cases where existing buildings or infrastructure face significant property damage or safety issues. Projects to stabilize banks to facilitate reductions in stormwater drainage setback widths for new construction should be avoided.
- B. Prior to stabilization, the causes of the instability should be considered, including the stream's current phase of channel evolution (Interagency, 2001, Chapter 7) and direction of meander migration. Stabilization may be unnecessary if a channel has ceased incision and widening and is in the process of deposition and restoration. If stability issues appear widespread or complex, a systematic evaluation of the stream system by professionals with expertise in river engineering and fluvial geomorphology may be justified.
- C. Instability caused by geotechnical failure (slumping of banks due to weak soils in the adjacent slopes) shall be distinguished from fluvial failure (erosion of banks caused by stream flows). For geotechnical issues, a geotechnical engineer shall evaluate the slope stability. Geotechnical designs shall provide for a 1.5 factor of safety (ratio of theoretical resisting forces to driving forces) against slope failure where it would endanger buildings, roadways, or other infrastructure, unless a lower factor of safety is approved by the City/County Engineer.
- D. Bank stability projects should have a design life greater than the useful life of the facility being protected, or a life cycle cost analyses shall be performed that considers replacement and repair over the entire protection period. Responsible parties for future maintenance should be identified.
- E. Stabilization should begin and end at stable locations along the bank. Bank stabilization should be limited to areas of potential erosion and are rarely required on the inside of bends. For long projects, stabilization may alternate from side to side and is rarely necessary across an entire cross section. The existing cross section should be mimicked to the extent practical and need not be planar or uniform over the entire length. Grade control shall be provided at the riffle both upstream and downstream of the stabilization to isolate it from the surrounding stream and protect the foundation from undercutting. Control at intermediate points for longer projects may also be required. Energy management and sediment transport continuity shall be checked, and energy dissipation provided if necessary.
- F. "Hard-Armor" projects are those projects that use rip-rap, placed stone, gabions, retaining walls, or other rigid structures to provide geotechnical and fluvial stability. Such projects shall be designed in accordance

with EM 1110-2-1205 (USACE, 1989), EM1110-2-1601 (USACE, 1994), or HEC-11 (FHWA 1989). Materials shall be sized to prevent dislodgement in the 100-year design storm with 10% temporal distribution. Gradation should comply with USACE or FHWA recommendations. Stones should be placed to maintain roughness and variations. All material shall be well placed to ensure interlock and stability. Materials shall be keyed into the bed and banks with adequate allowance for scour along the toe and the structure should have adequate foundation. Vertical walls should be avoided when possible as they tend to concentrate scour at their toe and are typically smoother than the natural channel.

- G. Soil bioengineering involves the use of living vegetation in combination with soil reinforcing agents such as geogrids to provide bank stabilization by increasing soil shear resistance, dewatering saturated soils, and by reducing local shear stresses through increased hydraulic roughness.
1. Bio-engineering projects shall be designed in accordance with the principals of NRCS (1996) and Gray and Sotir (1996). Designs will be tailored to the urban environment by consideration of the requirement for immediate functionality upon construction, the extreme variability and high shear stress of urban flows and the availability of mechanized equipment and skilled operators.
 2. Selection of plants and specifications for planting methods and soil amendments shall be prepared by a professional competent in the biological and stabilization properties of plants.
 3. Plants selected shall be appropriate to local conditions and shall be native varieties to the greatest extent practical. Evaluation of local conditions includes assessment of site microclimate, bank slope, soil composition, strength and fertility, type and condition of existing vegetation, proximity to existing infrastructure, soil moisture conditions and likelihood of wildlife predation. Engineering factors influencing plant selection include frequency, height and duration of inundation, near-bank shear stress, size and volume of bed load as well as depth and frequency of scour.
 4. Plants may be either locally harvested or purchased from commercial nurseries. When harvesting, no more than 10% of a given stand may be removed and no plant on the state rare or endangered species list may be harvested or damaged in harvesting operations. Plant material grown near the metropolitan area is adapted to local climatic conditions and is preferred over more remote sources. Some species such as red maple are particularly sensitive to locale and may only be used if locally available. Seed, plant plugs, rhizomes, whips, live stakes, bare root and container stock may be used. Turf grasses, noxious or invasive species shall not be used. A variety of plant species shall be used to provide greater reliability to a design. For critical functions such as protection from toe scour a minimum of three species should generally be employed.
 5. Soil bioengineering methods are properly applied in the context of a relatively stable stream system, and relevant general requirements for all stream bank stabilization projects given in this section apply to bio-engineered projects. Soil bioengineering alone is not appropriate when the zone of weakness lies below the root zone of the plantings, or when rapid drawdown can occur, such as in a spillway or dam embankment.
- H. Composite methods are those which employ both hard armor and soil bioengineering. Typically, armor for toe protection in critical locations is provided, with soil-bioengineering for the remainder. Design principles for both hard armor and soil-bioengineering shall be observed as appropriate.
- I. In-stream Stability Structures: In-stream structures are used to focus flow, control grade, dissipate energy and selectively lower near-bank stress. Stream barbs, weirs, guide vanes, vegetative sills, longitudinal peak

stone, and grade controls are among the more commonly used in-stream structures. When constructed of natural material such as rock, such structures also create aquatic habitat. They may be used alone or in combination with hard armor, bioengineering or composite methods. In-stream structure design is a river engineering practice and is beyond the scope of this standard. Preliminary guidance and references for the design of some common structures is given in Castro (1999) and Interagency (2001), Chapter 8 and Appendix A.

5605.13 Stream Restoration

Restoration of urban streams is defined as the re-establishment of natural channel geometry, materials and vegetative buffers with the intent of restoring natural geometry and functions to streams that have been disturbed or eliminated. While there are significant potential ecological and quality of life benefits from stream restoration, successful design is data-intensive and requires an interdisciplinary approach. Design of stream restoration projects is beyond the scope of this standard. Interagency (2001) describes the general procedures, benefits, and requirements of stream restoration.

5605.14 Comprehensive Stream Management:

The standards set forth in preceding sections provide a moderate degree of mitigation for potential damages from individual construction projects in streams of average stability. For more sensitive streams or to obtain a greater degree of protection, Cities or Counties may elect to implement comprehensive strategies for stream management. Such strategies should be based on specific investigations of the particular streams and watersheds in the city and consider local geology, geography, climate, and ecology. Strategies may include optimized or county stream buffers (see Paragraph 5605.3), hydrology controls, and comprehensive grade control. Detailed requirements for such studies and strategies are beyond the scope of this standard, and should be developed in consultation with professionals competent in river engineering and fluvial geomorphology. The following general recommendations may be considered:

- A. Hydrology Controls for Channel Protection:** Channels respond to changes in flow volumes and recurrence by altering width, depth, velocity, suspended load, meander radius, wavelength and pool and riffle. Avoiding significant changes in flow volume and recurrence should reduce the likelihood of major changes in stream form. Volume control may include practices that encourage infiltration, evapotranspiration, and short-term detention or retention. A successful strategy would require limitations on volume, duration and magnitude of post development discharges at a number of discharge points, including common storms such as the 1-year design storm. The tail of hydrographs would probably need to mimic groundwater base flow. The cumulative effect of multiple detention/retention structures on duration of high flows would be considered. The impact of large impoundments or retention lakes on trapping sediment and interrupting sediment transport would be considered. Volume control for channel protection would likely require significantly different control requirements than traditional detention practices that focused primarily on flood control from extreme events.
- B. Grade Control:** In watersheds subject to deep, rapid, and extensive incision or downcutting, a comprehensive program of controlling bed elevation (grade control) may be the most practical method of preserving stream function and avoiding future bank stability concerns. Streams with easily eroded soils and lacking in shallow bedrock are highly susceptible to extensive degradation. Existing and proposed crossing points such as culverts, bridges, and encased underground utilities should be incorporated into the program. Selection of grade elevations would be based on historical data, flooding or space constraints, restoration of wetlands and streambank hydrology, channel depths, and other relevant data.

Project: _____

Stream Name and Location: _____

Evaluated by: _____ Firm: _____ Date: _____

Table 5605-4: Channel Condition Scoring Matrix
(adapted from Johnson, et al 1999)

Stability Indicator	Good (1)	Fair (2)	Poor (3)	Score (S)	Weight (W)	Rating S*W= (R)
Bank soil texture and coherence	cohesive materials, clay (CL), silty clay (CL-ML), massive limestone, continuous concrete, clay loam (ML-CL), silty clay loam (ML-CL), thinly bedded limestone	sandy clay (SC), sandy loam (SM), fractured thinly bedded limestone	non-cohesive materials, shale in bank, (SM), (SP), (SW), (GC), (GM), (GP), (GW)		0.6	
Average bank slope angle	slopes \leq 2:1 on one or occasionally both banks	slopes up to 1.7:1 (60°) common on one or both banks	bank slopes over 60° on one or both banks		0.6	
Average bank height	less than 6 feet	greater than 6 and less than 15 feet	greater than 15 feet		0.8	
Vegetative bank protection	wide to medium band of woody vegetation with 70-90% plant density and cover. Majority are hardwood, deciduous trees with well-developed understory layer, minimal root exposure	narrow bank of woody vegetation, poor species diversity, 50-70% plant density, most vegetation on top of bank and not extending onto bank slope, some trees leaning over bank, root exposure common	thin or no band of woody vegetation, poor health, monoculture, many trees leaning over bank, extensive root exposure, turf grass to edge of bank		0.8	
Bank cutting	little to some evident along channel bends and at prominent constrictions, some raw banks up to 4 foot	Significant and frequent. Cut banks 4 feet high. Root mat overhangs common.	Almost continuous cut banks, some over 4 feet high. Undercut trees with sod-rootmat overhangs common. Bank failures frequent		0.4	
Mass wasting	little to some evidence of slight or infrequent mass wasting, past events healed over with vegetation. Channel width relatively uniform with only slight scalloping	Evidence of frequent and significant mass wasting events. Indications that higher flows aggravated undercutting and bank wasting. Channel width irregular with bank scalloping evident	Frequent and extensive mass wasting evident. Tension cracks, massive undercutting and bank slumping are considerable. Highly irregular channel width.		0.8	

Table 5605-4: Channel Condition Scoring Matrix
(adapted from Johnson, et al 1999)

Stability Indicator	Good (1)	Fair (2)	Poor (3)	Score (S)	Weight (W)	Rating S*W= (R)
Bar development	narrow relative to stream width at low flow, well-consolidated, vegetated and composed of coarse bed material to slight recent growth of bar as indicated by absence of vegetation on part of bar	Bar widths wide relative to stream width with freshly deposited sand to small cobbles with sparse vegetation	Bar widths greater than ½ the stream width at low flow. Bars are composed of extensive deposits of finer bed material with little vegetation		0.6	
Debris jam potential	slight – small amounts of debris in channel. Small jams could form	moderate – noticeable debris of all sizes present	significant – moderate to heavy accumulations of debris apparent		0.2	
Obstructions, flow deflectors (walls, bluffs) and sediment traps	negligible to few or small obstructions present causing secondary currents and minor bank and bottom erosion but no major influence on meander bend	moderately frequent and occasionally unstable obstructions, noticeable erosion of channel. Considerable sediment accumulation behind obstructions	frequent and unstable causing continual shift of sediment and flow		0.2	
Channel bed material consolidation and armoring	massive competent to thinly bedded limestone, continuous concrete, hard clay, moderately consolidated with some overlapping. Assorted sizes of particles, tightly packed and overlapped, possibly imbricated. Small % of particles < 4mm	shale in bed, soft silty clay, little consolidation of particles, no apparent overlap, moderate % of particles < 4mm	silt, weathered, thinly bedded, fractured shale, high slaking potential, very poorly consolidated, high % of material < 4mm		0.8	
Sinuosity	$1.2 \leq \text{Sinuosity} \leq 1.4$	$1.1 < \text{Sinuosity} < 1.2$	$\text{Sinuosity} < 1.1$		0.8	
Ratio of radius of curvature to channel width	$3 \leq R_c/W_b \leq 5$	$2 < R_c/W_b < 3$, $< R_c/W_b < 7$	$2 < R_c/W_b$, $R_c/W_b > 7$		0.8	
Ratio of pool-riffle spacing to channel width at elevation of 2-year flow	$4 \leq \text{Length}/W_b < 8$	$3 \leq \text{Length}/W_b < 4$, $8 < \text{Length}/W_b \leq 9$	$3 < \text{Length}/W_b$, $\text{Length}/W_b > 9$, unless long pool or run because of geologic influence		0.8	
Percentage of channel constriction	< 25%	26-50%	> 50%		0.8	
Sediment movement	little to no loose sediment	scour and/or deposition, some loose sediment	near continuous scour and/or deposition and/or loose sediment		0.8	

TOTAL _____

Table 5605-5: Characteristics of Certain Plants for Bio-Engineering

Common Name	Botanical Name	Forms Available	Comments* (see notes below)
Sandbar willow	<i>Salix exigua</i>	Live stake, whip, bare root	Shrub willow, stoloniferous, favors granular soils, inundation and scour tolerant, requires full sun, extensive fibrous roots
Peachleaf willow	<i>Salix amygdaloides</i>	Live stake, whip, bare root	Shrub willow, stoloniferous, favors granular soils, inundation and scour tolerant, requires full sun, extensive fibrous roots
Buttonbush	<i>Cephalanthus occidentalis</i>	Live stake, whip, bare root, container	Shrub, sun or shade, stoloniferous, tolerates extended inundation, high aesthetic value, nectar source
Silky dogwood	<i>Cornus amomum</i>	Live stake, bare root	Roots from cutting with root hormone, shade tolerant, stoloniferous, shallow, fibrous roots
Roughleaf dogwood	<i>Cornus drummondii</i>	Bare root, container	Most sun and drought tolerant dogwood, extensive fibrous roots
River birch	<i>Betula nigra</i>	Bare root, B&B	High root tensile strength, rapid establishment, high aesthetics
Black walnut	<i>Juglans nigra</i>	Bare root, B&B	Check for juglone toxicity in rest of palette, deep arching roots, buttressing effect in rock soils, canopy species
Switch grass	<i>Panicum virgatum</i>	Seed, plant plug	Deep, high tensile strength roots, aggressive, may out compete other warm season grasses, good for mesic to dry sites
Arrowwood viburnum	<i>Viburnum dentatum</i>	Bare root, container	Highly adaptable to range of soil, moisture and sun conditions, understory shrub, high aesthetic value
Little blue stem	<i>Schizachyrium scoparium</i>	Seed, plant plug, container	Deep, high tensile strength roots, adaptable to dry sites, full sun to light shade

Notes:

Stoloniferous species, those with the ability to sprout from a network of near-surface stems, are used in high stress applications to protect against toe scour. The stoloniferous species form dense colonies and quickly regenerate when damaged.

Common riparian species such as black willow, box elder, and most poplar species should not be used in soil bioengineering applications in urban areas. *Populus deltoides* (eastern cottonwood) should be used only sparingly and where deep, loam soil is present. If the site is infested with *Phragmites* spp (common reed), bamboo, *Phalaris arundinacea* (reed canary grass), and *polygonum* spp (knotweed), the design must include a plan to positively eliminate the weedy species. While plant selection is site-specific the following species have broad applicability in urban streams.

SECTION 5606 ENCLOSED PIPE SYSTEMS

5606.1 Design Criteria

Enclosed conveyance systems consisting of inlets, conduits, and manholes may be used to convey stormwater runoff where site conditions and open space requirements will not permit the use of natural drainage paths or engineered channels. A storm drainage system shall incorporate an overflow system that is capable of conveying flows in excess of the designed system capacity. Overflow systems can consist of natural drainage path preservation. Enclosed pipe systems shall convey the 10-year design storm assuming the temporal distributions per Section 5602, and be designed per Section 5603, as follows:

- A. **Gravity Flow Conditions:** 10-year design storm with median (50%) temporal distribution gravity flow conditions within the pipe system (e.g. no surcharging)
- B. **Pressure Flow Conditions:** 10-year design storm with 10% temporal distribution pressure flow conditions with surcharging less than 0.5 feet below the lowest opening to the surface or structure rim elevation.
- C. **Street Crossings:** Concentrated flow for open systems shall be conveyed under streets to prevent vehicles from being swept from the roadway during infrequent storms. These crossings may be bridges or culverts. Crossings shall be designed to completely convey flows without street overtopping in accordance with the design storms listed in Table 5606-1 based the 10% temporal distribution. Roadway classifications are defined per the Warsaw Livable Community Transportation Improvement Plan.

Table 5606-1 Level of Service for Street Crossings

Street Classification	Min. Design Storm
Principal Arterial	50-year
Primary Connectors	25-year
Minor Streets ⁽¹⁾	10-year

(1) Secondary connectors also fall into the category of minor streets

Further, concentrated flow in excess of the minimum design storm may only overtop the roadway if the following conditions are met:

1. The span of the structure opening is less than 20 feet.
2. The peak stormwater runoff from the 100-year design storm with 10% temporal distribution is 250 cfs or less unless a guard fence is installed on the downstream side of the roadway. Such overflow depths at low points in roadways during the 100-year design storm with 10% temporal distribution will be limited to 7 inches measured at the high point in the roadway cross section, typically at the upstream face of culvert headwall or roadway curb; except that it also shall not exceed 14 inches at the deepest point in the roadway cross section.

5606.2 Easements

Permanent drainage easements shall be dedicated to the City for all components of the storm drainage facilities and allow the City right of entry per the City of Warsaw Code of Ordinances Chapter §700.270. Easement width shall not be less than 15 feet, or the outside width of the pipe or conveyance structure plus 10 feet; whichever is greater. Easements shall be centered on the pipe.

- A. **Permanent:** The City/County Engineer may require wider easements when other utilities are located within the same easement and/or when the depth of cover is greater than 4 feet.
- B. **Temporary:** Temporary construction easements of sufficient width to provide access for construction shall be acquired when the proposed work is located in areas developed prior to construction.

5606.3 Capacity

Capacity shall be determined in accordance with Section 5603. Minimum design pipe size shall be 6-inch in diameter.

5606.4 Pressure Flow

After considering the discussion presented in Paragraph 5603.1 A, an enclosed system may be designed to operate with pressure flow, for the design storms specified in Paragraph 5601.5, if all the following conditions are met:

- A. The Hydraulic Grade Line (HGL) must be 0.5 feet below any openings to the ground or street at all locations.
- B. Watertight joints capable of withstanding the internal surcharge pressure are used in the construction.
- C. Appropriate energy losses for bends, transitions, manholes, inlets, and outlets, are used in computing the HGL.
- D. Energy methods (Bernoulli's equation) must be used for the computations.

5606.5 Energy Dissipation

The outfall, as defined in Paragraph 5605.6, of all enclosed systems shall include energy dissipation sufficient to transition outlet flows to velocities and applied shear stresses consistent with the normal flow conditions in the receiving channel for the range of flows up to and including the 100-year design storm with 10% temporal distribution. Calculations, at a minimum, should include the 2-year, the 10-year and the 100-year design storms with 10% temporal distributions.

Energy dissipation for lateral outflows to streams and edge of buffer outfalls to riparian buffers shall follow the guidance in Paragraph 5605.6. Effective energy dissipating structures shall be provided if necessary to meet the requirements stated in Tables 5605-2 and 5606-2. Examples of energy dissipating structures are:

- Check Dams
- Level Spreaders
- Hydraulic Jump Basins
- Impact Baffle Basins
- Plunge Pool and Plunge Basin
- Slotted-Grating or Slotted Bucket Dissipaters
- Stilling Basins
- Rock Revetment
- Internal Pipe Rings

Grade control shall be provided downstream of the dissipator or shall be constructed integrally with it. The suitability of each method is site dependent and subject to approval by the City/County Engineer. Table 5606-2 lists methods and applicability.

Table 5606-2: Energy Dissipation Counter Measures

Counter Measure	Functional Applications		Suitable Environment			References
	Vertical Control	Horizontal Control	Dam Outlets	Small Culverts	Large Culvert	
Check Dam	X	O	X	X	X	2, 6
Level Spreaders	X	X	O	X	O	1
Hydraulic Jump Basins	X	X	X	X	X	1, 3
Impact Baffle Basins	X	X	X	X	X	1
Plunge Pool & Plunge	X	O	X	X	X	1
Slotted-Grating or Slotted Bucket Dissipators	X	X	X	O	X	1
Stilling Basins	X	O	X	X	X	1, 2, 3, 4, 5, 6
Rock Revetment	X	X	X	X	X	1, 2, 6
Internal Pipe Rings	X	O	N/A	X	N/A	

LEGEND

X = Suitable Countermeasure

O = Marginal Countermeasure

REFERENCES

1. Design of Small Dams 1987 United States Department of Interior
2. HEC 23
3. Hydraulic Design of Stilling Basins and Energy Dissipaters
4. HEC-14 FHWA Hydraulic Design of Energy Dissipaters for Culverts and Channels
5. U.S. Army Corps of Engineers, 1994 Hydraulic Design of Flood Control Channels
6. Hydraulic Design Series (HDS-6)

NOTE: Other means may be used for Energy Dissipation and Stream Stability by designers as accepted by the City/County.

Energy dissipaters shall be designed according to the criteria and procedures defined in professionally acceptable references. Several such references include:

- United States. Department of the Interior. Bureau of Reclamation. Design of Small Dams. 1987 ed. Denver: GPO, 1987.
- United States. Department of the Interior. Bureau of Reclamation. A Water Resource Technical Publication. Engineering Monograph No. 25. Hydraulic Design of Stilling Basins and Energy Dissipaters. 1978 ed. GPO, 1978.
- Federal Highway Administration (FHWA), 1983. Hydraulic Design of Energy Dissipaters for Culverts and Channels, Hydraulic Engineering Circular (HEC) No. 14.
- US Army Corps of Engineers, 1994. Hydraulic Design of Flood Control Channels, US Army Corps of Engineers Engineer Manual EM 1110-2-1601.

- Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance (Latest Edition), National Highway Institute, HEC No. 23.
- River Engineering for Highway Encroachments, Highways in the River Environment, U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA NHI 01-004, December 2001.

5606.6 Velocity within the System

The velocity within the system shall be between 3 and 20 feet per second.

5606.7 Loading

- A. **Cover:** Minimum depth of cover shall be 18 inches. Designer shall consider pipe material and loading conditions for additional cover needs.
- B. Minimum Loading Conditions:
 1. Live load: H-20.
 2. Unit Weight of soil cover: 120 lbs/ft³.
 3. Rigid pipes shall be bedded and backfilled to provide a minimum factor of safety of 1.5 at the 0.01-inch crack loading condition.

SECTION 5607 ENGINEERED CHANNELS

5607.1 Design Criteria

The criteria in this section apply to open channels that are not natural. Streams are covered in Section 5605. A storm drainage system shall incorporate an overflow system that is capable of conveying flows in excess of the designed system capacity. Overflow systems can consist of natural drainage path preservation. Engineered channels, ditches, and swales shall be designed to convey the 10-year design storm with the 10% temporal distribution, as defined in Section 5602.

5607.2 Easements

Permanent drainage easements shall be dedicated to the City and allow the City right of entry per the City of Warsaw Code of Ordinances Chapter §700.270. .

- A. Engineered Channels:** Easements shall be as wide as the top of bank width; plus 10 feet on each side. Easements shall be continuous between street rights-of-way. When an improved channel begins or ends at a point other than the right-of-way of a dedicated street, a 15-foot or wider easement graded so as to permit access by truck shall be dedicated from the end of the channel to a street right-of-way. These are minimum requirements.

Generally, easements shall be required for swales that collect stormwater runoff from more than two acres per Stormwater Drainage Setback requirements defined in 5605.2, or as required by the City/County.

- B. Roadside Channels:** Roadside ditches are engineered channels that are located wholly or partly within the street right-of-way. When the entirety of the roadside ditch extents is within the street right-of-way, an easement is not required. Otherwise, roadside ditches shall have a dedicated easement from the street right-of-way extending to 10 feet outside of the top of the outside bank of the channel.

5607.3 Freeboard

Freeboard shall not be required above the design headwater pool elevation at culvert entrance.

5607.4 Channel Linings

- A.** Minimum lining height shall be the selected design storm water profile plus at least a 0.5-foot freeboard.
- B.** All channel linings, except turf, shall contain provision for relieving back pressures and water entrapment at regular intervals.
- C.** Lining height on the outside bend of curves shall be increased by:

$$y = \frac{D}{4}$$

Where:

y = Increased vertical height of lining in feet

D = Depth of design flow in feet

Increased lining height shall be transitioned from y to zero feet over a minimum of:

30 × y feet downstream from the point of tangency (P.T.).

10 × y feet upstream from the point of curvature (P.C.).

5607.5 Lining Material

The types of lining material listed in Table 5607-1 shall be used to control damage and erosion. All riprap, grouted riprap, and gabion linings shall be designed with a filter fabric in conformance with Paragraph

2605.2.C.2. The design of the lining material shall protect the channel for conditions up to the 100-year design storm with the 10% temporal distribution or the maximum channel capacity, whichever is less.

Other types of lining materials not specifically listed in Table 5607-1 may be used when approved by the City/County Engineer.

Concrete lined open channel bottoms are prohibited, unless a waiver to this criterion is granted by the City/County Engineer.

Table 5607-1: Permissible Shear Stresses for Lining Material

Lining Category	Lining Type	Permissible Shear Stress (lbs/ft ²)
General	Erosion Control Blankets	1.55-2.35
	Turf-Reinforced Matrix (TRMs): Unvegetated:	----
		3.0
	Vegetated:	8.0
	Geosynthetic Materials	3.01
	Cellular Containment	8.1
	Woven Paper Net	0.15
	Jut Net	0.45
	Fiberglass Roving:	---
		0.60
		0.85
	Straw With Net	1.45
	Curled Wood Mat	1.55
	Synthetic Mat	2.00
Vegetative (See Table 5607-2)	Class A	3.70
	Class B	2.10
	Class C	1.00
	Class D	0.60
	Class E	0.35
Gravel Riprap	25 mm	0.33
	50 mm	0.67
Rock Riprap	150 mm	2.00
	300 mm	4.00
Bare Soil	Non-Cohesive	See Figure 5607-1
	Cohesive	See Figure 5607-2

Table 5607-2: Classification of Vegetal Covers as to Degree of Retardance

Retardance Class	Cover	Condition
A	Weeping Love Grass	Excellent stand, tall (average 760 mm)
	Yellow Bluestem Ischaemum	Excellent stand, tall (average 910 mm)
B	Kudzu	Very dense growth, uncut
	Bermuda Grass	Good stand, tall (average 300 mm)
	Native Grass Mixture (little bluestem, bluestem, blue gamma, and other long and short Midwest grasses)	(Good stand, unmowed)
	Weeping lovegrass	Good stand, tall (average 610 mm)
	Lespedeza sericea	Good stand, not woody, tall (average 480 mm)
	Alfalfa	Good stand, uncut (average 280 mm)
	Weeping lovegrass	Good stand, unmowed (average 330 mm)
	Kudzu	Dense growth, uncut
C	Blue Gamma	Good stand, uncut (average 280 mm)
	Crabgrass	Fair stand, uncut 250 to 1200 mm
	Bermuda grass	Good stand, mowed (average 150 mm)
	Common Lespedeza	Good stand, uncut (average 280 mm)
	Grass-Legume mixture – summer (orchard grass, redtop, Italian ryerass, and common lespedeza)	(Good stand, uncut (150 to 200 mm)
	Centipedegrass	Very dense cover (average 150 mm)
D	Kentucky Bluegrass	Good stand, headed (150 to 300 mm)
	Bermuda grass	Good stand, cut to 60-mm height
	Common Lespedeza	Excellent stand, uncut (average 110 mm)
	Buffalo grass	Good stand, uncut (80 to 150 mm)
	Grass-legume mixture—fall, spring (orchard grass, redtop, Italian, ryegrass, and common lespedeza)	(Good stand, uncut (100 to 130 mm)
E	Lespedeza sericea	After cutting to 50-mm height. Very good stand before cutting
	Bermuda grass	Good stand, cut to height 40-mm
	Bermuda grass	Burned stubble
Note: Covers classified have been tested in experimental channels. Covers were green and generally uniform.		

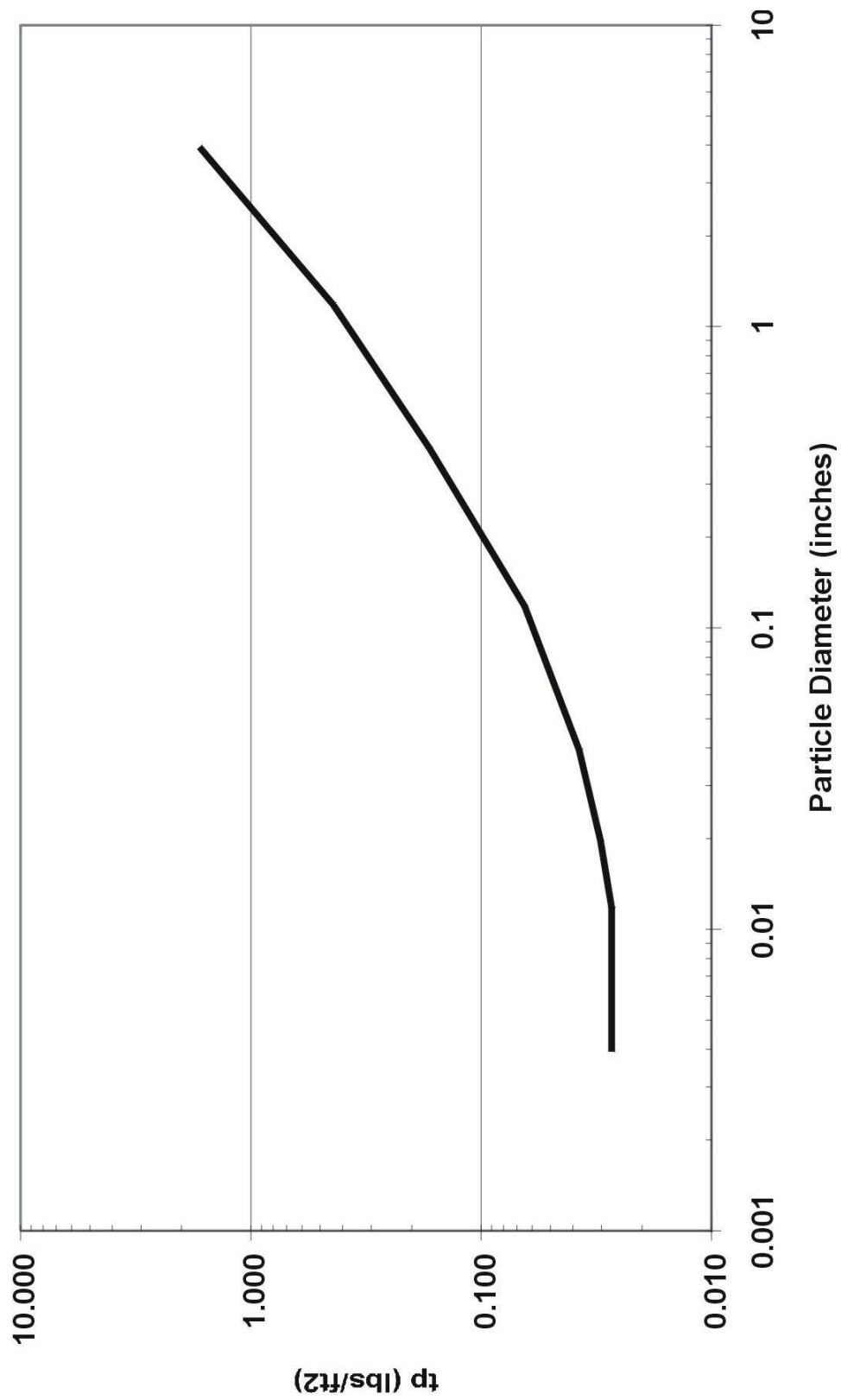


Figure 5607-1: Permissible Shear Stresses for Non-Cohesive Soils

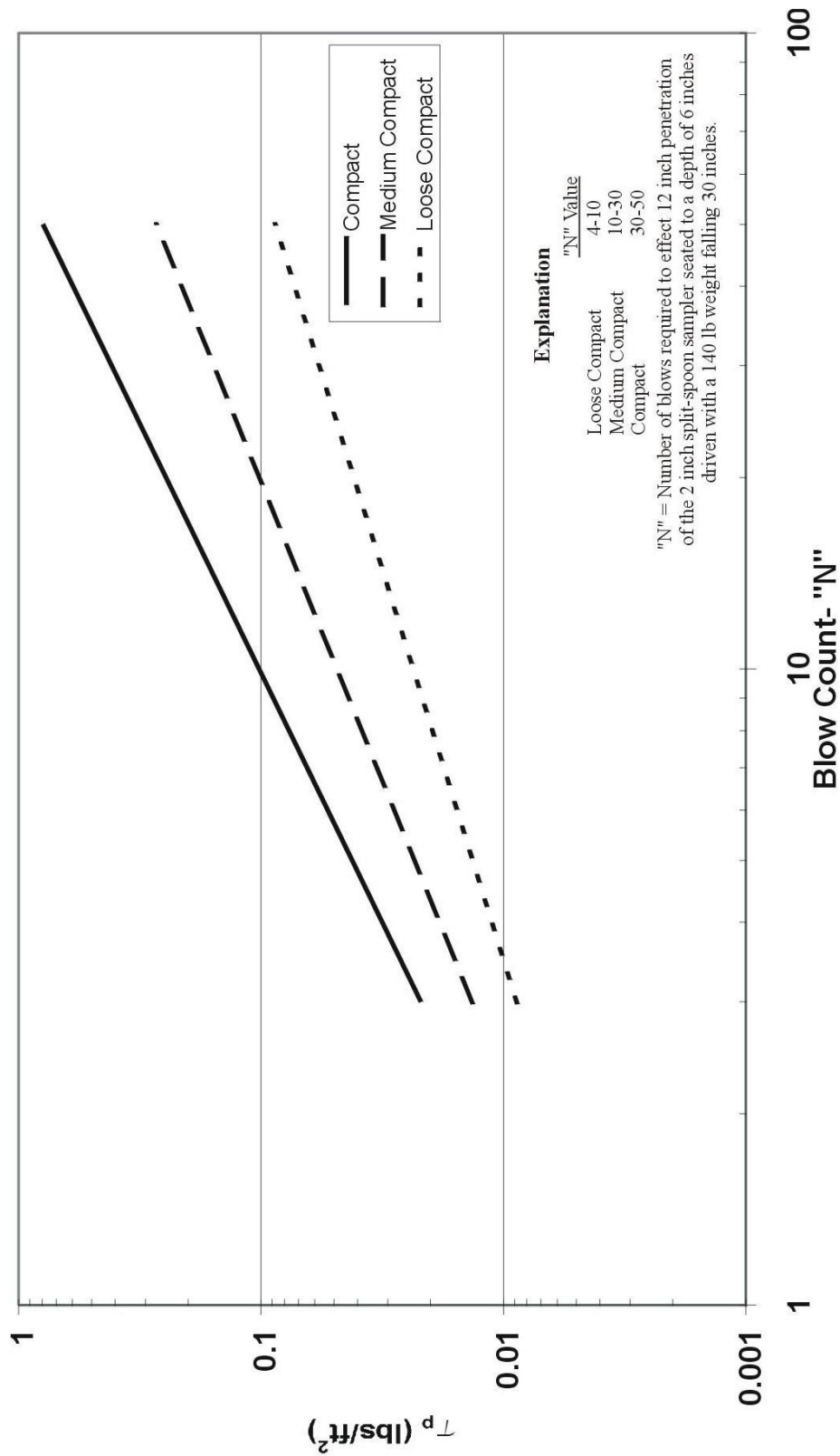


Figure 5607-2: Permissible Shear Stresses for Cohesive Soils

5607.6 Side Slopes

- A. Side slopes shall have a vegetated or other lining material cover. Bare soil is not permitted.
- B. Side slopes shall not be steeper than:
 - 1. 3:1 (horizontal:vertical) for vegetative lining; 4:1 is preferred.
 - 2. 2.5 horizontal to 1 vertical for all other lining materials, unless a geotechnical analysis indicates a steeper slope can be used.
 - 3. Flatter if necessary to stabilize slopes.

5607.7 Alignment Changes

Alignment changes shall be achieved by curves having a minimum radius of:

$$R = \frac{V^2 \cdot W}{8D}$$

Where:

R = Minimum radius on centerline in feet
V = Design velocity of flow in feet per second
W = Width of channel at water surface in feet
D = Depth of flow in feet

5607.8 Vertical Wall Channels

Vertical walls may be used for structural lining of improved channels when site conditions warrant; subject to the following special requirements:

- A. Walls shall be designed and constructed to act as retaining walls.
- B. Adequate provisions shall be made for pedestrian entry/exit from the channel.

5607.9 Energy Management

- A. Use of grade control structures can be used to manage boundary shear.
- B. Energy dissipation structures should be designed in accordance with Section 5606.

SECTION 5608 STORMWATER RETENTION AND DETENTION

5608.1 Design Criteria

This section governs the requirements and design of stormwater detention and retention facilities.

- A. **Retention:** Stormwater retention shall be provided for the 0.5-inch design storm over the tributary impervious area from the site, calculated as follows:

$$\text{Retention Volume, } V_R = \frac{P_R * I * A}{12}$$

Where:

P_R = Retention rain event, 0.5 inches

I = Impervious percentage (%)

A = Project drainage area (acres)

- B. **Detention:** Stormwater detention shall be provided for peak runoff control of the 2-, 10, and 100-year design storms. Post-improvement peak discharge rates from the site shall not exceed the allowable release rates expressed in discharge rate per tributary area in Table 5608-1.

Table 5608-1: Allowable Release Rate by Tributary Area

Design Storm Average Recurrence Interval	Temporal Distribution	Allowable Release Rate by Tributary Area (cfs/acre)
2-Year	Median (50%)	0.1
10-Year	Median (50%)	0.2
10-Year	10%	2.0
100-Year	10%	3.0

5608.2 Access and Easements

Permanent access and buffers must be provided for maintenance of detention and retention facilities with the following minimum requirements:

- A. The water surface of the 100-year design storm storage pool shall be a minimum of 10 feet from building structures unless impermeable liners are used. A greater distance may be necessary when the retention/detention facility might compromise foundations or slope stability.
- B. A 15-foot-wide access strip, with slopes less than 5 horizontal to 1 vertical, shall be provided around the perimeter of the facility, unless it can be demonstrated that all points of the facility can be maintained with less access provided.
- C. The property owner shall also maintain a minimum 15-foot-wide access route to the facility(ies) from a street or parking lot with slopes no greater than 5:1 (horizontal: vertical) in any direction.
- D. Structures, inlet pipes, outlet pipes, spillways, and appurtenances required for the operation of the facility shall also be provided access which is no less than easement widths established in Paragraphs 5606.2 and 5607.2.
- E. Provisions shall be made to permit access and use of auxiliary equipment to facilitate emptying, cleaning, maintenance, or for emergency purposes.
- F. Detention and retention facilities shall be maintained by the property owner. If the detention facility is not maintained by the property owner or involves multiple ownerships, easements must be dedicated to the party responsible for maintenance. All drainage easements shall allow the City right of entry per the City of

Warsaw Code of Ordinances Chapter §700.270. At a minimum the dedicated easements shall include: 1) the detention pond extending 15-feet from top of embankment or 15-feet from the exterior toe of the embankment slope; 2) appurtenances; and 3) access required by Paragraphs 5608.2.B through 5608.2.D.

5608.3 Maintenance and Continued Performance

Maintenance responsibility for all elements of the detention and retention facility should be designated prior to construction. However, when no designation is made the property owner shall be considered the responsible party. Annual or more frequent inspections shall be made by the responsible party to document that all inlet and outlet structures are functional as per the design and the facility has storage capacity as designed.

5608.4 Retention Criteria

- A. Retention-based facilities are designed to either capture and infiltrate or re-use the required retention volume with no discharge from the site for the minimum design event. Retention shall be provided in the form of GSI/stormwater BMPs, as defined in Section 8 of the MARC BMP Manual. For detailed design and construction guidance of GSI practices/stormwater BMPs, see the KCMO GSI Manual. The KCMO GSI Manual includes design guidance for sizing of GSI practices, design considerations and checklists for GSI components, design detail templates, construction specification templates, as well as establishment and maintenance recommendations.
- B. To the maximum extent practicable, retention facilities shall be designed and constructed to use vegetative, rather than mechanical, measures.
- C. Retention volume shall be provided such that surface ponding is limited to a maximum of 12 inches and draws down within 48 hours after the rain event. Drawdown time may be calculated as follows:

$$t_{drawdown} = \frac{V_{ponding}}{A_{inf} * \left(\frac{k_{sat}}{12}\right)}$$

Where:

$t_{drawdown}$ = Time to draw down surface ponding (hours)

$V_{ponding}$ = Volume of surface ponding layer (acre-ft)

A_{inf} = Infiltration area of retention facility interface with in-situ soils (acres)

K_{sat} = saturated hydraulic conductivity of in-situ soils (inches per hour)

- D. Retention requirements may be achieved in conjunction with detention storage, or independently.

5608.5 Detention Criteria

In addition to the foregoing criteria, the following shall be applicable, depending on the detention alternative(s) selected:

- A. **Wet Detention Facility:** For detention facilities designed with permanent pools:
 - 1. **Sediment Forebay:** A sediment forebay shall be provided to trap coarse particles. Refer to the MARC BMP Manual for typical design specifications and configurations of sediment forebays.
 - 2. **Minimum Depth:** The minimum normal depth of water before the introduction of excess stormwater shall be four feet plus a sedimentation allowance of not less than 5 years accumulation. Sedimentation shall be determined in accordance with the procedures shown in Figure 5608-1.

3. **Depth for Fish:** If the pond is to contain fish, at least one-quarter of the area of the permanent pool must have a minimum depth of 10 feet plus sedimentation allowance.
 4. **Side Slopes:** The side slopes shall conform as closely as possible to regraded or natural land contours, and should not exceed three horizontal to one vertical with four to one side slopes being preferred. Slopes exceeding this limit shall require erosion control and safety measures and a geotechnical analysis.
 5. Refer to the MARC BMP Manual when designing wet detention facilities for stormwater detention and retention.
- B. Dry Detention Facility:** For detention facilities designed to be normally dry:
1. **Interior Drainage for non-BMP Facilities:** Grading must be incorporated to facilitate interior drainage to outlet structures. Grades for drainage facilities shall not be less than 0.5 percent on turf. Interior drainage design should not facilitate short circuiting of the facility for the design events.
 2. **Earth Bottoms:** Earth bottoms shall be vegetated.
 3. **Side Slopes:** The side slopes of dry detention facilities should be relatively flat to reduce safety risks and help to lengthen the effective flow path. Slopes shall not be steeper than 3 (horizontal) to 1 (vertical), with four to one side slopes being preferred.
 4. Refer to the MARC BMP Manual when designing dry detention facilities for stormwater detention and retention.
- C. Underground Detention:** Underground detention facilities consisting of subsurface storage chambers may be allowed at the discretion of the City/County Engineer. Requests for underground detention must be submitted as a Request for Variance in the Drainage Permit and shall meet the following requirements:
1. A minimum of two (2) access points shall be provided for maintenance and inspection activities.
 2. Maintenance access points should be located at opposite ends of the system, and horizontal bends in the alignment greater than 45 degrees.
 3. Maintenance access points shall be sized accordingly for maintenance activities.
 4. Maintenance access points should be at least 6 inches in any dimension for 45-degree vertical bends.
 5. Maintenance access points should be at least 8 inches in any dimension for 90-degree vertical bends.
- D. Green Roof/Rooftop Storage:** Detention storage may be met in part by detention on roofs, as a green roof. Details of such designs shall include the depth and volume of storage, details of outlet devices and down drains, elevations and details of overflow scuppers, and emergency overflow provisions. Connections of roof drains to sanitary sewers are prohibited. Design loadings and special building and structural details shall be subject to approval by the City/County Engineer.
- E. Parking Lot Storage:** Paved parking lots may be designed to provide temporary detention storage of stormwater on a portion of their surfaces. Generally, such detention areas shall be in the more remote portions of such parking lots. Depths of storage shall be limited to a maximum depth of nine inches, and such areas shall be located so that access to and from parking areas is not impaired.

F. General Provisions

1. Detention facilities shall have 1,000 acres or less area tributary to the facility.
2. If the detention facility embankment meets state classification parameters for a dam, then facility shall be designed per state requirements. Dams shall be permitted through the state following state guidelines.
3. All lake and pond development must conform to local, state, and federal regulations. Legal definitions and regulations for dams and reservoirs can be found in the Missouri Code of State Regulations, Division 22.

G. Computational Methods

1. Time of Concentration and Travel Time: Refer to Section 5602 for acceptable hydrology methods.
2. Hydrograph Routing: The storage indication method (Modified Puls) of routing a hydrograph through a detention facility may be utilized. Reference: (Chow, 1964). If retention and detention are provided within the same facility, the retention component shall be designed to store the retention volume with no outflow from the facility. Routing of the other larger storms is then done independently, assuming the retention volume is available and modeling all outlet orifices as part of the rating curve.

H. Detention Facility Size: Owners/engineers may utilize methodology outlined in (SCS, 1986). 6-hour duration, first quartile temporal distributions for Region 3 from NOAA Atlas 14 Volume 8 shall be the required storm hyetograph as defined in Table 5602-2. Maximum detention storage shall be based upon the allowable release rate defined in Table 5608-1 and upon the developed condition for the site.

I. Primary Outlet: The primary outlet shall be designed to meet the following requirements:

1. All allowable discharge from the detention facility when inflow is equal to or less than the 2-year and 10-year design storms with median (50%) temporal distribution shall be via the primary outlet system.
2. The design discharge rate via the outlet shall continuously increase with increasing head and shall have hydraulic characteristics similar to weirs, orifices or pipes.
3. Detention time for any design storm shall not exceed 72 hours after the peak or center of mass of the inflow has entered the detention facility.
4. Wet detention facilities shall be designed with a non-clogging outlet such as a reverse-slope pipe, or a weir outlet with a trash rack. A reverse-slope pipe draws from below the permanent pool extending in a reverse angle up to the riser and establishes the water elevation of the permanent pool. Because these outlets draw water from below the level of the permanent pool, they are less likely to be clogged by floating debris.
5. All openings shall be protected by trash racks, grates, stone filters, or other devices approved by the City/County Engineer. Minimum orifice size shall be per the current version MARC BMP Manual. See MARC BMP Manual Sections 8.6, 8.10 and 8.12 for design guidance and typical details for low-flow outlets and trash rack designs. Note that multiple design options are available for non-clogging low flow outlets and debris collection and designers are encouraged to select the best design for their site.

J. Primary Spillways: The primary spillway may either be combined with the outlet works or be a separate structure or channel meeting the following criteria:

1. **Elevation:** Primary spillways shall be designed so that the top of the embankment is 0.5 feet or more above the maximum water surface elevation in the detention facility attained by the maximum design storm for the facility. The 10-year and 100-year design storms with 10% temporal distribution may utilize the primary spillway to safely pass the peak discharge but shall not exceed the maximum release rates and shall not overtop the embankment.
 2. **Capacity:** In cases where the impoundment/primary spillway is not regulated by either State or Federal agencies, the primary spillway shall be designed to pass the 100-year design storm with 10% temporal distribution with 0.5 feet of freeboard from the design stage to the top of dam, assuming zero available storage in the facility and zero flow through the primary outlet. This design provides an added level of protection in the event of a clogged primary outlet or a subsequent 100-year design storm that occurs before the flood pool from the initial storm event recedes to the principal outlet elevation.
- K. **Drawdown Provision:** Drain works consisting of valves, gates, pipes, and other devices as necessary to completely drain the facility in 72 hours or less when required for maintenance or inspection shall be provided.
- L. Retention facilities shall be designed with sufficient volume to capture the required Retention Volume (V_R) tributary to the facility. Multiple facilities may be required to meet retention requirements for the entire site. Retention facilities may provide storage capacity in the surface ponding layer, subsurface soil, aggregate or piping layers, or a combination thereof. The provided retention volume may be calculated as follows:

$$V_{provided} = \sum_{layer} n \cdot V_{layer}$$

Where:

$V_{provided}$ = Retention volume provided by the green stormwater infrastructure/post-construction permanent stormwater BMP facility

n = porosity of layer material (decimal) per Table 5608-2

V_{layer} = Volume of layer material (acre-ft)

Table 5608-2: Porosity Assumptions for Common Materials

Material	Description	Porosity (n)
Clean¹ Gravel	ASTM C33 Coarse Aggregates	0.40
	No. 2	
	No. 3	
	No. 56 No. 57	
Clean¹ Pea Gravel	ASTM C33 Coarse Aggregates	0.35
	No. 8	
	No. 89 No. 9	
Sand	ASTM C33 Fine Aggregate	0.32
Bioretention Soil Media (BSM)	Sandy Clay Loam (NRCS Soil Texture Classification)	0.30
Notes: (1) "Clean" shall indicate washed aggregates, free of fines, as determined by less than 1% passing the No. 200 sieve.		

- M. Erosion Control:** Primary outlet works, emergency spillways, and drain works, as well as conveyance system entrances to detention facilities, shall be equipped with energy dissipating devices as necessary to limit shear stresses on receiving channels. See Tables 5605-2 and 5606-2 for shear stress criteria.

EXAMPLE:

TRIBUTARY AREA = 20 ACRES

RATIONAL METHOD RUNOFF COEFFICIENT "C" = 0.6

SEDIMENT STORAGE = 120 CU. FT. PER ACRE PER YEAR

TOTAL SEDIMENT STORAGE = $120 \times 20 = 2400$ CU. FT. PER YEAR.

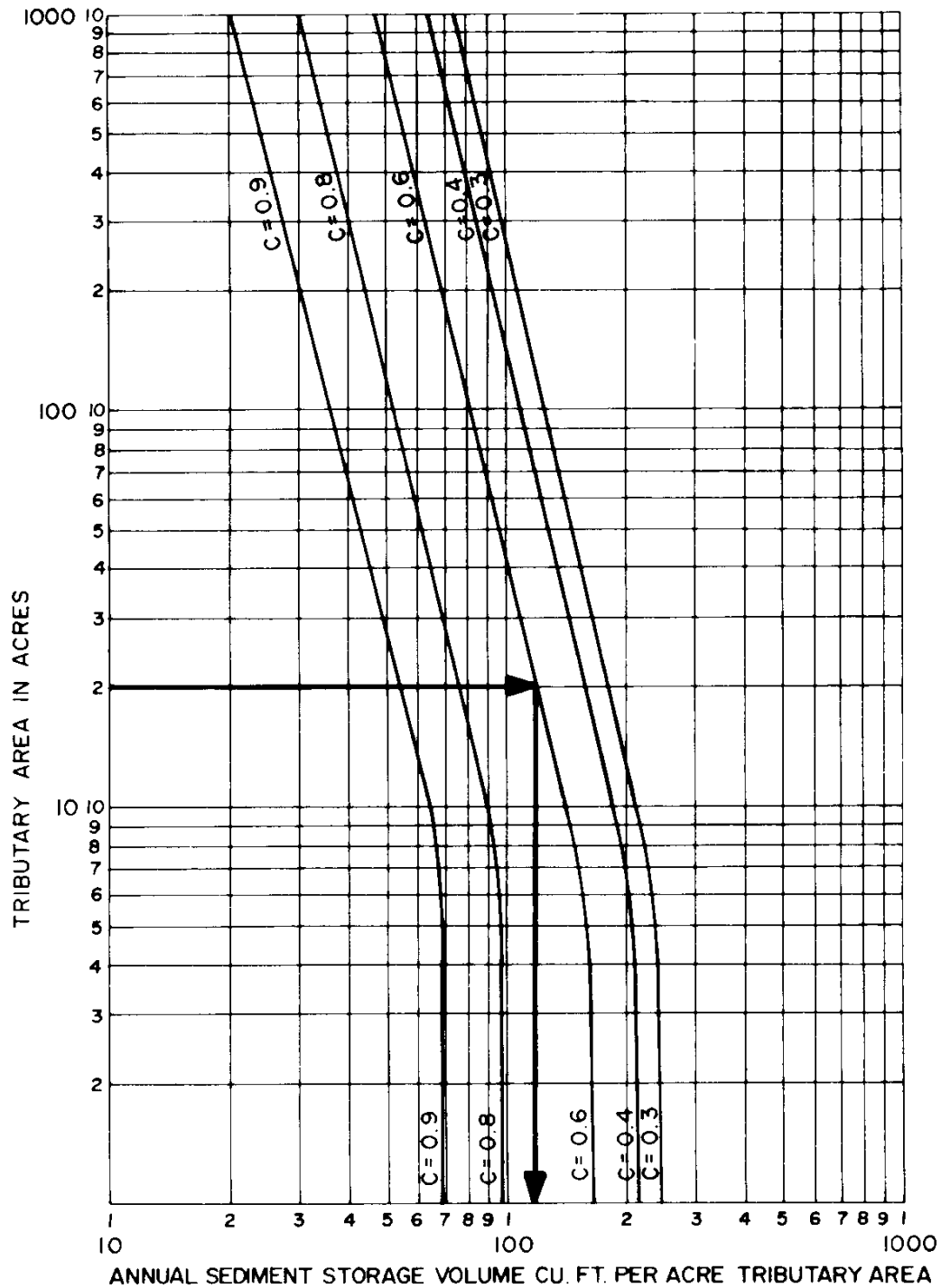


Figure 5608-1: Annual Sediment Storage

SECTION 5609 SUBMITTAL REQUIREMENTS

5609.1 Scope

The section governs the preparation of the Stormwater Drainage Permit and construction plans for the stormwater management components of projects.

5609.2 Stormwater Drainage Permit Requirements

A Stormwater Drainage Permit per the City of Warsaw Code of Ordinances Chapter §405.020 is required to demonstrate compliance with this design criteria. The purpose of the drainage permit is to identify existing and potential drainage issues and delineate required stormwater infrastructure early in the development process so that stormwater management is proactively planned for with improvements. The Stormwater Drainage Permit shall include the following items and associated project details:

- A. Watershed Location Map:** designer shall develop a watershed location map to identify the project's location within the watershed, which shall depict the following:
 1. Watershed boundary and area (acres)
 2. Delineated drainage area to the project (acres)
 3. Natural drainage paths (may reference Appendix A Warsaw Natural Drainage Paths, 2016 LiDAR-based delineation)
 4. Water bodies (lakes, rivers, streams, creeks, wetlands, etc.)
 5. Stormwater retention/detention facility location(s) in watershed affecting stormwater management at project site (if applicable)
 6. Conveyance route for overflow system to downstream destination of runoff
- B. Existing and Proposed Site Conditions Maps:** the designer shall develop a Site Conditions Map to compare existing site drainage with proposed site drainage. This map is used to verify that proposed site conditions mimic natural topography, maintain overland drainage paths, and provide appropriate stormwater drainage setbacks to protect natural resources. The following shall be depicted on the Site Conditions Map:
 1. Existing Site Conditions
 - a. Existing contours
 - b. Aerial imagery
 - c. Water bodies (lakes, rivers, streams, creeks, wetlands, etc.)
 - d. Utilities, including existing stormwater infrastructure
 - e. Natural drainage paths
 - f. Parcel boundaries
 - g. Impervious surfaces and types (i.e. building, parking lot, etc.)
 - h. Key statistics (areas of boundaries, area of impervious surfaces, etc.)
 2. Proposed Site Conditions
 - a. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information
 - b. Utilities, including existing stormwater infrastructure

- c. Overland drainage paths
 - d. Parcel boundaries
 - e. Impervious surfaces and types (i.e. building, parking lot, etc.)
 - f. Stormwater improvements (i.e. detention/retention facilities, open and enclosed conveyance systems, storm drainage structures, etc.)
 - g. Drainage easements depicting maintained stormwater drainage setbacks and dimensions
- C. Stormwater Improvement Calculation Tables:** include the following calculation tables for applicable stormwater drainage system components, detailed in the Stormwater Drainage Permit application.
- 1. Hydrology
 - 2. Conveyance
 - 3. Collection (Inlets)
 - 4. Retention
 - 5. Detention

5609.3 Type of Sheets in Construction Plans

The plans shall include all information necessary to build and check the design of storm drainage systems and related appurtenances. The plans shall be arranged as required by the City/County Engineer. Applicable standard plans of City/County may be included in whole or by reference.

Plans shall be sealed by a Registered Professional Engineer in the state of Missouri and shall be submitted to the City/County for review.

The plans shall consist of:

- A. Title sheet
- B. General layout sheets
- C. Plan and profile sheets
- D. Cross-section sheets including GSI/stormwater BMP section details
- E. Drainage area map and table
- F. Standard and special detail sheets
- G. Traffic control plans (if required)
- H. Temporary erosion control plans including control and protection plans for GSI/stormwater BMPs
- I. Grading plans (if required) including retention and detention design parameters
- J. Property line and easement sheets (if required)
- K. Each sheet shall contain a sheet number, including the individual sheet number and the total number of sheets, proper project identification and all revision dates.
- L. Engineer's seal shall appear on the title sheet and other sheets as required by the State licensing requirements.

5609.4 Sheet Sizes

The suggested sheet size is 22 inches by 34 inches (full-size) with all text legible when printed to half-size scale (11 inches by 17 inches). All sheets in a given set of plans shall be of the same size. Plan and profile shall be drawn on combined or separate plan and profile sheets to minimum scales indicated herein.

5609.5 Scales

Plans shall be drawn at the minimum scales indicated in Table 5609-1. Other scales may be needed to clearly present the design. Bar Scales shall be shown on each sheet for each scale.

Table 5609-1: Drawing Scales	
<u>Drawing Type</u>	<u>Scale</u>
Plan	1 inch = 20 feet
Profile	
Horizontal	1 inch = 5 feet
Vertical	1 inch = 20 feet
Cross Sections	
Horizontal	1 inch = 5 feet
Vertical	1 inch = 10 feet
Drainage Area Map	
Onsite	1 inch = 5 feet
Offsite	1 inch = 10 feet
Structural Plans	¼ inch = 1 foot

5609.6 Required Information for Title Sheet:

- A. Name of project
- B. Project number
- C. Index to sheets
- D. A location map adequately showing the project location in relation to major streets, with north arrow and scale. Map shall be oriented with north arrow up
- E. A signature block for City/County approval
- F. Name, address and telephone number of the consulting engineer and owner/developer as well as signature block for the owner/developer
- G. A legend of symbols shall be shown that apply to all sheets
- H. List containing name and telephone number of each utility company and state One-Call system
- I. Engineer's seal, signed and dated
- J. Other information as per City/County requirements

5609.7 Required Information for General Layout Sheet:

- A. General Notes: Minor construction notes shall appear on the proper plans and profile sheets
- B. North arrow and bar scale. North arrow shall be oriented up or to the right
- C. Surveyed or aerial base map detail indicating existing man-made or natural topographical features, such as buildings, fences, trees, channels, ponds, streams, etc., and proposed and existing utilities

- D. Subdivision information including, but not limited to, rights-of-way; property and lot lines; existing and proposed easements; subdivision nomenclature; street names; and other pertinent information impacting the project
- E. Identification and location of all existing and proposed drainage features
- F. Elevation and location of all applicable benchmarks: datum shall be as required by the City/County. A minimum of two (2) benchmarks are required for each project
- G. Survey control line or base line with adequate ties to land lines
- H. Locations of test borings if taken
- I. Existing and finish grade contours at intervals of 2.0 feet or less in elevation; or equivalent detail indicating existing and finish grades and slopes
- J. A uniform set of symbols subject to the approval of the City/County
- K. Addresses of homes abutting the projects, and current homeowner names associated with properties impacted by the project

5609.8 Required Information for Plan and Profile Sheets:

- A. North arrow and bar scale. North shall be oriented such that profile alignments are shown from downstream to upstream, left to right, respectively.
- B. Ties to permanent reference points for each system
- C. A uniform set of symbols subject to the approval of the City/County
- D. Existing man-made and natural topographic features, such as buildings, fences, trees, channels, ponds, streams, etc., and all existing and proposed utilities
- E. Identification and location of each storm drainage segment and existing utilities affecting construction
- F. Length, size and slope of each line or channel segment. The profile shall indicate the hydraulic grade line of the underground as well as the overland design flows
- G. Right-of-Way, property, easement lines and street names
- H. The 1 percent floodplain and setback from the top of bank of an open channel to any building
- I. Location of test borings
- J. Existing and finish grade contours at intervals of 1.0 feet or less in elevation; or equivalent detail in profiles and cross-sections indicating existing and finish grading
- K. Headwater elevation at the inlet end of each culvert
- L. Invert elevations in and out and top elevations of each structure shall be shown.
- M. Each utility line crossing the alignment shall be properly located and identified as to type, size and material. This information shall be to the best information available and provided through records, field prospecting and or excavation
- N. Test borings representing depth of drilled hole and refusal elevation if applicable
- O. All station and invert elevations of manholes, junction boxes, inlets and other significant structures
- P. The profile shall show existing grade above the centerline as a dashed line, proposed Finish grades or established street grades by solid lines; and shall show the flow line of any drainage channel, either improved or unimproved, within 50-feet of either side of centerline. Each line shall be properly identified. The proposed sewer shall be shown as double solid lines properly showing the top and bottom of pipe

- Q. All structures shall be shown and labeled with appropriate drawing references

5609.9 Cross-Section Sheets

Cross-sections shall be drawn for all open channels and GSI/stormwater BMPs. Sections for channels shall be at appropriate intervals not greater than 50 feet or at any changes to the section geometry. Additional cross sections shall be drawn at all structures and intersecting drainage systems. Cross sections shall also provide for overflow drainage paths that are designated to convey overland flows in excess of underground system capacity. The following shall be indicated on each section:

- A. Ties from centerline to base line.
- B. Existing and proposed grades.
- C. Elevation of proposed flow-lines.
- D. Cut and fill end areas if required for bid quantities.
- E. GSI/stormwater BMPs sections shall specify media depths and pertinent piping/structure configurations and elevations. A summary table shall be included summarizing GSI/stormwater BMP target and provided storage volumes. This information may be included with the cross-sections, or, the grading plan sheets per Paragraph 5609.14. See the KCMO GSI Manual for additional recommendations and details to include for GSI components.

5609.10 Drainage Area Map

The drainage area map shall be supported by a drainage table tabulating the physical properties of the drainage sub-basins, as well as the hydrologic and hydraulic properties of the design. The drainage map shall have the following.

- A. North arrow and bar scale. North shall be oriented up or to the right.
- B. Drainage area boundaries for all watersheds including sub-watersheds of analysis including pass through waters, inlet drainage areas, culvert drainage areas and other points of interest.
- C. Natural drainage paths (may reference Appendix A Warsaw Natural Drainage Paths, 2016 LiDAR-based delineation).
- D. Drainage system nomenclature matching that on the “designed” systems shown in the plans.

5609.11 Standard and Special Detail Sheets

Detail sheets shall be included to show all details of appurtenances, materials and construction. Details shall conform to the requirements of the City/County and are to be drawn clearly and neatly with proper identifications, dimensions materials and other information necessary guide desired construction. Details shall be provided for all GSI/stormwater BMP components specified in the cross sections (Paragraph 5606.9) and grading plans (Paragraph 5609.14). See the KCMO GSI Manual for additional recommendations and details to include for GSI components.

5609.12 Traffic Control Plans (if required)

Traffic control plans shall conform to design and principals contained the most recent copy of Manual of Uniform Traffic Control Devices (MUTCD).

5609.13 Temporary Erosion Control Plan Sheets

- A. Each temporary erosion control feature designation shall be shown in its proper location on the plans
- B. Temporary erosion control devices shall be detailed in the plans as necessary.

- C. Notes shall be included in the plans indicating that the erosion control systems shall be monitored throughout the project life and maintained and adjusted as necessary to control erosion.
- D. Erosion control plans shall be shown and be designed specific to each phase of development or construction.
- E. Erosion control plans shall provide for internal site erosion control and protection for all green stormwater infrastructure/post-construction permanent stormwater BMPs. Internal erosion control plans shall include identification and protection of areas and soil/aggregate media intended for infiltration with notes describing maintenance requirements for protection measures, timing for installation, replacement, and permanent removal.

5609.14 Grading Plan Sheets (if required)

Grading plan sheets shall be included as required by the City/County. The grading plans shall incorporate information concerning the changes in the land geometry to accommodate the development. It shall include but not be limited to:

- A. Existing and proposed contours
- B. Contour and/or spot elevations for all retention/detention facilities, including GSI/stormwater BMPs. Include a summary table specifying facility stage (elevation), storage, and discharge relationships with associated design storm water surface elevations.
- C. Building and finished floor elevations
- D. Curb elevations
- E. Retaining wall elevations
- F. Sufficient spot elevations to verify storage depths, slope and finished grade elevation requirements meet the design criteria specified herein.

5609.15 Property Line and Easement Sheets

Separate property line and easement sheets may be required to adequately show required stormwater drainage setbacks. The information on this sheet shall be sufficient to display the existing and proposed property line and easement changes relative to the project.

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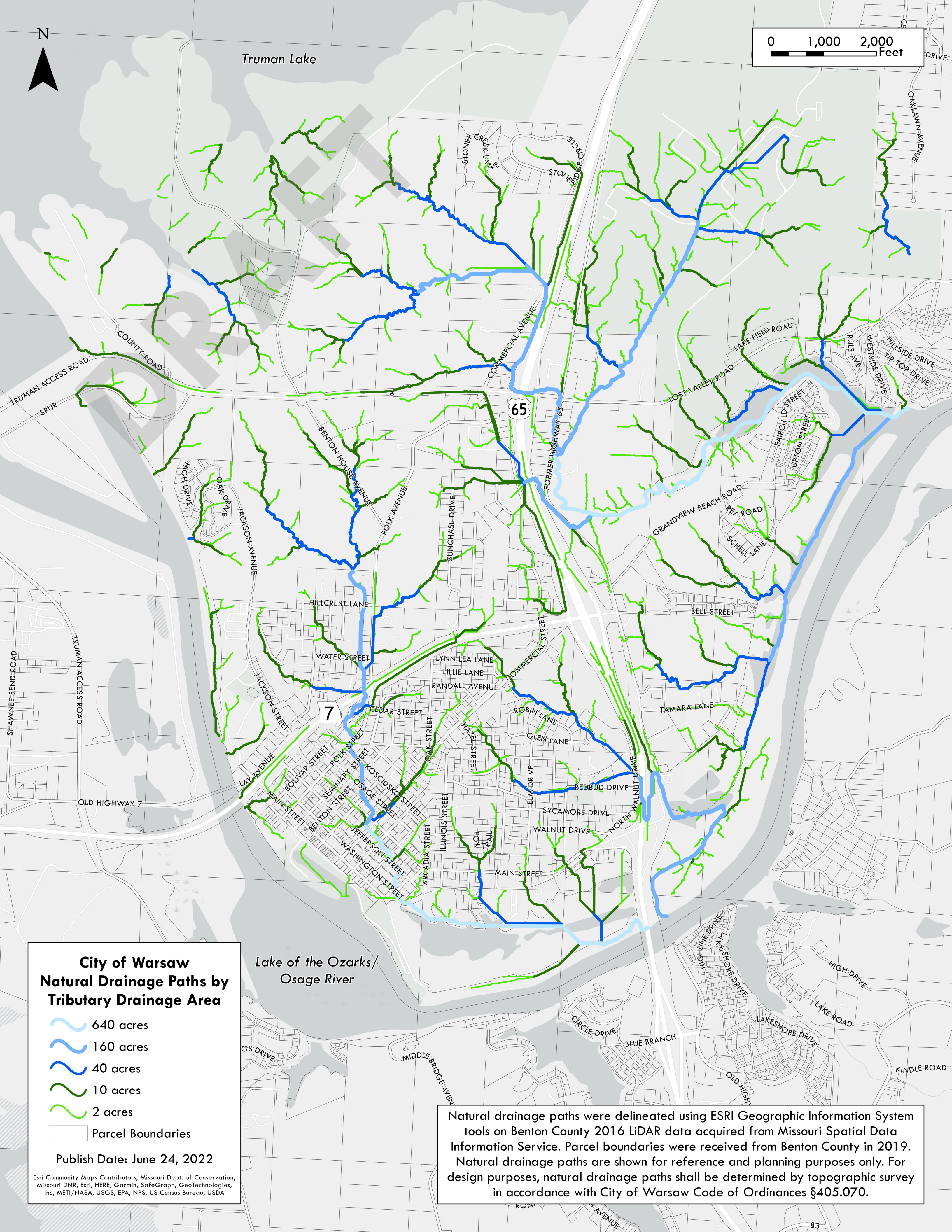
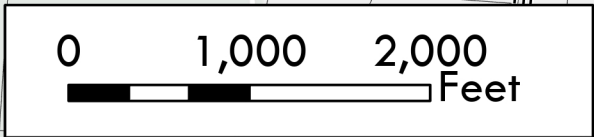
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APPENDIX A

Warsaw Natural Drainage Paths (2016 LiDAR-based delineation)



City of Warsaw Natural Drainage Paths by Tributary Drainage Area

- 640 acres
- 160 acres
- 40 acres
- 10 acres
- 2 acres

Parcel Boundaries

Publish Date: June 24, 2022

Esri Community Maps Contributors, Missouri Dept. of Conservation,
Missouri DNR, Esri, HERE, Garmin, SafeGraph, GeoTechnologies,
Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA

Natural drainage paths were delineated using ESRI Geographic Information System tools on Benton County 2016 LiDAR data acquired from Missouri Spatial Data Information Service. Parcel boundaries were received from Benton County in 2019. Natural drainage paths are shown for reference and planning purposes only. For design purposes, natural drainage paths shall be determined by topographic survey in accordance with City of Warsaw Code of Ordinances §405.070.

APPENDIX B: STORMWATER MANAGEMENT DESIGN CRITERIA (APWA 5600) REDLINES

**CITY OF WARSAW,
MISSOURI
STORMWATER
MANAGEMENT DESIGN
CRITERIA**

**DIVISION V
SECTION 5600
STORM DRAINAGE SYSTEMS &
FACILITIES**

~~(February 16, 2011)~~ September 2022

DIVISION V

DESIGN CRITERIA

5600 STORM DRAINAGE SYSTEMS & FACILITIES

~~APPROVED AND
ADOPTED THIS 15 DAY
OF DECEMBER 2010
KANSAS CITY~~

**METROPOLITAN
CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION**

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Division V
Design Criteria
SECTION 5600 STORM DRAINAGE SYSTEMS & FACILITIES

SECTION 5601 ADMINISTRATIVE

5601.1 Introduction

These criteria provide uniform procedures for designing and checking the design of storm drainage systems under the rainfall and land characteristics typical of the ~~Kansas City Metropolitan Area~~ [City of Warsaw and Benton County area, Missouri](#). This manual generally focuses on water quantity concerns including: conveyance, flow rates, and construction design parameters of stormwater systems. For an in-depth discussion ~~of water quality design standards and of post-construction permanent stormwater~~ Best Management Practices (BMPs) ~~for the Kansas City Metropolitan area~~ see [Section 8](#) of the “Mid-America Regional Council and American Public Works Association; Manual for Best Management Practices for Stormwater Quality” (herein referred to as the MARC BMP Manual). For detailed design and construction guidance for stormwater BMPs/green stormwater infrastructure (GSI) practices see the [Kansas City, Missouri Green Stormwater Infrastructure Manual \(KCMO GSI Manual\)](#).

Federal law requires that “Waters of the United States may be disturbed only after permission is received from the City/County and permitted by the U.S. Army Corps of Engineers, if applicable. A jurisdictional determination by the Army Corps of Engineers shall be obtained prior to beginning design.” Besides federal guidelines, specific criteria have been developed and are applicable to the types of drainage systems and facilities ordinarily encountered in local urban and suburban areas. Other special situations may be encountered that require added criteria or more complex technology than included herein such as maintaining or improving water quality. Any design procedure conforming to current accepted engineering practice may be used for the design of storm drainage systems in lieu of the computation methods presented in this manual, providing equivalent results are obtained and have been approved by the City/County Engineer. Drainage systems for all developments shall be designed assuming ultimate or built-out land-use conditions. ~~The decision flowchart in Figure 5601-1, “Guide to Stormwater Management for Site Development”, shall be used to determine the appropriate runoff controls (see end of this section).~~

5601.2 Definitions

Best Management Practice (stormwater BMP): Stormwater management practice used to prevent or control the discharge of pollutants to waters of the U.S. BMPs may include structural or non-structural solutions, a schedule of activities, prohibition of practices, maintenance procedures, or other management practices. ~~For a comprehensive discussion on BMPs refer to the “Mid-America Regional Council and American Public Works Association; Manual for Best Management Practices for Stormwater Quality”.~~ For the purpose of this document, stormwater BMP is intended to mean post-construction, permanent stormwater BMPs designed to manage stormwater runoff. Stormwater BMPs may also be referred to as green stormwater infrastructure practices.

City/County: The municipality or body having jurisdiction and authority to govern.

City/County Engineer: The municipal or county public works official or body having jurisdiction and authority to review and approve plans and designs for storm drainage systems.

Channel Lining: Includes any type of material used to stabilize the banks or bed of an engineered channel.

Design Storm: The combination of rainfall depth, duration, and distribution of a hypothetical rainfall event with a given likelihood of occurring in any year. The design storm is defined by the average recurrence interval (ARI) or probability such an event will be equaled or exceeded in any one year.

Detention Facility: A storm water management facility controlling storm water runoff from a site or watershed. The allowable runoff specified for detention facilities in Section 5608 is intended to manage maximum storm water release rates to minimize flooding and downstream erosion.

Detention Storage: The volume occupied by water ~~above~~ below the level of the principal spillway crest during operation of a stormwater detention facility.

Development: Any activity, including subdivision, that alters the surface of the land to create additional impervious surfaces, including, but not limited to, pavement, buildings, and structures. Refer to ~~Section~~ Paragraph 5601.3 for applicability.

Drainage Easement: Authorization by the property owner to the public, a corporation or persons of the use of an area of land for stormwater management purposes.

Dry Detention: A detention facility that is designed for the temporary storage of water to control discharge rates from the facility and is normally dry between rainfall events.

Easement: A grant by the property owner to the public, a corporation or persons of the use of a strip of land for specific purposes ~~Authorization by a property owner for the use by another for a specified purpose, of any designated part of the property.~~

Emergency Primary Spillway: A device or devices used to discharge water under conditions of inflow that exceed the design outflow from the primary ~~spillway~~ outlet of the detention facility. The ~~emergency~~ primary spillway functions primarily to safely pass larger, more infrequent design storms and prevent damage to the detention facility that would permit the sudden release of impounded water.

Engineer: See 'Registered Professional Engineer'.

Engineered Channel: An open drainage channel that has been explicitly designed to convey stormwater runoff in accordance with Section 5607 or as approved by the City/County engineer.

FHWA: Federal Highway Administration.

Floodplain: A relatively level surface of stratified alluvial soils on either side of a watercourse that is inundated during flood events.

Freeboard: The difference in elevation between the top of a structure such as a dam or open channel and the maximum design water surface elevation or high water mark. It is an allowance against overtopping by waves or other transient disturbances.

Green Stormwater Infrastructure (GSI): Stormwater management solutions designed to capture, filter, absorb, and/or re-use stormwater by mimicking natural hydrologic processes. GSI may also be referred to as stormwater BMPs.

Impact Stilling Basin: A device that dissipates energy by allowing flowing water to strike a stationary surface therefore producing turbulence and energy loss. -

Impervious Surface: A surface that prevents the infiltration of stormwater.

Improved Channel: Any channel changed by grading or the construction of lining materials as approved by the City/County Engineer.

Incision: Adjustment of the channel bed elevation downwards, typically in response to some type of disturbance.

Increased Runoff: Increase in volume or peak flow of stormwater runoff.

Meander Amplitude: The linear distance between the apex of one meander and the apex of the next meander in a naturally curving stream.

Meander Length: The length measured along the thalweg of one complete waveform.

Meander Wavelength: The length of one complete waveform, measured as the straight-line linear distance along the valley between two analogous points on a waveform.

Low-Drop Structures: A step pool energy dissipation structure typically constructed out of rock or concrete with a design vertical drop of 2 feet or less per step.

Natural Channel Stream: Perennial or intermittent waters included within a channel of land, and its adjacent riparian zones, which serve as a transitional zone between the aquatic and terrestrial upland ecosystems. Any Streams waterway with have the ability to self-form by virtue of having at least one unfixed boundary. This includes drainage ways that may have been previously disturbed- but through inactivity over time have begun to reform one or more characteristics of undisturbed streams.

Natural Drainage Path: The overland route in which water concentrates based on the natural topography of the land. Natural drainage paths function as the surface drainage component of a stormwater drainage system and represent the path stormwater will take when the design capacity is exceeded in the enclosed system. Natural drainage paths typically begin with approximately 2 acres of drainage area.

Open Channel: A maintained earthen or lined waterway with an open water surface as approved by the City/County engineer.

Ordinary High Water Mark: A line on the bank established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Owner: The owner of record of real property.

Point Bars: Depositional features generally occurring on the inside of stream bends and opposite cut banks.

Pools: A deep reach of a stream. The reach of a stream between two riffles; a small and relatively deep body of quiet water in a stream or river.

Primary Outlet Works: A device such as an inlet, pipe, weir, etc., used to discharge water during operation of a storage facility under the conditions of the 1% storm or more frequent event.

Principal Stream: Stream Segments included in FEMA Flood Insurance Studies where the limits of the 1% floodplain and 1% base flood elevations have been determined.

Redevelopment: Remodeling, repair, replacement, or other improvements to any existing structure, facility, or site.

Registered Professional Engineer: A licensed engineer who is registered with and authorized to practice engineering within the state of registration.

Riffles: Shallow rapids in an open stream, where the water surface is broken into waves by obstructions such as ~~natural channel stream~~ armoring or bedrock outcrop wholly or partly submerged beneath the water surface.

Sediment Storage: The volume allocated to contain accumulated sediments within a detention facility.

Site: A tract or contiguous tracts of land owned and/or controlled by a developer or owner. Platted subdivisions, industrial and/or office commercial parks, and other planned unit developments shall be considered a single site. This shall include phased development where construction at a tract or contiguous tracts of land may occur in increments.

~~**Storm:** A rainfall event used for design which is defined by the probability such an event will be equaled or exceeded in any one year. When designing in accordance with these criteria, the storm event probabilities used are: 1%, 2%, 4%, 10% and 50%~~

Storm Drainage System: All of the natural and man-made facilities and appurtenances such as ~~natural drainage paths, ditches, natural streams channels~~, pipes, culverts, bridges, open ~~improved~~ channels, swales, street gutters, inlets, ~~and retention~~/detention facilities, ~~and stormwater~~ BMPs/GSI which serve to convey ~~and control~~ surface drainage.

Stormwater Drainage Setback: preservation of vegetated areas adjacent to a natural drainage path or stream defined by a drainage easement with limitations on allowable development and uses. Stormwater drainage setbacks consist of preservation, protection, and limited-use setback widths.

Swale: An engineered channel conveying stormwater from more than two lots; often the swale is maintained by the property owner but an easement is required when requested by the City/County.

Thalweg: The deepest part of a channel cross-section. The dominant thread of stream flow creates the thalweg.

Top of Bank: The vertical point along a stream bank where an abrupt change in slope is evident, typically representative of the bank-full or channel-forming flow caused by approximately the 2-year design storm.

Tributary Area: All land draining to the point of consideration, regardless of ownership. ~~Tributary area may also be referred to as watershed.~~

~~**Watershed:** All the land area that drains to a given point.~~

Waveform: A complete cycle of two channel bends in opposite directions.

Wet Detention Facility: A detention facility that is designed to include permanent storage of water in addition to the temporary storage used to control discharge rates from the facility.

5601.3 General Requirements and Applicability

The design shall be accomplished under the direction of a Registered Professional Engineer qualified in the field of stormwater design. The design shall be based on land use in the tributary area as zoned, actually developed, or indicated by an adopted future land use plan, whichever basis produces the greatest runoff. Compliance with criteria shall be demonstrated through application and approval of a Stormwater Drainage Permit per Paragraph 5601.5, A.

This design criterion shall apply to all new development and redevelopment, including subdivision development and construction, which alters the surface of the land to create additional impervious surfaces, including, but not limited to, pavement, buildings, and structures with the following exceptions:

~~A. Redevelopment, Expansion, Renovation, Repair and Maintenance Activities~~ Listed Below

- ~~1. Additions to, improvements, and repair of existing single family and duplex dwellings.~~
- ~~2. Remodeling, repair, replacement, or other improvements to any existing structure or facility and appurtenances that does not cause an increased area of impervious surface on the site.~~

~~B.A. Exceptions for Existing Development:~~ Remodeling, repair, replacement or other improvements to any existing structure or facility and appurtenances on sites smaller than two acres ~~Improvements that does not cause an increased area of impervious surface on the site in excess of less than 1,000 square feet 10 percent of that previously existing.~~

- ~~1. Remodeling, repair, replacement, or other improvements to any existing structure or facility and appurtenances that does not cause an increased area of impervious surface on the site in excess of 10 percent of that previously existing, provided the total impervious area of the site is less than 5,000 square feet. (See "Site Planning for Urban Stream Protection" provided by the "Center for Watershed Protection" for a discussion on imperviousness and its effect on watershed health; Error! Hyperlink reference not valid.)~~

~~C.B. Exceptions for New Construction Development:~~ Meeting the Following Criteria

1. Construction of any one new single family or duplex dwelling unit, ~~irrespective of the site area on which the structure may be situated,~~ provided the total impervious area of the site is less than 5,000 square feet.
2. Construction ~~of any buildings, structures, and/or appurtenant service roads, drives, and walks~~ on a site having previously provided stormwater management ~~per the stormwater criteria adopted herein, as defined in Section 5601.5 A4~~ as part of a larger unit of development assuming fully developed conditions. If previously provided stormwater management for the project predates these standards, stormwater management shall be re-evaluated for compliance with the current requirements, ~~OR a site previously relieved of stormwater management requirements.~~

5601.4 Existing Drainage System

Existing drainage system component pipes, structures, and appurtenances within the project limits may be retained as elements of an improved system providing:

- They are in sound structural condition.
- Their hydraulic capacity, including surcharge, is equal to or greater than the capacity required by these criteria.

- Easements exist or are dedicated to allow operation and maintenance.

Discharge from an existing upstream storm drainage system shall be computed assuming its capacity is adequate to meet the performance criteria listed in ~~Section Paragraph~~ 5601.58. The computed discharge shall be used to design the new downstream system even if the actual capacity of the existing upstream system is less.

5601.5 ~~System Types and Applications~~ Stormwater Management Requirements

General Guidelines: ~~Natural channels~~ Natural drainage paths and streams are to be preserved to the maximum extent practicable as site conditions permit. ~~Design standards~~ Requirements for preservation of natural drainage paths and ~~natural channels~~ streams are addressed in Section 5605. Engineered channels, the next highest priority system component, shall be designated and coordinated with the design of building lots and streets in accordance with the design criteria and performance standards addressed in ~~Section~~ 5607.

To the maximum extent possible, drainage systems, street layout and grades, lot patterns and placement of curbs, inlets and site drainage, and overflow swales shall be concurrently designed in accordance with the design criteria and performance standards set forth in this document. Curb and gutter may be omitted or modified where ~~approved by the City/County Engineer and deemed~~ feasible in conjunction with other stormwater management practices including ~~water quality BMPs~~ green stormwater infrastructure.

All improvements defined in Paragraph 5601.3 shall incorporate stormwater management measures to control runoff from the site. Allowable runoff from a site may be limited by the need to minimize downstream flood damage, prevent erosion, and/or minimize impacts to the ecology and water quality of the downstream drainage system. A layered approach to stormwater management level of service is applied to distribute the stormwater risk created from improvements throughout the watershed and provide protection for the community as a whole.

A. Stormwater Drainage Permit: A stormwater Drainage Permit per the City of Warsaw Code of Ordinances Chapter §405.020 is required to demonstrate compliance with this design criteria, as detailed in Section 5609.

B. Protection of Property

1. Property not reserved or designed for conveying storm water shall be protected from frequent inundation:

a. When the total drainage area including all upstream tributary area is less than 2 acres, protection may be provided by following the following lot-to-lot grading practices or by one of the conveyances described ~~below~~ as follows.

- 1) Maintain natural drainage path preservation/overflow system per Paragraph 5601.5.C, 1. such that the freeboard requirements for protection of buildings are met.
- 2) When swales (engineered channels) are required for overflow systems, swales shall be approximately centered on the rear and/or side lot line with a minimum 15-~~foot~~ drainage easement.
- 3) Lawn grading shall maintain slopes between 1% and 33% (3 horizontal : 1 vertical) graded to drain away from buildings. Grading shall be designed to avoid localized sumps with potential to create ponding or flooding issues within the property or between multiple properties. If localized sumps are unavoidable, a drainage system shall be required.

Drainage system may include collection and conveyance. Retention designs using GSI/stormwater BMP are also encouraged, as defined in Section 8 of the MARC BMP Manual. See the KCMO GSI Manual for detailed design and construction guidance of GSI/stormwater BMPs.

- When the total drainage area is 2 acres or more, one or a combination of the following conveyances must be used to meeting the conveyance system requirements specified in Paragraph 5601.5 B

b.

- 1) Enclosed pipe system
- 2) Engineered channel
- 3) Street gutter
- 4) Natural drainage path or stream

2. Buildings shall be protected from infrequent flooding by:

- a. Providing a minimum of one-foot freeboard above the 100-year design storm stage based on a 10% temporal distribution, at any point along the drainage system, for openings in a building. For dry and wet detention facilities the 100-year design storm stage will be the water surface elevation of flow through the primary spillway.
- b. Flood-proofing a building below the 100-year design storm with 10% temporal distribution water surface elevation plus one foot of freeboard, in accordance with the current edition of the International Building Code or as required by the City/County.
- c. Non habitable accessory buildings are sometimes provided less protection by local City/County ordinances or policies. Consult the local authority for exceptions.

C. Retention: Stormwater retention shall be provided for the 0.5-inch design event over the tributary impervious area from the site. Retention-based facilities are designed to either capture and infiltrate or re-use the required retention volume with no discharge from the site for the minimum design event. Retention shall be provided in the form of GSI/stormwater BMPs, as defined in Section 8 of the MARC BMP Manual. See the KCMO GSI Manual for detailed design and construction guidance of GSI/stormwater BMPs. Retention requirements may be achieved in conjunction with detention storage, or independently.

D. Detention: Detention storage shall be maximized for the smaller, more frequent events while allowing larger, less frequent events to pass through the facility without overtopping the facility. Peak runoff control shall be provided for the 2-, 10-, and 100-year design storms for broad protection of the receiving system, including channel erosion protection and flood peak reductions over a range of design storm average recurrence intervals (ARI). Post-improvement peak discharge rates from the site shall not exceed the allowable release rates expressed in discharge rate per tributary area as follows:

- a. 2-year design storm with median (50%) temporal distribution shall have a maximum release rate of 0.1 cfs/acre of drainage area without overtopping of the primary spillway
- b. 10-year design storm with median (50%) temporal distribution shall have a maximum release rate of 0.2 cfs/acre of drainage area without overtopping of the primary spillway
- c. 10-year design storm with 10% temporal distribution shall have a maximum release rate of 2.0 cfs/acre of drainage area with allowable discharge through the primary spillway without overtopping the facility

- d. 100-year design storm with 10% temporal distribution shall have a maximum release rate of 3.0 cfs/acre of drainage area with allowable discharge through the primary spillway without overtopping the facility.

B.E. Conveyance: Generally, a stormwater drainage system is ~~engineered and constructed~~ defined when the drainage area ~~exceeds~~ is 2 acres or more. As defined in Paragraph 5601.2, the stormwater drainage system may consist of natural drainage paths in combination with engineered channels and enclosed systems. A storm drainage system shall incorporate an overflow system that is capable of conveying flows in excess of the designed system capacity. Overflow systems can consist of natural drainage path preservation. Enclosed conveyance systems consisting of inlets, conduits, and manholes may be used to convey stormwater runoff where site conditions and open space requirements will not permit the use of natural drainage paths or engineered channels. Where used, such systems must be designed in accordance with design criteria and performance standards addressed ~~in section 5606~~ herein.

1. Natural Drainage Path Preservation and Overflow Systems: Natural drainage paths shall be preserved to reduce the risk for property damage by designating space for the overland conveyance of stormwater for rainfall events exceeding the capacity of the engineered system. Natural drainage paths delineated from 2016 LiDAR data for the City of Warsaw are shown in Appendix A, for reference. Stormwater drainage setback requirements are defined in Section 5605. Each element of the stormwater drainage system (whether open, enclosed, retention, or detention) shall include an overflow element to a preserved natural drainage path. Overflow systems shall:

- a. Be designed to route downstream flows in excess of the engineered system design capacity.
- b. May include streets, natural drainage paths, engineered channels, redundant piping, spillways, parking lots, drives or combinations thereof.
- c. Limit the maximum water surface elevation generated by the 100-year design storm with the 10% temporal distribution to meet protection of property requirements.
- d. Conform to Paragraph 5605.2 Easements regarding easements and restricted uses for overflow systems within stormwater drainage setbacks.

4.2. Open Systems: Engineered channels, ditches, and swales shall be designed to convey the 10-year design storm with the 10% temporal distribution, as defined in Section 5602. Where feasible, open systems consisting of open or engineered channels shall be used if all of the following ~~design criteria and the conditions of Section 5601.8~~ are met:

- a. The channel slope is less than or equal to 5 percent or where appropriate armoring techniques are used to prevent erosion.
- b. The ~~50%~~2-year design storm velocity is less than or equal to 5 feet per second (fps) or where appropriate armoring techniques are used to prevent erosion.
- c. When required stormwater drainage setbacks can be maintained ~~60 feet or farther away from top of bank to any existing or proposed habitable building, regardless of system design capacity.~~

~~2.~~—

- 3. Enclosed Systems:** Enclosed systems consisting of underground pipes, culverts, and similar underground structures shall be used to convey stormwater at all locations ~~whenever one of the following design criteria and the conditions of 5601.8 are met:~~
3. ~~Where natural channels drainage paths or open-engineered channels systems are not feasible.~~ Enclosed pipe systems shall convey the 10-year design storm assuming the temporal distributions per Section 5602, and be designed per Section 5603, as follows:
- a. **Gravity Flow Conditions:** 10-year design storm with median (50%) temporal distribution gravity flow conditions within the pipe system (e.g. no surcharging)
 - b. **Pressure Flow Conditions:** 10-year design storm with 10% temporal distribution pressure flow conditions with surcharging less than 0.5 feet below the lowest opening to the surface or structure rim elevation.
4. **Street Crossings:** Concentrated flow for open systems shall be conveyed under streets to prevent vehicles from being swept from the roadway ~~in during~~ infrequent storms. These crossings may be bridges or culverts ~~or underground systems. A common practice is to construct the low point in the roadway so that it does not fall on the bridge or culvert. This practice protects the structure from damage in an overflow condition, but does not change this requirement.~~ Crossings ~~will~~ shall be designed to completely convey ~~flood~~ flows without street overtopping in accordance with the design storms listed in Table 5601-1 based the 10% temporal distribution. Roadway classifications are defined per the Warsaw Livable Community Transportation Improvement Plan.

Table 5601-1: Level of Service for Street Crossings

Street Classification	Min. Design Storm
Principal Arterial	50-Year
Primary Connectors	25-Year
Minor Streets ⁽¹⁾	10-Year
⁽¹⁾ Secondary connectors also fall into the category of minor streets	

Further, concentrated flow in excess of the minimum design storm may only overtop the roadway if the following conditions are met:

- a. The span of the structure opening is less than 20 feet.
- b. The peak stormwater runoff from the ~~1%100-year design~~ storm with 10% temporal distribution is 250 cfs or less unless a guard fence is installed on the downstream side of the roadway. Such overflow depths at low points in roadways during the ~~1%100-year design~~ storm with 10% temporal distribution will be limited to 7 inches measured at the high point in the roadway cross section, typically at the upstream face of culvert headwall or roadway curb; except that it also shall not exceed 14 inches at the deepest point in the roadway cross section.

C.F. Collection: Inlet placement in roadway sections shall limit the allowable gutter spread to maintain one lane width for emergency vehicle access during the 10-year design storm with the median (50%) temporal distribution, as defined in Section 5602. Water spread may exceed these limits within 50 feet of a sump location, however, protection of property shall be maintained per Paragraph 5601.58, A. by limited overtopping of curb and/or flooding beyond the right-of-way.

~~Within the right-of-way of streets with curbs, regardless of system design capacity.~~

~~1.—**Overflow Systems:** Each conveyance element of the stormwater drainage system (whether open, enclosed, or detention) shall include an overflow element. Overflow systems shall:~~

~~a.—Be designed to route downstream any amount of the 1% storm exceeding the in-system design capacity specified in Section 5601.8.~~

~~b.—Include streets, engineered channels, redundant piping, spillways, parking lots, drives or combinations thereof.~~

~~c.—Limit the maximum water surface elevation generated by the 1% storm as specified in Section 5601.8.~~

~~d.—Conform to local standards regarding dedicated easements and/or restricted uses for overflow systems; consult with the local authority for requirements.~~

~~e.—Be limited to the natural drainage basins, unless overflows transferred out of a natural drainage basin (e.g. a thoroughfare straight graded through a drainage basin with a sump in another drainage basin) are added to the overflows in the receiving drainage basin and the combined overflow still meets the criteria at 5601.5 A 3C~~

~~2.—**Stormwater Management:** New development or redevelopment as defined in Section 5601.2 shall incorporate stormwater management measures to control runoff from the site. Allowable runoff from a site may be limited by the need to minimize downstream flood damage, prevent erosion, and/or minimize impacts to the ecology and water quality of the downstream drainage system. It is recognized for site-level runoff controls to be effective, consistent application across a watershed is necessary to realize measurable benefits along the downstream system. This section presents four site runoff control strategies that can be applied to sites within a watershed based on watershed protection goals and identified problems. The City/County or local authority shall pre-determine which strategy is to be applied within its watersheds or subsheds. If watershed control strategies are not defined by the local authority, the default strategy for new development shall be the Comprehensive Protection strategy.~~

~~a.—Default Strategy: Comprehensive Protection~~

~~Under this strategy, peak runoff control is provided for the 1%, 10% and 50% chance storms and volumetric and/or extended detention control of the 90% mean annual event storm for broad protection of the receiving system, including channel erosion protection and flood peak reductions over a range of return periods. This strategy shall be the default strategy unless otherwise designated or approved by the local authority. Performance standards and sizing criteria are provided in Section 5608.~~

~~b.—Reduced Control Strategies~~

~~1) —**Frequent Event Control for Stream Erosion Protection:** This strategy provides runoff control for the 10% and 50% chance storms and volumetric and/or extended detention control of the 90% mean annual event storm in order to protect downstream channels~~

from erosion. This strategy is appropriate for largely undeveloped watersheds containing natural streams where downstream flooding of existing structures is not present and would not occur under future upstream full-development conditions.

- 2) ~~**Extreme Flood Event Control Only:**~~ Under this strategy, detention is provided solely to reduce peak runoff rates for the 10% and 1% storm events. Over detention of the peak release rates at the discharge point (i.e. requiring the post-development rate to be less than the pre-development rate) is used to ensure a cumulative benefit for a reasonable distance downstream. If known flooding occurs downstream in flood events more frequent than the 10% event, the local authority may require control of these events.

~~This strategy is not effective at protecting stream channels and banks from erosion. It is most applicable in certain redevelopment and in-fill situations where flooding problems are known, existing downstream stream conditions are already poor, and economic barriers to redevelopment preclude more extensive control.~~

- 3) ~~**Special Locally-Defined Strategies:**~~ The City/County may develop alternative strategies that are tailored to the unique circumstances of their watersheds. Such strategies may apply globally to the City/County or only to certain designated areas. The City/County will identify each alternative strategy with a unique descriptor and publish the requirements for each.

~~Such alternative strategies may involve increased or decreased allowable release rates, relaxed or more stringent controls for certain storm return intervals, reliance on infiltration or low-impact development practices for added volume control, planning and open space controls, and/or special requirements to participate in regional control facilities instead of development scale facilities.~~

~~Stormwater management for site development may include structural facilities and/or non-structural solutions. Where runoff controls are required, low-impact development practices or, off-site control of runoff in addition to or instead of the standard wet or dry bottom basins may be used.~~

5601.6 Waivers

The Developer may submit a ~~study~~ **stormwater Drainage** Permit by a registered professional engineer that quantifies the problems and demonstrates that a waiver (exemption) of the requirement to provide stormwater management is appropriate. The City/County Engineer may waive requirements to address *unique* conditions or constraints:

- A. **Stormwater Management ~~Facilities~~Requirements:** Stormwater management ~~facilities~~ requirements may be waived ~~and/or release rates other than those permitted by Section 5608~~ when supported by a ~~developer's Stormwater Drainage Permit Drainage Study~~ performed in accordance with Section 5609 and approved by the City/County Engineer.
- B. **Overflow Channels:** In previously developed areas, requirements to provide for ~~1%~~ **100-year design storm with 10% temporal** distribution conveyance may be reduced by the City/County Engineer in circumstances where flood protection for the ~~1%~~ **100-year design** storm is not reasonably attainable due to the location of damageable improvements with respect to the drainage system and where non-attainment is supported by an approved ~~Drainage~~ **Drainage Study** Permit.

5601.7 Other Requirements

Rules and regulations of other agencies also pertain to drainage systems which may or may not complement these criteria. When conflicts are encountered, the more stringent criteria shall govern.

The following agencies have jurisdiction over streams and/or drainage systems and often require permits. Other regulations, permits and requirements may not be limited to these agencies.

- Federal Emergency Management Agency.
- U.S. Army Corps of Engineers.
- Missouri Department of Natural Resources.
- ~~a. Kansas Department of Agriculture—Division of Water Resources.~~
- ~~b. Kansas Department of Health and Environment~~
- ~~Municipal Ordinances.~~

5601.8 Levels of Service

~~Drainage systems shall be designed to meet all levels of service described below. In addition, natural streams include requirements specified in Section 5605.~~

~~A storm drainage system shall be provided that is capable of conveying the peak discharge generated by the 1% storm. If the in-system capacity established in this section is less the 1% storm peak discharge, then an overflow system as specified in Section 5601.5 A-3 may provide the additional system capacity.~~

~~A. Protection of Property~~

- ~~1. Property not reserved or designed for conveying storm water shall be protected from frequent inundation:
 - ~~a. When the total drainage area is less than 2 acres, protection may be provided by following good lot grading practices or by one of the conveyances described below.~~
 - ~~b. When the total drainage area is 2 acres or more, one of the following conveyances must be used to convey the 10% storm:
 - ~~1) Pipe system conveying the design storm under a regime of pressure flow with no overflow at inlets or manholes, or~~
 - ~~2) An engineered open channel conveying the 10% storm at bank full~~
 - ~~3) A street gutter~~
 - ~~4) A natural stream~~~~~~
- ~~2. Buildings shall be protected from infrequent flooding by:
 - ~~a. Providing a minimum of one foot freeboard above the 1% storm stage, at any point along the drainage system, for openings in a building. For lakes and detention basins the 1% storm stage will be the water surface of flow through the emergency spillway.~~
 - ~~b. Flood proofing a building below the 1% storm water surface elevation plus one foot of freeboard, in accordance with the current edition of the International Building Code or as required by the City/County.~~
 - ~~c. Non habitable accessory buildings are sometimes provided less protection by local City/County ordinances or policies. Consult the local authority for exceptions.~~~~

B. Protection for Streets

1. ~~Gutter Spread: Water spread in streets shall meet the requirements in Section 5604.2 for the 10% design storm. These values are intended to establish a standard of accessibility for the widths (classes) of roadways listed during the 10% storm. When the local jurisdiction requires a higher standard for curb inlets, the conveyance system connected to the roadway must also meet that higher standard. If the roadway conveyance system connects to an underground system with lesser capacity, the system must be constructed to allow the discharge of that excess capacity into the overflow system.~~
2. ~~Street Crossings: Concentrated flow not conveyed in the gutter system, shall be conveyed under streets to prevent vehicles from being swept from the roadway in infrequent storms. These crossings may be bridges, culverts or underground systems. A common practice is to construct the low point in the roadway so that it does not fall on the bridge or culvert. This practice protects the structure from damage in an overflow condition, but does not change this requirement. Crossings will be designed to completely convey flood flows without street overtopping in accordance with Table 5601-1.~~

Table 5601-1: Level of Service for Street Crossings

Street Classification	Min. Design Storm Capacity
Arterial	2%
Collector	4%
Residential	10%
Residential with open channel downstream	4%

~~Further, concentrated flow in excess of the minimum design storm may only overtop the roadway if the following conditions are met:~~

- a. ~~The span of the structure opening is less than 20 feet.~~
- b. ~~The peak stormwater runoff from the 1% storm is 250 cfs or less unless a guard fence is installed on the downstream side of the roadway.~~

~~Such overflow depths at low points in roadways during the 1% storm will be limited to 7 inches measured at the high point in the roadway cross section; except that it also shall not exceed 14 inches at the deepest point in the roadway cross section. Depths may be limited where necessary by reverse grading the downstream right of way area, by lengthening the vertical curve of the roadway, by reducing roadway crown, or by other similar means. Roadway overtopping depths shall be determined by integrating the broad-crested weir formula across the roadway profile. Each incremental flow can be determined by using the formula:~~

$$q = C \cdot L \cdot h^{\frac{2}{3}}$$

Where:

-

~~q = the flow for an increment of profile length (width of flow)~~
~~l = the incremental width~~
~~C = a flow coefficient that shall not exceed 3.0~~
~~h = the average depth of flow at each increment~~

~~The total flow Q is the sum of the incremental flows. Depth determinations can be made through an iterative process where successive depths are chosen; Q is calculated for each depth and then compared to the known Q at the overtopping point.~~

~~Overflow protection criteria provides additional accessibility criteria at major stream crossings for emergency personnel, and provides the public with protection against injury and property damage.~~

~~C. Downstream Impacts~~

- ~~1. The negative impacts of development on flooding problems in the downstream system shall be mitigated through detention as specified in Section 5601.5-A 4, or through other means approved by the City/County.~~
 - ~~a. Impacts on natural channels are regulated in Section 5605.~~
 - ~~b. Communities that have adopted the recommended "Manual of Best Management Practices (BMPs) for Stormwater Quality" should also mitigate the negative impact of development on natural channels through the installation of water quality BMPs and closely adhere to practices specified in Section 5605 on natural channels.~~

D. Adjoining Property: State and Federal regulations often establish requirements for a storm drainage project that impacts adjoining property, especially when a project causes a rise in water surface elevations. In addition to all Federal and State regulations the following shall be met:

- **Drainageways not designated a Special Flood Hazard Area (FEMA 1% Floodplain):** Construction of a storm drainage system, including grading and filling within a ~~natural stormwater~~ drainage ~~way setback is not permitted unless~~, requires agreement from adjoining property owners if the work will cause a rise in the water surface elevation on the adjoining property for the 1% storm. Agreement shall be considered granted by recording a document which reserves the affected property for inundation during the 1% storm, or by other means approved by the City/County.
- **Drainageways designated a Special Flood Hazard Areas (FEMA 1% Floodplain) and City/County participates in the National Flood Insurance Program:** When impacting adjoining properties, refer to the ~~local community's~~ adopted Floodplain Management Ordinance for any requirements, in addition to all current FEMA regulations.

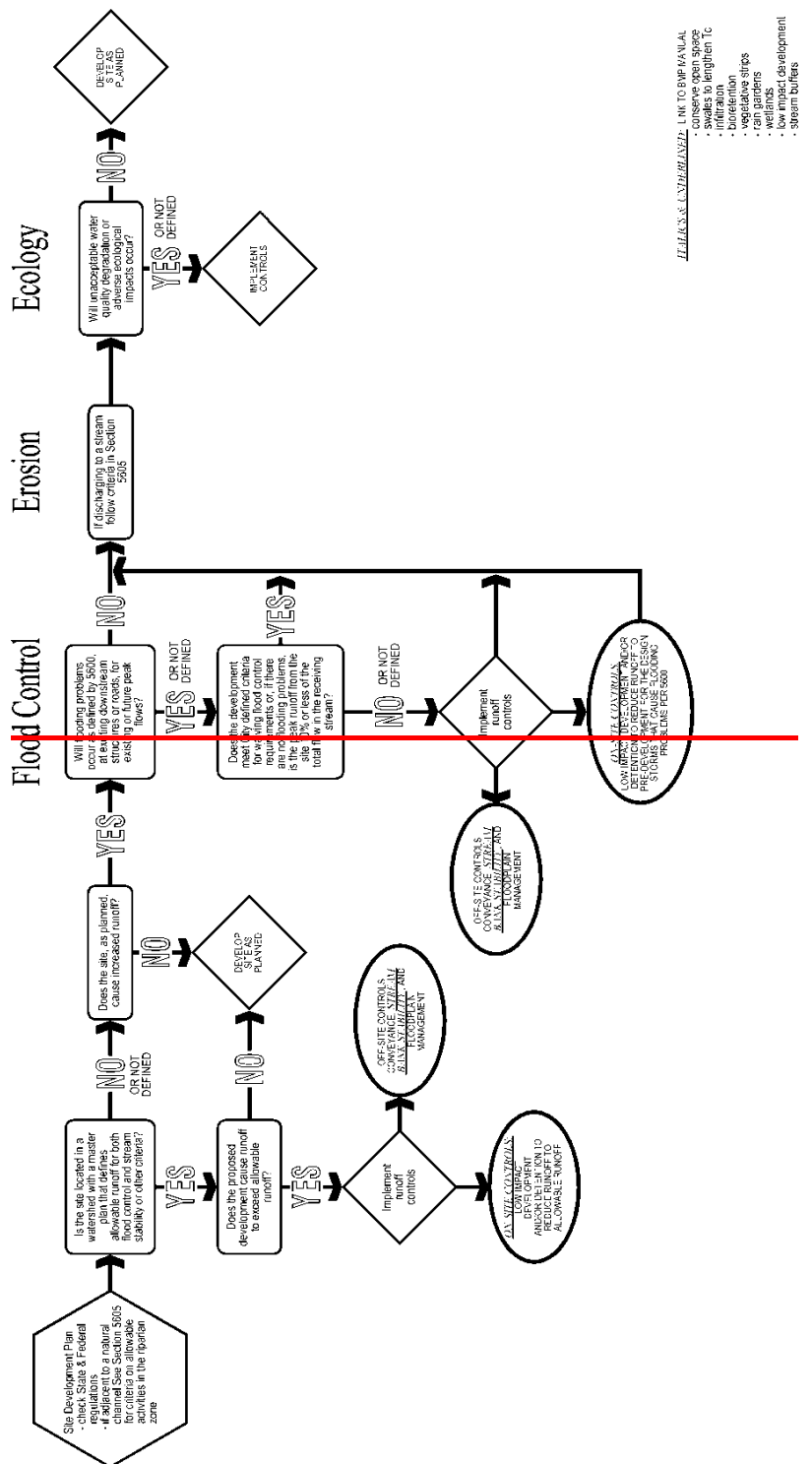


Figure 5604-1: Guide to Stormwater Management for Site Developmet

SECTION 5602 HYDROLOGY

5602.1 Scope

This section sets forth the hydrologic parameters to be used for computations involving the definition of runoff mass and peak rates to be accommodated by the storm drainage system. The methods to be used for calculating runoff mass and peak rates are intended for the design of drainage systems. ~~Refer to the "Mid-America Regional Council and American Public Works Association; Manual for Best Management Practices for Stormwater Quality" for design methods and calculations of runoff water quality.~~ The hydrologic calculations included are based on the *NOAA Atlas 14 Volume 8 Precipitation Frequency Atlas of the United States for Midwestern States* (NOAA, 2013), herein referred to as NOAA Atlas 14. The 6-hour temporal rainfall distributions were applied to the location of Warsaw, Missouri based on point precipitation frequency data from the NOAA Precipitation Frequency Data Server. Documentation of this data analysis can be found in the *Warsaw Stormwater Study: Hydrologic Analysis & Hydraulic Review* (Burns & McDonnell, September 2020).

5602.2 Computation Methods for Runoff

Runoff rates to be accommodated by each element of the proposed storm drainage system shall be calculated using the criteria of this section for land use runoff factors, rainfall, and system time. The following methods of computations are allowed:

- A. Watersheds Less than 200 Acres:** The Rational Method may be used to calculate peak rates of runoff to elements of enclosed and open channel systems, including inlets, when the total upstream area tributary to the point of consideration is less than 200 acres. The Rational Method is defined as follows:

$$Q = C \cdot i \cdot A$$

Where:

Q = Peak rate of runoff to system in cfs

C = Runoff coefficient as determined in accordance with Paragraph 5602.3

i = Rainfall intensity in inches per hour as determined in accordance with Paragraph 5602.6

A = Tributary drainage area (acres)

~~K = Dimensionless coefficient to account for antecedent precipitation as follows, except the product of~~

~~C-K shall not exceed 1.0. See Table 5602-1.~~

~~Table 5602-1: Antecedent Coefficient~~

Design Storm	K
10% and more frequent	1.0
4%	1.1
2%	1.2
1%	1.25

- B. Baseline Unit Hydrograph Method:** The following computer implementations of the unit hydrograph method are acceptable for all watersheds:

- SCS Technical Release No. 55 "Urban Hydrology for Small Watersheds", 2nd Edition, June 1986.
- ~~2-~~SCS Technical Release No. 20 "Project Formulation - Hydrology", 2nd Edition, May 1983.
- ~~3-~~U.S. Army Corps of Engineers, Hydrologic Engineering Center - "HEC-1 Flood Hydrograph Package".
- ~~4-~~U.S. Army Corps of Engineers, Hydrologic Engineering Center - "HEC-HMS Hydrologic Modeling System", current version.
- Other industry standard practices as approved by City/County Engineer.

~~Copies of the above publications and micro computer programs based thereon are available for purchase through National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. Inputs for unit hydrograph procedures shall conform to the requirements of sections~~ Paragraph 5602.3 through 5602.8.

~~C. Kansas "Calibrated" Design Method:~~ In lieu of the input parameters set forth in sections 5602.3 through 5602.8, an alternative unit hydrograph method using HEC-1 or HEC-HMS and conforming to recommendations based on research conducted at the University of Kansas for gauged basins in Kansas (McEnroe and Zhao, August 2001 and McEnroe and Gonzalez, July 2002) are allowed. Such alternate procedures must use the appropriate total combinations of HEC-1 hypothetical storm distributions, storm durations, antecedent moisture conditions, unit hydrograph peaking coefficients, and basin lag times as calibrated in the research. All other computations shall be given as required in this standard.

~~Antecedent moisture condition adjustments shall be made only to the pervious component of a watershed, direct conversion of composite antecedent moisture conditions is not appropriate.~~

~~D.C.~~ **Other Alternative Design Methods:** Alternative design methods, including computer models ~~and Kansas "Calibrated" Design Method,~~ may be employed so long as they produce runoff hydrographs to the system that are substantially the same ~~or more conservative than~~ as those calculated by the baseline method. To assess the equivalence of such methods, the Engineer shall prepare estimates using both the alternate design method and the baseline unit hydrograph method, and shall report for every sub-basin the following data from both: peak flow rate, lag time, runoff volume, and equivalent curve number based on total storm precipitation and direct runoff. Any discrepancy greater than 5% between the two models shall be clearly identified, ~~and discrepancies that produce less conservative results shall be justified.~~ Testing of equivalence is not required if the alternative method has been proven to the City/County engineer to be consistently more conservative than the baseline unit hydrograph method or if the City/County Engineer has determined that the alternative method is reliably more accurate or appropriate for the design condition.

~~E.D.~~ **Regression Formulas Equations:** Rural and urban regression formulas equations prepared by the U.S. Geological Survey (USGS) for Kansas (Rasmussen and Perry, 2000) and Missouri (Alexander and Wilson, 1995 Southard and Veilleux, 2014) and urban regression formulas equations prepared by the U.S. Geological Survey for nationwide use (Sauer, Thomas, Stricker, and Wilson, 1983) or Missouri use (Becker, 1986 Southard, 2010), or their subsequent revisions, shall not be used as the sole input for project design, but are useful tools for evaluating design models. USGS StreamStats web application provides access to Geographic Information System analytical tools that are useful for stormwater planning. Rural regression formulas shall be used only to represent rural or pre-development conditions when significant basin storage does not exist. ~~The Kansas rural regression formula produces substantially more conservative peak flow estimates than the Missouri equation and should be used unless specifically allowed otherwise by the City/County. For urban watersheds, the rural regression results can be used as inputs to the urban regression formula, or~~ a pre-development scenario of the basin model can be developed to compare to the rural regression, and then physically realistic adjustments can then be made to impervious percentages, ground cover, basin lag times, and channel routing to produce the urban scenario. ~~Figures 5602-4-3 and 5602-5-4 show typical results for Kansas and Missouri, including a summary of the gauge data estimates~~

used to derive the equations. Table 5602-2-1 and Figures 5602-6 and 5602-7 present documented extreme stream flows in Kansas City and other areas. Engineers shall use caution in interpreting regression formula-equation results and acknowledge the range of standard error and uncertainty of both the regression formulas and the underlying gauge estimates.

Table 5602-12—Documented Extreme Stream Flows in Kansas City Area and Surrounding Region

ID No.	USGS Station Number	Station Name	Contributing Drainage Area (sq. miles)	Date of Max. Discharge	Max. Recorded Discharge (cfs)	Max. Discharge per Basin Area (cfs/acre)	Period of Record (Water Yr.)	References
Kansas City Metropolitan Area, Missouri and Kansas								
1.	06821130	First Creek near Nashua	0.55	18-May-74	1,250	3.6	1959-84	1,7
2.	--	Turkey Creek trib. at Carter St. at Merriam, Ks.	0.82	12-Sep-77	1,200	2.3	--	3
3.	--	Little Blue River trib. at Noland Road at Independence, Mo.	0.83	12-Sep-77	2,330	4.4	--	3
4.	--	Rock Creek at Woodson and Martway St. at Mission, Ks.	1.15	12-Sep-77	1,980	2.7	--	3
5.	--	Tucker Creek at Highway FF near Grain Valley, Mo.	1.45	12-Sep-77	1,890	2.0	--	3
6.	--	Brush Creek at 75th and Nall at Prairie Village, Ks.	1.51	12-Sep-77	3,000	3.1	--	3
7.	--	White Oak Creek at Raytown, Mo. (Raytown Road)	1.78	12-Sep-77	2,290	2.0	--	3
8.	--	Cedar Creek at Lee's Summit, Mo. (Chicago Rock Island and Pacific RR)	1.84	12-Sep-77	2,410	2.0	--	3
9.	06893710	Gates Branch near Liberty, Mo. (Sherril Drive)	1.95	12-Sep-77	2,480	2.0	--	3
10.	--	Mill Creek near Independence, Mo. (Courtney Road)	1.95	12-Sep-77	2,240	1.8	--	3
11.	--	Rock Creek at Sheridan Road at Fairway, Ks.	3.04	12-Sep-77	4,900	2.5	--	3
12.	--	Blue River trib. at Bannister Road near Kansas City, Mo. (U.S. Hwy 71)	3.38	13-Sep-77	4,040	1.9	--	3
13.	06893600	Rock Creek at Independence, Mo.	5.2	12-Sep-77	7,760	2.3	1967-75	3,7
14.	--	Brush Creek at 73rd St. and Mission Hills, Ks.	5.84	12-Sep-77	14,400	3.9	--	3
15.	06893570	Round Grove Creek at Raytown Road at Kansas City, Mo.	5.87	Sep-77	13,200	3.5		3
16.	06892800	Turkey Creek at Merriam, Ks. (67th St.)	6.76	12-Sep-77	5,300	1.2	1974-86	3,7
17.	--	Turkey Creek at Merriam, Ks. (63rd St.)	7.84	12-Sep-77	6,490	1.3	--	3
18.	06893560	Brush Creek at Main St. at Kansas City, Mo.	14.89	12-Sep-77	17,600	1.8	1971-79	3,7
19.	06894500							

		East Fork Fishing River at Excelsior Springs, Mo.	20	6-Jul-51	12,000	0.9	1951-72	1,2,7
20.	06892940	Turkey Creek at Kansas City, Ks. (State Hwy. 10)	22.3	1-May-83	12,500	0.9	1974-87	3,7
21.	06893350	Tomahawk Creek near Overland Park, Ks.	23.9	13-Aug-82	8,250	0.5	1970-82	4
22.	06893300	Indian Creek at Overland Park, Ks. (Marty St.)	26.6	9-Jun-84	12,800	0.8	1964-01	4
23.	06894680	Sni-A-Bar Creek near Tarsney, Mo. (Colburn Road)	29.1	12-Sep-77	15,700	0.8	1970-79	3,7
24.	--	Fishing Creek near Kearney,	39.4	22-Jun-47		1.2	--	2

Table 5602-12 Documented Extreme Stream Flows in Kansas City Area and Surrounding Region

ID No.	USGS Station Number	Station Name	Contributing Drainage Area (sq. miles)	Date of Max. Discharge	Max. Recorded Discharge (cfs)	Max. Discharge per Basin Area (cfs/acre)	Period of Record (Water Yr.)	References
		Mo.			30,000			
25.	06893080	Blue River near Stanley, Ks.	46	15-May-90	20,200	0.7	1970-01	4
26.	06893793	Little Blue River (below Longview Road Dam) at Kansas City, Mo.	50.7	13-Aug-82	18,700	0.6	1967-99	1,3,7
27.	" "	" " (2nd highest peak)	50.7	13-Sep-77	18,100	0.6	" "	1,3,7
Kansas, outside the Kansas City Metropolitan Area								
28.	--	Dry Walnut Creek trib. near Great Bend	1.19	15-Jun-81	3,080	4.0	--	4
29.	06889100	Soldier Creek near Goff	2.06	10-May-70	7,080	5.4	--	2,4
30.	--	Dry Walnut Creek trib. near Great Bend	2.28	15-Jun-81	5,720	3.9	--	4
31.	06912300	Dragoon Creek trib. near Lyndon	3.76	11-Jun-81	8,200	3.4	--	4
32.	06879650	Kings Creek near Manhattan	4.09	13-May-95	10,200	3.9	--	4
33.	07166700	Burnt Creek at Reece	8.85	9-Jun-65	20,500	3.6	--	2,4
34.	--	Mill Creek near Alta Vista	18.7	1951	19,800	1.7	--	6
35.	07184600	Fly Creek near Faulkner	27	3-Jul-76	28,000	1.6	1957-77	4
36.	06815600	Wolf River near Hiawatha	41	9-Aug-68	40,000	1.5	--	4
37.	07179600	Four Mile Creek near Council Grove	55	26-Jun-69	68,100	1.9	1964-77	4
38.	07181500	Middle Creek near Elmdale	92	27-Jun-69	60,000	1.0	17, 38- 90	4
Missouri, Outside the Kansas City Metropolitan Area								
39.	--	Nemo Branch at Nemo	0.52	30-May-56	1,950	5.9	--	2

40.	07011500	Green-Acre-Branch-near-Rolla	0.62	9-Jun-50	1,900	4.8	1948-75	1,2,7
41.	--	Boney-Draw-at-Rockport	0.76	18-Jul-65	5,080	10.4	--	2
42.	--	Clear-Creek-tributary-near-Holt	6.52	22-Jun-47	14,000	3.4	--	2
43.	07019790	Plattin-Creek-at-Plattin	65.8	Jun-64	36,800	0.9	1966-72	2,7
Midwest, Outside Missouri and Kansas								
44.	--	East-Fork-Big-Creek-near-Bowlegs, Okla.	0.89	14-Apr-45	3,000	5.3	--	2

Table 5602-12—Documented Extreme Stream Flows in Kansas City Area and Surrounding Region

ID No.	USGS Station Number	Station Name	Contributing Drainage Area (sq. miles)	Date of Max. Discharge	Max. Recorded Discharge (cfs)	Max. Discharge per-Basin Area (cfs/acre)	Period of Record (Water Yr.)	References
45.	--	Stratton-Creek-near-Washta, Iowa	1.9	9-Aug-61	11,000	9.0	--	2
46.	--	West-Fork-Big-Blue-River-trib.-near-York, Nebr.	6.9	9-Jul-50	23,000	5.2	--	2
47.	08057140	Cottonwood-Creek-at-Forest-Lane, Dallas, Tx.	8.5	28-Apr-66	17,600	3.2	1962-78	5,7
48.	--	Ranch-Creek-near-Halley, Okla.	17.1	4-Sep-40	32,400	3.0	--	2

References Cited:

1. Alexander and Wilson. Technique for Estimating the 2-to 500-Year Flood Discharges on Unregulated Streams in Rural Missouri. USGS WRIR 95-4231. 1995
2. Crippen and Bue. Maximum Floodflows in the Conterminous United States. USGS WSP 1887. 1977.
3. Hauth. Floods in Kansas City, Missouri and Kansas, September 12-13, 1977. USGS Prof. Paper 1169. 1981.
4. Rasmussen and Perry. Estimate of Peak Streamflows for Unregulated Rural Streams in Kansas. USGS WRIR 00-4079. 2000.
5. Sauer et al. Flood Characteristics of Urban Watersheds in the United States. USGS WSP 2207. 1983.
6. USGS. Kansas-Missouri—Floods of July 1951. USGS WSP 1139. 1952.
7. USGS. Surface-Water Data for the Nation. Peak flow database at Queried January 2003.

5602.3 Runoff Coefficients

- A. Rational Method “C”:** A composite runoff coefficient based on the actual percentages of pervious and impervious surfaces shall be used when feasible. The “C” value can be calculated from any type of land use and known percent impervious surface from the following equation:

$$C = 0.3 + 0.6 \cdot I$$

Where:

I = percent impervious divided by 100

- A.B. SCS Runoff Curve Number Method “CN” Basis of Curve Number Coefficients:** All Curve-Number coefficients in this section are values for Hydrologic Group “C” soils. For soils in other Hydrologic Groups, equivalent SCS Curve Numbers can be found in shall be determined per SCS Technical Release No. 55. No soil disturbed by construction shall be assigned a Hydrologic Group classification of ‘A’ or ‘B’.

B. C. Standard Land Use/Zoning Classifications: Runoff Coefficients relative to development, undeveloped land and land use ~~shall have the~~ may use the values indicated in ~~Table 5602-3~~ Tabel 5602-1 for preliminary planning purposes. Drainage Permit shall reflect actual percent imperviousness for the site.

Table 5602-1: Runoff Parameters

Land Use / Zoning	Average Percent Impervious	Average Percent Pervious	Rational Method “C” ¹	SCS Curve Number by Hydrologic Soil Group ²			
				A	B	C	D
Commercial & Business							
Local, Central and Commercial Business Districts (C-1, C-2, and C-3)	85	15	0.81	89	92	94	95
Residential							
Single Family and Two-Family Dwelling District (R-1 and R-2)	35	65	0.51	60	74	82	87
Multifamily Dwelling District (R-3)	60	40	0.66	74	83	88	91
Mobile Home District (R-4)	25	75	0.45	54	70	80	85
Churches & Schools	75	25	0.75	83	89	92	94
Industrial							
Light Industrial District (M-1)	60	40	0.66	74	83	88	91
Heavy Industrial District (M-2)	80	20	0.78	86	91	93	94
Parks, Cemeteries	10	90	0.36	45	64	76	82
Railroad Yard Areas	25	75	0.45	54	70	80	85
Open Space District (O) and Undeveloped Areas	0	100	0.3	39	61	74	80
All Surfaces							
Impervious: Asphalt, Concrete, Roofs, etc.	100	0	0.9	98	98	98	98
Turfed	0	100	0.3	39	61	74	80
Ponds/Permanent Water Surface	100	0	0.9	98	98	98	98
¹Rational C is calculated based on average percent impervious per Paragraph 5602.3 A. ²SCS Curve Number calculated based on average percent impervious area (Purdue University, 2011)							

Table 5602-23: Runoff Parameters

Land Use / Zoning	Average- Percent- Impervious	Average- Percent- Pervious	Rational- Method- "C"	SCS Curve- Number
Business				
Downtown Area	95	5	0.87	97
Neighborhood Areas	85	15	0.81	
Residential				
Single Family Areas	35	65	0.51	82

Multifamily Areas	60	40	0.66	88
Churches & Schools	75	25	0.75	92
Industrial				
Light Areas	60	40	0.66	88
Heavy Areas	80	20	0.78	93
Parks, Cemeteries	40	90	0.36	76
Railroad Yard Areas	25	75	0.45	80
Undeveloped Areas	0	100	0.30	74
All Surfaces				
Impervious: Asphalt, Concrete, Roofs, etc.	100	0	0.90	98
Turfed	0	100	0.30	74
Wet Detention Basins	100	0	0.90	98

Rational Method “C” for Non-Standard Land Use/Zoning Classifications: The “C” value can be calculated from any type of land use and known percent impervious surface from the following equation:

$$C = 0.3 + 0.6 \cdot I$$

Where:

I = percent impervious divided by 100

B.C. Un-zoned, but Master Planned Areas: Areas whose future land use is defined by an adopted land use plan shall be assigned runoff coefficients for the land use indicated on such plan.

C.D. Agricultural and Unplanned Areas

- Existing Conditions: For purposes of determination of development impact, undeveloped areas whose current land use is agriculture (crops, pasture, meadow, brush, woods) shall be assigned have an assumed a maximum of 0% impervious surface area or a maximum Curve Number equivalent to based on good condition pasture, grassland or range (C=0.30, CN=74) hydrologic condition.
- Proposed Conditions: Undeveloped areas designated as agricultural or those areas for which no specific land use is indicated shall be assigned a minimum of 35% impervious surface area based on good hydrologic condition with Hydrologic Soil Group ‘C’ for purposes of the design of storm drainage systems (C=0.51, CN=82). Existing undeveloped land with a Hydrologic Soil Group of ‘A’ or ‘B’ shall be assigned a Hydrologic Soil Group of ‘C’ for the proposed (developed) condition if the undeveloped land would be disturbed as a result of the development (e.g. Pasture with good hydrologic condition and Hydrologic Soil Group ‘B’ that will be open space for a park would be assign a Hydrologic Soil Group ‘C’).

D.—Composite Coefficients: As an alternative to the above coefficients and for areas not listed above (office parks, shopping centers, trailer parks, etc.), a composite runoff coefficient based on the actual percentages of pervious and impervious surfaces shall be used.

5602.4 Rainfall Mass

The NOAA Atlas 14 Volume 8, 6-hour duration, median and 10% first-quartile U.S. Soil Conservation Service (SCS) Type 2 twenty four hour rainfall distributions for Region 3 shall be used for all computations that employ the use of rainfall mass. The at rainfall distribution for the median (50%) and 10% temporal distributions is reproduced in Table 5602-2.

Table 5602-2: Rainfall Mass

Table 5602-34: Rainfall Mass

Time in Hours	Accumulated Rainfall in Percent of 24-hour Rainfall
0.0	0.00
2.0	2.20
4.0	4.80
6.0	8.00
8.0	12.00
9.0	14.70
9.5	16.30
10.0	18.10
10.5	20.40
11.0	23.50
11.5	28.30
11.75	38.70
12.0	66.30
12.5	73.50
13.0	77.20
13.5	79.90
14.0	82.00
16.0	88.00
20.0	95.20
24.0	100.00

Time (hours)	Accumulated Percentage of Total Precipitation (%)	
	Median (50%) Temporal Distribution	10% Temporal Distribution
0	0	0
0.5	19.52	39.62
1.0	38.51	73.03
1.5	57.82	90.42
2.0	74.88	97.12
2.5	84.23	99.38
3.0	88.12	99.89
3.5	91.8	99.91
4.0	95.37	99.96
4.5	97.28	99.97
5.0	98.96	99.99
5.5	99.82	100
6.0	100	100

5602.5 Unit Hydrographs

The SCS Dimensionless Unit Hydrograph (either curvilinear or triangular) shall be the basis for computation of runoff hydrographs.

5602.6 Rainfall Intensity

Rainfall intensity shall be determined from ~~Figure 5602-1 or~~ Table 5602-3
~~Table 5602-5~~ per NOAA Atlas 14 Volume 8, 6-hour duration, median and 10% first quartile rainfall
distributions for Region 3 ~~using a calculated Time of Concentration.~~

Table 5602-3: Rainfall Intensity (in/hr) for Warsaw, Missouri
~~Table 5602-45: Design Aide for Calculating Rainfall Intensity Kansas City Metropolitan Area (in/hr)~~

Average Recurrence Interval (ARI)	Median (50%) Temporal Distribution	10% Temporal Distribution
1-Year	0.90	1.82
2-Year	1.04	2.12
5-Year	1.29	2.62
10-Year	1.51	3.07
25-Year	1.83	3.71
50-Year	2.08	4.22
100-Year	2.35	4.76

Return Period	Equation 1 $5 \leq T_c \leq 15$	Equation 2 $15 < T_c \leq 60$
2 yr.	$i = \frac{119}{T_c + 17}$	$i = \frac{134}{T_c + 21.4}$
5 yr.	$i = \frac{154}{T_c + 18.8}$	$i = \frac{182}{T_c + 25}$
10 yr.	$i = \frac{175}{T_c + 18.8}$	$i = \frac{214}{T_c + 26.7}$
25 yr.	$i = \frac{203}{T_c + 18.8}$	$i = \frac{262}{T_c + 28.8}$
50 yr.	$i = \frac{233}{T_c + 19.8}$	$i = \frac{296}{T_c + 29.6}$
100 yr.	$i = \frac{256}{T_c + 19.8}$	$i = \frac{331}{T_c + 30}$

5602.7 Time of Concentration and Lag Time

Time of Concentration (T_C) is equal to the overland flow time to the most upstream inlet or other point of entry to the system, Inlet Time (T_I), plus the time for flow in the system to travel to the point under consideration, Travel Time (T_T).

$$T_C = T_I + T_T$$

- A. **Inlet Time:** T_I shall be calculated by the following formula or determined graphically from Figure 5602-1, but shall not be less than 5.0 minutes nor greater than 15.0 minutes:

$$T_I = 1.8 \cdot (1.1 - C) \cdot \frac{D^{1/2}}{S^{1/3}}$$

Where:

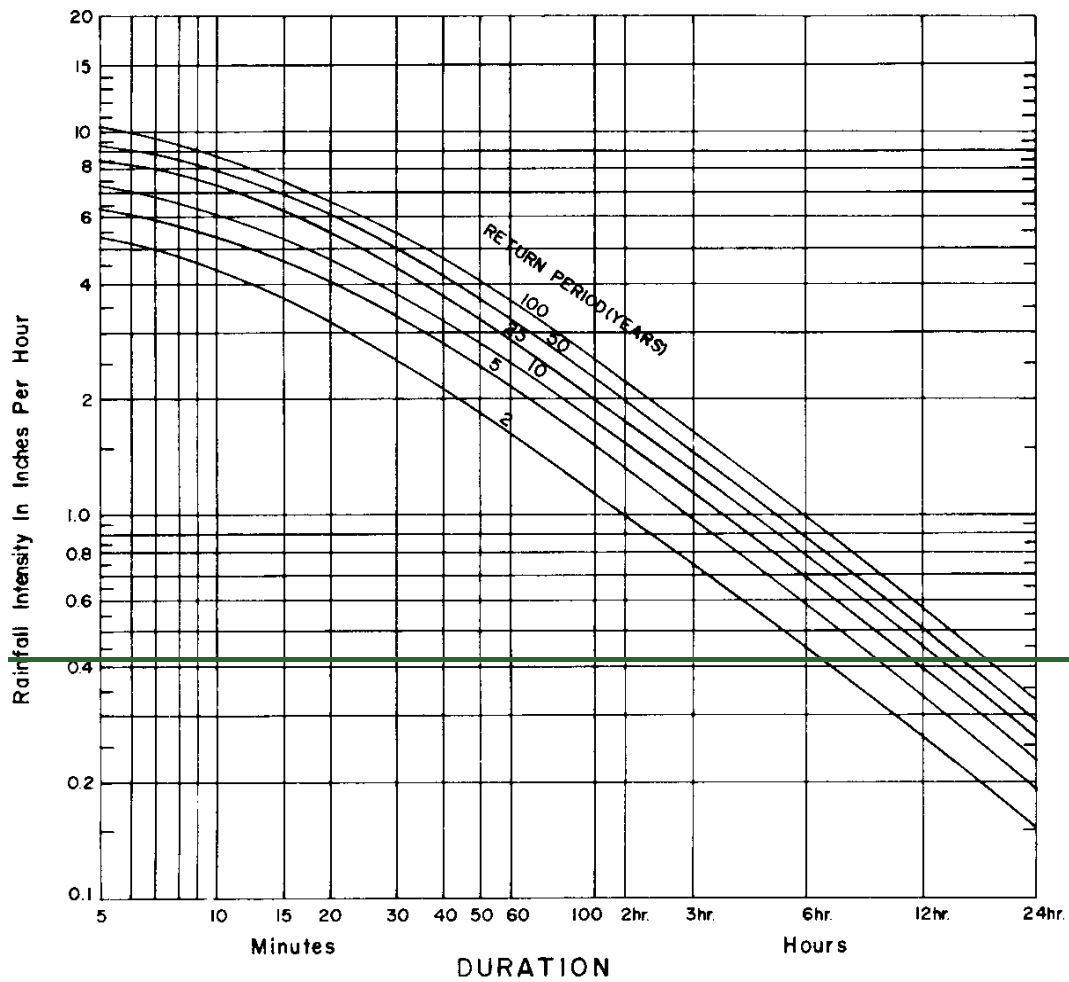
~~T_i~~-T_I = Inlet time in minutes

C = Rational Method Runoff Coefficient as determined in accordance with

~~paragraph~~ Paragraph 5602.3

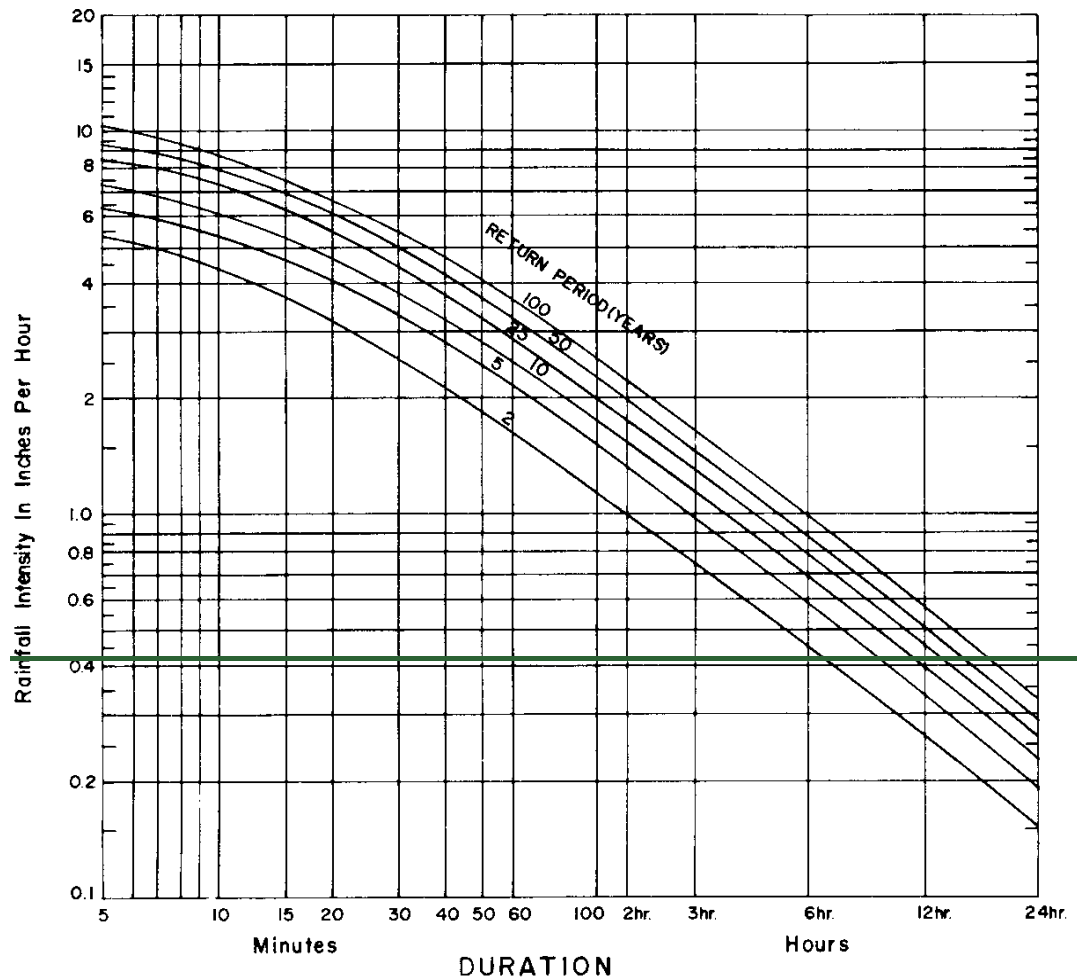
D = Overland flow distance parallel to slope in feet (100 feet shall be the maximum distance used for overland flow)

S ~~=~~ Slope of tributary area surface perpendicular to contour in percent



REFERENCES

1. NOAA Technical Memorandum NWS HYDRO-35 National Oceanic and Atmospheric Administration Of The National Weather Service, Department Of Commerce Silver Spring, Md., June 1977.
2. Technical Paper No. 40, Rainfall Frequency Atlas For Durations From 30 Minutes To 24 Hours And Return Periods From 1yr To 100 Yrs. U.S. Weather Bureau, Department Of Commerce, Washington, D.C., January 1963.
3. Design Of Urban Highway Drainage-State Of The Art FHWA-TS-79-225 U.S. Department Of Transportation Federal Highway Administration, Washington, D.C., August 1979.



REFERENCES

1. NOAA Technical Memorandum NWS HYDRO-35 National Oceanic and Atmospheric Administration Of The National Weather Service, Department Of Commerce Silver Spring, Md., June 1977.
2. Technical Paper No. 40, Rainfall Frequency Atlas For Durations From 30 Minutes To 24 Hours And Return Periods From 1yr To 100 Yrs. U.S. Weather Bureau, Department Of Commerce, Washington, D.C., January 1963.
3. Design Of Urban Highway Drainage-State Of The Art FHWA-TS-79-225 U.S. Department Of Transportation Federal Highway Administration, Washington, D.C., August 1979.

Figure 5602-1: Intensity-Duration-Frequency (IDF) Curves for Kansas City, Missouri (1896 to 1972)

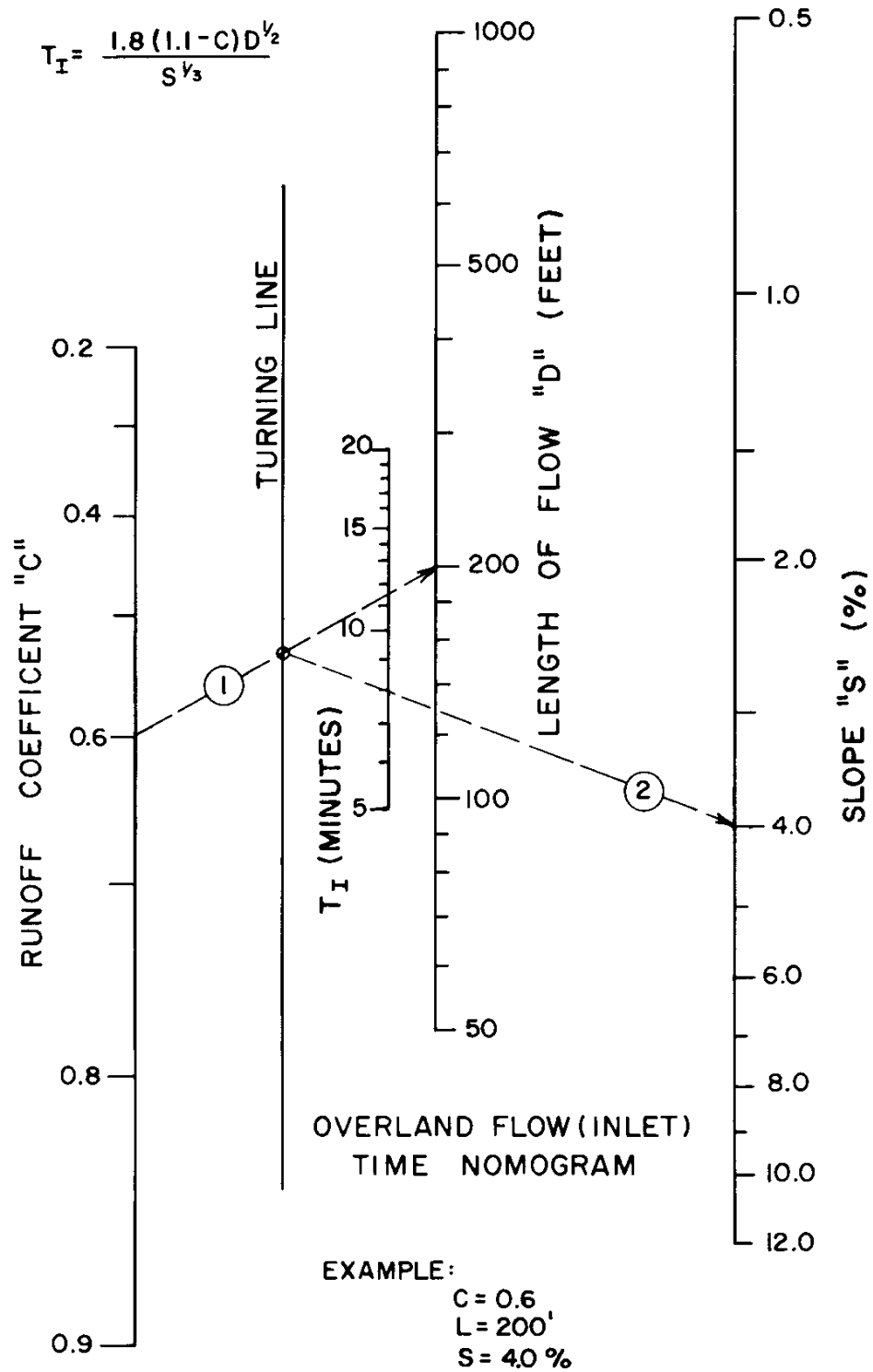
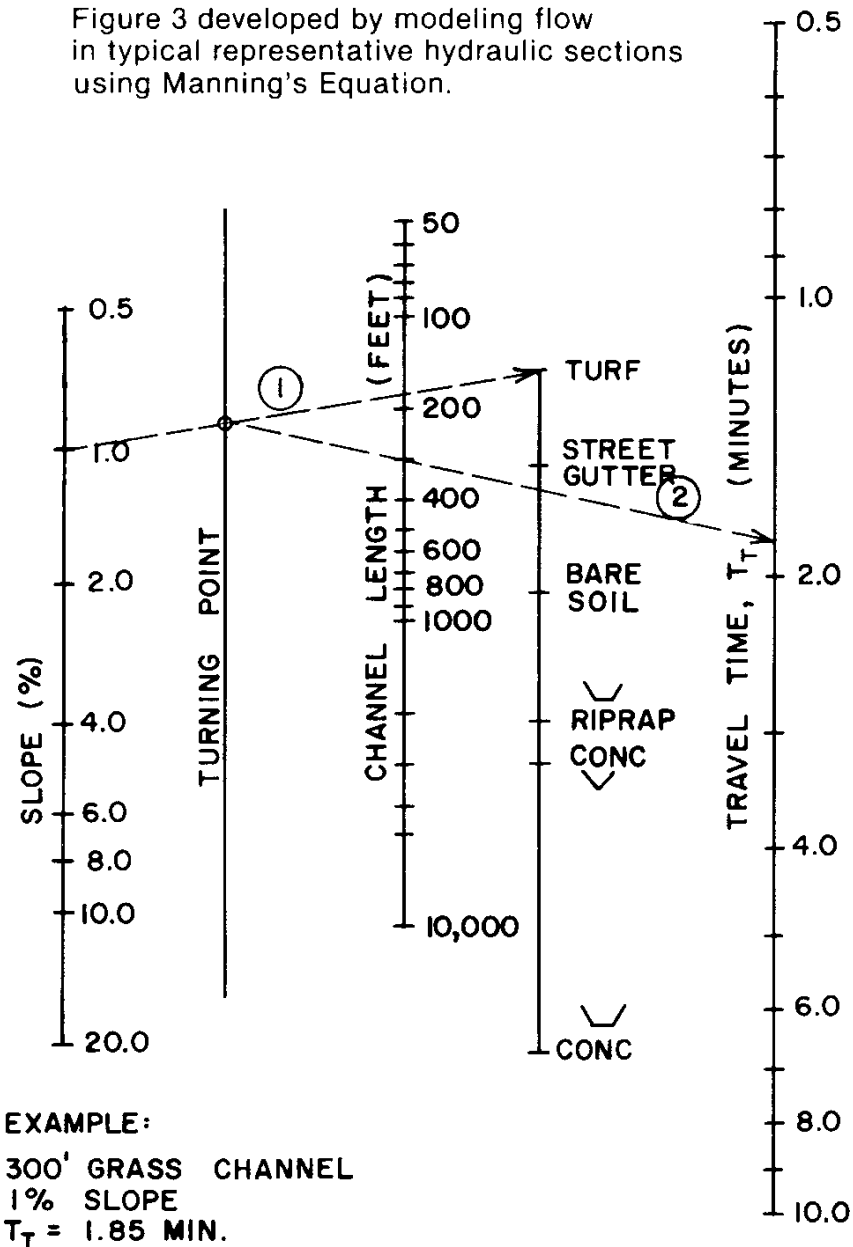


Figure 5602-1: Overland Flow (Inlet) Time Nomograph

Figure 3 developed by modeling flow in typical representative hydraulic sections using Manning's Equation.



- ① Connect Slope & Channel Condition to locate point on Turning Line
- ② Extend line from Turning Line through Channel Length, Read T_T

Figure 5602-2: Channel Flow Time Nomograph

- B. **Travel Time:** T_T shall be calculated as the length of travel in the channelized system divided by the velocity of flow. Velocity shall be calculated by Manning's equation assuming all system elements are flowing full without surcharge. Travel time may be determined graphically from Figure 5602-2 in lieu of calculation.

To provide for future development when the upstream channel is unimproved, the Table 5602-4 shall be used for calculating T_T .

Table 5602-4: Travel Time Estimates for Future Development

Average Channel Slope (%)	Velocity (ft/sec)
< 2	7
2 to 5	10
> 5	15

- C. **Lag Time:** Lag Time (T_L) is the calculated time between the maximum rainfall intensity of a storm and the point of maximum discharge on the outlet hydrograph. Lag Time is used instead of time of concentration for unit hydrograph models. It shall be calculated as 3/5th the time of concentration (T_c) given by paragraph-Paragraph 5602.7 (A and B).

5602.8 Hydrograph Routing

Routing of hydrographs through storage elements or reservoirs shall be by modified-Puls level pool routing. Routing through channels shall be by the Muskingum-Cunge method. If the detention effect of significant storage in channels behind roadway embankments or culverts is to be modeled, the area impacted by the storage shall be modeled as a reservoir, and the remainder of the channel modeled using Muskingum-Cunge. Such incidental detention shall not be used for design discharge estimates unless allowed by the City/County and it can be reliably demonstrated that such storage will be maintained over the useful life of the proposed improvements.

5602.9 Calibration and Model Verification

All design discharge estimates should be calibrated to the extent possible using reliable gauge data, high water marks, or historical accounts. Model results should be evaluated to verify that they are ~~reasonably conservative~~ as compared to observed data and standard practice. ~~Model calibration shall not be used to justify discharge estimates that are lower than those provided by the baseline unit hydrograph method, unless unusual site specific factors justify, where the hydrologic impact of such factors must be thoroughly examined and documented.~~ Engineers shall recognize the significant uncertainty associated with design discharge estimates and provide estimates that are ~~reasonably conservative and~~ protective of the public interest. To permit model verification, discharge rates (expressed as absolute discharge or discharge per acre of tributary area) ~~shall be plotted~~ relative to tributary area ~~and may be~~ compared to regression ~~formula equation~~ results, gauge estimates, and/or known historical extremes.

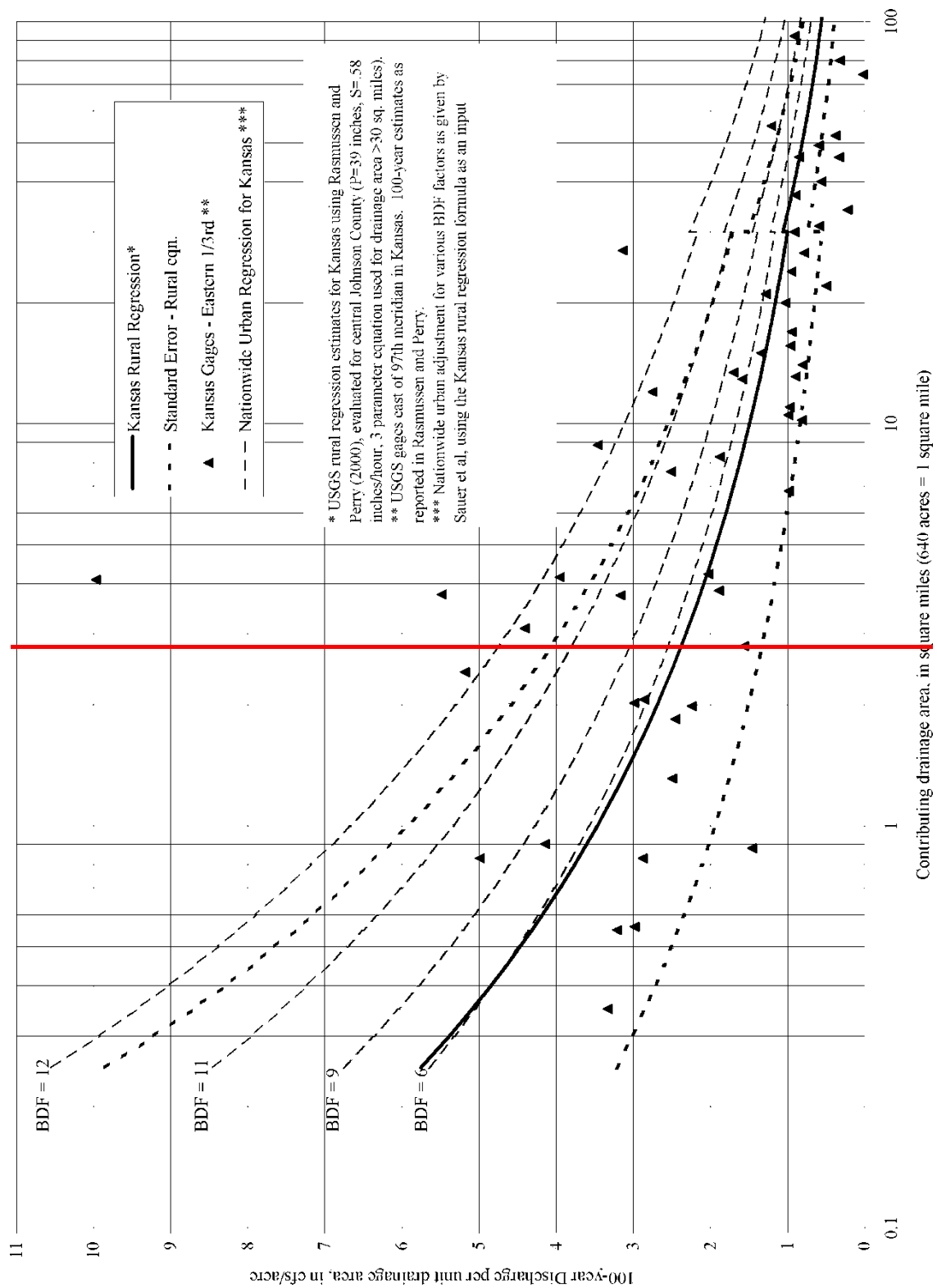


Figure 5602-4: 100-year Discharge per Kansas Rural Regression Formula (2000) and Gage Estimates

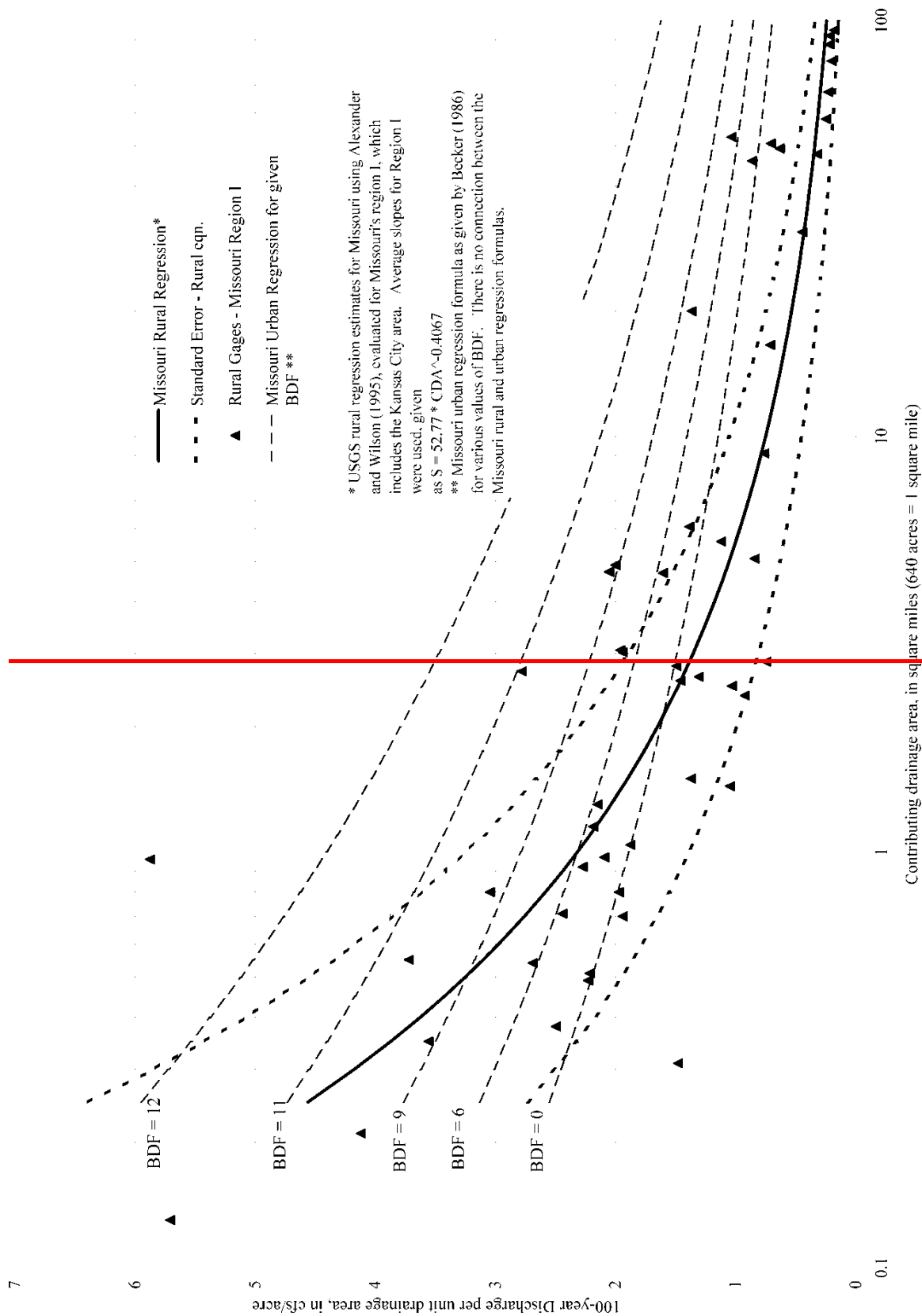


Figure 5602-5: 100-year Discharge per Missouri Rural Regression Formula and Gage Estimates

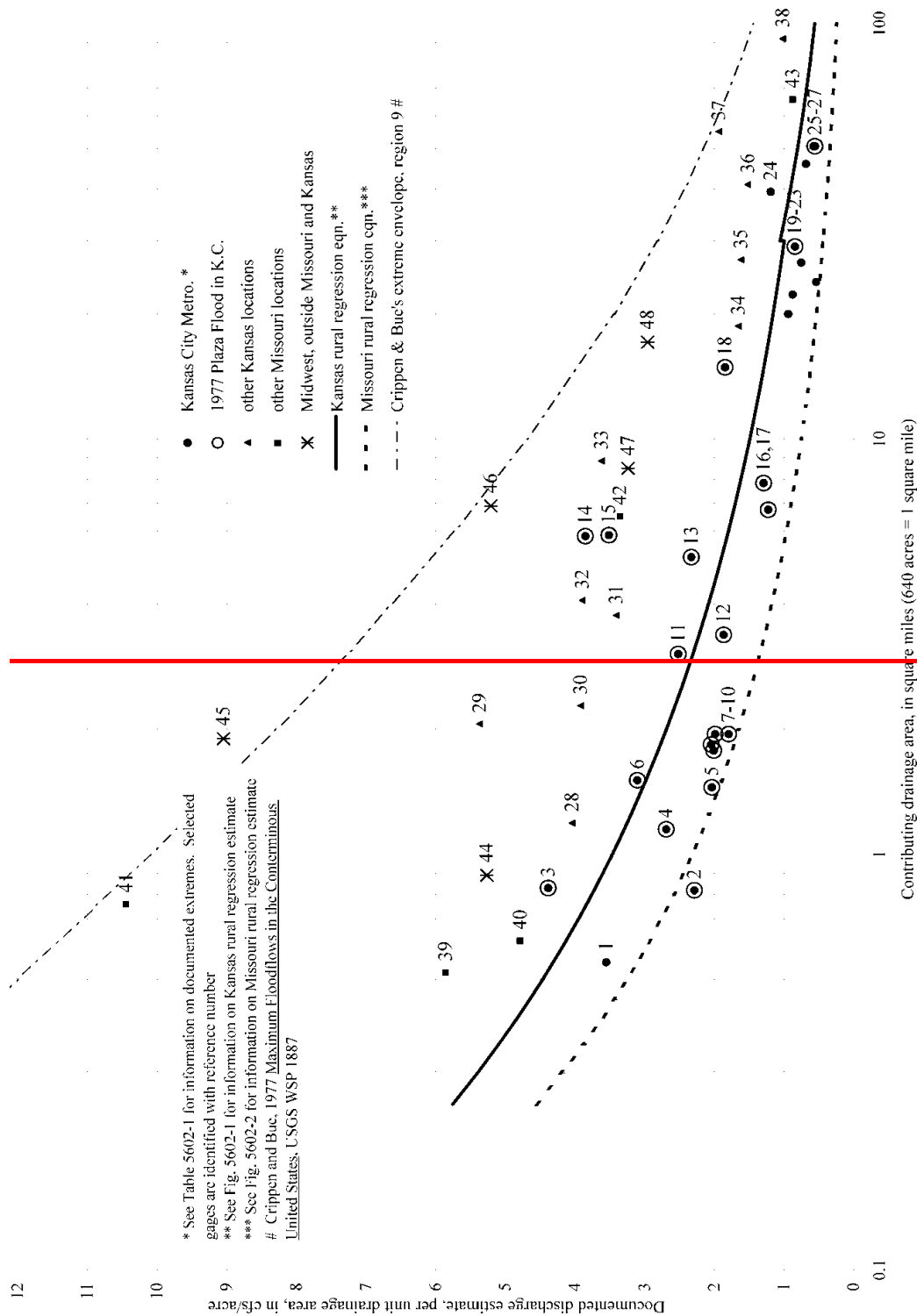


Figure 5602-6: Documented Extreme Streamflows (no return period estimates) in Kansas City and the Region, as Discharges per Unit Drainage Area

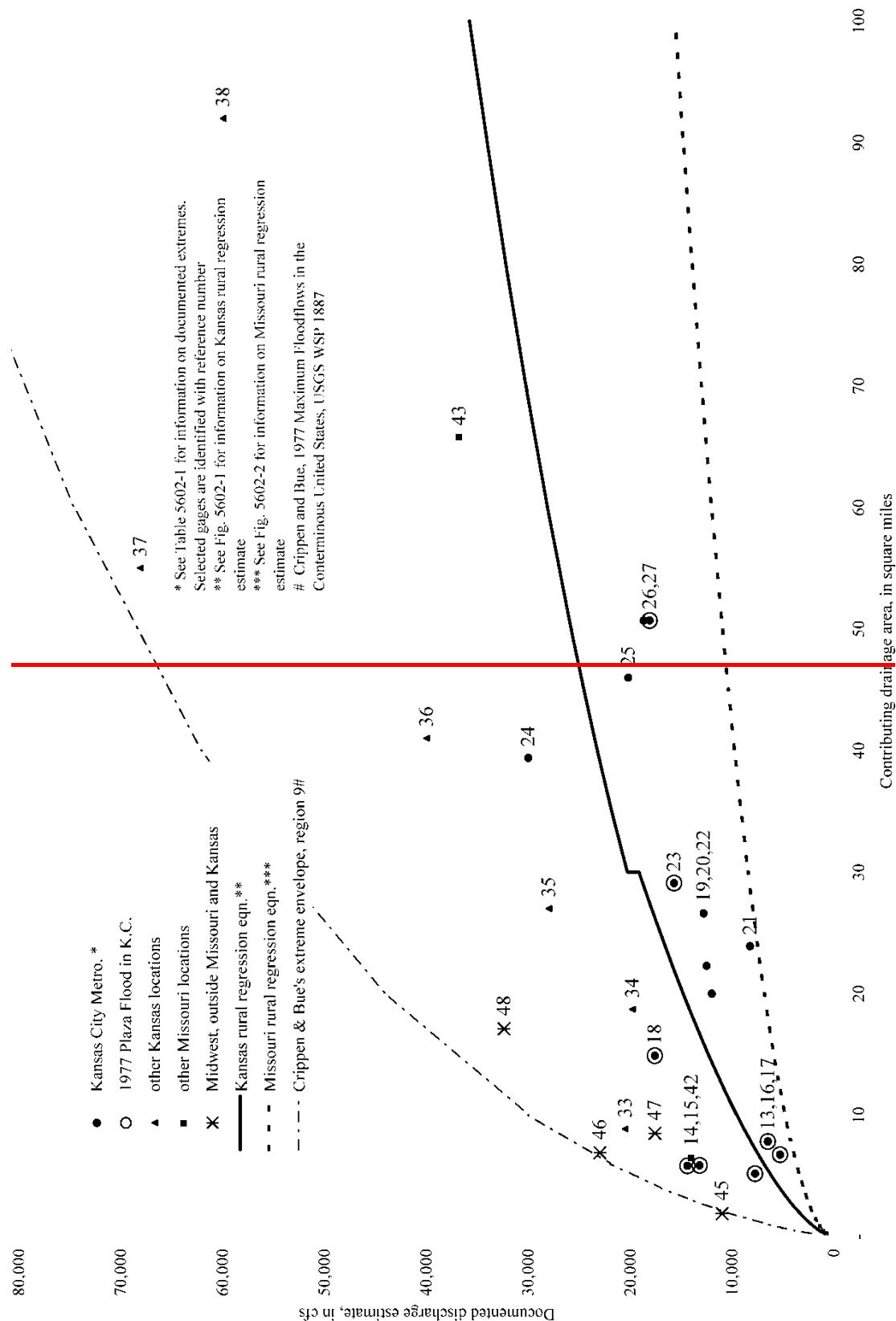


Figure 5602-7: Documented Extreme Streamflows (no return period estimated) in Kansas City and the Region, as Absolute Discharges

SECTION 5603 HYDRAULICS

5603.1 Hydraulic Calculations for Pipes, Culverts, and Open Channels

- A. **Gravity versus Pressure Flow for Enclosed Systems:** Two design philosophies exist for sizing storm drains under the steady uniform flow assumption. The first is referred to as open channel, or gravity flow design, in which the water surface within the conduit remains open to atmospheric pressure. Pressure flow design, on the other hand, requires that the flow in the conduit be at a pressure greater than atmospheric. For a given flow rate, design based on open channel flow requires larger conduit sizes than those sized based on pressure flow. ~~While it may be more expensive to construct storm drainage systems designed based on open channel flow, this design procedure provides a margin of safety by providing additional headroom in the conduit to accommodate an increase in flow above the design discharge. Under most ordinary conditions, it is recommended that storm drains be sized based on a gravity flow criteria at full flow or near full. Pressure flow design may be justified in certain instances.~~ Paragraph 5601.5 specifies hydraulic grade requirements associated with both gravity and pressure flow conditions. As hydraulic calculations are performed, frequent verification of the existence of the desired flow condition should be made.

Storm drainage systems can often alternate between pressure and open channel flow conditions from one section to another (~~U.S. Department of Transportation Federal Highway Administration, 1996~~).

- B. ~~For~~ Gravity flow conditions, use Manning's formula shall be used as described below.

$$Q = \frac{1.486}{n} \cdot A \cdot R^{2/3} \cdot S^{1/2}$$

Where:

Q = Discharge, cubic feet per second

A = Cross sectional area of flow, square feet

n = Manning's roughness coefficient (see Table 5603-1)

R = Hydraulic radius, feet

$$R = \frac{A}{P}$$

S = Slope in feet per foot

P = Wetted perimeter in feet

- C. ~~In~~ Closed conduits flowing under pressure flow, the energy grade line (EGL) will be above the crown of the pipe. In this case, the Bernoulli equation shall be used to calculate pipe capacity:

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h_f + h_m$$

Where:

$\frac{p_1}{\gamma}$ = pressure head in the upstream system segment, feet

$\frac{V_1^2}{2g}$ = velocity head in the upstream system segment, feet

z_1 = elevation of the system invert in the upstream system segment, feet

$\frac{p_2}{\gamma}$ = pressure head in the downstream system segment, feet

$\frac{V_2^2}{2g}$ = velocity head in the downstream system segment, feet

z_2 = elevation of the system invert in the downstream system segment, feet

h_f = friction loss in the downstream system segment in feet

h_m = minor system losses in the downstream segment in feet

Pipe friction losses, h_f , may be calculated using the friction slope method, using the following -

~~Friction Slope Method~~

~~This~~ derivation of Manning's equation ~~is~~ from (FHWA, 1996).

$$h_f = S_f \cdot L$$
$$S_f = \frac{(Q \cdot n)^2}{\left(1.486 \cdot A \cdot R^{\frac{2}{3}}\right)^2}$$

Where:

S_f = friction slope, feet/foot (which is also the slope of the HGL)

Minor losses, h_m , shall be calculated by:

$$h_m = k \cdot \frac{v^2}{2g}$$

Where:

k = Coefficient as shown in [Table 5603-2](#)

A step-by-step procedure for manual calculation of the EGL using the energy loss method is presented in ~~Section 7.5 of (FHWA, 1996)~~ [Hydraulic Engineering Circular No. 22 \(HEC-22\) Urban Drainage Manual \(FHWA, 2013\)](#). For most drainage systems, ~~computer~~ [computer evaluation methods such as HYDRA, StormCAD, CulvertMaster, or SWMM](#) utilizing continuous dynamic hydraulic modeling software are the most efficient means of evaluating the EGL and designing the system elements.

Table 5603-1: Manning's Roughness Coefficient
Type of Channel

	n
Closed Conduits	
Reinforced Concrete Pipe (RCPs)	0.013
Reinforced Concrete Elliptical Pipe	0.013
Corrugated Metal Pipe (CMPs):	
2 $\frac{2}{3}$ x $\frac{1}{2}$ in. Annular or Helical Corrugations unpaved - plain	0.024
2 $\frac{2}{3}$ x $\frac{1}{2}$ in. Annular or Helical Corrugations paved invert	0.021
3x1 in. Annular or Helical Corrugations unpaved - plain	0.027
3x1 in. Annular or Helical Corrugations paved invert	0.023
6x2 in. Corrugations unpaved - plain	0.033
6x2 in. Corrugations paved invert	0.028
24" diameter and smaller with Helical Corrugations.*	0.02
Vitrified Clay Pipe	0.013
Asbestos Cement Pipe	0.012
Open Channels (Lined)	
Gabions	0.025
Concrete	
Trowel Finish	0.013
Float Finish	0.015
Unfinished	0.017
Concrete, bottom float finished, with sides of	
Dressed Stone	0.017
Random Stone	0.02
Cement Rubble masonry	0.025
Dry Rubble or Riprap	0.03
Gravel bottom, side of	
Random Stone	0.023
Riprap	0.033
Grass (Sod)	0.03
Riprap	0.035
Grouted Riprap	0.03
Open Channels (Unlined) Excavated or Dredged	
Earth, straight and uniform	0.027
Earth, winding and sluggish	0.035
Channels, not maintained, weeds & brush uncut	0.09
Stream	
Clean stream, straight	0.03
Stream with pools, sluggish reaches, heavy underbrush	0.1
Flood Plains	
Grass, no brush	0.03
With some brush	0.09
Street Curbing	
*Allowed only when the pipe length between structures is at least 20 pipe diameters	0.014

Table 5603-2: Head Loss Coefficients

Condition	k
Manhole, junction boxes and inlets with shaped inverts:	
Thru flow	0.15
Junction	0.4
Contraction transition	0.1
Expansion transition	0.2
90 degree bend	0.4
45 degree and less bends	0.3
Culvert Inlets:	
Pipe, Concrete	
Projecting from fill, socket end (groove end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove end)	0.2
Square edge	0.5
Round (radius=1/12D)	0.2
Mitered to conform to fill slope	0.7
Standard end section	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
Standard end section	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dim. or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension or beveled top edge	0.2
Wingwalls at 10° to 25° to barrel - square edged at crown	0.5
Wingwalls parallel (extension of sides) - square edged at crown	0.7
Side or slope-tapered inlet	0.2

Note: When 50 percent or more of the discharge enters the structure from the surface, "k" shall be 1.0.

D. **Culverts:** Classified as having either entrance or outlet control. Either the inlet opening (entrance control), or friction loss within the culvert or backwater from the downstream system (outlet control) will control the discharge capacity.

1. **Entrance Control:** Entrance control occurs when the culvert is hydraulically short (when the culvert is not flowing full) and steep. Flow at the entrance would be critical as the water falls over the brink. If the tailwater covers the culvert completely (i.e., a submerged exit), the culvert will be full at that point, even though the inlet control forces the culvert to be only partially full at the inlet. The transition from partially full to full occurs in a hydraulic jump, the location of which depends on the flow resistance and water levels. If the flow resistance is very high, or if the headwater and tailwater levels are high enough, the jump will occur close to or at the entrance. Design variables for culverts operating under entrance control ~~shall~~ may be determined from [Figure 5603-1](#) through [Figure 5603-7](#).

2. **Outlet Control:** If the flow in a culvert is full for its entire length, then the flow is said to be under outlet control. The discharge will be a function of the differences in tailwater and headwater levels, as well as the flow resistance along the barrel length. Design variables for culverts operating under outlet control ~~shall~~ may be determined from [Figure 5603-8](#) through [Figure 5603-14](#).

Alternatively, refer to the Federal Highway Administration website for these charts (www.fhwa.dot.gov/bridge/hec05.pdf). Download applicable design manuals, reports, and FHWA hydraulics engineering such as Bridge Waterways Analysis Model (WSPRO), FHWA Culvert Analysis, and HDS 5 Hydraulic Design of Highway Culverts from www.fhwa.dot.gov/bridge/hydsft.htm. These are applicable when flow in the upstream channel is subcritical.

E. **Open Channels/Bridges:** Proper evaluation of the velocity, depth, and width of flow requires analyses of the structures and conditions that impact the flow. Boundary flow conditions upstream and downstream from the open channel system must be established. The standard-step backwater method, using the energy equation, can be used to determine the depth, velocity, and width of flow. Major stream obstructions, changes in slope, changes in cross-section, and other flow controls can cause significant energy loss. In these cases, the energy equation does not apply and the momentum equation must be used to determine the depth, velocity, and width of flow.

~~Hydraulic calculations for open channels may also be made by the U.S. Army Corps of Engineer's 'HEC-2 Water Surface Profiles' or 'HEC-RAS River Analysis System' computer programs. The HEC-2 program computes water surface profiles for one-dimensional steady, gradually varied flow in rivers of any cross section. HEC-RAS is an integrated system of software, designed for interactive use in a multi-tasking, multi-user network environment. The system has separate hydraulic analysis components, data storage and management capabilities, graphics and reporting facilities. The HEC-RAS system is intended for calculating water surface profiles for steady and unsteady gradually varied flow. The system can handle a full network of channels, a dendritic system, or a single river reach. Like HEC-2, HEC-RAS is capable of modeling subcritical, supercritical, and mixed flow regime water surface profiles. <http://www.hec.usace.army.mil/> Error! Hyperlink reference not valid.)~~

5603.2 Analysis of Systems by Computer Models

Hydraulic calculations may also be made using industry standard continuous simulation hydraulic modeling software that dynamically routes stormwater flows. The following list provides the commonly used computer programs for analyzing specific hydraulic systems. This is not an exhaustive list and alternates may be used with approval by the City/County Engineer.

A. — Enclosed Pipe Systems in Gravity Flow

SWMM Transport (EPA)
HYDRA (FHWA)
StormCad (Bentley)
DR3M (USGS)

B. — Enclosed Pipe Systems in Pressure Flow

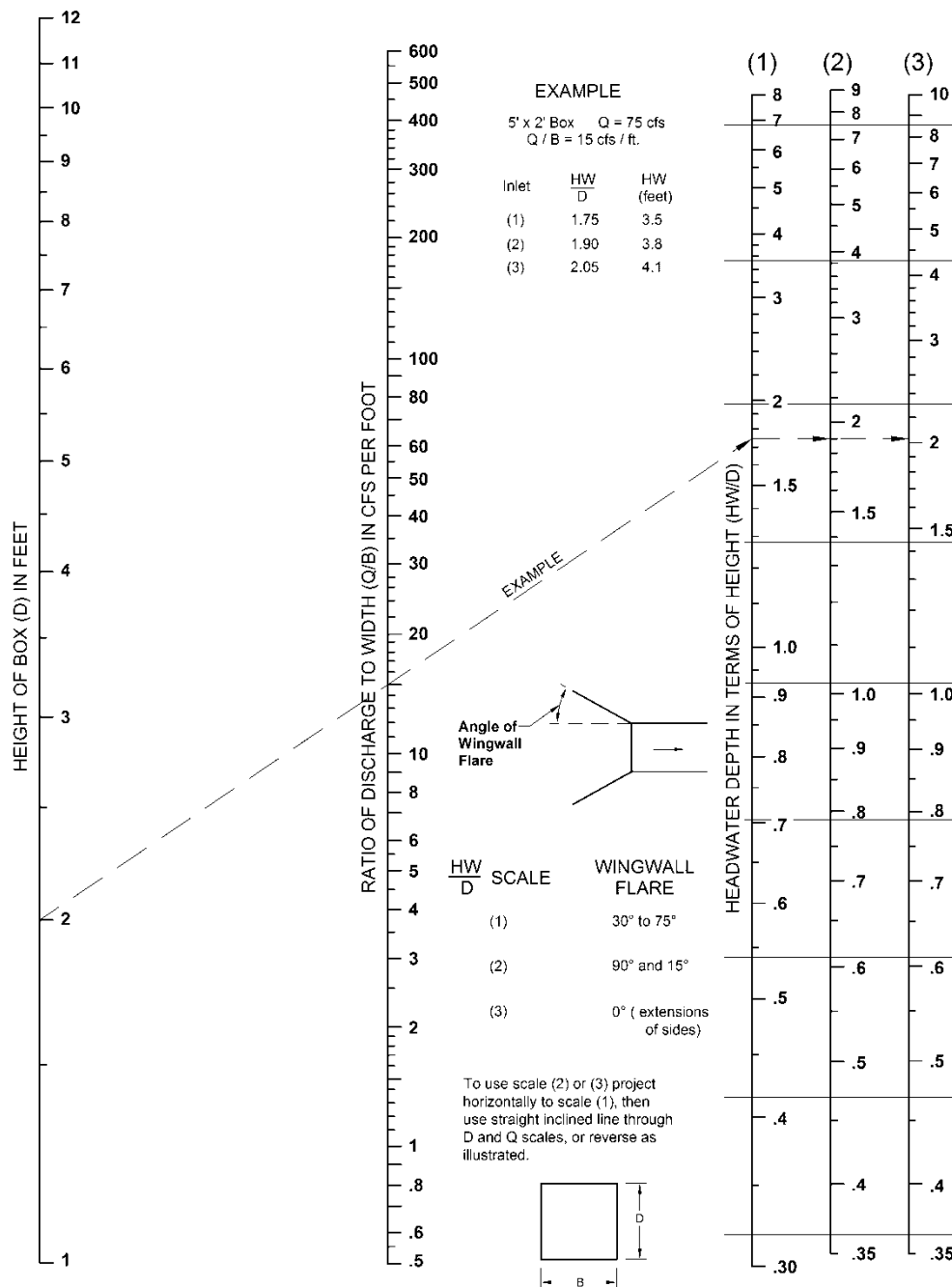
SWMM-EXTRAN (EPA)
MOUSE (DHI)
HYDRA (FHWA)
StormCad (Bentley)

C. — Culverts

HY8 (FHWA)
WSPRO (USGS)
CulvertMaster (Bentley)

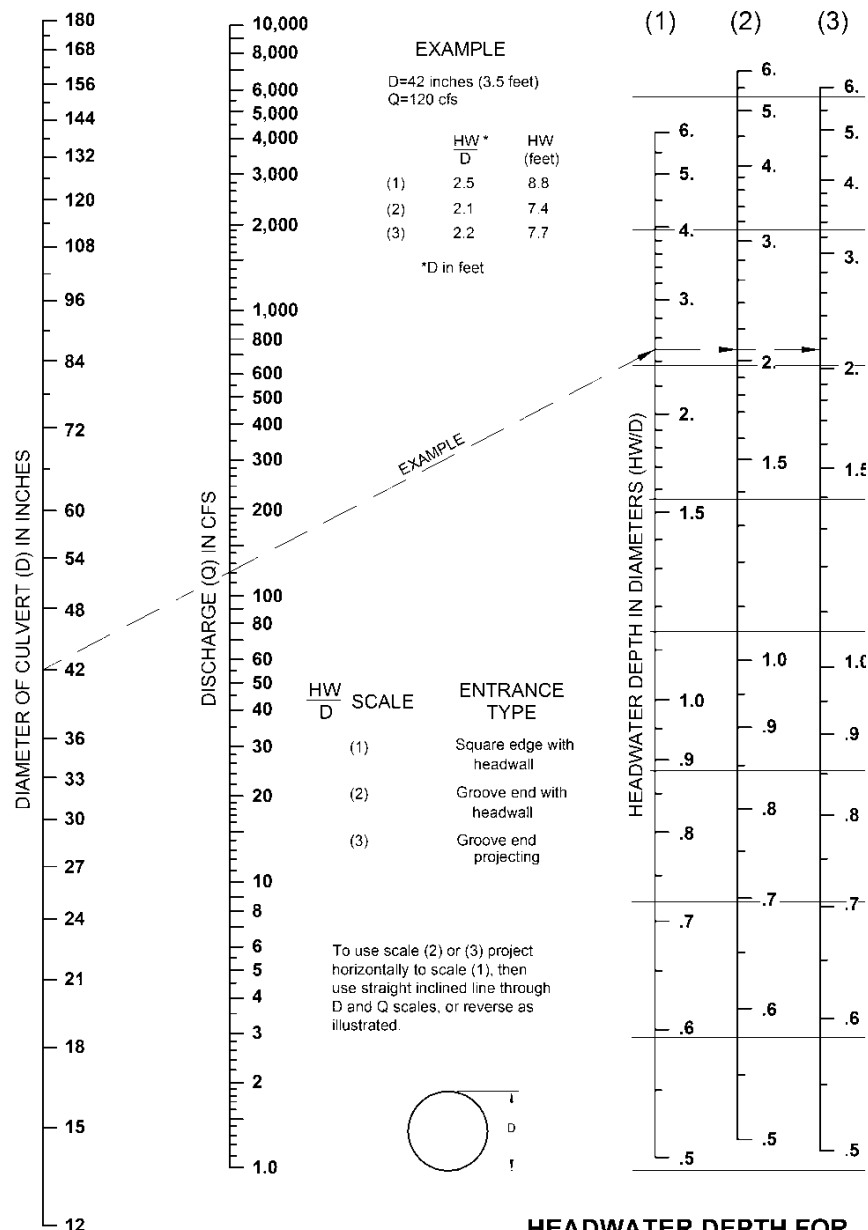
D. — Open Channels and Culverts/Bridges:

HEC-2 (USACE)
HEC-RAS (USACE)
WSPRO (USGS)
HYCHL (FHWA)
SWMM Transport and EXTRAN (EPA)
DR3M (USGS)



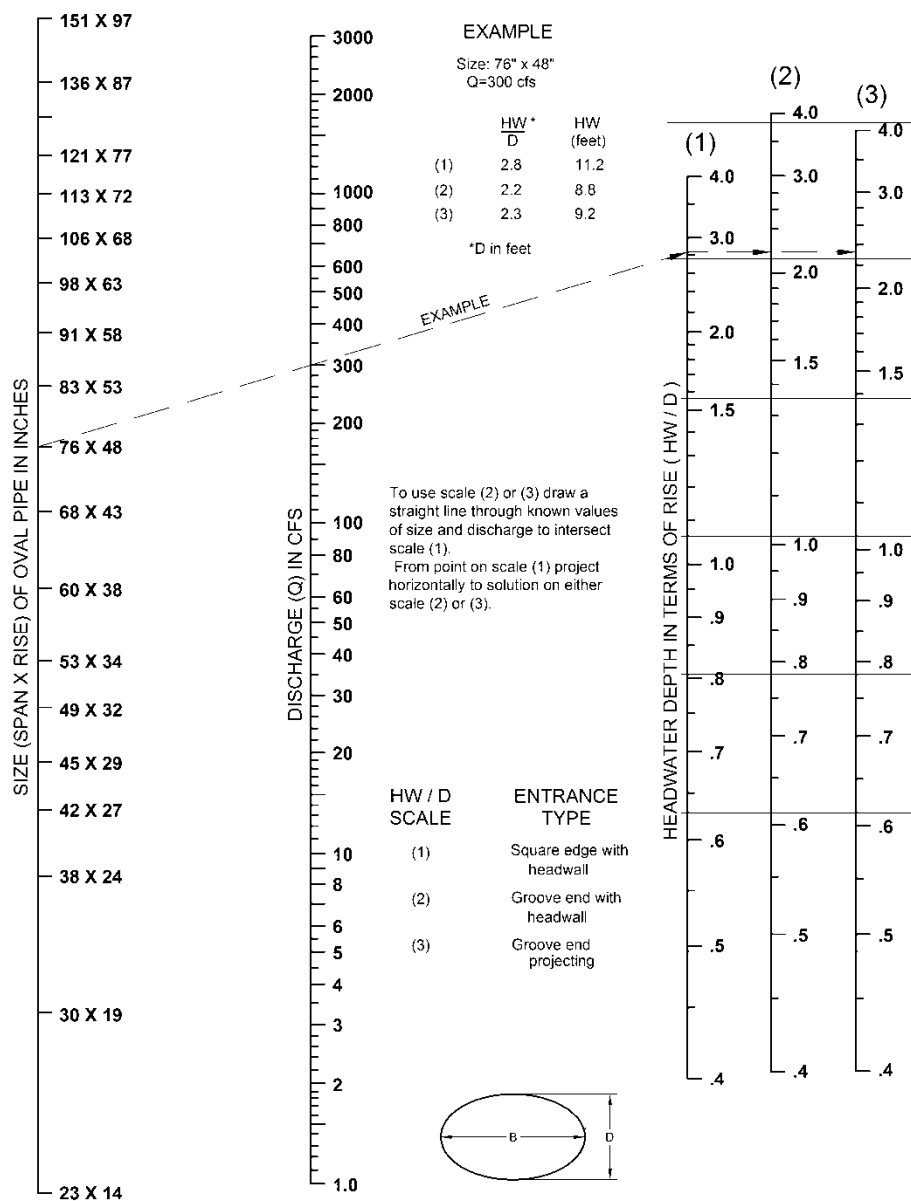
BUREAU OF PUBLIC ROADS JAN. 1963

Figure 5603-1: Headwater Depth for Box Culverts with Inlet Control



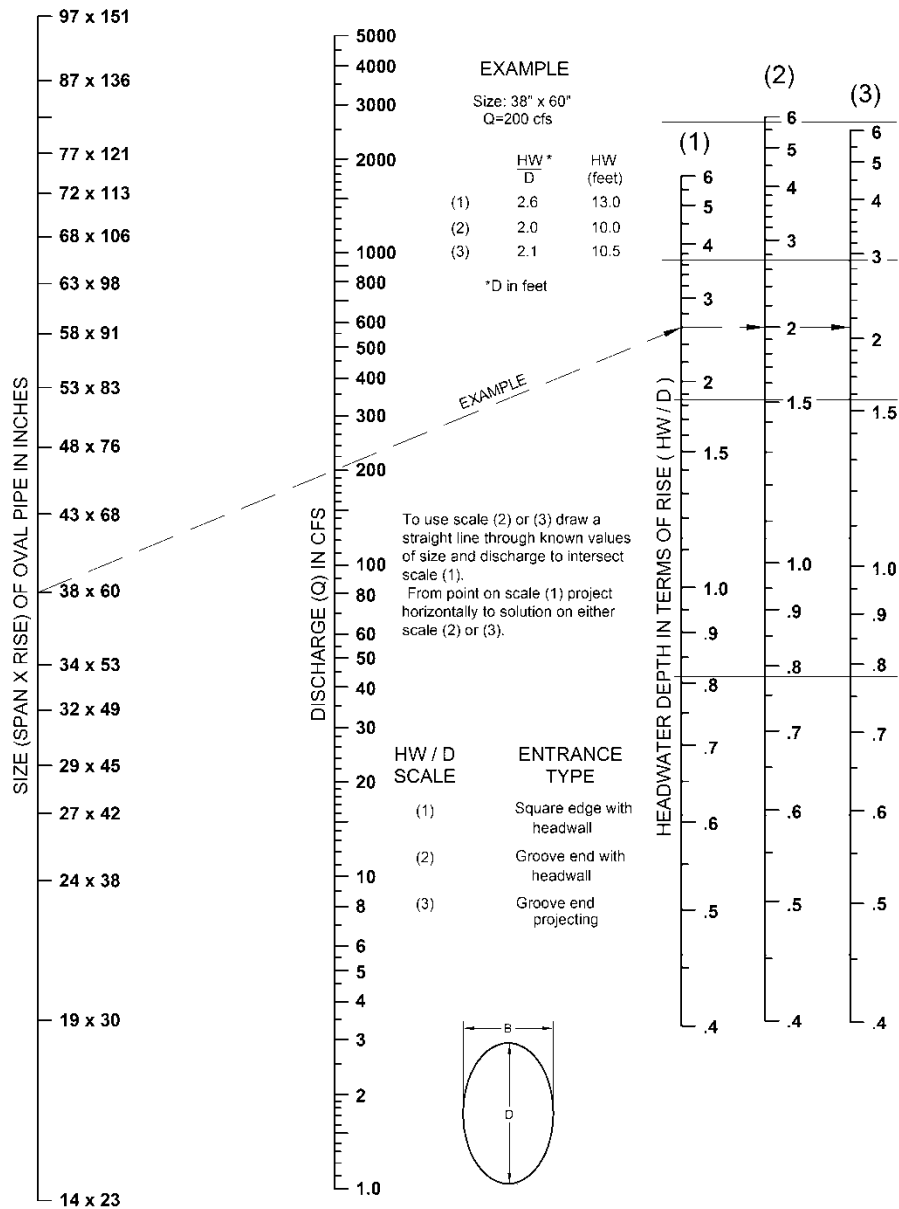
BUREAU OF PUBLIC ROADS JAN. 1963
 HEADWATER SCALES 2 & 3 REVISED MAY 1964

Figure 5603-2: Headwater Depth for Concrete Pipe Culverts with Inlet Control



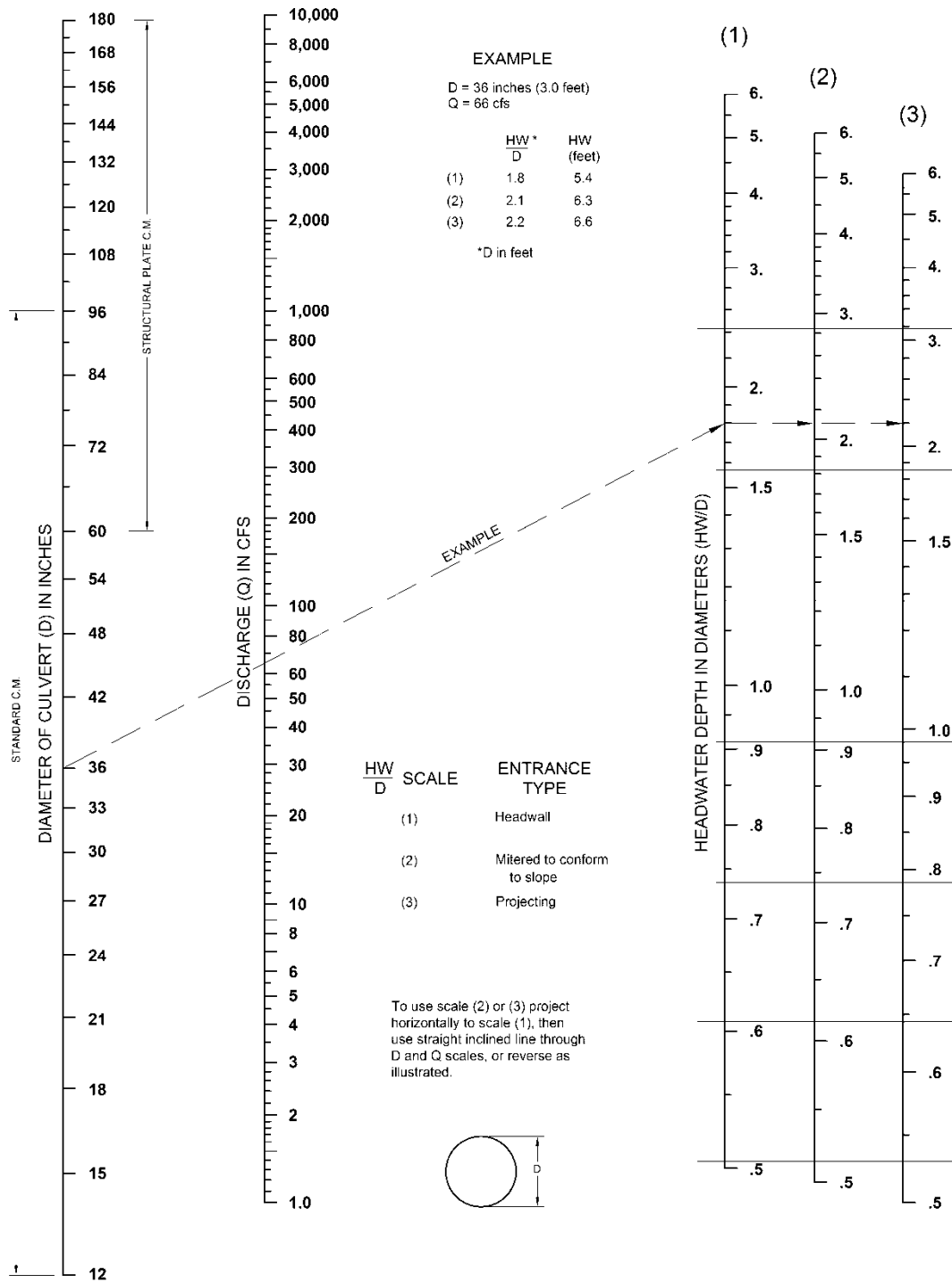
BUREAU OF PUBLIC ROADS JAN. 1963

Figure 5603-3: Headwater Depth for Oval Concrete Pipe Culverts, Long Axis Horizontal with Inlet Control



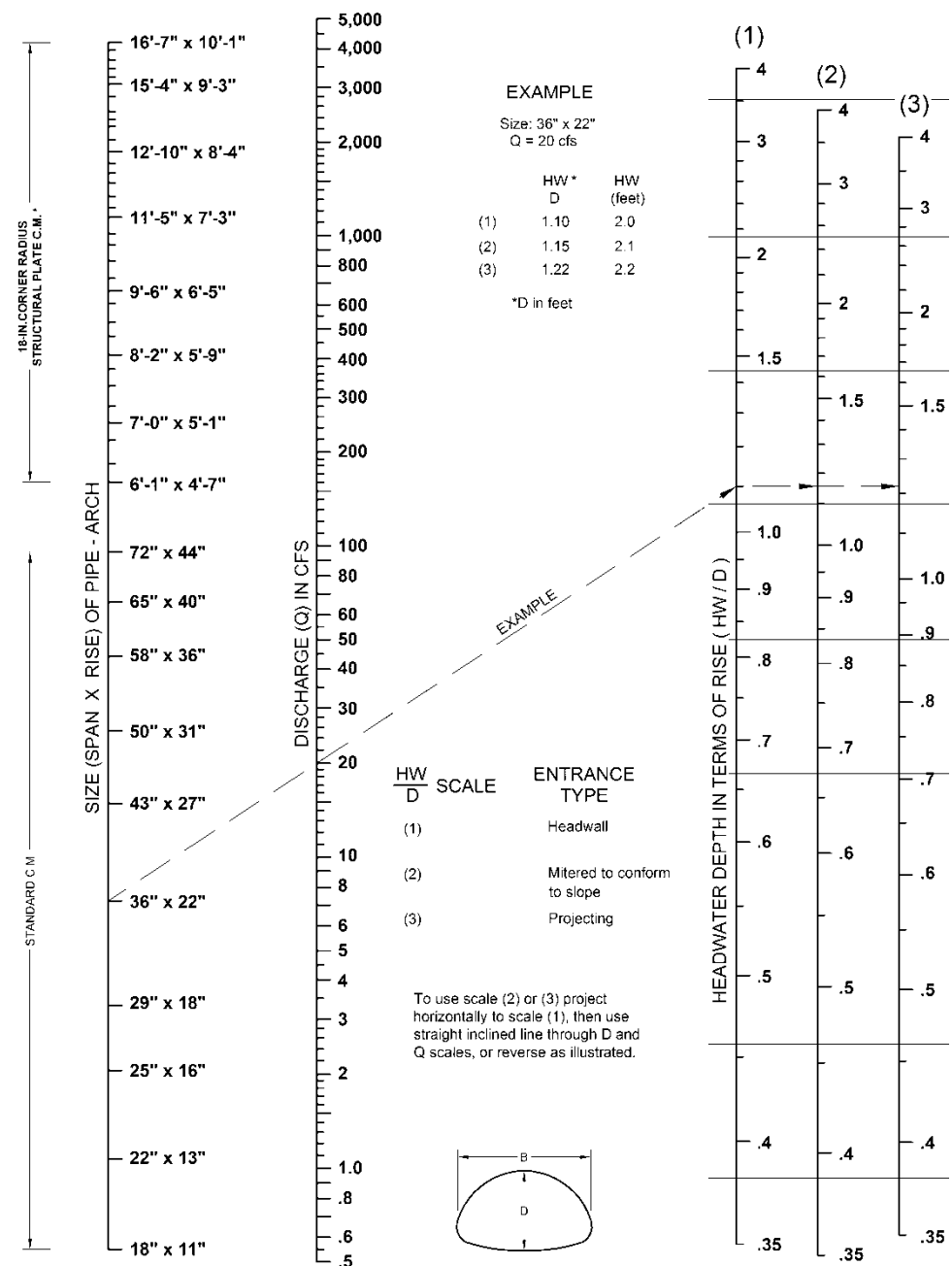
BUREAU OF PUBLIC ROADS JAN. 1963

Figure 5603-4: Headwater Depth for Oval Concrete Pipe Culverts, Long Axis Vertical with Inlet Control



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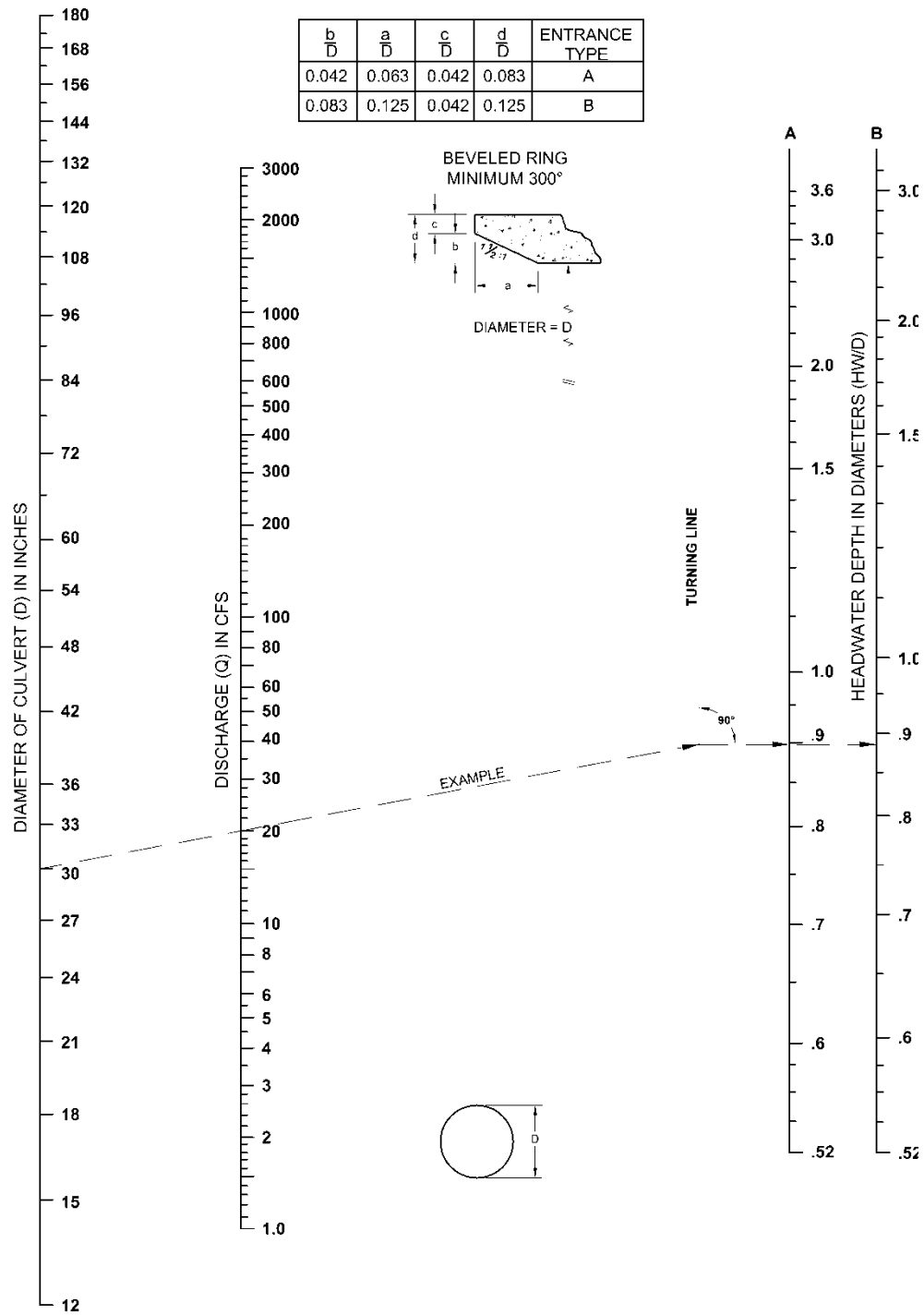
Figure 5603-5: Headwater Depth for Corrugated Metal Pipe Culverts with Inlet Control



* ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

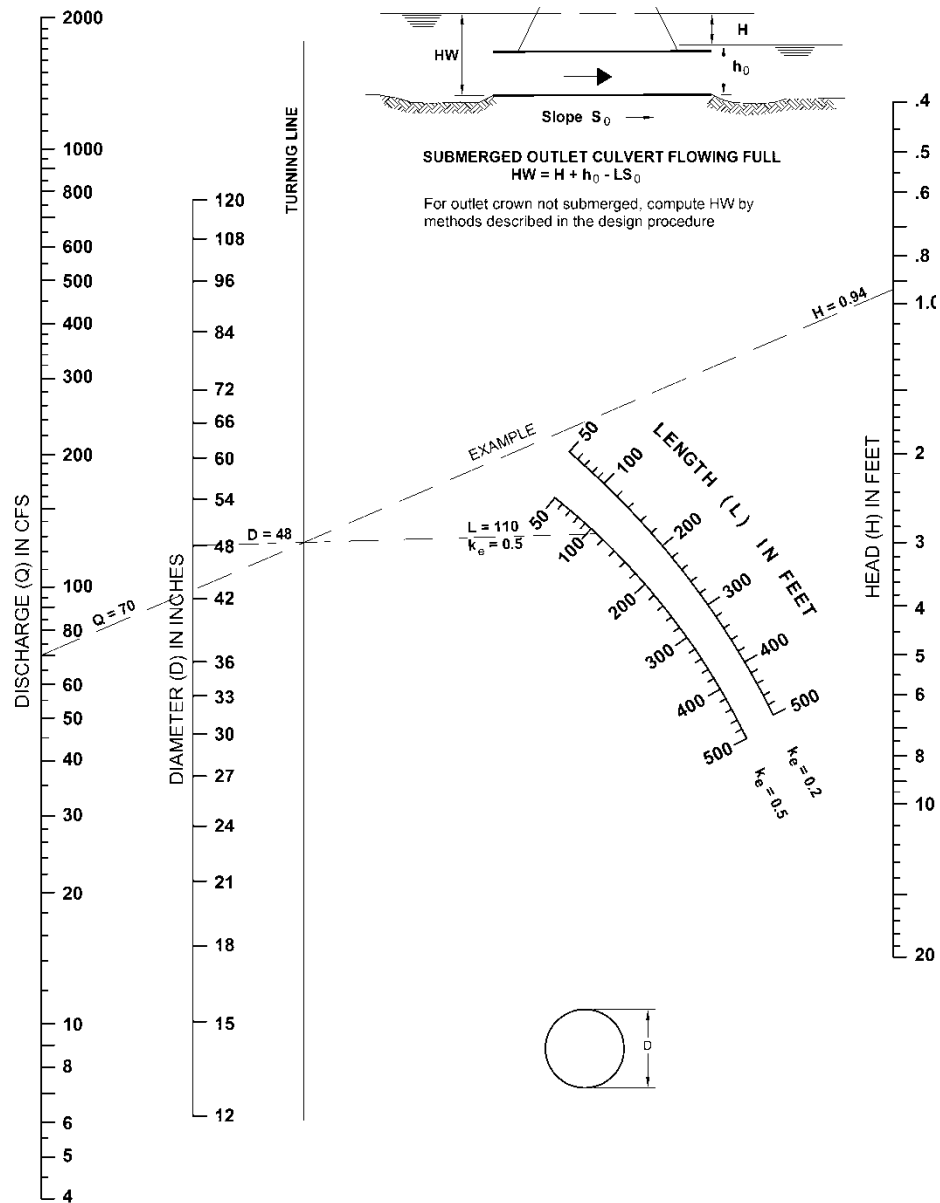
BUREAU OF PUBLIC ROADS, JAN. 1963

Figure 5603-6: Headwater Depth for Corrugate Metal Pipe – Arch Culvert with Inlet Control



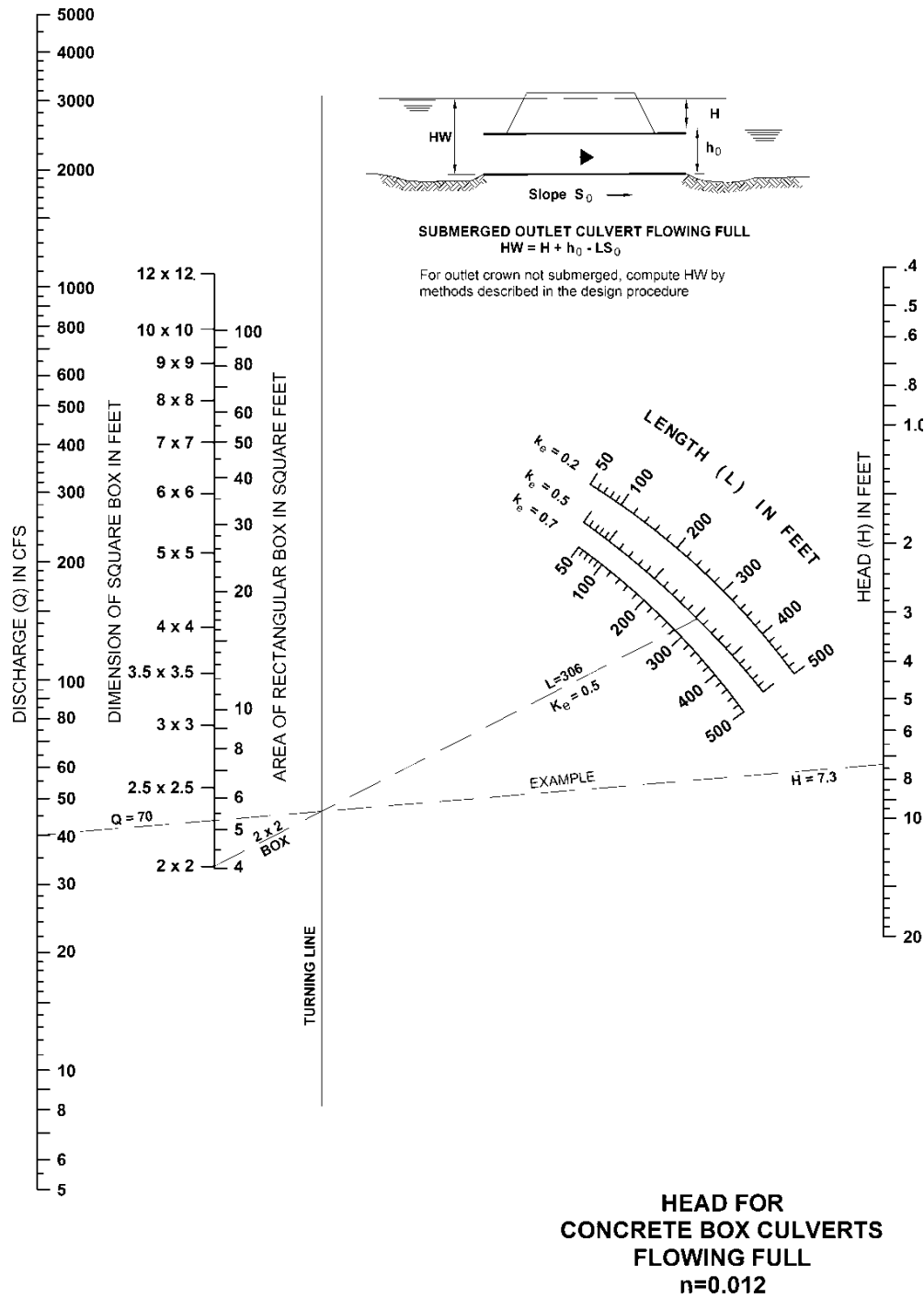
FEDERAL HIGHWAY ADMINISTRATION
MAY 1973

Figure 5603-7: Headwater Depth for Circular Pipe Culverts with Beveled Ring Inlet Control



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Figure 5603-8: Head for Concrete Pipe Culverts Flowing Full ($n=0.12$)



BUREAU OF PUBLIC ROADS, JAN. 1963

Figure 5603-9: Head for Concrete Box Culverts Flowing Full ($n=0.012$)

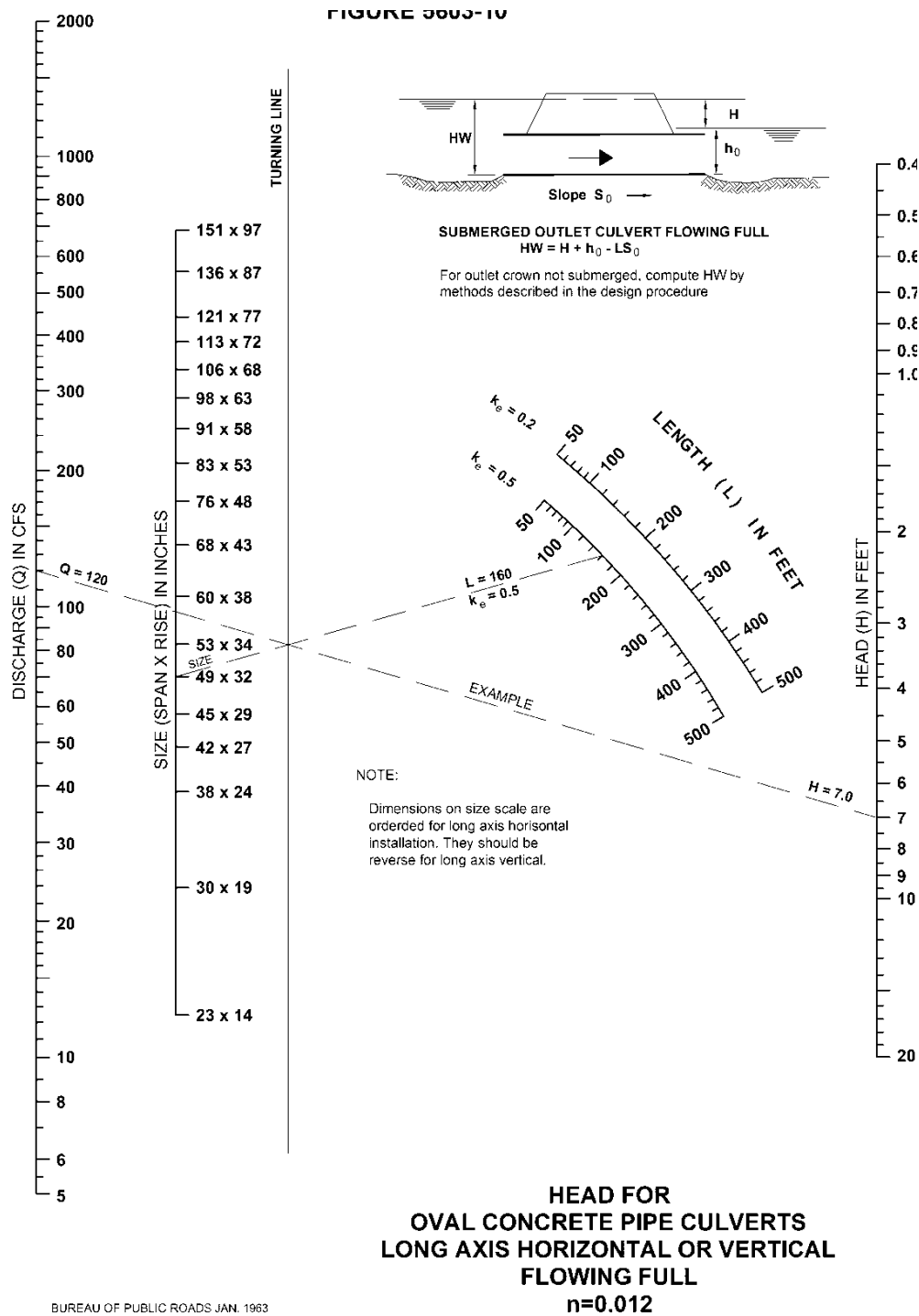
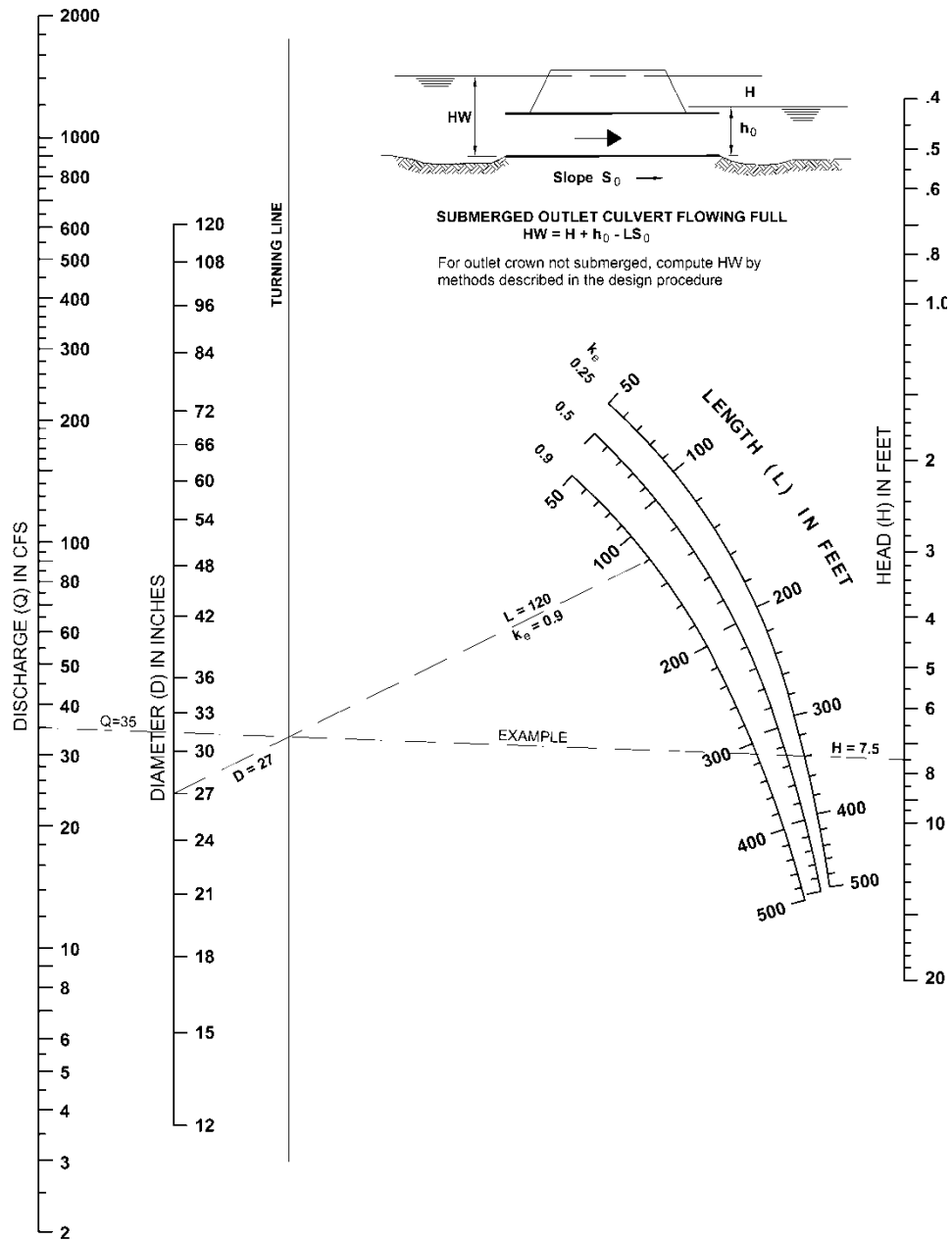
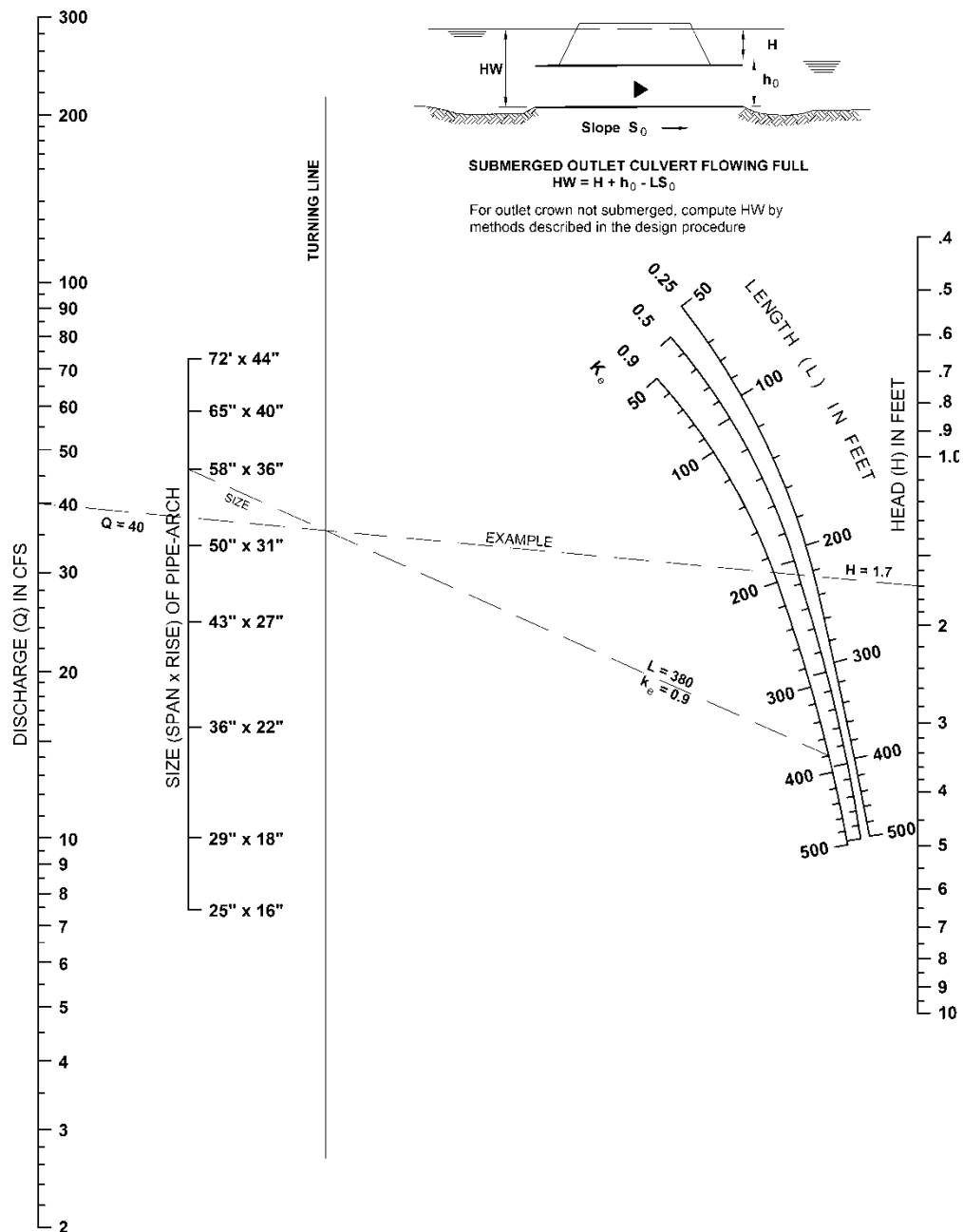


Figure 5603-10: Head for Oval Concrete Pipe Culverts, Long Axis Horizontal or Vertical Flowing Full ($n=0.12$)



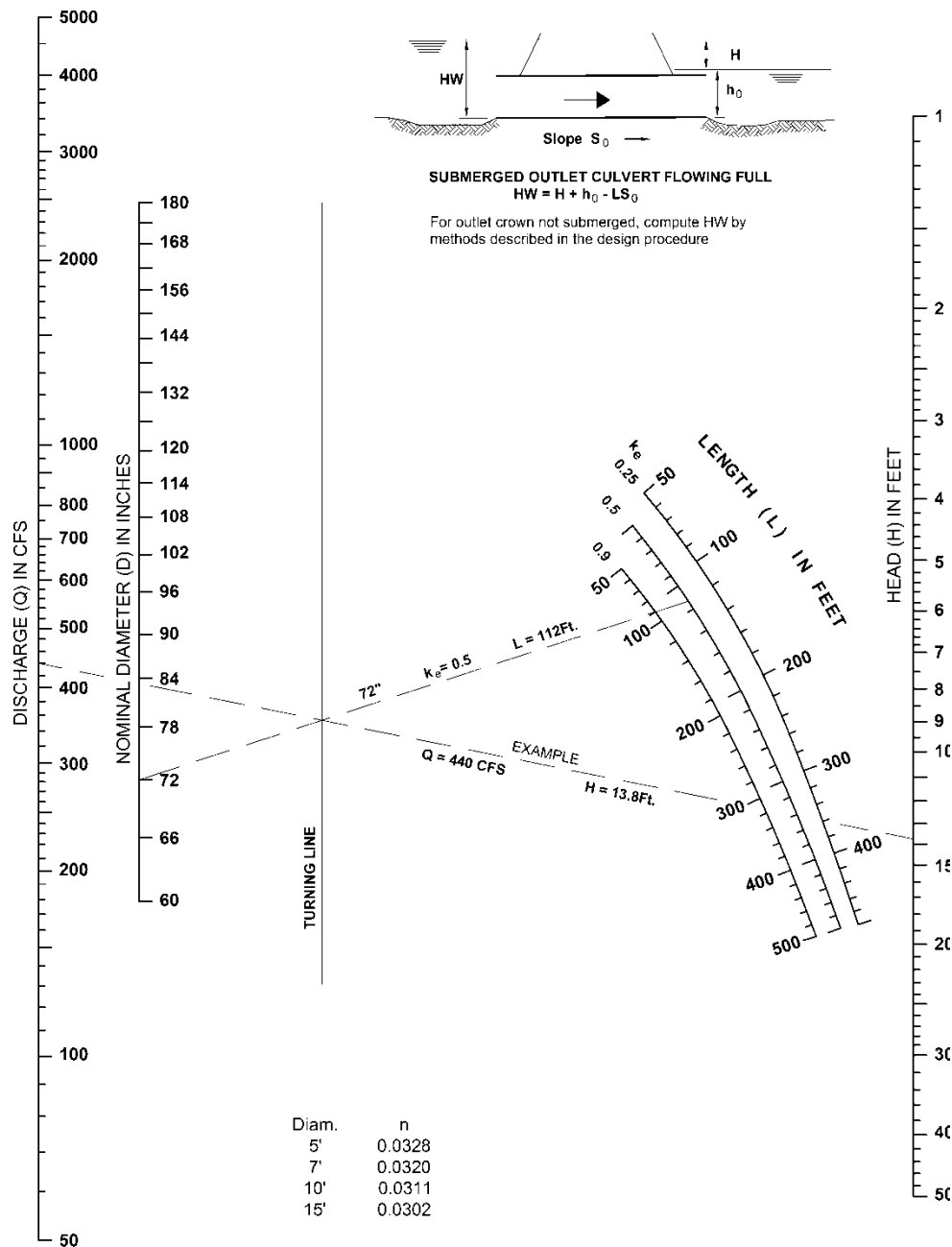
BUREAU OF PUBLIC ROADS JAN. 1963

Figure 5603-11: Head for Standard Corrugate Metal Pipe Culverts Flowing Full ($n=0.024$)



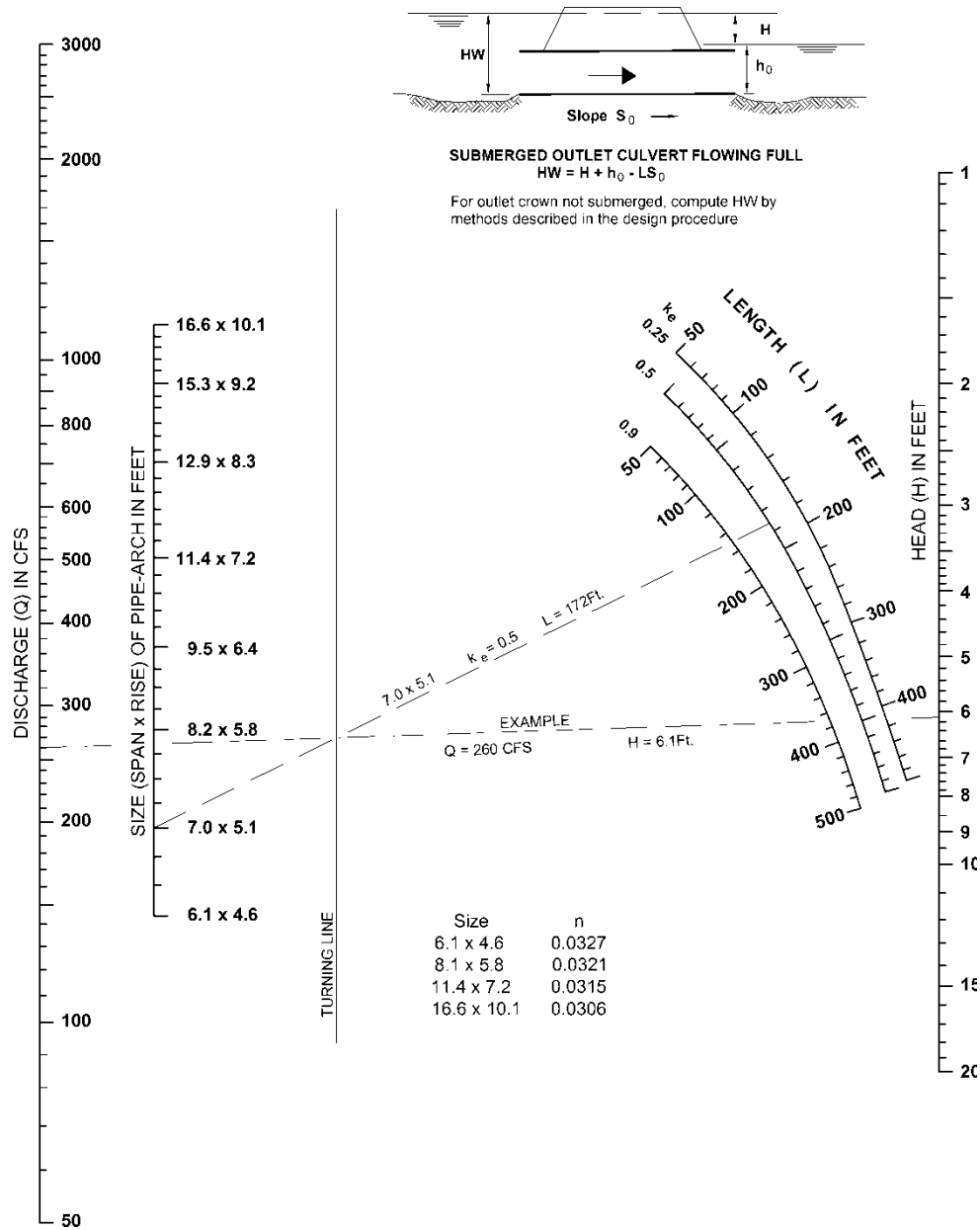
BUREAU OF PUBLIC ROADS, JAN. 1963

Figure 5603-12: Head for Standard Corrugated Metal Pipe-Arch Culverts Flowing Full ($n=0.024$)



BUREAU OF PUBLIC ROADS, JAN. 1963

Figure 5603-13: Head for Structural Plate Corrugated Metal Pipe Culverts Flowing Full ($n=0.0328$ to 0.0302)



BUREAU OF PUBLIC ROADS JAN. 1963

Figure 5603-14: Head for Structural Plate Corrugated Metal Pipe Arch Culverts, 18 inch Corner Radius, Flowing Full ($n=0.0328$ to 0.0302)

SECTION 5604 INLETS, MANHOLES AND JUNCTION BOXES

5604.1 Design Criteria

Stormwater inlet, manhole and junction box criteria is related to collection of stormwater from the surface and allowable hydraulic grade within the enclosed system. Collection design criteria focuses on inlet requirements in roadway applications within the public right-of-way and allowable spread of water in the street. Freeboard requirements focus on hydraulic grade elevations within the structures during the design storm.

- A. **Gutter Spread:** Inlet placement in roadway sections shall limit the allowable gutter spread to maintain one lane width for emergency vehicle access during the 10-year design storm with the median (50%) temporal distribution, as defined in Section 5602. Water spread may exceed these limits within 50 feet of a sump location, however, protection of property shall be maintained per Paragraph 5601.5, A. by limited overtopping of curb and/or flooding beyond the right-of-way.
- B. **Freeboard:** At all drainage structures and points of surface water entry into the enclosed drainage system, a minimum of 0.5-feet of freeboard shall be provided as measured from the lowest elevation of the inlet opening or structure rim elevation to the maximum water surface elevation in the inlet structure for the 10-year design storm with 10% temporal distribution, as defined in Paragraph 5601.5 and Section 5602.

5604.2 Inlet Design

Stormwater collection is the interception of stormwater runoff at specific locations. Stormwater collection is most often associated with stormwater inlets, which collect stormwater from roadways, parking lots, and other runoff generating surfaces and discharge the collected stormwater to the drainage system.

- A. **Inlet Placement:** inlets should be placed at sump locations along the project corridor. On-grade inlets shall be placed at suitable intervals that are governed by the allowable gutter spread. Inlets should also be considered for the following geometric controls:
 - 1. Immediately upstream of intersections, cross walks, and median breaks
 - 2. Immediately upstream and downstream of bridges
 - 3. Immediately upstream of superelevated sections of roadway
- B. **Gutter Spread:** Gutter spread in roadway sections shall be calculated using the methods prescribed in Hydraulic Engineering Circular No. 22 (HEC-22) Urban Drainage Manual (FHWA, 2013) based on a composite curb and gutter section, as shown in Figure 5604-1 and parameters shown in Table 5604-1.

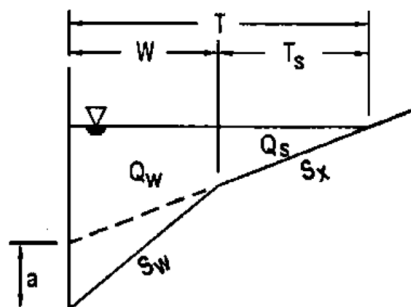


Figure 5604-1: Composite Curb and Gutter Section (Figure 4-1 of HEC-22, 2013)

- C. **Inlet Type:** ~~Only~~ Curb opening inlets ~~shall be used~~ are preferred for use on public streets. Grate and combination inlets may be used ~~except~~ as approved by the City/County Engineer.
- D. **Inlet Design:** Inlets should be designed using the methods prescribed in Hydraulic Engineering Circular No. 22 (HEC-22) Urban Drainage Manual (FHWA, 2013), following the general procedures listed in this paragraph. HEC-22 parameters for APWA standard inlets are shown in Table 5604-1. Industry standard computer software models that follow HEC-22 may also be used for inlet design and gutter spread calculations.

Table 5604-1: Inlet Parameters for Curb Opening Inlets

Parameter	Curb Inlet Type 1 with C-1 Curb ⁽⁶⁾	Curb Inlet Type 1	Curb Inlet Type 2	Curb Inlet Type 3
Inlet Location ⁽¹⁾	Designer Specified based on roadway geometry			
Units Conversion Factor, K_u (ft/ft)	0.6	0.6	0.6	0.6
Gutter Cross-Slope ⁽²⁾ , S_w (ft/ft)	0.50	0.21	0.28	0.28
Curb Opening Height ⁽²⁾ , H (in)	6	6	10	10
Width of Gutter ⁽²⁾⁽³⁾ , W (ft)	1	2.3	3	3
Local Depression ⁽⁴⁾ , a (in)	$12 * W * (S_w - S_x)$			
Street Cross-Slope, S_x (ft/ft)	Designer Specified based on roadway geometry			
Street Longitudinal Slope, S_L (ft/ft)	Designer Specified based on roadway geometry			
Curb Opening Length, L (ft)	Designer Specified based on required inlet length, intercept, and gutter spread relationship			
Manning's Coefficient ⁽⁵⁾ , n	Designer Specified based on pavement type			
<div>(1) Specify Inlet on Grade or Inlet in Sag based on location of inlet in roadway alignment (FHWA, 2013)</div> <div>(2) APWA Division III Standard Drawings (Revised April 2019)</div> <div>(3) As measured from edge of street to front face of inlet</div> <div>(4) Local depression calculated per HEC-22 equation 4-6 (FHWA, 2013)</div> <div>(5) Defined by pavement type per HEC-22 Table 4-3 (FHWA, 2013)</div> <div>(6) Straight curb type C-1 directly abuts pavement without a gutter section. Unless designated in the table header as using type C-1 curb, all other parameters assume a standard CG-1 or CG-2 curb and gutter section.</div>				

- E. **Configuration:** These minimum dimensions (shown in Table 5604-2 and illustrated by Figure 5604-2) apply to either the ~~lazy-roll~~ back or ~~steep-face~~ straight type curbs:

Table 5604-2: Minimum Inlet Configuration Dimensions

Description	Dimension
Opening length, inside	4.0 ft (min)
Width, perpendicular to curb line, inside	3.0 ft (min)
Setback curb line to face	1.0 ft (min)
Opening, clear height	6.0 in. (min)
Gutter depression at inlet	6 1/4 in. (min)
Gutter transition length	
(a) Both sides in sump and upstream side on slopes	5.0 ft (min)
(b) Downstream on slopes	3.0 ft (min)

~~A. Design Method: Inlets should be designed using the methods prescribed in Section 5604.8 and/or Figures 5604-2 through 5604-19. Note that the Theoretical Captured Discharge (right side of chart) is the design capacity. 80 percent clogging factor should not be used for inlets on grade, unless deemed necessary by the engineer. Figures 5604-2 through 5604-19 describe inlet efficiency as a function of street slope (See Figure 5604-3 for design example) and in most cases will require the designer to add bypassed flow to the next downstream inlet. Figure 5604-21 describes inlet capacity for sump regions using HEC-22 equation 4-31a. Inlet capacity for sump regions shall be rated at 80 percent of the theoretical capacity to allow for partial obstruction and clogging. "Type CG-2 Curb" and "Type CG-1 Curb", as indicated on these figures, refers to the lazy-back and steep-face style curbs, respectively.~~

5604.2 GutterFlow

~~Inlets shall be located to limit the width of flow in street gutters at the time of peak discharge for the design storm specified in 5601.8 B to the limits indicated in Table 5604-2.~~

Table 5604-2: Gutter Spread Criteria

Back to Back of Curb Street Width (feet)	Maximum Allowable Spread in Each Outside Curb Lane from Back of Curb* (feet)
28 or Less	12.0
Over 28 to 36	12.0
Over 36	12.0
Divided Roadways	As above for each direction roadway

~~* spread may exceed these limits within 50 feet of a sump inlet.~~

~~In addition to the inlet spacing requirements for limiting width of flow, inlets shall be locate to limit gutter flow from crossing the street centerline at the time of peak discharge for the design storm to the limits shown in Table 5604-3.~~

Table 5604-3: Inlet Bypass Spread Criteria

Condition Causing Flow Crossing Street Centerline	Maximum Discharge (cfs)
Sump at intersection return*	1.0
Transitions to superelevation	1.0
Sump at midblock	Not Allowed
Overflow of non-gutter flow	Per 5601.8.B
* For new development, inlets at intersections shall be positioned outside the curb return.	

5604.3 Gutter Capacity

Izzard's Formula shall be used to determine gutter capacity (see Figure 5604-20 for graphical solution):

$$Q = \frac{0.56z \cdot S^{1/2} \cdot D^{8/3}}{n}$$

Where:

Q = The gutter capacity in cubic feet per second

z = The reciprocal of the average cross slope, including gutter section, in feet per foot

S = The longitudinal street grade in feet per foot

D = The depth of flow at curb face in feet

n = Manning's "n" (see Table 5603-1)

5604.4 Freeboard Requirements

Any opening which surface water is intended to enter (or may backflow from) the system shall be 0.5 feet or more above the hydraulic grade line in the inlet during the design storm, specified in Section 5601.8, where such calculation must include minor losses.

5604.5 Inverts and Pipes

The crown(s) of pipe(s) entering a drainage structure shall be at or above the crown invert of the pipe exiting from the structure and provide a minimum fall of the invert in the structure of 0.2-1 feet for straight flow through the structure or feet fall for all other types of flow (bends more than 22.5 deflection angle, multiple lines entering, enlargement transition, etc.) through the structure. The desirable minimum fall across the invert is a minimum of 0.5-2 feet. Alternatively, the crowns of the pipes may be at or above the EGL of normal flow at design frequency.

5604.4 Manholes and Junction Structures

The maximum spacing between manholes shall be 500 feet. A manhole or junction structure shall be located at any change in alignment of the pipe system and/or connection with other pipe systems.

5604.5 Loading Conditions for Structures

Loading shall be in accordance with ~~Section~~ Paragraph 5710.3.

5604.6 Street Grade on Vertical Curves

The following formula shall be used to determine the street grade (S_x) at any point on a vertical curve using plus for grades ascending forward and minus for grades descending forward, in feet per foot.

$$S_x = S_1 + \frac{x \cdot (S_2 - S_1)}{L}$$

Where:

S_x = the street grade on a vertical curve at point x, in feet per foot

S_1 = the street grade at the PC of a vertical curve, in feet per foot

S_2 = the street grade at the PT of a vertical curve, in feet per foot

x = the distance measured from the PC to point x on a vertical curve, in feet

L = the total length of a vertical curve, in feet

5604.75604.8 Curb Inlet Intercept Equations¹

~~A. For any given set of conditions (curb type, inlet length, street grade and cross slope), the relationship between the captured discharge and the total discharge can be approximated satisfactorily by an equation~~

$$Q_c = \left\{ \begin{array}{l} Q_t \text{ for } Q_t \leq Q_o \\ Q_o + (Q_a - Q_o) \left\{ 1 - \exp \left[- \left(\frac{Q_t - Q_o}{Q_a - Q_o} \right) \right] \right\} \text{ for } Q_t > Q_o \end{array} \right\}$$

of the form:

Q_o and Q_a are constants. The constant Q_o represents the largest discharge that is captured completely, and the constant Q_a represents the upper limit on the captured discharge, which is approached asymptotically with increasing total discharge. For a particular curb type and street cross-slope, Q_o and Q_a vary with inlet length (L_o) and street grade (S_o) according to the formulas

$$Q_o = (a + b \cdot L_o)(S_o)^x$$

$$Q_a = (c + d \cdot L_o)(S_o)^x$$

Where a, b, c, d and x are constants. Table 5604-4 shows these constants in U.S. customary units.

Table 5604-4: Values of Coefficients and Exponent

Curb Type	S_x , %	a	b	c	d	x
CG-1 (B)	2	1.0	0	3.2	1.7	-0.5
CG-1 (B)	4	1.5	0.5	2.6	1.9	-0.5
CG-2 (A)	2	-0.4	0.1	3.5	0.8	-0.7
CG-2 (A)	4	-0.3	0.3	4.3	2.5	-0.8

~~B. Appendix A provides a Microsoft Visual Basic function that can be added to a Microsoft Excel (97 or later) worksheet or template for inlet intercept calculations.~~

~~¹-"Hydraulic Performance of Set Back Curb Inlets", McEnroe et al., University of Kansas, 1998.~~

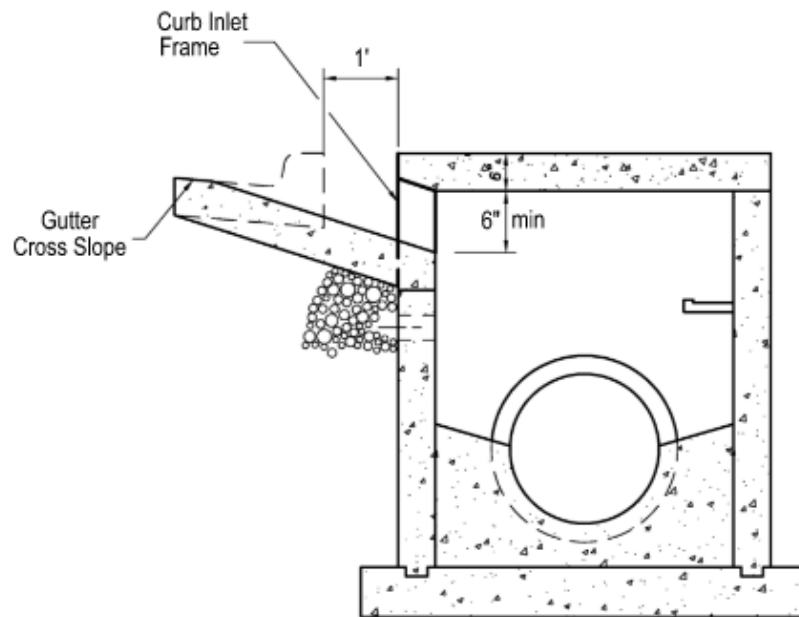
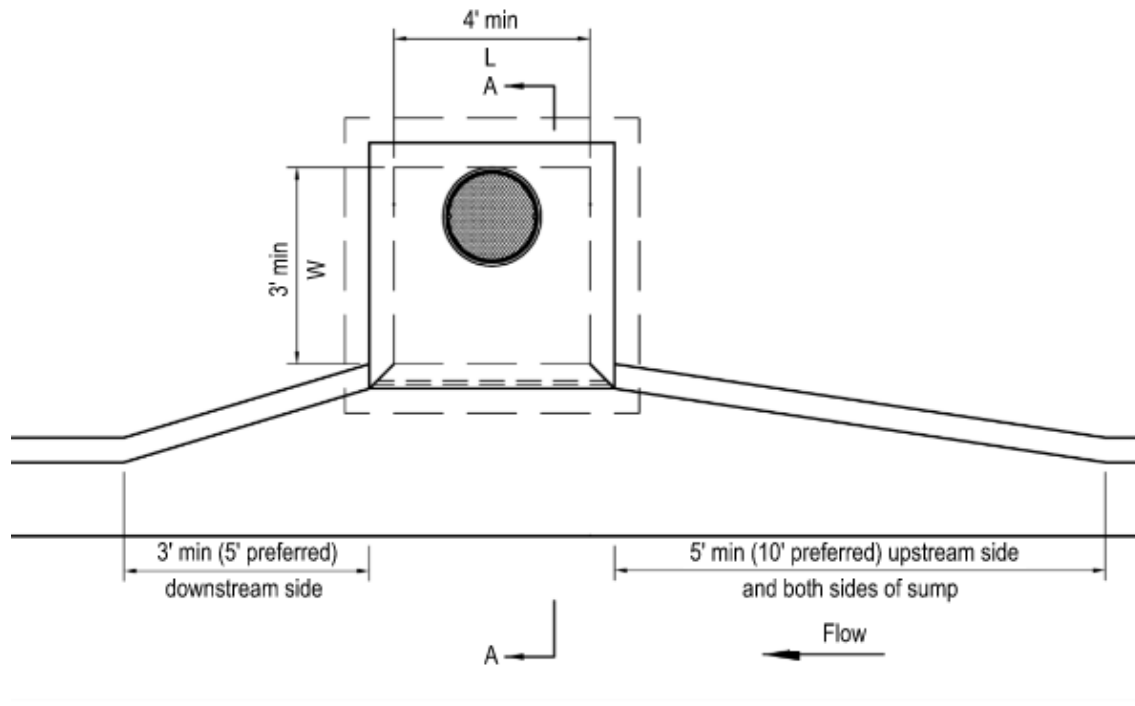


Figure 5604-22: Curb Inlet (10' Throat) Minimum Hydraulic Dimensions

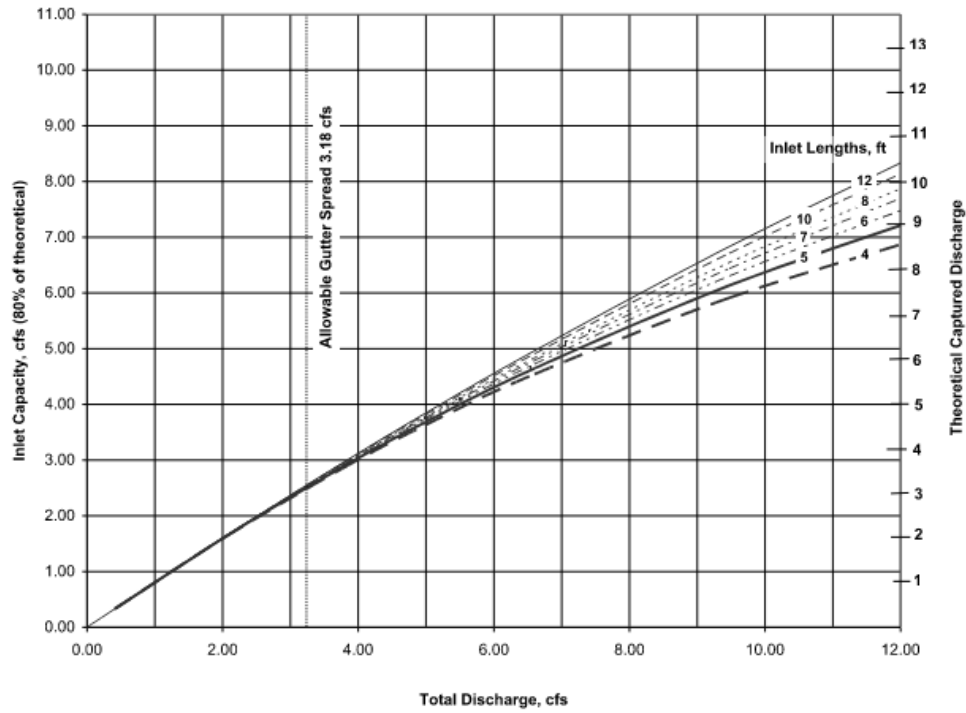


Figure 5604-2: Type CG-1 Curb, $S_x=2\%$, $S_o=0.5\%$

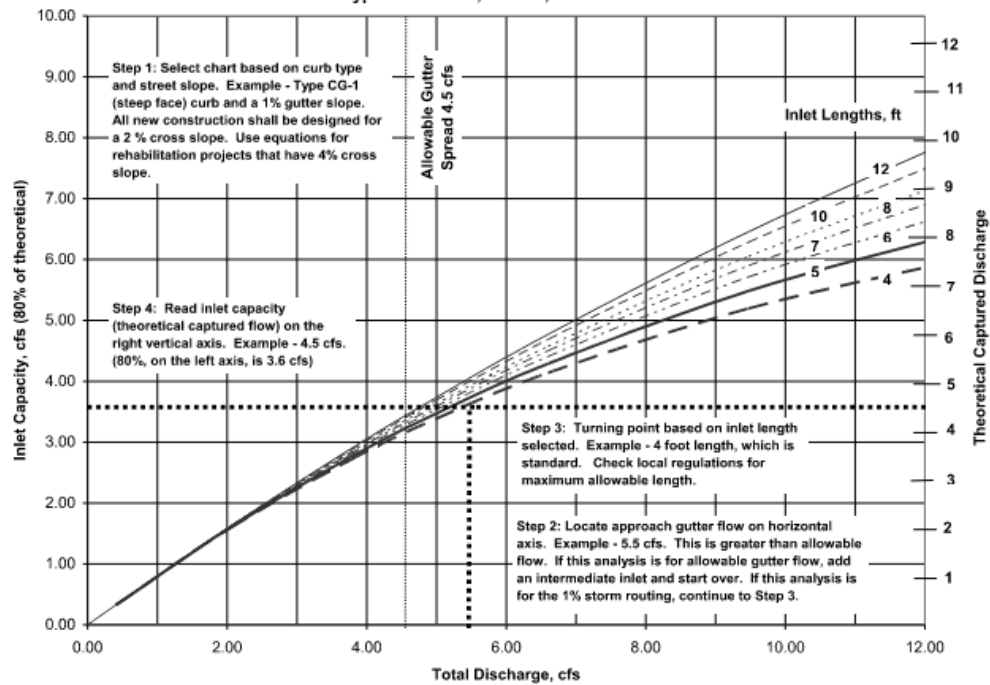


Figure 5604-3: Type CG-1 Curb, $S_x=2\%$, $S_o=1.0\%$

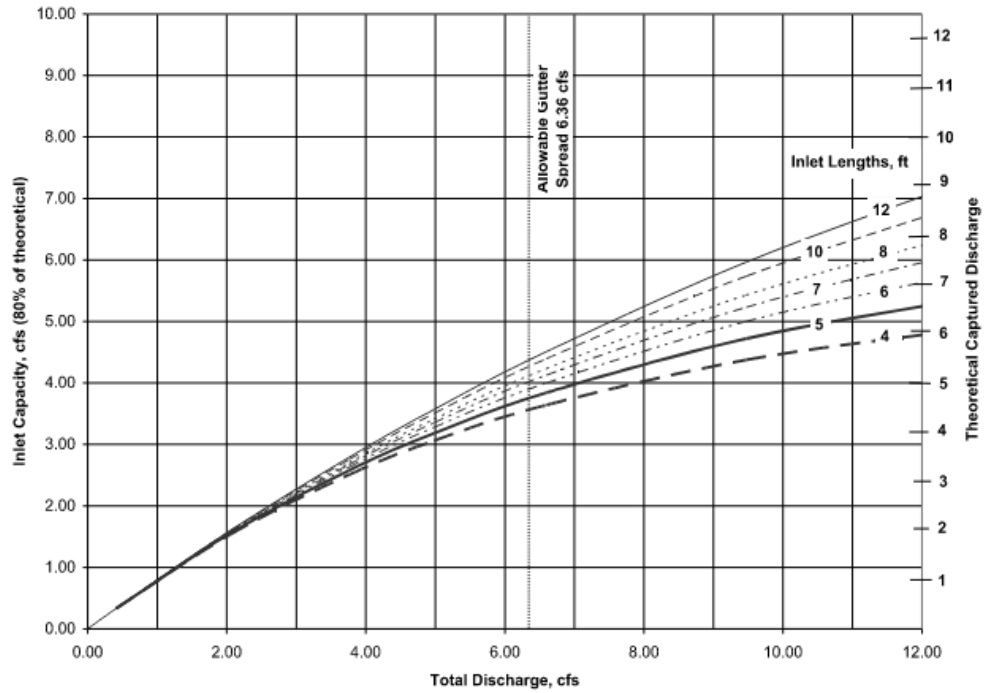


Figure 5604-4: Type CG-1 Curb, $S_x=2\%$, $S_o=2.0\%$

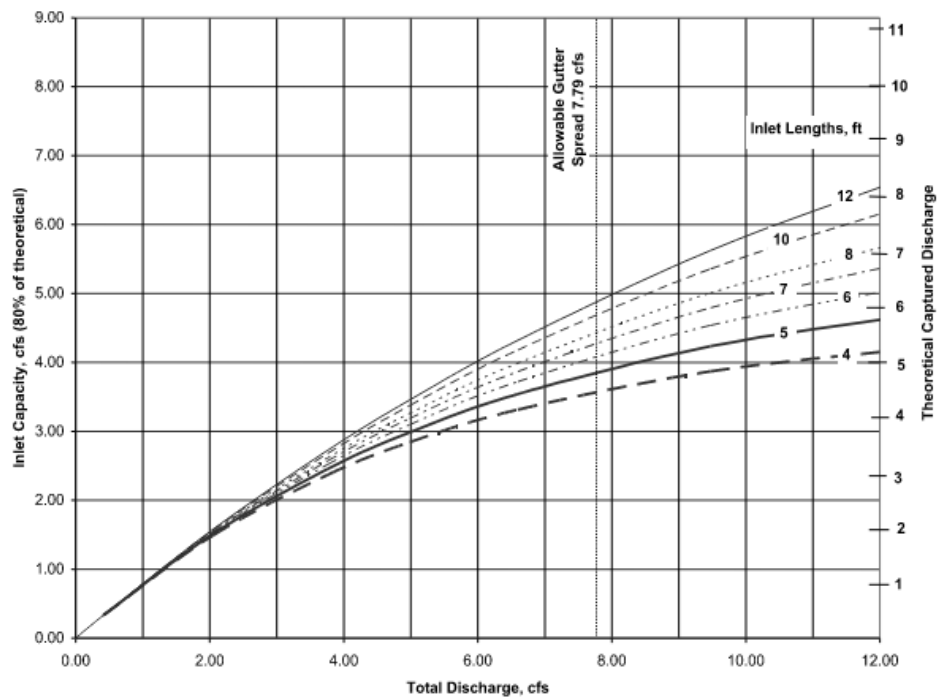


Figure 5604-5: Type CG-1 Curb, $S_x=2\%$, $S_o=3.0\%$

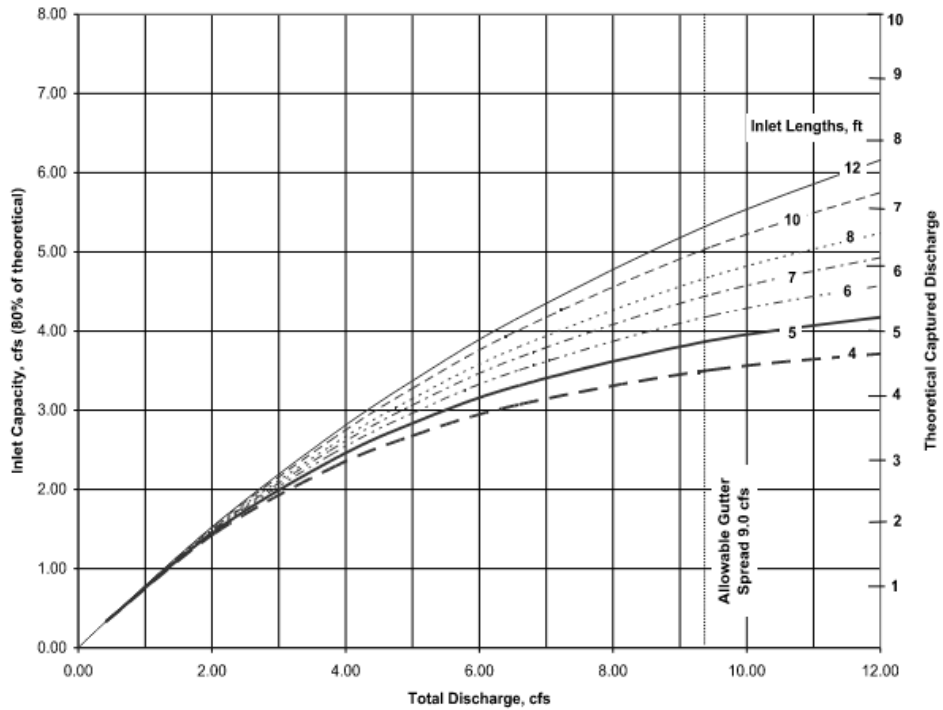


Figure 5604-6: Type CG-1 Curb, $S_x=2\%$, $S_o=4.0\%$

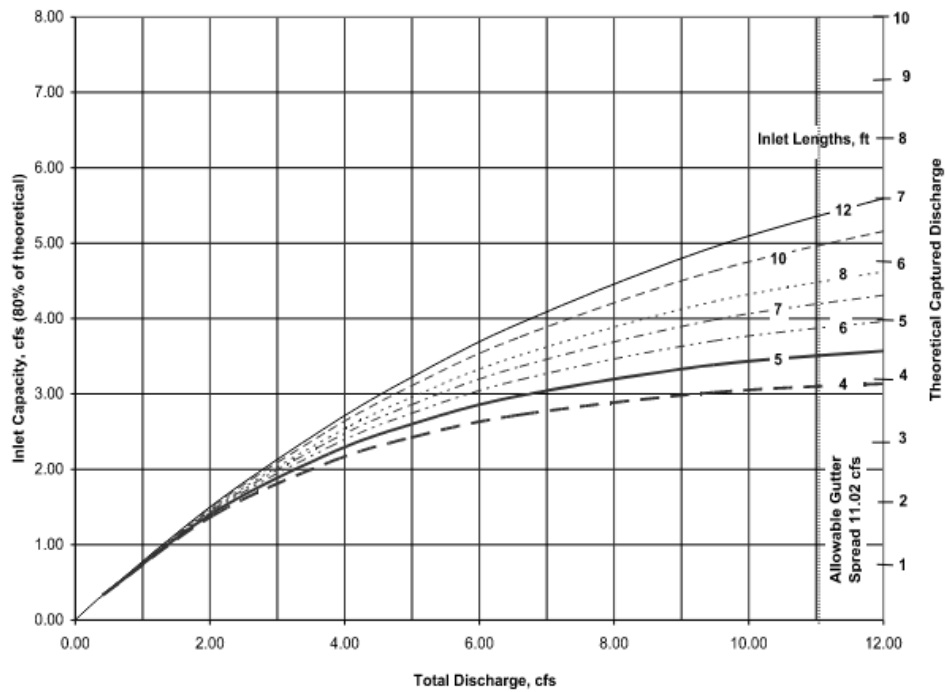


Figure 5604-7: Type CG-1 Curb, $S_x=2\%$, $S_o=6.0\%$

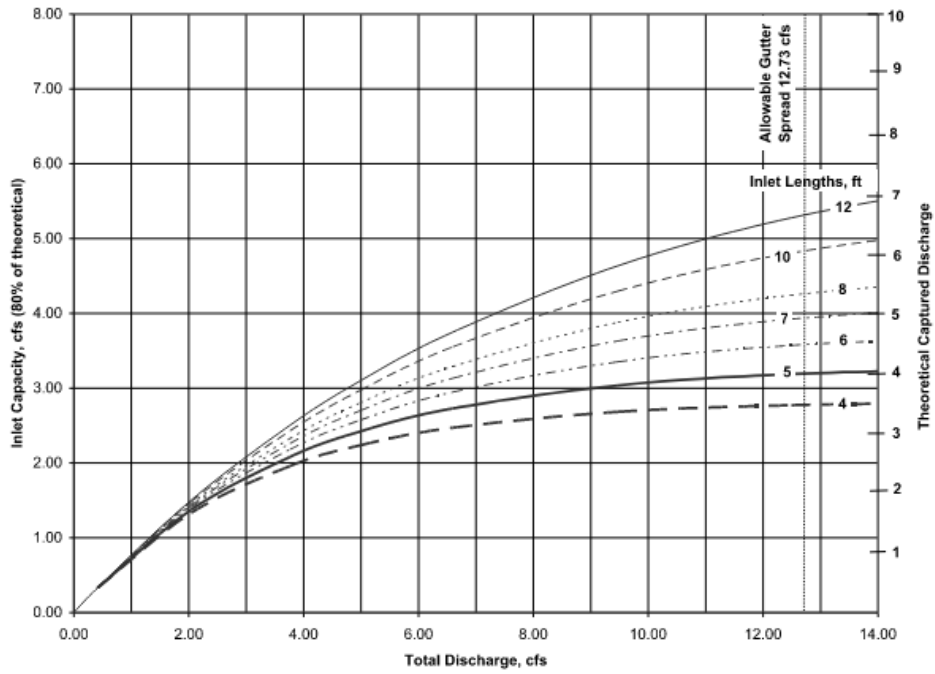


Figure 5604-9: Type CG-1 Curb, $S_x=2\%$, $S_o=8.0\%$

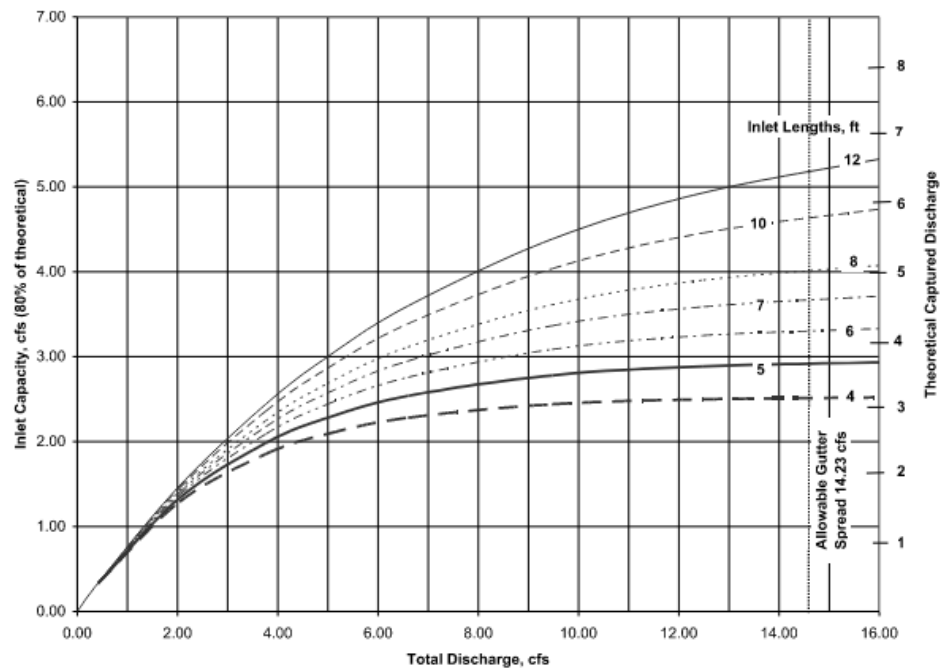


Figure 5604-8: Type CG-1 Curb, $S_x=2\%$, $S_o=10.0\%$

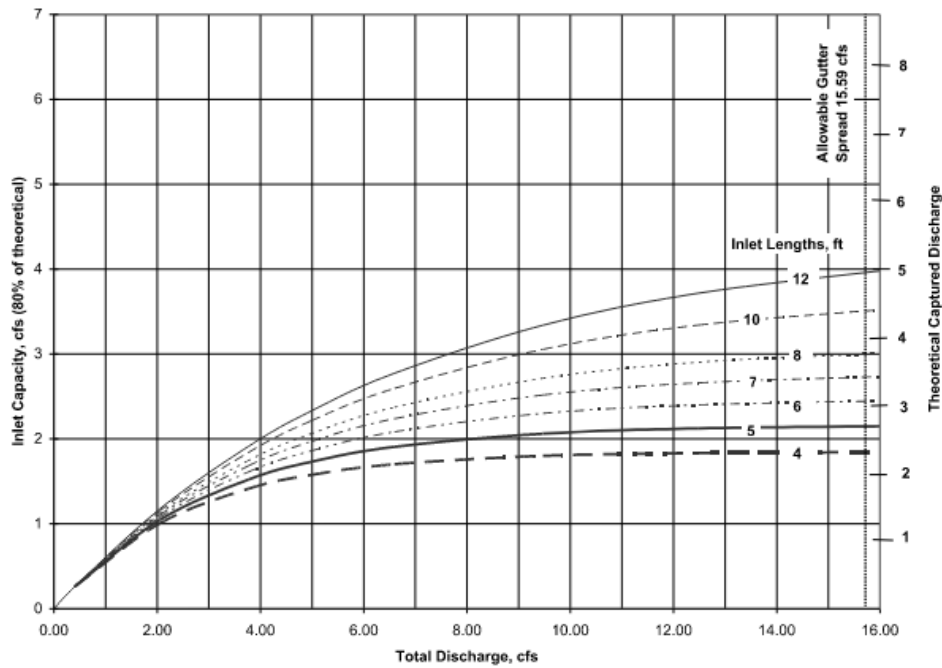


Figure 5604-10: Type CG-1 Curb, $S_x=2\%$, $S_o=12.0\%$

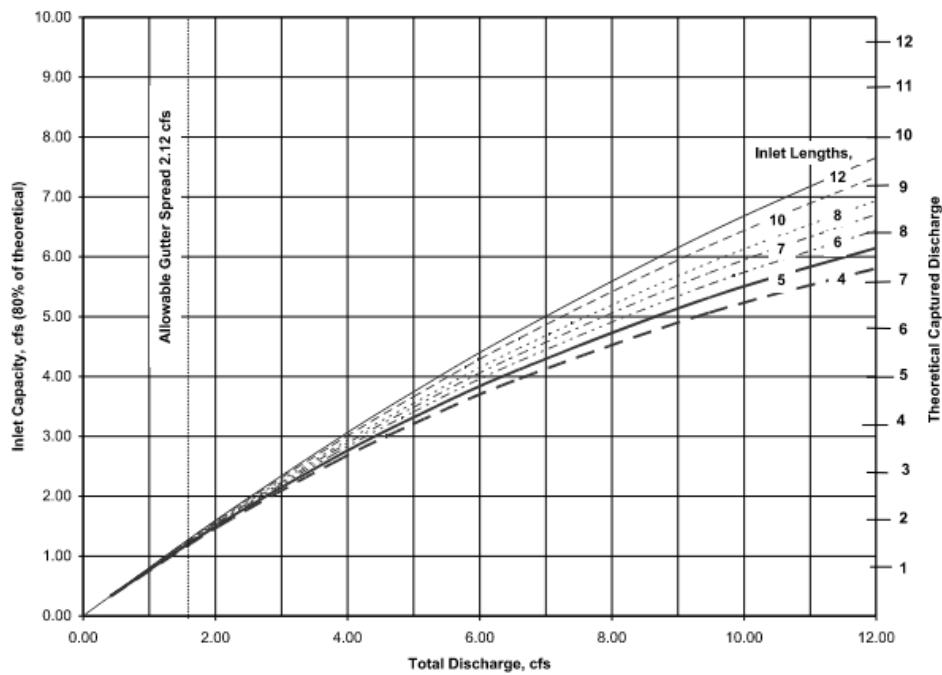


Figure 5604-11: Type CG-2 Curb, $S_x=2\%$, $S_o=0.5\%$

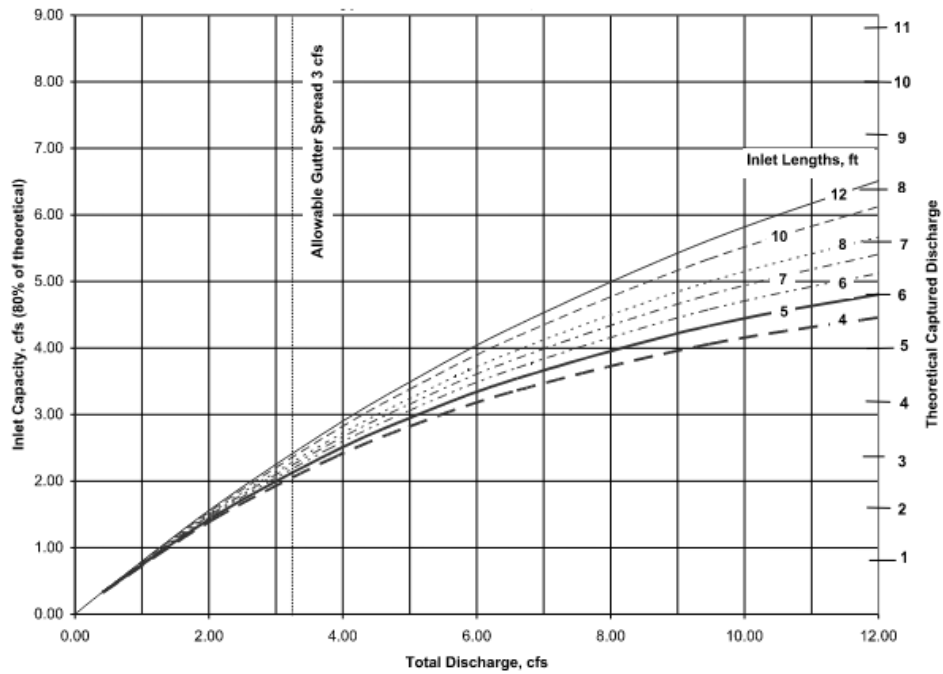


Figure 5604-12: Type CG-2 Curb, $S_x=2\%$, $S_o=1.0\%$

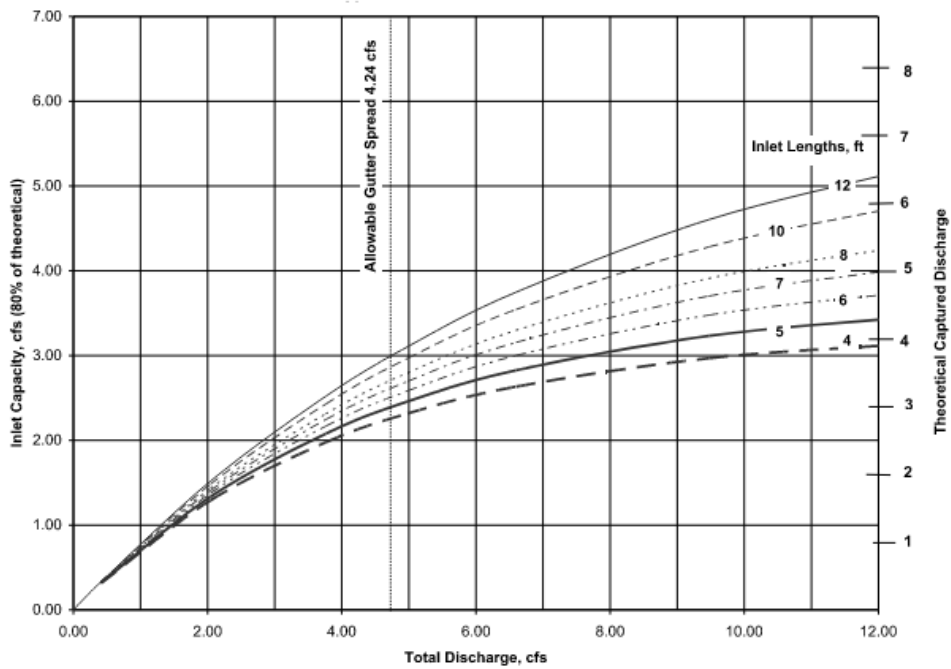


Figure 5604-13: Type CG-2 Curb, $S_x=2\%$, $S_o=2.0\%$

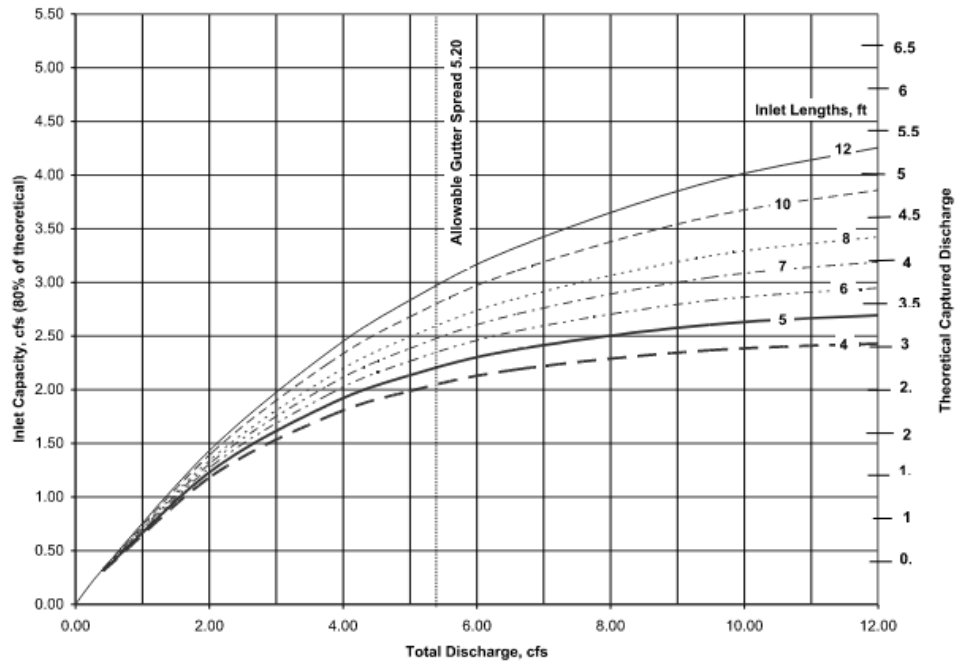


Figure 5604-14: Type CG-2 Curb, $S_x=2\%$, $S_o=3.0\%$

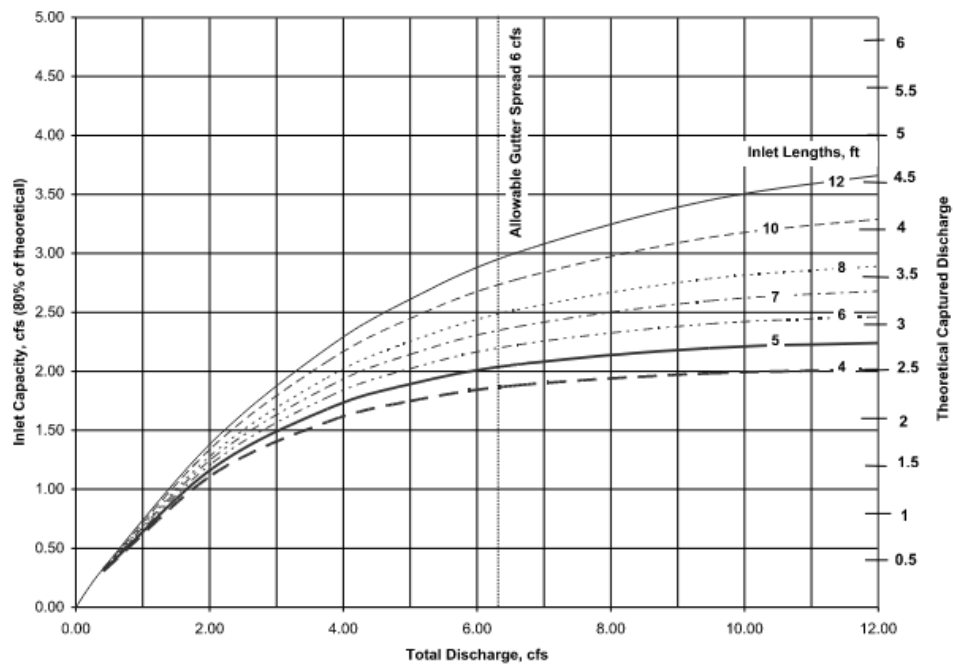


Figure 5604-15: Type CG-2 Curb, $S_x=2\%$, $S_o=4.0\%$

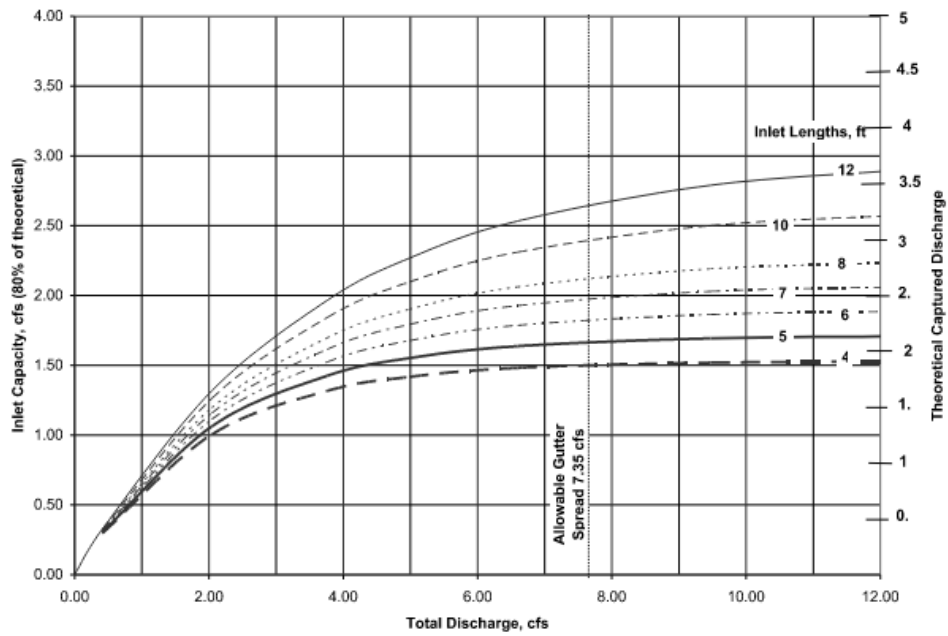


Figure 5604-16: Type CG-2 Curb, $S_x=2\%$, $S_o=6.0\%$

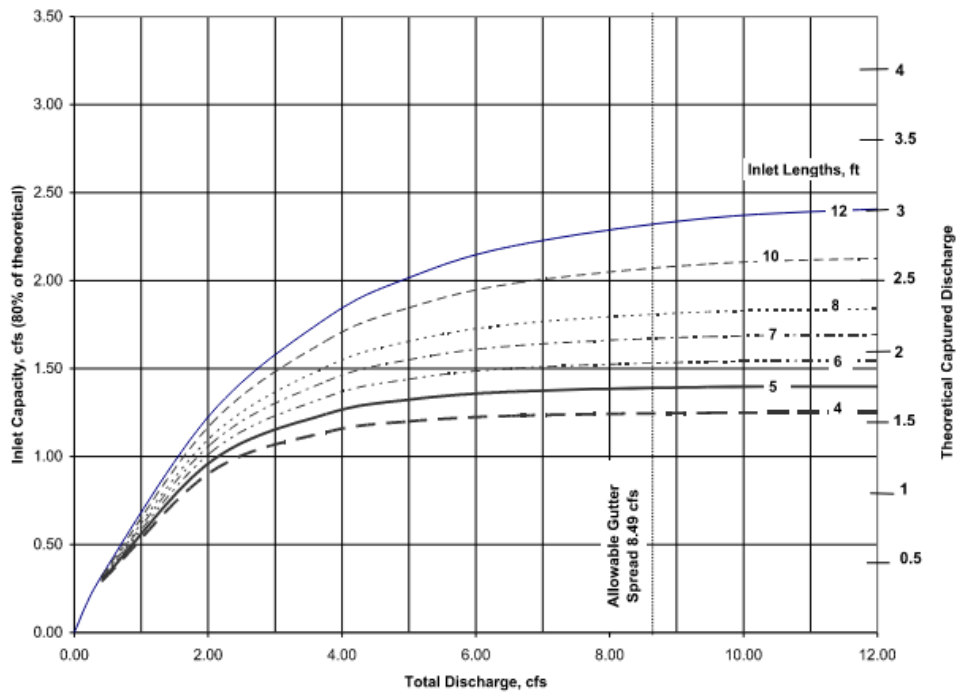


Figure 5604-17: Type CG-2 Curb, $S_x=2\%$, $S_o=8.0\%$

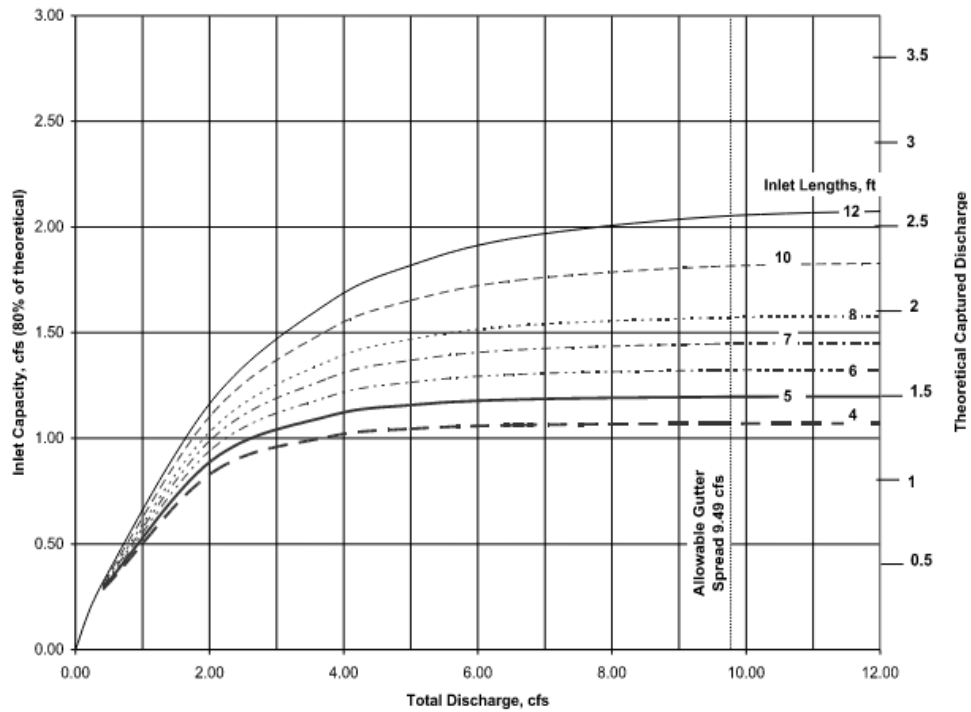


Figure 5604-19: Type CG-2 Curb, $S_x=2\%$, $S_o=10.0\%$

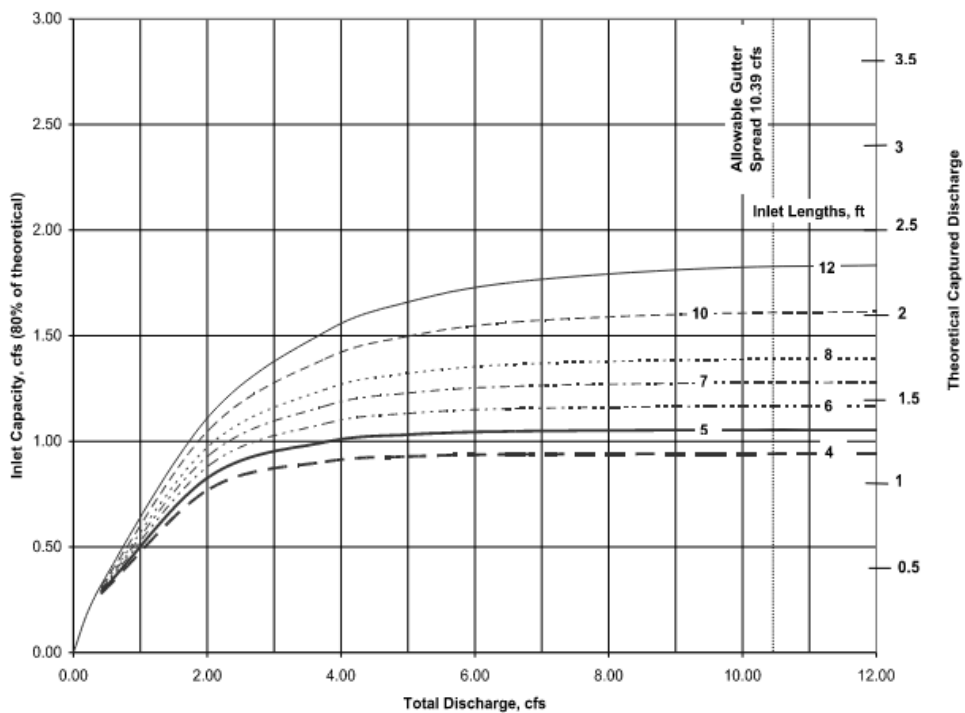


Figure 5604-18: Type CG-2 Curb, $S_x=2\%$, $S_o=12.0\%$

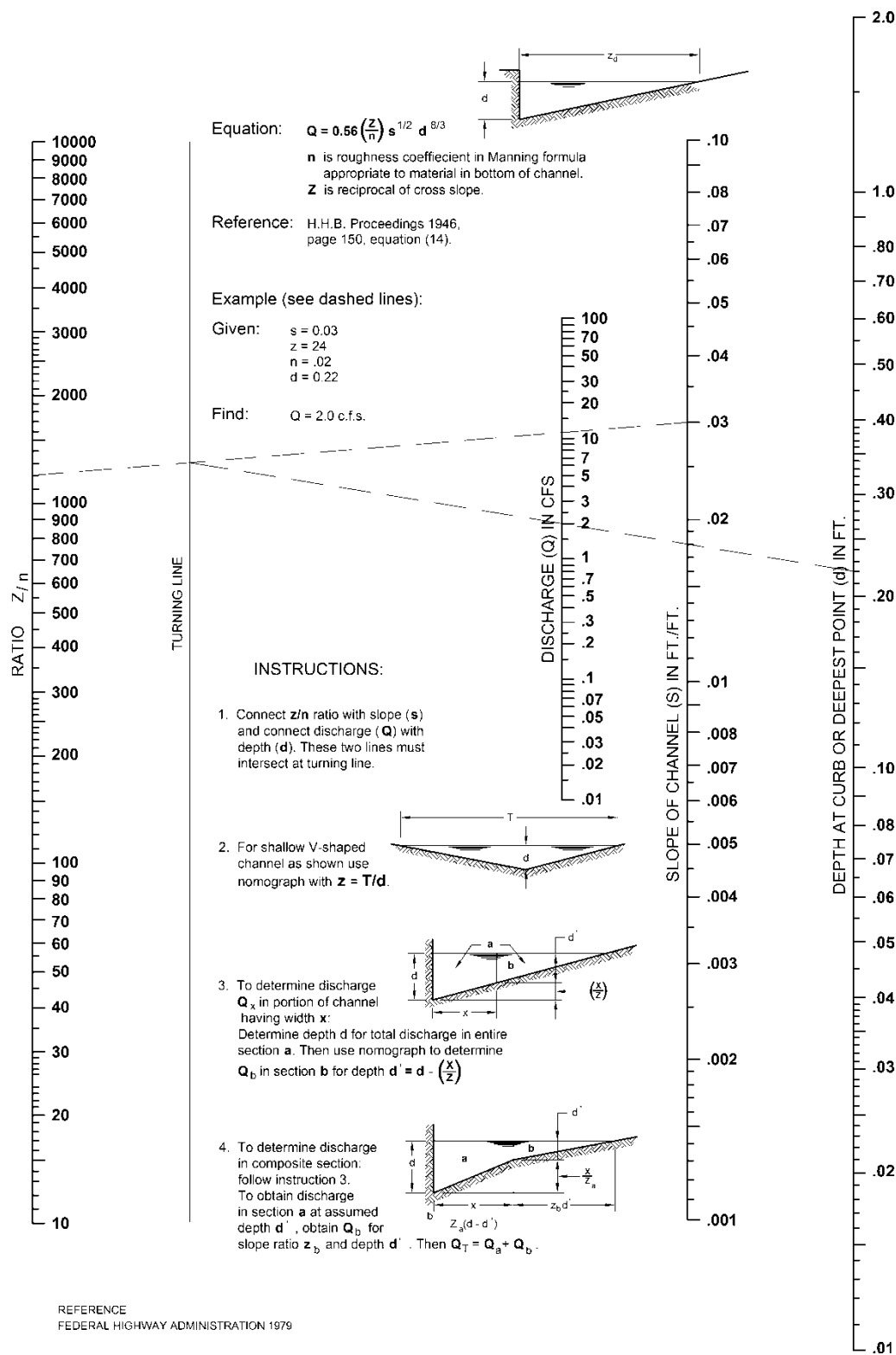
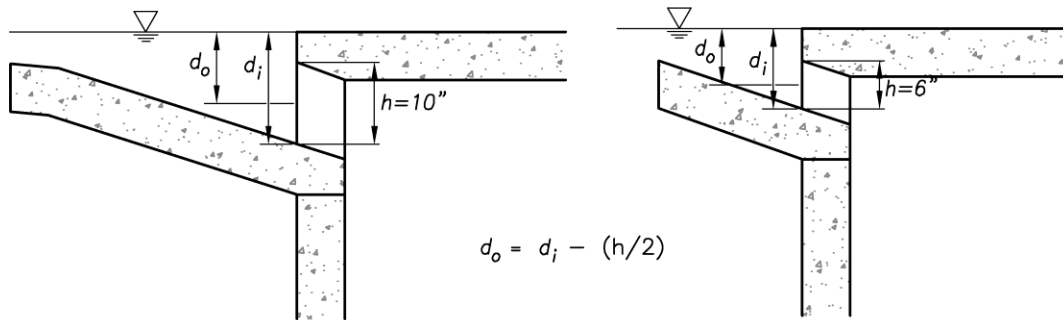


Figure 5604-20: Nomograph for Flow in Triangular Channels



TYPE 1 CURB INLET

TYPE 2 CURB INLET

Type	h	di	do	Qi	80% Qi
1	10"	14"	9"	3.9L	3.1L
2	6"	10"	7"	2.1L	1.7L

$$Q_i = C_o \ h \ L \ (2 \ g \ d_o)^{0.5}$$

C_o = orifice coefficient (0.67)
 d_o = effective head on the center of the orifice throat, ft
 L = length of orifice opening, ft
 d_i = depth at lip of curb opening, ft
 h = height of curb opening orifice, ft
 g = gravitational constant, 32.2 ft/sec²
 Q_i = theoretical inlet capacity (cfs)

Figure 5604-21: Capacity of Curb Opening Inlet at Sump

SECTION 5605 NATURAL DRAINAGE PATHS & STREAMS

5605.1 ~~5605.1 Scope~~Design Criteria

This section sets forth requirements for the protection of natural ~~drainage paths and~~ streams as a conveyance for stormwater. Unless otherwise provided for by City, State, or Federal ordinance, regulation, or standards, existing ~~natural~~ streams shall be preserved and protected in accordance with this section.

~~Where natural streams are not preserved, the drainage will be handled through systems designed in accordance with Sections 5606 and 5607.~~ The City of Warsaw Code of Ordinances Chapter §405.070 Stormwater Management and Natural Area Protection Standards adopts requirements to preserve natural drainage paths through Stormwater Drainage Setbacks to protect the community's natural amenities. These policies are enforced during the planning phase of land development through requirement of a Stormwater Drainage Permit, as required by Chapter §405.020 and detailed in §405.030.

Natural drainage paths shall be preserved to reduce the risk for property damage by designating space for the overland conveyance of stormwater for rainfall events exceeding the capacity of the engineered system. Natural drainage paths delineated from 2016 LiDAR data for the City of Warsaw are shown in Appendix A, for reference. Stormwater drainage setback requirements are defined in Paragraph 5605.2. Each element of the stormwater drainage system (whether open, enclosed, retention, or detention) shall include an overflow element to a preserved natural drainage path. Overflow systems shall:

- A. Be designed to route downstream flows in excess of the engineered system design capacity.
- B. May include streets, natural drainage paths, engineered channels, redundant piping, spillways, parking lots, drives or combinations thereof.
- C. Limit the maximum water surface elevation generated by the 100-year design storm with the 10% temporal distribution to meet protection of property requirements.
- D. Conform to Paragraph 5605.2 Easements regarding easements and restricted uses for overflow systems within stormwater drainage setbacks.

5605.2 Easements

- A. **Natural Drainage Path Requirements:** Natural drainage paths and stream corridors shall be preserved and protected by limiting development activity in and adjacent to these areas to reduce risk of property damage from flooding and stream bank erosion, and to protect the safety of the public. Natural drainage paths delineated from 2016 LiDAR data for the City of Warsaw are shown in Appendix A, for reference.
 - 1. All final grading and drainage shall comply with applicable City/County and State requirements.
 - 2. To the maximum extent feasible, development shall preserve the natural drainage paths unique to each site as a result of topography and vegetation. Natural drainage paths may be modified on site only if outside of the stormwater drainage setback. If natural drainage paths are modified, appropriate stabilization techniques shall be employed.
 - 3. Streets, roads, private access roads and other vehicular routes shall, to the maximum extent feasible, not be within a natural drainage path.
 - 4. Grading shall be designed to ensure that drainage flows away from all structures and heavily used areas.
 - 5. Development shall be designed to mitigate all negative or adverse drainage impacts on adjacent and surrounding sites.

- B. Stormwater Drainage Setbacks:** Stormwater drainage setbacks shall be dedicated as a drainage easement to the City and apply to all land or development that includes natural drainage paths. The requirements for stormwater drainage setbacks are as follows:
1. The stormwater drainage setback shall start at the top of bank of the natural drainage path or stream, to be determined by topographic survey, and move outward on either side of the channel. If a top of bank cannot be determined, one of the following methods may be applied to define the top of bank for the stormwater drainage setback:
 - a. Apply the assumed channel width to the centerline of the natural drainage path.
 - b. Delineate the bank-full or channel-forming flow caused by approximately the 2-year design storm with the median (50%) temporal distribution.
 2. Stormwater drainage setbacks shall be identified on the site plan and dedicated on the preliminary and final plats as a Drainage Easement.
 3. Stormwater drainage setback widths have been determined based on tributary drainage area, as shown in Table 5605-1 and Figure 5605-1, with the following defined setback widths:
 - a. **Channel Width:** centered on the natural drainage path is preserved for frequent stormwater flows with no other allowable uses.
 - b. **Preservation Setback Width:** begins at the top of bank of the natural drainage path/stream and is preserved for vegetation or other forms of bank stabilization with no other allowable uses.
 - c. **Protection Setback Width:** extends a predetermined distance from the preservation setback or to the extents of the 100-year effective FEMA floodplain, whichever is greater. Allowable uses within the protection setback include community amenities such as trails and greenways, as well as utility rights-of-way.

Table 5605-1: Stormwater Drainage Setbacks

Drainage Area (acre)	Assumed Channel Width (feet)*	Preservation Setback Width (feet)	Limited-Use Setback Width (feet)	Total Setback Width (feet)
2 to < 10	5	5	-	15
10 to < 40	10	10	10	50
40 to < 160	30	30	10	110
160 to < 640	60	60	20	220
640+	80	80	20	280
*Actual channel width may differ from Assumed Channel Width values presented in table based on results of topographic survey.				

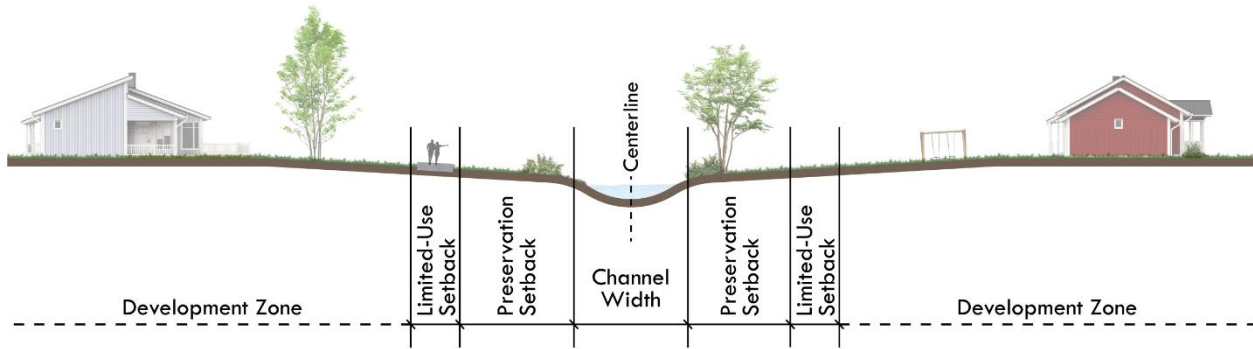


Figure 5605-1: Stormwater Drainage Setbacks

4. No construction or disturbance of any type, including clearing, grubbing, stripping, fill, excavation, linear grading, paving, or building is allowed in the setback widths except as falls within the allowable setback uses or by permission of the City/County Engineer. Dense stands of native vegetation shall be maintained, particularly in the preservation setback.
5. Unless otherwise accepted by the City/County, any maintenance of stormwater drainage setbacks shall be the responsibility of the property owner.
- 4.6. For work on existing facilities already located closer to the natural drainage path than allowed per these standards, the new construction shall not encroach closer to the drainage path. Bank stability concerns shall be addressed for improvements to existing land within the setback width.

5605.25605.3 Natural Stream Benefits and Characteristics:

Natural streams provide numerous water quality, ecological, and quality of life benefits. Protection and preservation of natural streams is a national environmental objective, as set forth in the Clean Water Act. Streams and their associated wetlands provide critical habitat for plants and wildlife, water quality treatment, and improved infiltration of rainfall which lessens flood impacts, recharges groundwater, and preserves base flow. Streams provide recreational and open space in communities, improve aesthetics, provide natural landscapes, and enhance adjacent property values.

Stable streams in nature maintain a shape in plan, profile, and section that most efficiently transports the water and sediment supplied to them. The geometry and processes of ~~natural~~ streams involve unique terminology and concepts not common to engineered channels or pipe systems. Common features of stream geometry and characteristics are presented in ~~Figure 5605-2 through and 5606~~ Figure 5605-3. Certain definitions are contained in Section 5601. More complete information regarding the character and function of ~~natural~~ streams is given in Interagency (2001).

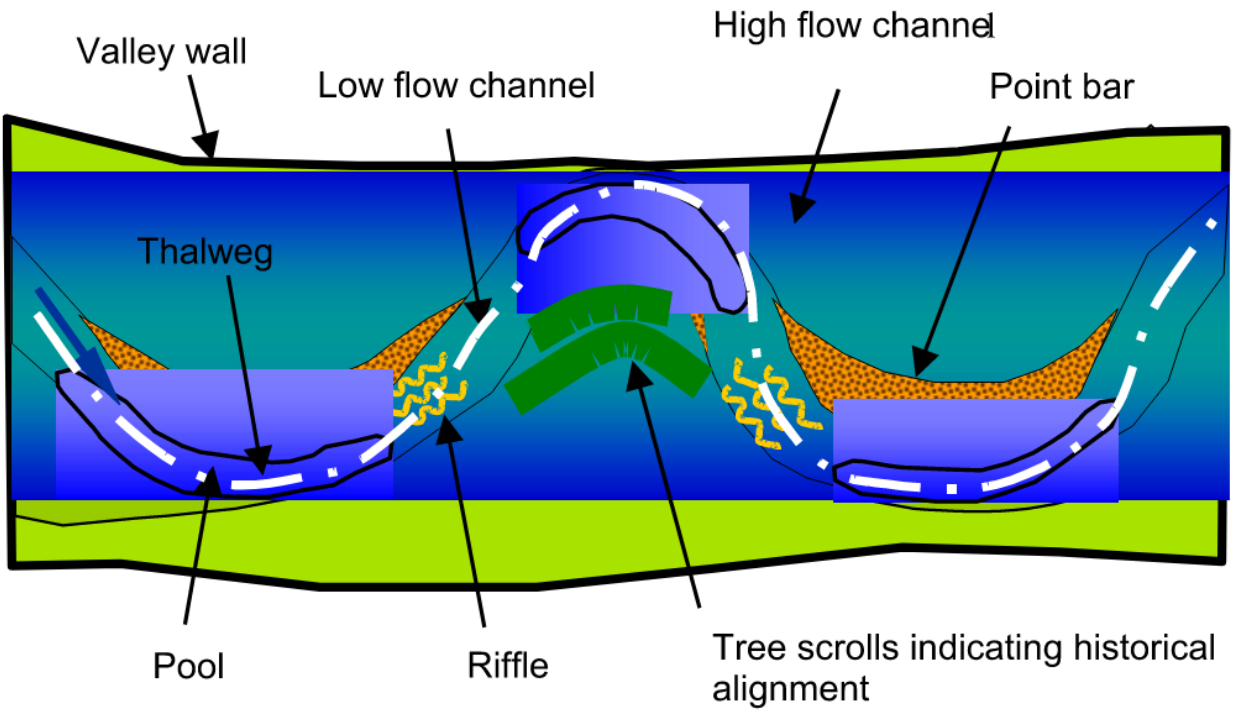


Figure 5605-2: Typical Stream Characteristics (1 of 32)

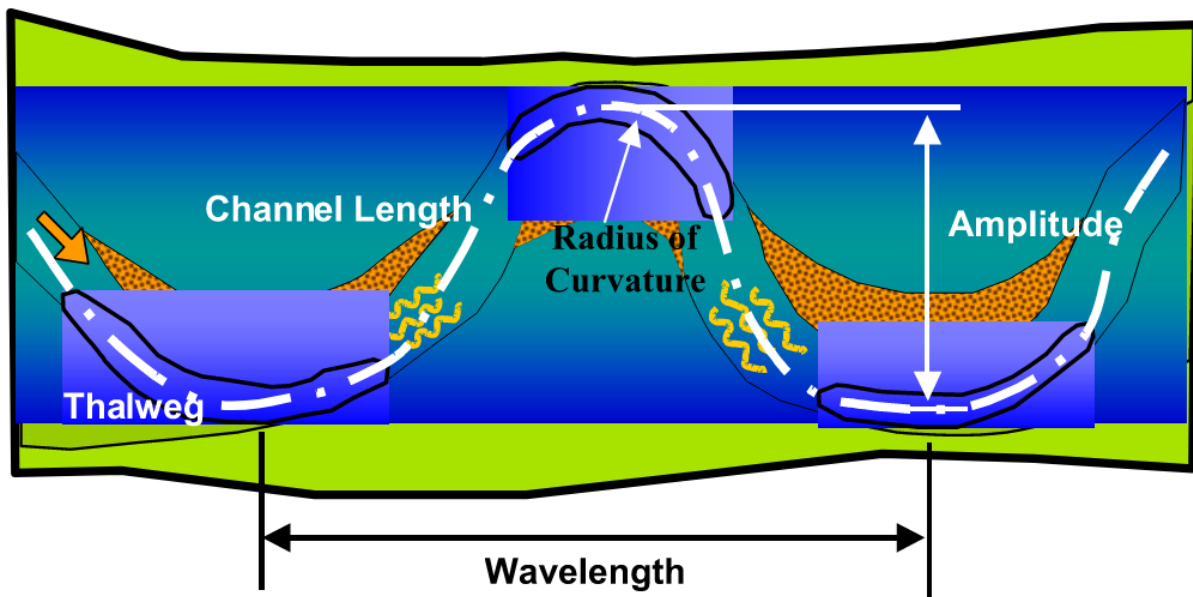


Figure 5605-33: Typical Stream Characteristics (2 of 32)

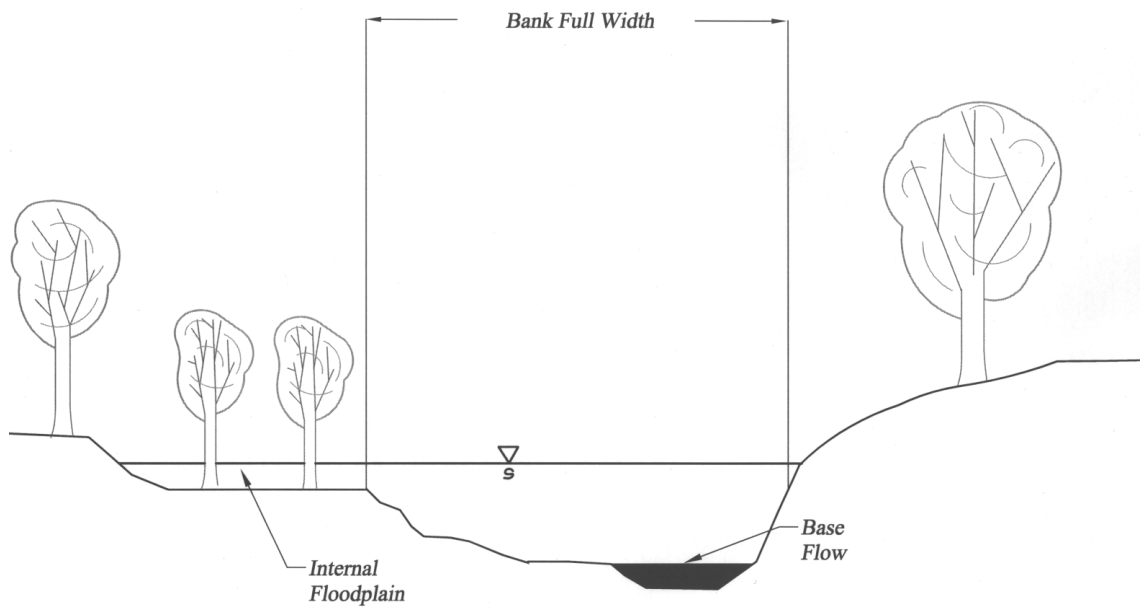


Figure 5605-43: Typical Stream Characteristics (3 of 3)

5605.3 Stream Preservation and Buffers Zones

A. Recommended Approach: It is recommended that Cities adopt comprehensive stream preservation and buffer zone requirements as part of their master plan and enforce those policies during the planning phase of land development. Requirements may be selected to protect environmental and quality of life benefits and be tailored to local geography and natural resources. The size of buffers may be adjusted to reflect local experience with stream migration and stability, protection of adjacent wetlands or critical habitat, or water quality treatment.

Guidance on stream protection is given in Wegner (1999), National Academy of Sciences (1999), and Heraty (1995). Natural streams should be preserved as systems and not segmented on a project-by-project basis, as the frequent intermixing of natural and man-made systems tends to degrade the function of both.

B. Default Approach: Where such comprehensive strategies have not been adopted, the following requirements shall be satisfied for all development/redevelopment proposed adjacent to or ultimately discharging to an existing natural channel:

1. Streams having a tributary area in excess of 40 acres shall be preserved. Preservation of smaller streams is encouraged. Preservation may be waived by the City/County Engineer where it is impractical, provided that the project has also received appropriate state and federal permits.
2. Buffer zones shall be established around all preserved streams. The limit of buffer zones shall be formally designated on a plat, deed, easement, or restrictive covenant, as directed by the City. Buffer widths as measured from the ordinary high water mark (OHM) outward in each direction shall exceed the dimensions shown in Table 5605-1.

Table 5605-1: Stream Buffer Widths

Contributing- Drainage Basin- Size (acres)	Buffer- Width*
Less than 40 acres	40 feet
40 acres to 160 acres	60 feet
160 acres to 5000 acres	100 feet
Greater than 5000 acres	120 feet
*Measured from OHM outwards, measured separately in each direction	

3. The City/County Engineer may require wider buffers for less stable stream or special conditions to address water quality and ecological needs. These widths provide only moderate allowance for widening or migration in local streams of average stability. Geotechnical studies may be required if there is a risk of slope failure due to underlying soil or rock materials, and the buffer width shall be expanded to contain the zone of failure. Smaller buffers in isolated locations may be allowed where provision of the full width is impractical and bank stability concerns have been addressed.
4. No construction or disturbance of any type, including clearing, grubbing, stripping, fill, excavation, linear grading, paving, or building is allowed in the buffer zone except by

~~permission of the City/County Engineer. Dense stands of native vegetation shall be maintained, particularly in the 25 feet closest to the top of bank.~~

- ~~5. Unless otherwise accepted by the City/County, any maintenance of riparian buffers shall be the responsibility of the property owner.~~

~~For work on existing facilities already located closer to the stream than allowed above, the new construction shall not encroach closer to the stream. Bank stability concerns shall be addressed. Formal designation of a buffer zone is not required.~~

5605.4 In Stream Construction - General Requirements

Construction in **natural drainage paths**, streams or their **buffer-setback zones-widths** shall conform to the general requirements of this subsection and to the appropriate specific requirements of the subsections following:

- A. **Stream Assessment:** A stream assessment shall be conducted in accordance with **Section-Paragraph 5605.5** for all construction within the **buffer-setback zone-widths** except for discharge outfalls, unless otherwise directed by the City/County Engineer.
- B. **Energy Management:** The pre-project and post-project hydraulic and energy grade lines for the **1002-year%, 10%10-year, and 1%100-year design** storm with **10% temporal distribution** flows shall be plotted. The region of a stream where in-stream construction causes a change in these grade lines is considered the zone of influence. The extent of the zone of influence downstream shall be generally limited by energy dissipation and grade control. The upstream limit of the zone may extend a distance beyond the construction as a drawdown or backwater curve. Within the zone of influence, the energy of the flow on the channel will be evaluated for the potential of excessive scour, deposition, initiation of head cuts, or other instability. Use of vegetation to increase bank resistance and minimize increases or abrupt changes in velocities is recommended. Bank or bed stabilization may be required in areas of unavoidable velocity or depth increase.
- C. **Sediment Transport Continuity:** The minimum post-project applied shear to the bed of the channel in the zone of influence at the **1002-year%, 10%10-year, and 4%25-year ultimate conditions** storm flow shall not be less than 90% of the minimum pre-project applied shear in the zone, so as to maintain the ability of the channel to transport sediment. If such shear stresses cannot be maintained, the engineer will evaluate the potential for future sediment removal or maintenance.
- D. **Transitions:** In-stream structures shall be designed to gradually blend into the natural **channel-stream** and provide a smooth transition of both geometry and roughness.
- E. **Repair of Disturbed Banks:** The side slopes of banks where construction occurs shall be restored with vegetation in accordance with **Section-Paragraph 5605-.13** as quickly as possible.
- F. **Professional Judgment:** ~~Natural~~**s**Streams are complex, variable, and strongly governed by local geology and climate. These standards are based on general guidelines of good practice on typical local streams and may not be optimal or sufficient in all cases. Specific requirements may be increased or waived by the City/County Engineer if conditions warrant and decisions should be guided by prudent engineering judgment.

5605.5 Stream Assessment

When conducted, a stream assessment will extend a minimum of one wavelength up and downstream of the area to be impacted by construction. It shall include the components listed below, except modified by the City/County Engineer to better fit project needs. An example submittal is shown in **Figure 5605-4** and **Figure 5605-5**.

- A. Plan Form Analyses and Inventory:** The plan-view of the ~~natural~~ stream using aerial photographs or planning-level aerial survey shall be plotted to an appropriate scale. Field surveys of the entire reach study area are not required. The following items shall be shown:
- Ordinary high water mark.
 - Top of bank.
 - Ground contours (if available).
 - Hydraulic grade line for "B bank-full" conditions (see Paragraph 5605.5.B) and floodplain for the ~~1%~~ 100-year design storm with 10% temporal distribution ~~ultimate conditions storm (see paragraph B)~~.
 - Thalweg, locations of riffles and pools, and spacing between riffles (see ~~paragraph~~ Paragraph 5605.5.C).
 - Exposed bedrock, areas of differing bed and bank soil or rock materials, and the D_{50} and shear stress ratio at each riffle (see ~~paragraph~~ Paragraph 5605.5D)
 - Active scour and depositional areas, point bars, and islands.
 - Vegetation within the ~~buffer~~ stormwater drainage setback widths, called out as mowed grass, mowed with trees, unmowed grass and plants, wooded, and bare. Trees greater than 6" diameter within 25 feet of the top of bank shall be located individually or by group. The species of dominant trees should be noted.
 - Meander length, wavelength, meander amplitude, bank-full width, and radius of curvature for each bend.
 - Total meander and valley length and sinuosity for the reach.
 - Photographs of main channel, streamside vegetation, and each riffle, appropriately referenced to plan-view location.
- B. Bank-full Width, Depth and Discharge:** If directed by the City/County Engineer, the geomorphic "bank-full" width, depth, and discharge shall be estimated using field indicators as detailed in Chapter 7 of USDA (1994). If field indicators are not used, "bank-full" flow shall be estimated as the rural-conditions ~~50%~~ 2-year ~~storm design storm with the median (50%)~~ temporal distribution flow, and the bank-full width and depth estimated based on the dimensions of that flow through the existing channel. This assumption is intended to provide a rough upper estimate of the bank-full flow.
- C. Longitudinal Profile and Sections:** The elevations of the profile along the thalweg shall be field surveyed to the nearest 0.1 ft. and the following features noted: riffles, pools, exposed bed rock, and advancing head cuts (areas of bed elevation change that appear to be actively migrating upstream). The top of left and right bank and any field indicators of bank-full flow such as limits of woody vegetation or top of point bars shall be plotted at correct elevation along the profile. The bank-full flow and ~~1%~~ 100-year design storm with 10% temporal distribution ~~ultimate storm~~ flow profiles shall be plotted.
- One field cross section shall be surveyed through each pool and riffle, and the depth and width of bank-full flow and floodplain for the ~~1%~~ 100-year design storm with 10% temporal distribution ~~ultimate conditions storm~~ shall be shown on each section.
- D. Bed and Bank Materials Analyses:** The type of rock exposed in the bed and banks shall be identified. Bank soils shall be reported by Uniform Soil Classification using the visual-manual procedures (ASTM D 2488-00). The median (D_{50}) particle size shall be determined using the Wolman Pebble Count Method (USDA, 1994, Chapter 11). A shear stress ratio shall be calculated for each riffle based on the applied shear at bank-full flow divided by the critical shear of the D_{50} particle in the riffle, using methods and tables described below.

- E. **Critical Shear Stress Analysis:** The shear stress ratio must be less than one at the extreme downstream point of any development in accordance with the guidelines below:

1. The average applied shear stress (τ_o) may be calculated from the hydraulic data as follows:

$$\tau_o = \gamma \cdot R \cdot S$$

Where:

γ = the specific weight of water (62.4 lbs/ft³)

R = hydraulic radius at bank-full flow (feet)

S = the water surface slope along the main channel bank full flow, averaged over several bends in the area of the intervention

Effective flow may be calculated using methods described in detail in USACE 2001 or may be assumed to be equivalent to the 50% 2-year storm.

2. The critical shear stress (τ_c) is that at which particles in the bed or bank are entrained and scour ensues. Shield's method is used for calculating the critical shear stress of spherical, non-cohesive particles, as follows:

$$\tau_c = \theta \cdot (\gamma_s - \gamma) \cdot D_{50}$$

Where

γ_s = the specific weight of sediment

γ = specific weight of water (62.4 lb/ft³)

D_{50} = the median particle size in the surface layer of bed or banks

θ = the Shield's parameter (0.06 for gravel to cobble, 0.044 for sand)

There are limited methods for calculating τ_c for fine-grained material. Field or laboratory testing generally determines the critical shear stress for these materials. The most widely available source is Chow (1988). Table 7-3, p. 165 is particularly relevant. More recently, the USDA Agricultural Research

Service National Sedimentation Laboratory has developed computer software for calculating toe scour (ARS Bank-Toe Erosion Model, Prototype, August 2001). As part of that software, there are look-up tables.

The combination of these two sources is presented in Table 5605-2 Critical shear stress may also be determined from Urban Water Resources Research Council (1992), Figure 9.6, p. 335.

In lieu of calculated values, the critical shear stress from Table 5605-2 may be used. Table 5605-2 presents critical shear for sediment-laden water and where noted, clear water. The user must exercise judgment as to future conditions. Clear water values may be used below a heavily piped area, concrete channels designed to contain the future flows or immediately below a managed detention pond.

3. The ratio of average boundary stress to critical stress is the shear stress ratio:

$$\text{shear stress ratio} = \frac{\tau_o}{\tau_c}$$

If bed and bank materials are distinct, then the shear stress ratio should be calculated for each. If the shear stress ratio of either stream bed or bank is greater than one, the channel is prone to near-term adjustment and any interventions should be designed to prevent accelerated erosion. If the bed consists of rock, then the shear stress ratio is not applicable, unless the rock is prone to fracturing, slaking, or break-up, in which case the median size of particle should be used for calculation of the ratio.

Table 5605-25-2: Critical Shear Stresses for Channel Materials

Material	Shear Stress (psf)
Granular Material	
Boulders (100 cm)	20.295
Boulders (75 cm)	15.222
Boulders (50 cm)	10.148
Boulders (25.6 cm)	5.196
Rip Rap	3.132
Cobbles (6.4 cm)	1.299
Cobbles and shingles	1.1
Cobbles and shingles, clear water	0.91
Coarse sand (1mm)	0.015
Coarse sand (1mm)	0.015
Coarse gravel, noncolloidal (GW), clear water	0.3
Coarse gravel, noncolloidal, (GW)	0.67
Gravel (2cm)	0.406
Fine gravel	0.32
Fine gravel, clear water	0.075
Fine sand (0.125 mm)	0.002
Fine sand (0.125 mm) (SP)	0.002
Fine sand (SW), (SP), colloidal	0.075
Fine sand, colloidal, (SW), (SP), clear water	0.027
Graded loam to cobbles, noncolloidal (GM)	0.66
Graded loam to cobbles, noncolloidal, (GM), clear water	0.38
Graded silts to cobbles, colloidal (GC)	0.8
Graded silts to cobbles, colloidal, (GC), clear water	0.43
Fine Grained	
Resistant cohesive (CL), (CH)	1.044
Stiff clay, very colloidal, (CL)	0.46
Stiff clay, very colloidal, (CL), clear water	0.26
Moderate cohesive (ML-CL)	0.104
Ordinary firm loam (CL-ML)	0.15
Ordinary firm loam, (CL-ML), clear water	0.075
Alluvial silts, colloidal (CL-ML)	0.46
Alluvial silts, colloidal, (CL-ML), clear water	0.26
Alluvial silts, noncolloidal (ML)	0.15
Alluvial silts, noncolloidal, (ML), clear water	0.048
Sandy loam, noncolloidal (ML)	0.075
Sandy loam, noncolloidal (ML), clear water	0.037
Silt loam, noncolloidal (ML)	0.11
Silt loam, noncolloidal, (ML), clear water	0.048
Shales and hardpans	0.67
Others	
Jute net	0.46
Plant cuttings	2.09
Well established dense vegetation to the normal low water	2.16
Geotextile (synthetic)	3.01
Large Woody Debris	3.13

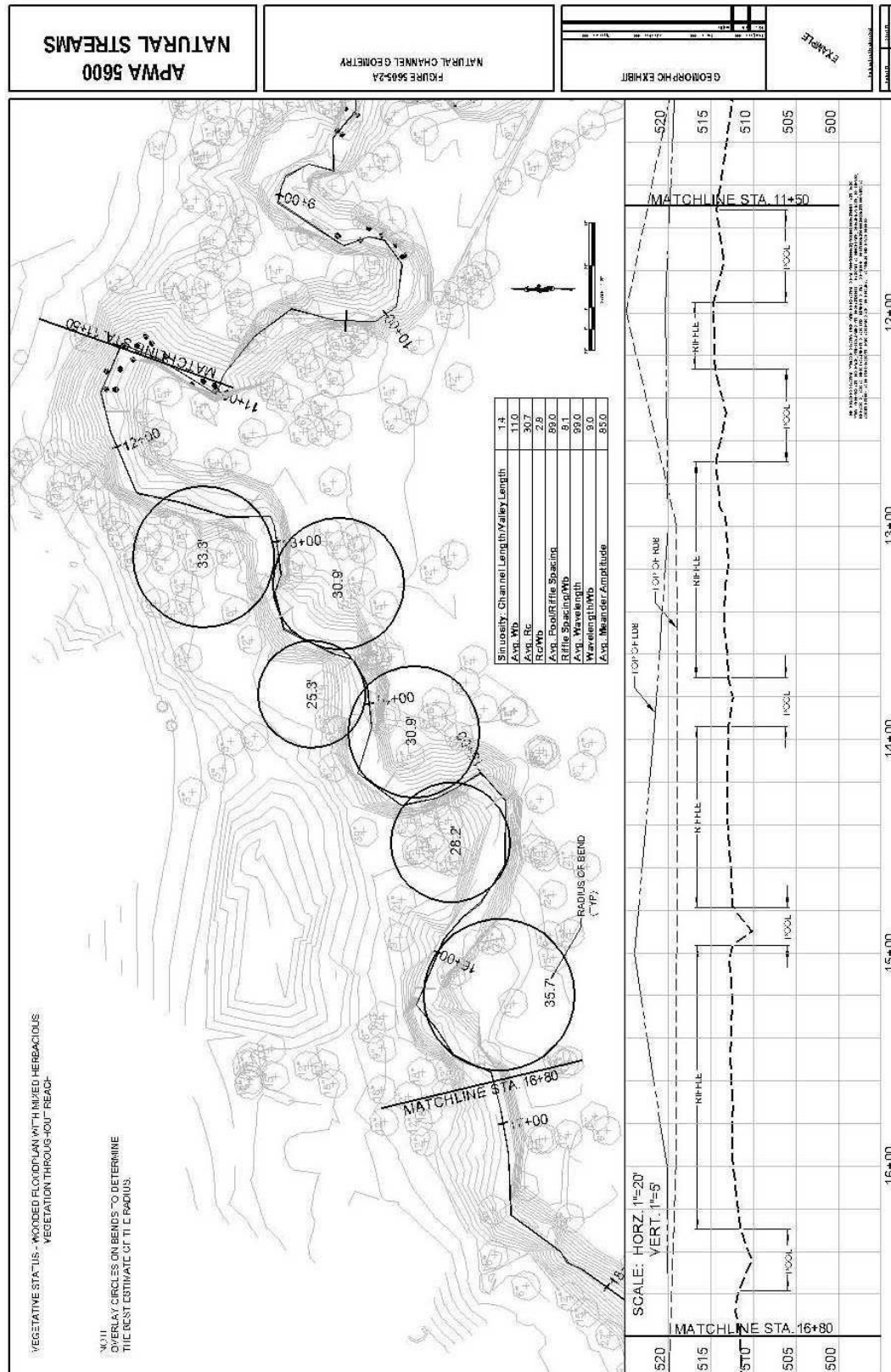
Note: For non-cohesive soils, the table values are based on spherical particles and Shield equation, as follows: $\tau_c = \Theta(\gamma_s - \gamma) D$ where γ_s is the specific weight of sediment (165 pcf), γ is specific weight of water, D is the reference particle size, and Θ is the Shield's parameter (0.06 for gravel to cobble, 0.044 for sand). For cohesive soils the values are based on limited testing as reported in Chow (1988) and USDA (2001).

- F. **Plan-Form Ratios:** The following ratios shall be calculated, and those that lie outside the typical range shall be noted. Streams are highly variable and ratios outside these ranges do not necessarily indicate problems.

Table 5605-35-3: Plan-Form Ratios

Ratio	Typical Range
Meander length / Wavelength (sinuosity)	1.1 to 1.5
Meander length / Bank-full width	10 to 14
Radius of curvature / Bank-full width	2 to 5
Riffle Spacing / Bank-full width	5 to 7

- G. **Channel Condition Scoring Matrix:** Using information summarized above, the channel condition scoring matrix given in [Table 5605-4](#) shall be completed. A rating of 12 indicates a stream of moderate stability that will likely require only standard levels of protection during construction. A rating between 12 and 18 indicates that special measures may be necessary address those issues rated as poor in the assessment. Streams with a rating greater than 18 may exhibit significant system-wide instability. These streams should be studied in more detail by experts in river engineering and fluvial geomorphology. (This scoring system is newly developed and its results shall be considered provisional.)



5605.6 Discharge Outfalls

Discharge points for inflows from enclosed systems or constructed channels shall be designed as one of the following. Energy management and sediment continuity checks are not required; however, energy dissipation shall be provided to reduce post development shear stress to pre-development shear stress at the outfall:

- A. Primary outfalls are those where the entire upstream channel is replaced by an enclosed system or ~~constructed~~ engineered channel which discharges flow in line with the direction of the downstream segment. Energy dissipation should be provided at the outlet to reduce velocities per ~~Section~~ Paragraph 5606.4. Grade control downstream of the outlet and an energy dissipater should be provided to prevent undermining of the outfall by future head cuts per ~~Section~~ Paragraph 5605.10. The alignment and location of the outfall and associated energy dissipater and grade control should make a smooth transition into the downstream channel. Primary outfalls shall be used whenever the contributing drainage area of the outfalls is greater than 80% of the downstream channel.
- B. Tributary outfalls are primary outfalls located on a tributary to a larger downstream segment. Energy dissipation and transition to natural stream flow should take place in the tributary at least one channel width upstream of the confluence per ~~Section~~ Paragraph 5606.4. Grade control in the tributary upstream of the confluence shall be provided if the tributary flow line is higher than the adjoining channel or if future incision of the adjoining channel is anticipated. Tributary outfalls may be used in all situations of tributary flow.
- C. Lateral outfalls are small outfalls that discharge from the banks of a ~~natural~~ stream. Outfalls shall be located to enter on a riffle or from the outside of a bend, but should generally not enter from the inside of a bend. Outfall pipes shall be oriented to discharge with the direction of flow at a minimum of 10-15 degrees downstream from a line perpendicular to the flow of the stream alignment. ~~with t~~ The invert shall be at or slightly below the top of the next downstream riffle. Outfalls shall be flush with or setback from the bank. The bank shall be shaped to provide a smooth transition and protected with reinforced vegetation (preferred) or rip-rap. If the outfall is in a bend, it shall be set back from the existing bank a sufficient distance to account for future meander migration, and the transition shall be graded and reinforced with vegetation. Riprap or hard armor protection should not be used in a bend. Perpendicular outfalls may only be used when the contributing drainage area of the outfall is less than 40% of that in the downstream channel.
- D. Edge-of-buffer outfalls are discharge points in the outer half of the riparian buffer that return the discharge to diffused overland flow. Outfalls shall be designed to spread flow and allow overland flow and infiltration to occur. Overland flow shall be directed to run in the outer portion of the buffer parallel to the channel direction to increase length of flow and prevent short-circuiting directly into the stream. Low weirs and berms may be graded to direct flow and encourage short-term ponding. The buffer zone utilized for infiltration shall be maintained in dense, erosion-resistant grasses or grasses reinforced with turf- reinforcing mats designed to withstand the shear stresses of a ~~10%~~ 10-year design storm with 10% temporal distribution. Edge-of-buffer outfalls that are part of a system of upland drainage using multiple small, distributed overland swales and ditches instead of pipes may provide significant infiltration and water quality treatment. Edge-of-buffer outfalls shall only be used if each individual outfall can be designed to operate without scour or the formation of gullies.

5605.7 Culverts, Bridges, and Above Grade Crossings

- A. Crossings should generally be located on a riffle. If the width of the crossing is large relative to the length of the riffle, then grade control structures shall be provided at the riffles upstream and downstream to isolate the impact of the crossings. If a crossing cannot be made at a riffle, avoid armoring a pool and place at-grade ~~grade~~ control structures at the riffle immediately upstream and downstream of the crossing. Maintain sediment transport continuity and avoid altering the channel cross-section.

- B. Realignment of channels to accommodate crossings and their approach should be avoided and minimized as much as possible. Any areas relocated shall have the banks stabilized in accordance with 5605.13 and shall be included in the reach isolated by upstream and downstream grade control.
- C. For bridges the multi-stage channel shape should be maintained and additional area to convey the design flow shall be above the elevation of the bank-full discharge.
- D. For multi-cell pipe and culvert crossings that have a cumulative width larger than the bank-full width, those cells wider than the bank-full width shall have a flow line located at the lowest estimated bank-full depth, or a weir wall or other structure upstream of the culvert opening shall be installed with a height to prevent access to the cell during flows less than bank-full flow. The weir wall shall be designed so that the hydraulic efficiency at the ~~100-year 1% design storm with 10% temporal distribution ultimate conditions storm~~ is not reduced. Without these features, the culvert may have a tendency to build up deposits and lose capacity or require frequent maintenance, particularly when crossings are located in sharp bends or streams with high sediment loads.
- E. Culverts shall be designed so that there is minimal backwater effect at all flows up to the ~~4%~~25-year storm discharge. Energy management and sediment transport continuity shall be checked.

5605.8 Below Grade Stream Crossings

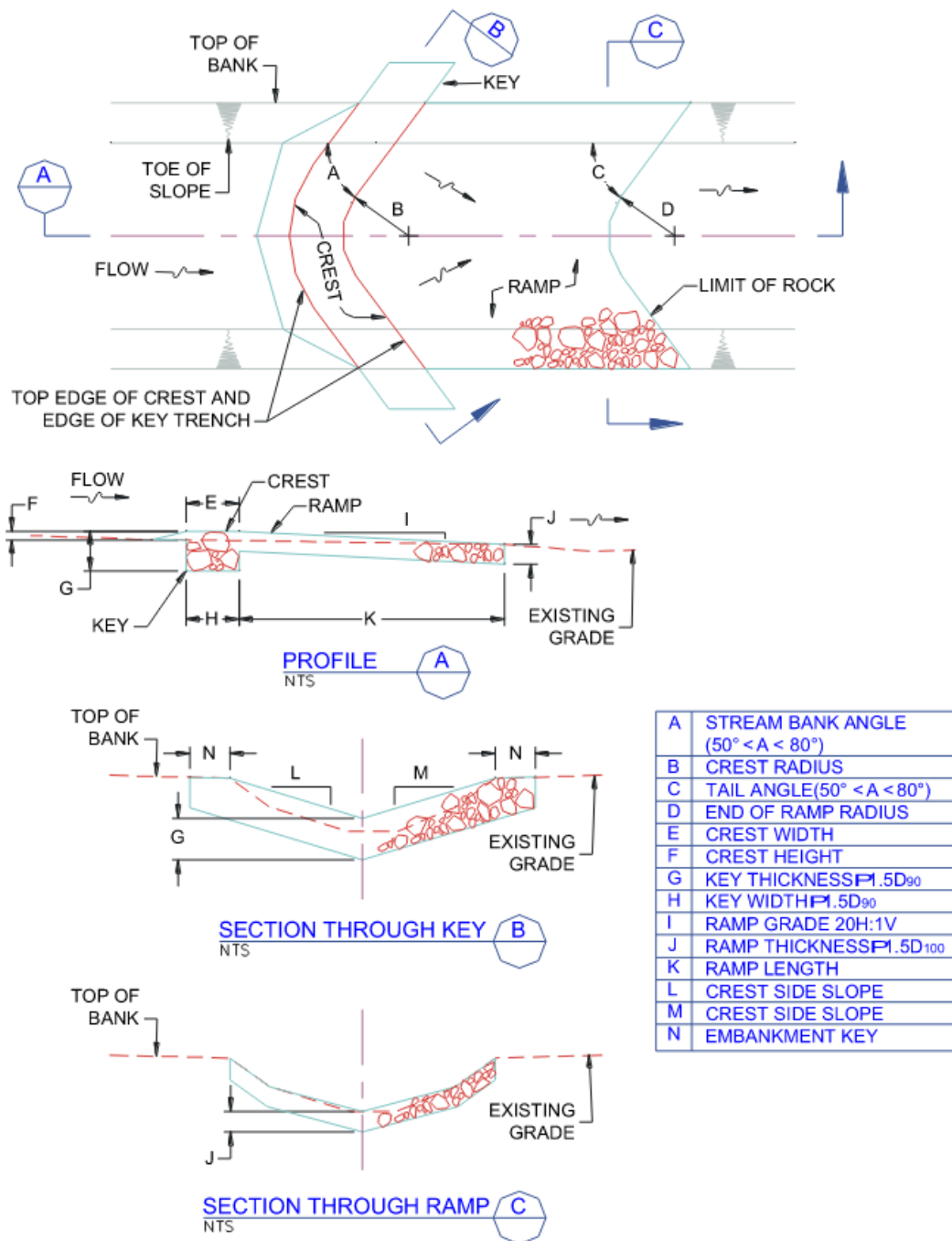
- A. Below grade stream crossings primarily include utility pipelines. Crossings should generally be at riffles and grade control structures constructed at the riffle, in addition to or constructed integrally with any encasement of the line the utility may require. ~~Utility encasements shall extend a minimum of five (5) feet into the stream bank on both the upstream and downstream sides of the crossing to account for the natural stream morphology. If a crossing is at a bend in the stream this minimum shall extend ten (10) feet into the stream bank.~~
- B. If riffle crossing is not feasible, the crossing should be in a pool that is protected by a downstream grade control structure. The top of crossing elevation should be at least two feet below the top of grade control. Crossings under pools should not be armored directly, but are protected by downstream grade control.
- C. Below grade crossings shall be perpendicular to ~~and along a straight section of~~ the stream whenever possible. If a perpendicular crossing is not feasible, the grade control protecting the crossing shall be perpendicular.
- D. Constriction or alteration of the pre-existing channel shape shall be avoided. If alteration occurs, sediment transport continuity and energy management shall be verified. Stream banks shall be repaired using vegetative methods whenever possible and the hydraulic roughness of the repaired stream bank should match that of the undisturbed stream banks.
- E. ~~Utility structures or manholes should not be placed within the stream cross section, when possible. Consider stream morphology when placing structures. Generally avoid placement of structures on the outside bend of a stream.~~
- ~~D.F.~~ Avoid utility crossings immediately downstream of a stormwater outfall.

5605.9 Grade Control

- A. Where grade control structures are required, they shall be placed in locations where the stream bed profile will support the creation or continuance of a riffle. The flow line of the grade control shall match the existing riffle.
- B. Where stream slope is less than 2%, the Newberry-style grade control structure detailed in Figure 5605-6 is recommended. Structures shall be constructed from durable stone sized using USACE methodology for steep channels (USACE EM 1110-2-1601, page 3-8, Equation 3-5). Rock shall generally comply with USACE gradations as given in (USACE EM 1110-2-1601, Hydraulic Design of Flood Control Channels,

Chapter 3). Shotrock with sufficient fines to fill voids may be used. The use of filter fabric and uniform gradations of stone are discouraged in stream beds.

- C. Where grades are in excess of 2%, low-drop step structures should be used.
- D. Alternate styles of grade control may be approved by the City/County Engineer. Guidance for grade control design is given in Thomas et.al.
- E. Construction of new grade controls structures may be waived by the City/County Engineer if it is determined that existing riffles are adequate to prevent or retard advancing head cuts, or if it is preferable to accept the risk of future head cut than to further disturb the channel.
- F. When grade control is not part of a larger project, energy management and sediment continuity checks are not required.



Notes

1. The depth of key trench shall be a minimum of 1.5 D₉₀. The crest shall slope downward from the stream bank to the center of the structure to focus the flow to the channel center. The tail ramp is generally sloped at 20 horizontal to 1 vertical and dissipates energy gradually over its length. The upstream face is not perpendicular to the flow but has an upstream oriented "V" or arch shape in plan form.
2. For item A, Stream Bank Angle, and item C Tail Angle, the lower end of the range should be used for softer soils.
3. For items L and M, crest angle, the typical range is 5 to 1 to 10 to 1.

Figure 5605-6: Grade Control Structure

5605.10 Floodplain Fills:

No fill shall be placed within the ~~bank full~~ effective FEMA floodplain, ~~nor should fill be placed within the designated buffer zone and/or floodway~~. Fill placed outside these limits shall not cause a rise in the FEMA effective floodplain ~~of the 1% ultimate conditions storm~~ beyond the limits of the property controlled by the developer, ~~unless authorized by the City/County Engineer~~. Fills placed within floodplain designated as a special flood hazard area by FEMA shall conform to FEMA and community floodplain management requirements. Energy management and sediment transport continuity shall be checked.

5605.11 Flood Control Projects:

- A. The flood control projects that increase conveyance capacity in ~~natural~~ streams should generally be limited to cases where existing buildings or infrastructure face significant damage or life and safety issues. Projects to lower floodplain elevations to facilitate new development near streams at lowered elevations should be avoided.
- B. The portion of the channel within the ~~bank full~~ effective floodplain should be left undisturbed if possible, with conveyance increases primarily from excavation of a larger cross sectional area in the over-bank. Excavated areas within the ~~stormwater drainage setback~~ ~~buffer zones~~ should be revegetated with dense, native-type vegetation. Reducing roughness in the over-bank by paving or mowing to increase velocities should be avoided.
- C. Flood control projects should be evaluated on a project by project basis, and abide by current, effective floodplain management regulations. ~~If adequate conveyance cannot be provided using the methods above, then excavation of the over bank below the bank full floodplain and/or reduction in over bank roughness may be necessary. Energy management and sediment continuity should be checked. Effort should be made to avoid direct widening of the active channel at low flows and to minimize disturbance of the active channel and nearest adjacent stream side vegetation.~~

5605.12 Bank Stabilization Projects

- A. Bank stabilization projects should generally be limited to cases where existing buildings or infrastructure face significant property damage or safety issues. Projects to stabilize banks to facilitate reductions in ~~stormwater drainage setback~~ ~~buffer~~ widths for new construction should be avoided.
- B. Prior to stabilization, the causes of the instability should be considered, including the stream's current phase of channel evolution (Interagency, 2001, Chapter 7) and direction of meander migration. Stabilization may be unnecessary if a channel has ceased incision and widening and is in the process of deposition and restoration. If stability issues appear widespread or complex, a systematic evaluation of the stream system by professionals with expertise in river engineering and fluvial geomorphology may be justified.
- C. Instability caused by geotechnical failure (slumping of banks due to weak soils in the adjacent slopes) shall be distinguished from fluvial failure (erosion of banks caused by stream flows). For geotechnical issues, a geotechnical engineer shall evaluate the slope stability. Geotechnical designs shall provide for a 1.5 factor of safety (ratio of theoretical resisting forces to driving forces) against slope failure where it would endanger buildings, roadways, or other infrastructure, unless a lower factor of safety is approved by the City/County Engineer.
- D. Bank stability projects should have a design life greater than the useful life of the facility being protected, or a life cycle cost analyses shall be performed that considers replacement and repair over the entire protection period. Responsible parties for future maintenance should be identified.
- E. Stabilization should begin and end at stable locations along the bank. Bank stabilization should be limited to areas of potential erosion and are rarely required on the inside of bends. For long projects, stabilization may alternate from side to side and is rarely necessary across an entire cross section. The existing cross section should be mimicked to the extent practical and need not be planar or uniform over the entire length. Grade

control shall be provided at the riffle both upstream and downstream of the stabilization to isolate it from the surrounding stream and protect the foundation from undercutting. Control at intermediate points for longer projects may also be required. Energy management and sediment transport continuity shall be checked, and energy dissipation provided if necessary.

- F. "Hard-Armor" projects are those projects that use rip-rap, placed stone, gabions, retaining walls, or other rigid structures to provide geotechnical and fluvial stability. Such projects shall be designed in accordance with EM 1110-2-1205 (USACE, 1989), EM1110-2-1601 (USACE, 1994), or HEC-11 (FHWA 1989). Materials shall be sized to prevent dislodgement in the 1%-00-year design storm with 10% temporal distribution. Gradation should comply with USACE or FHWA recommendations. Stones should be placed to maintain roughness and variations. All material shall be well placed to ensure interlock and stability. Materials shall be keyed into the bed and banks with adequate allowance for scour along the toe and the structure should have adequate foundation. Vertical walls should be avoided when possible as they tend to concentrate scour at their toe and are typically smoother than the natural channel.
- G. Soil bioengineering involves the use of living vegetation in combination with soil reinforcing agents such as geogrids to provide bank stabilization by increasing soil shear resistance, dewatering saturated soils, and by reducing local shear stresses through increased hydraulic roughness.
1. Bio-engineering projects shall be designed in accordance with the principals of NRCS (1996) and Gray and Sotir (1996). Designs will be tailored to the urban environment by consideration of the requirement for immediate functionality upon construction, the extreme variability and high shear stress of urban flows and the availability of mechanized equipment and skilled operators.
 2. Selection of plants and specifications for planting methods and soil amendments shall be prepared by a professional competent in the biological and stabilization properties of plants.
 3. Plants selected shall be appropriate to local conditions and shall be native varieties to the greatest extent practical. Evaluation of local conditions includes assessment of site microclimate, bank slope, soil composition, strength and fertility, type and condition of existing vegetation, proximity to existing infrastructure, soil moisture conditions and likelihood of wildlife predation. Engineering factors influencing plant selection include frequency, height and duration of inundation, near-bank shear stress, size and volume of bed load as well as depth and frequency of scour.
 4. Plants may be either locally harvested or purchased from commercial nurseries. When harvesting, no more than 10% of a given stand may be removed and no plant on the state rare or endangered species list may be harvested or damaged in harvesting operations. Plant material grown near the metropolitan area is adapted to local climatic conditions and is preferred over more remote sources. Some species such as red maple are particularly sensitive to locale and may only be used if locally available. Seed, plant plugs, rhizomes, whips, live stakes, bare root and container stock may be used. Turf grasses, noxious or invasive species shall not be used. A variety of plant species shall be used to provide greater reliability to a design. For critical functions such as protection from toe scour a minimum of three species should generally be employed.
 5. Soil bioengineering methods are properly applied in the context of a relatively stable stream system, and relevant general requirements for all stream bank stabilization projects given in this section apply to bio-engineered projects. Soil bioengineering alone is not appropriate when the zone of weakness lies below the root zone of the plantings, or when rapid drawdown can occur, such as in a spillway or dam embankment.

- H. Composite methods are those which employ both hard armor and soil bioengineering. Typically, armor for toe protection in critical locations is provided, with soil-bioengineering for the remainder. Design principles for both hard armor and soil-bioengineering shall be observed as appropriate.
- I. In-stream Stability Structures: In-stream structures are used to focus flow, control grade, dissipate energy and selectively lower near-bank stress. Stream barbs, weirs, guide vanes, vegetative sills, longitudinal peak stone, and grade controls are among the more commonly used in-stream structures. When constructed of natural material such as rock, such structures also create aquatic habitat. They may be used alone or in combination with hard armor, bioengineering or composite methods. In-stream structure design is a river engineering practice and is beyond the scope of this standard. Preliminary guidance and references for the design of some common structures is given in Castro (1999) and Interagency (2001), Chapter 8 and Appendix A.

5605.13 Stream Restoration

Restoration of urban streams is defined as the re-establishment of natural channel geometry, materials and vegetative buffers with the intent of restoring natural geometry and functions to streams that have been disturbed or eliminated. While there are significant potential ecological and quality of life benefits from stream restoration, successful design is data-intensive and requires an interdisciplinary approach. Design of stream restoration projects is beyond the scope of this standard. Interagency (2001) describes the general procedures, benefits, and requirements of stream restoration.

5605.14 Comprehensive Stream Management:

The standards set forth in preceding sections provide a moderate degree of mitigation for potential damages from individual construction projects in streams of average stability. For more sensitive streams or to obtain a greater degree of protection, Cities or Counties may elect to implement comprehensive strategies for stream management. Such strategies should be based on specific investigations of the particular streams and watersheds in the city and consider local geology, geography, climate, and ecology. Strategies may include optimized or county stream buffers (see [section Paragraph 5605.3](#)), hydrology controls, and comprehensive grade control. Detailed requirements for such studies and strategies are beyond the scope of this standard, and should be developed in consultation with professionals competent in river engineering and fluvial geomorphology. The following general recommendations may be considered:

- A. **Hydrology Controls for Channel Protection:** Channels respond to changes in flow volumes and recurrence by altering width, depth, velocity, suspended load, meander radius, wavelength and pool and riffle. Avoiding significant changes in flow volume and recurrence should reduce the likelihood of major changes in stream form. Volume control may include practices that encourage infiltration, evapotranspiration, and short-term detention or retention. A successful strategy would require limitations on volume, duration and magnitude of post development discharges at a number of discharge points, including common storms such as the [100% 1-year design](#) storm. The tail of hydrographs would probably need to mimic groundwater base flow. The cumulative effect of multiple detention/retention structures on duration of high flows would be considered. The impact of large impoundments or retention lakes on trapping sediment and interrupting sediment transport would be considered. Volume control for channel protection would likely require significantly different control requirements than traditional detention practices that focused primarily on flood control from extreme events.
- B. **Grade Control:** In watersheds subject to deep, rapid, and extensive incision or downcutting, a comprehensive program of controlling bed elevation (grade control) may be the most practical method of preserving stream function and avoiding future bank stability concerns. Streams with easily eroded soils and lacking in shallow bedrock are highly susceptible to extensive degradation. Existing and proposed crossing points such as culverts, bridges, and encased underground utilities should be incorporated into the program.

Selection of grade elevations would be based on historical data, flooding or space constraints, restoration of wetlands and streambank hydrology, channel depths, and other relevant data.

Project: _____

Stream Name and Location: _____

Evaluated by: _____ Firm: _____ Date: _____

Table 5605-4: Channel Condition Scoring Matrix
(adapted from Johnson, et al 1999)

Stability Indicator	Good (1)	Fair (2)	Poor (3)	Score (S)	Weight (W)	Rating S*W= (R)
Bank soil texture and coherence	cohesive materials, clay (CL), silty clay (CL-ML), massive limestone, continuous concrete, clay loam (ML-CL), silty clay loam (ML-CL), thinly bed limestone	sandy clay (SC), sandy loam (SM), fractured thinly bedded limestone	non-cohesive materials, shale in bank, (SM), (SP), (SW), (GC), (GM), (GP), (GW)		0.6	
Average bank slope angle	slopes \leq 2:1 on one or occasionally both banks	slopes up to 1.7:1 (60°) common on one or both banks	bank slopes over 60° on one or both banks		0.6	
Average bank height	less than 6 feet	greater than 6 and less than 15 feet	greater than 15 feet		0.8	
Vegetative bank protection	wide to medium band of woody vegetation with 70-90% plant density and cover. Majority are hardwood, deciduous trees with well-developed understory layer, minimal root exposure	narrow bank of woody vegetation, poor species diversity, 50-70% plant density, most vegetation on top of bank and not extending onto bank slope, some trees leaning over bank, root exposure common	thin or no band of woody vegetation, poor health, monoculture, many trees leaning over bank, extensive root exposure, turf grass to edge of bank		0.8	
Bank cutting	little to some evident along channel bends and at prominent constrictions, some raw banks up to 4 foot	Significant and frequent. Cut banks 4 feet high. Root mat overhangs common.	Almost continuous cut banks, some over 4 feet high. Undercut trees with sod-rootmat overhangs common. Bank failures frequent		0.4	
Mass wasting	little to some evidence of slight or infrequent mass wasting, past events healed over with vegetation. Channel width relatively uniform with only slight scalloping	Evidence of frequent and significant mass wasting events. Indications that higher flows aggravated undercutting and bank wasting. Channel width irregular with bank scalloping evident	Frequent and extensive mass wasting evident. Tension cracks, massive undercutting and bank slumping are considerable. Highly irregular channel width.		0.8	

Table 5605-4: Channel Condition Scoring Matrix
(adapted from Johnson, et al 1999)

Stability Indicator	Good (1)	Fair (2)	Poor (3)	Score (S)	Weight (W)	Rating S*W= (R)
Bar development	narrow relative to stream width at low flow, well-consolidated, vegetated and composed of coarse bed material to slight recent growth of bar as indicated by absence of vegetation on part of bar	Bar widths wide relative to stream width with freshly deposited sand to small cobbles with sparse vegetation	Bar widths greater than ½ the stream width at low flow. Bars are composed of extensive deposits of finer bed material with little vegetation		0.6	
Debris jam potential	slight – small amounts of debris in channel. Small jams could form	moderate – noticeable debris of all sizes present	significant – moderate to heavy accumulations of debris apparent		0.2	
Obstructions, flow deflectors (walls, bluffs) and sediment traps	negligible to few or small obstructions present causing secondary currents and minor bank and bottom erosion but no major influence on meander bend	moderately frequent and occasionally unstable obstructions, noticeable erosion of channel. Considerable sediment accumulation behind obstructions	frequent and unstable causing continual shift of sediment and flow		0.2	
Channel bed material consolidation and armoring	massive competent to thinly bedded limestone, continuous concrete, hard clay, moderately consolidated with some overlapping. Assorted sizes of particles, tightly packed and overlapped, possibly imbricated. Small % of particles < 4mm	shale in bed, soft silty clay, little consolidation of particles, no apparent overlap, moderate % of particles < 4mm	silt, weathered, thinly bedded, fractured shale, high slaking potential, very poorly consolidated, high % of material < 4mm		0.8	
Sinuosity	$1.2 \leq \text{Sinuosity} \leq 1.4$	$1.1 < \text{Sinuosity} < 1.2$	$\text{Sinuosity} < 1.1$		0.8	
Ratio of radius of curvature to channel width	$3 \leq R_c/W_b \leq 5$	$2 < R_c/W_b < 3$, $< R_c/W_b < 7$	$2 < R_c/W_b$, $R_c/W_b > 7$		0.8	
Ratio of pool-riffle spacing to channel width at elevation of 2-year flow	$4 \leq \text{Length}/W_b < 8$	$3 \leq \text{Length}/W_b < 4$, $8 < \text{Length}/W_b \leq 9$	$3 < \text{Length}/W_b$, $\text{Length}/W_b > 9$, unless long pool or run because of geologic influence		0.8	
Percentage of channel constriction	< 25%	26-50%	> 50%		0.8	
Sediment movement	little to no loose sediment	scour and/or deposition, some loose sediment	near continuous scour and/or deposition and/or loose sediment		0.8	

TOTAL _____

Table 5605-5: Characteristics of Certain Plants for Bio-Engineering

Common Name	Botanical Name	Forms Available	Comments* (see notes below)
Sandbar willow	<i>Salix exigua</i>	Live stake, whip, bare root	Shrub willow, stoloniferous, favors granular soils, inundation and scour tolerant, requires full sun, extensive fibrous roots
Peachleaf willow	<i>Salix amygdaloides</i>	Live stake, whip, bare root	Shrub willow, stoloniferous, favors granular soils, inundation and scour tolerant, requires full sun, extensive fibrous roots
Buttonbush	<i>Cephalanthus occidentalis</i>	Live stake, whip, bare root, container	Shrub, sun or shade, stoloniferous, tolerates extended inundation, high aesthetic value, nectar source
Silky dogwood	<i>Cornus amomum</i>	Live stake, bare root	Roots from cutting with root hormone, shade tolerant, stoloniferous, shallow, fibrous roots
Roughleaf dogwood	<i>Cornus drummondii</i>	Bare root, container	Most sun and drought tolerant dogwood, extensive fibrous roots
River birch	<i>Betula nigra</i>	Bare root, B&B	High root tensile strength, rapid establishment, high aesthetics
Black walnut	<i>Juglans nigra</i>	Bare root, B&B	Check for juglone toxicity in rest of palette, deep arching roots, buttressing effect in rock soils, canopy species
Switch grass	<i>Panicum virgatum</i>	Seed, plant plug	Deep, high tensile strength roots, aggressive, may out compete other warm season grasses, good for mesic to dry sites
Arrowwood viburnum	<i>Viburnum dentatum</i>	Bare root, container	Highly adaptable to range of soil, moisture and sun conditions, understory shrub, high aesthetic value
Little blue stem	<i>Schizachyrium scoparium</i>	Seed, plant plug, container	Deep, high tensile strength roots, adaptable to dry sites, full sun to light shade

Notes:

Stoloniferous species, those with the ability to sprout from a network of near-surface stems, are used in high stress applications to protect against toe scour. The stoloniferous species form dense colonies and quickly regenerate when damaged.

Common riparian species such as black willow, box elder, and most poplar species should not be used in soil bioengineering applications in urban areas. *Populus deltoides* (eastern cottonwood) should be used only sparingly and where deep, loam soil is present. If the site is infested with *Phragmites* spp (common reed), bamboo, *Phalaris arundinacea* (reed canary grass), and *polygonum* spp (knotweed), the design must include a plan to positively eliminate the weedy species. While plant selection is site-specific the following species have broad applicability in urban streams.

SECTION 5606 ENCLOSED PIPE SYSTEMS

5606.1 Design Criteria

Enclosed conveyance systems consisting of inlets, conduits, and manholes may be used to convey stormwater runoff where site conditions and open space requirements will not permit the use of natural drainage paths or engineered channels. A storm drainage system shall incorporate an overflow system that is capable of conveying flows in excess of the designed system capacity. Overflow systems can consist of natural drainage path preservation. Enclosed pipe systems shall convey the 10-year design storm assuming the temporal distributions per Section 5602, and be designed per Section 5603, as follows:

- A. **Gravity Flow Conditions:** 10-year design storm with median (50%) temporal distribution gravity flow conditions within the pipe system (e.g. no surcharging)
- B. **Pressure Flow Conditions:** 10-year design storm with 10% temporal distribution pressure flow conditions with surcharging less than 0.5 feet below the lowest opening to the surface or structure rim elevation.
- C. **Street Crossings:** Concentrated flow for open systems shall be conveyed under streets to prevent vehicles from being swept from the roadway during infrequent storms. These crossings may be bridges or culverts. Crossings shall be designed to completely convey flows without street overtopping in accordance with the design storms listed in Table 5606-1 based the 10% temporal distribution. Roadway classifications are defined per the Warsaw Livable Community Transportation Improvement Plan.

Table 5606-1 Level of Service for Street Crossings

Street Classification	Min. Design Storm
Principal Arterial	50-year
Primary Connectors	25-year
Minor Streets ⁽¹⁾	10-year

(1) Secondary connectors also fall into the category of minor streets

Further, concentrated flow in excess of the minimum design storm may only overtop the roadway if the following conditions are met:

1. The span of the structure opening is less than 20 feet.
2. The peak stormwater runoff from the 100-year design storm with 10% temporal distribution is 250 cfs or less unless a guard fence is installed on the downstream side of the roadway. Such overflow depths at low points in roadways during the 100-year design storm with 10% temporal distribution will be limited to 7 inches measured at the high point in the roadway cross section, typically at the upstream face of culvert headwall or roadway curb; except that it also shall not exceed 14 inches at the deepest point in the roadway cross section.

~~5606.1~~ 5606.2 Easements

Permanent drainage easements shall be dedicated to the City/County for ~~operation and maintenance of all components of the storm drainage facilities~~ and allow the City right of entry per the City of Warsaw Code of Ordinances Chapter §700.270. Easement width shall not be less than 15 feet, or the outside width of the pipe or conveyance structure plus 10 feet; whichever is greater. Easements shall be centered on the pipe.

- A. **Permanent:** The City/County Engineer may require wider easements when other utilities are located within the same easement and/or when the depth of cover is greater than 4 feet.
- B. **Temporary:** Temporary construction easements of sufficient width to provide access for construction shall be acquired when the proposed work is located in areas developed prior to construction.

5606.25606.3 Capacity

Capacity shall be determined in accordance with Section 5603. Minimum design pipe size shall be 456-inch in diameter. For partially full pipe flow, Figure 5606-1 can be used to obtain hydraulic parameters of the

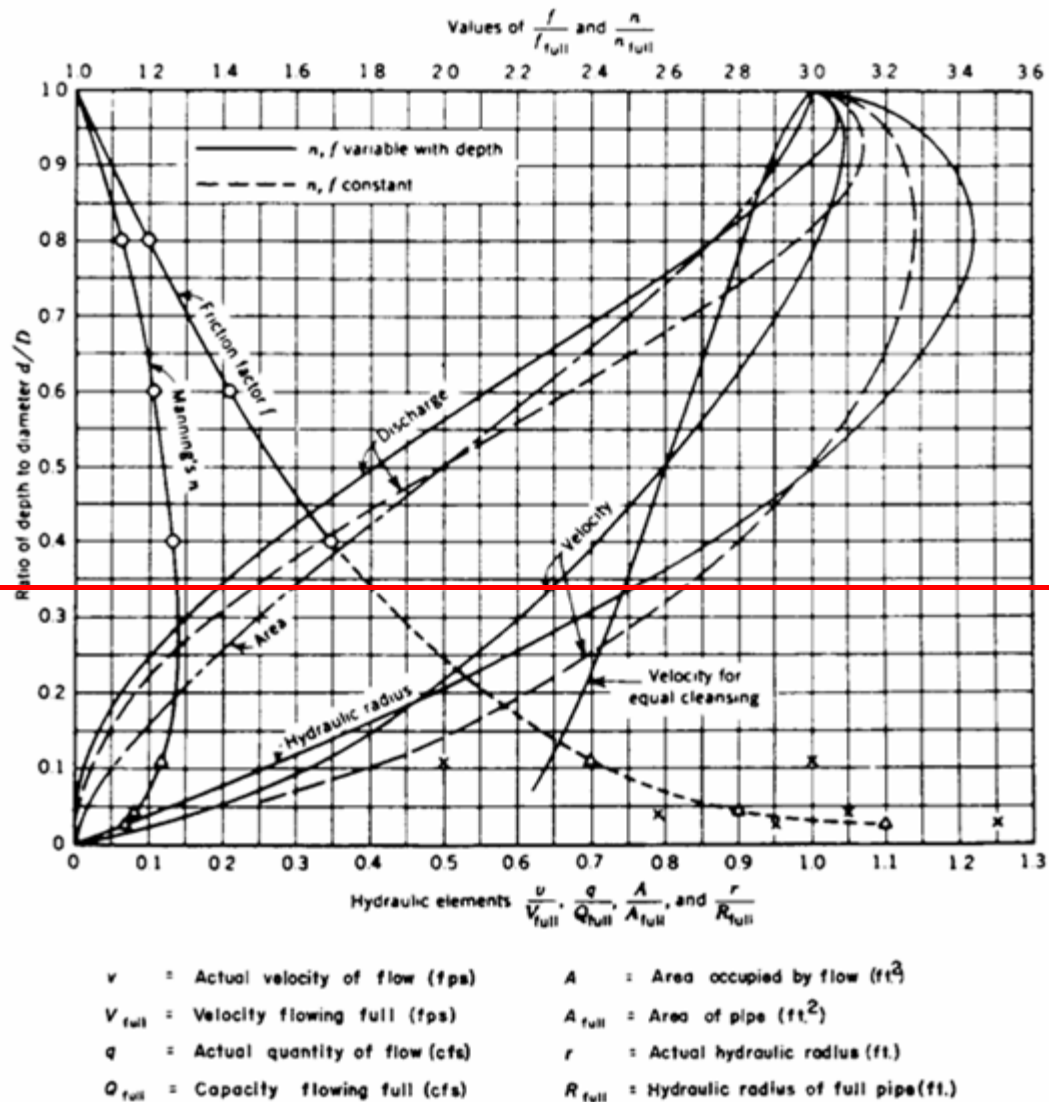


Figure 5606-1: Hydraulic Elements of Circular

flow.

~~5606.3~~5606.4 Pressure Flow

After considering the discussion presented in ~~Section-Paragraph~~ 5603.1 A, an enclosed system may be designed to operate with pressure flow, for the design storms specified in ~~Section-Paragraph~~ 5601.85, if all the following conditions are met:

- A. The Hydraulic Grade Line (HGL) must be 0.5 feet below any openings to the ground or street at all locations.
- B. Watertight joints capable of withstanding the internal surcharge pressure are used in the construction.
- C. Appropriate energy losses for bends, transitions, manholes, inlets, and outlets, are used in computing the HGL.
- D. Energy methods (Bernoulli's equation) must be used for the computations.

~~5606.4~~5606.5 Energy Dissipation:

The outfall, as defined in ~~Section-Paragraph~~ 5605.6, of all enclosed systems shall include energy dissipation sufficient to transition outlet flows to velocities and applied shear stresses consistent with the normal flow conditions in the receiving channel for the range of flows up to and including the ~~1%100-year design storm with 10% temporal distribution~~storm. Calculations, at a minimum, should include the ~~1002-year%~~, the ~~10%10-year~~ and the ~~1%100-year design storms with 10% temporal distributions~~.

Energy dissipation for lateral outflows to ~~natural~~ streams and edge of buffer outfalls to riparian buffers shall follow the guidance in ~~Section-Paragraph~~ 5605.6. Effective energy dissipating structures shall be provided if necessary to meet the requirements stated in Tables 5605-2 and 5606-42. Examples of energy dissipating structures are:

- Check Dams
- Level Spreaders
- Hydraulic Jump Basins
- Impact Baffle Basins
- Plunge Pool and Plunge Basin
- Slotted-Grating or Slotted Bucket Dissipaters
- Stilling Basins
- Rock Revetment
- Internal Pipe Rings

Grade control shall be provided downstream of the dissipator or shall be constructed integrally with it.

The suitability of each method is site dependent and subject to approval by the City/County Engineer. ~~Table 5606-2~~ ~~5606-1~~ lists methods and applicability.

Table 5606-2: Energy Dissipation Counter Measures

Counter Measure	Functional Applications		Suitable Environment			References
	Vertical Control	Horizontal Control	Dam Outlets	Small Culverts	Large Culvert	
Check Dam	X	O	X	X	X	2, 6
Level Spreaders	X	X	O	X	O	1
Hydraulic Jump Basins	X	X	X	X	X	1, 3
Impact Baffle Basins	X	X	X	X	X	1
Plunge Pool & Plunge	X	O	X	X	X	1
Slotted-Grating or Slotted Bucket Dissipators	X	X	X	O	X	1
Stilling Basins	X	O	X	X	X	1, 2, 3, 4, 5, 6
Rock Revetment	X	X	X	X	X	1, 2, 6
Internal Pipe Rings	X	O	N/A	X	N/A	

LEGEND

X = Suitable Countermeasure

O = Marginal Countermeasure

REFERENCES

1. Design of Small Dams 1987 United States Department of Interior
2. HEC 23
3. Hydraulic Design of Stilling Basins and Energy Dissipaters
4. HEC-14 FHWA Hydraulic Design of Energy Dissipaters for Culverts and Channels
5. U.S. Army Corps of Engineers, 1994 Hydraulic Design of Flood Control Channels
6. Hydraulic Design Series (HDS-6)

NOTE: Other means may be used for Energy Dissipation and Stream Stability by designers as accepted by the City/County.

Energy dissipaters shall be designed according to the criteria and procedures defined in professionally acceptable references. Several such references include:

- United States. Department of the Interior. Bureau of Reclamation. Design of Small Dams. 1987 ed. Denver: GPO, 1987.
- United States. Department of the Interior. Bureau of Reclamation. A Water Resource Technical Publication. Engineering Monograph No. 25. Hydraulic Design of Stilling Basins and Energy Dissipaters. 1978 ed. GPO, 1978.
- Federal Highway Administration (FHWA), 1983. Hydraulic Design of Energy Dissipaters for Culverts and Channels, Hydraulic Engineering Circular (HEC) No. 14.
- US Army Corps of Engineers, 1994. Hydraulic Design of Flood Control Channels, US Army Corps of Engineers Engineer Manual EM 1110-2-1601.

- Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance (Latest Edition), National Highway Institute, HEC No. 23.
- River Engineering for Highway Encroachments, Highways in the River Environment, U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA NHI 01-004, December 2001.

~~5606.5~~ **5606.6 Velocity within the System**

The velocity within the system shall be between 3 and 20 feet per second.

~~5606.6~~ **5606.7 Loading**

- A. **Cover:** Minimum depth of cover shall be 18 inches. [Designer shall consider pipe material and loading conditions for additional cover needs.](#)
- B. Minimum Loading Conditions:
 1. Live load: H-20.
 2. Unit Weight of soil cover: 120 lbs/ft³.
 3. Rigid pipes shall be bedded and backfilled to provide a minimum factor of safety of 1.5 at the 0.01-inch crack loading condition.

SECTION 5607 ENGINEERED CHANNELS

5607.1 ~~Introduction~~Design Criteria

The criteria in this section apply to open channels that are not natural. ~~Natural channels~~ Streams are covered in Section 5605. ~~New buffers and filter strips are not required because engineered channels are strictly for conveyance.~~ A storm drainage system shall incorporate an overflow system that is capable of conveying flows in excess of the designed system capacity. Overflow systems can consist of natural drainage path preservation. Engineered channels, ditches, and swales shall be designed to convey the 10-year design storm with the 10% temporal distribution, as defined in Section 5602.

5607.2 Easements

Permanent drainage easements shall be dedicated to the City and allow the City right of entry per the City of Warsaw Code of Ordinances Chapter §700.270. ~~County for operation and maintenance of open channels that will be publicly maintained.~~

- A. **Engineered Channels:** Easements shall be as wide as the top of bank width; plus 10 feet on each side. Easements shall be continuous between street rights-of-way. When an improved channel begins or ends at a point other than the right-of-way of a dedicated street, a 15-foot or wider easement graded so as to permit access by truck shall be dedicated from the end of the channel to a street right-of-way. These are minimum requirements.

Generally, easements shall be required for swales that collect stormwater runoff from more than two acres per Stormwater Drainage Setback requirements defined in 5605.2, or as required by the City/County.

- B. **Roadside Channels:** Roadside ditches are engineered channels that are located wholly or partly within the street right-of-way. ~~When the entirety of the R~~oadside ditch ~~extents is with~~es in the street right-of-way, ~~do not require~~ an easement ~~is not required~~. Otherwise, roadside ditches shall have a dedicated easement from the street right-of-way extending to ~~five~~ 10 feet outside of the top of the outside bank of the channel.

5607.3 Freeboard

Freeboard shall not be required above the design headwater pool elevation at culvert entrance.

5607.4 Channel Linings

- A. Minimum lining height shall be the selected design storm water profile plus at least a 0.5-foot freeboard.
- B. All channel linings, except turf, shall contain provision for relieving back pressures and water entrapment at regular intervals.
- C. Lining height on the outside bend of curves shall be increased by:

$$y = \frac{D}{4}$$

Where:

y = Increased vertical height of lining in feet

D = Depth of design flow in feet

Increased lining height shall be transitioned from y to zero feet over a minimum of:

30 × y feet downstream from the point of tangency (P.T.).

10 × y feet upstream from the point of curvature (P.C.).

5607.5 Lining Material

The types of lining material listed in Table 5607-1 shall be used to control damage and erosion. All riprap, grouted riprap, and gabion linings shall be designed with a filter fabric in conformance with ~~Section-Paragraph~~ 2605.2.C.2. The design of the lining material shall protect the channel for conditions up to the ~~1%~~ 100-year design storm with the 10% temporal distribution or the maximum channel capacity, whichever is less. ~~This criteria may be reduced to the 10% storm if the City/County Engineer approves and if responsibility for repair of channel linings in storms greater than 10% is clearly established.~~

Other types of lining materials not specifically listed in Table 5607-1 may be used when approved by the City/County Engineer.

Concrete lined open channel bottoms are prohibited, unless a waiver to this criterion is granted by the City/County Engineer.

Table 5607-1: Permissible Shear Stresses for Lining Material

Lining Category	Lining Type	Permissible Shear Stress (lbs/ft ²)
General	Erosion Control Blankets	1.55-2.35
	Turf-Reinforced Matrix (TRMs): Unvegetated:	----
		3.0
	Vegetated:	8.0
	Geosynthetic Materials	3.01
	Cellular Containment	8.1
	Woven Paper Net	0.15
	Jut Net	0.45
	Fiberglass Roving:	---
		0.60
		0.85
	Straw With Net	1.45
	Curled Wood Mat	1.55
	Synthetic Mat	2.00
Vegetative (See Table 5607-2)	Class A (see Table 5607-2)	3.70
	Class B (see Table 5607-2)	2.10
	Class C (see Table 5607-2)	1.00
	Class D (see Table 5607-2)	0.60
	Class E (see Table 5607-2)	0.35
Gravel Riprap	25 mm	0.33
	50 mm	0.67
Rock Riprap	150 mm	2.00
	300 mm	4.00

Lining Category	Lining Type	Permissible Shear Stress (lbs/ft ²)
Bare Soil	Non-Cohesive	See Figure 5607-1
	Cohesive	See Figure 5607-2

Table 5607-2: Classification of Vegetal Covers as to Degree of Retardance

Retardance Class	Cover	Condition
A	Weeping Love Grass	Excellent stand, tall (average 760 mm)
	Yellow Bluestem Ischaemum	Excellent stand, tall (average 910 mm)
B	Kudzu	Very dense growth, uncut
	Bermuda Grass	Good stand, tall (average 300 mm)
	Native Grass Mixture (little bluestem, bluestem, blue gamma, and other long and short Midwest grasses)	(Good stand, unmowed)
	Weeping lovegrass	Good stand, tall (average 610 mm)
	Lespedeza sericea	Good stand, not woody, tall (average 480 mm)
	Alfalfa	Good stand, uncut (average 280 mm)
	Weeping lovegrass	Good stand, unmowed (average 330 mm)
	Kudzu	Dense growth, uncut
	Blue Gamma	Good stand, uncut (average 280 mm)
C	Crabgrass	Fair stand, uncut 250 to 1200 mm
	Bermuda grass	Good stand, mowed (average 150 mm)
	Common Lespedeza	Good stand, uncut (average 280 mm)
	Grass-Legume mixture – summer (orchard grass, redtop, Italian ryerass, and common lespedeza)	(Good stand, uncut (150 to 200 mm)
	Centipedegrass	Very dense cover (average 150 mm)
	Kentucky Bluegrass	Good stand, headed (150 to 300 mm)
D	Bermuda grass	Good stand, cut to 60-mm height
	Common Lespedeza	Excellent stand, uncut (average 110 mm)
	Buffalo grass	Good stand, uncut (80 to 150 mm)
	Grass-legume mixture—fall, spring (orchard grass, redtop, Italian, ryegrass, and common lespedeza)	(Good stand, uncut (100 to 130 mm)
	Lespedeza sericea	After cutting to 50-mm height. Very good stand before cutting
E	Bermuda grass	Good stand, cut to height 40-mm
	Bermuda grass	Burned stubble

Note: Covers classified have been tested in experimental channels. Covers were green and generally uniform.

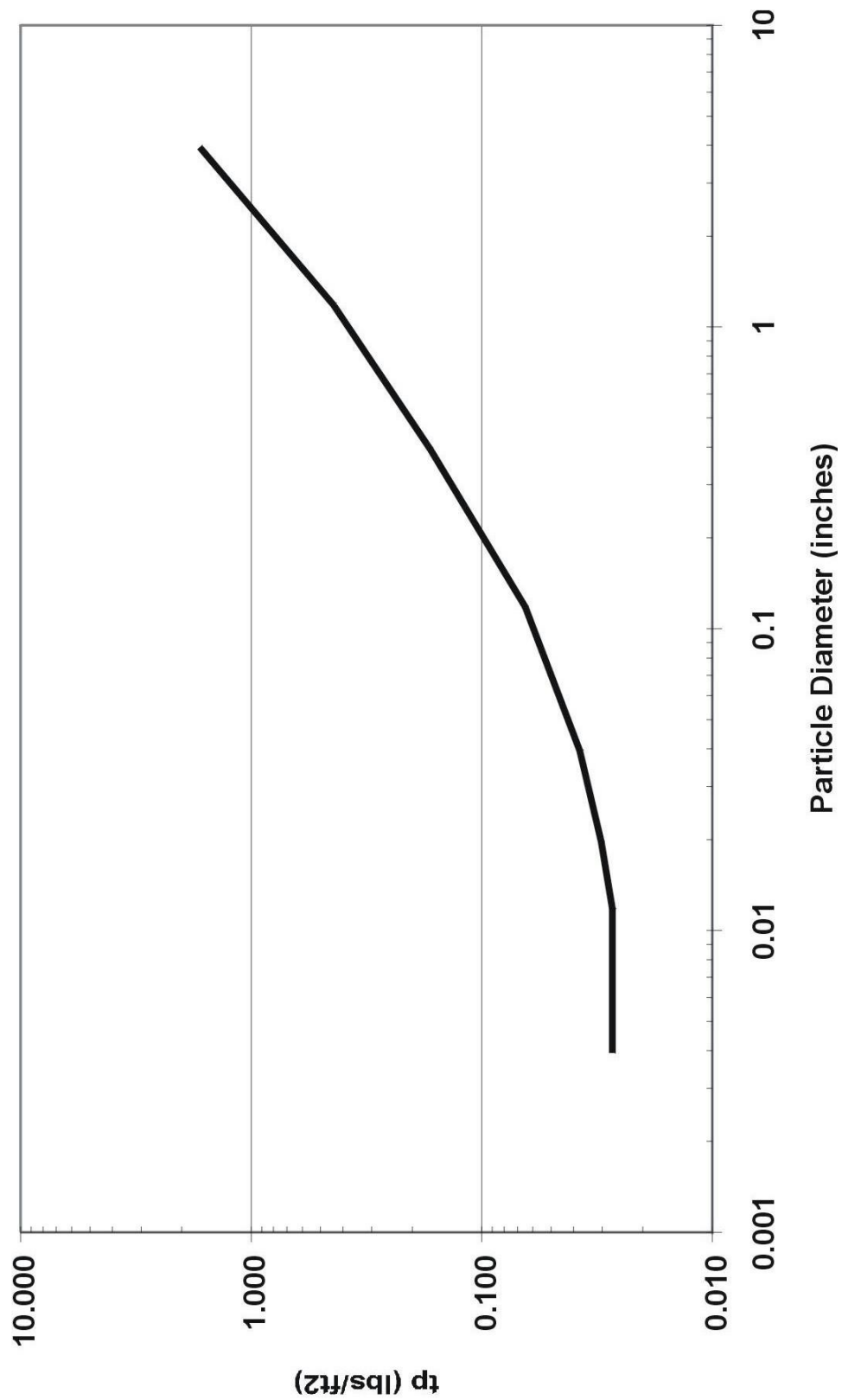


Figure 5607-1: Permissible Shear Stresses for Non-Cohesive Soils

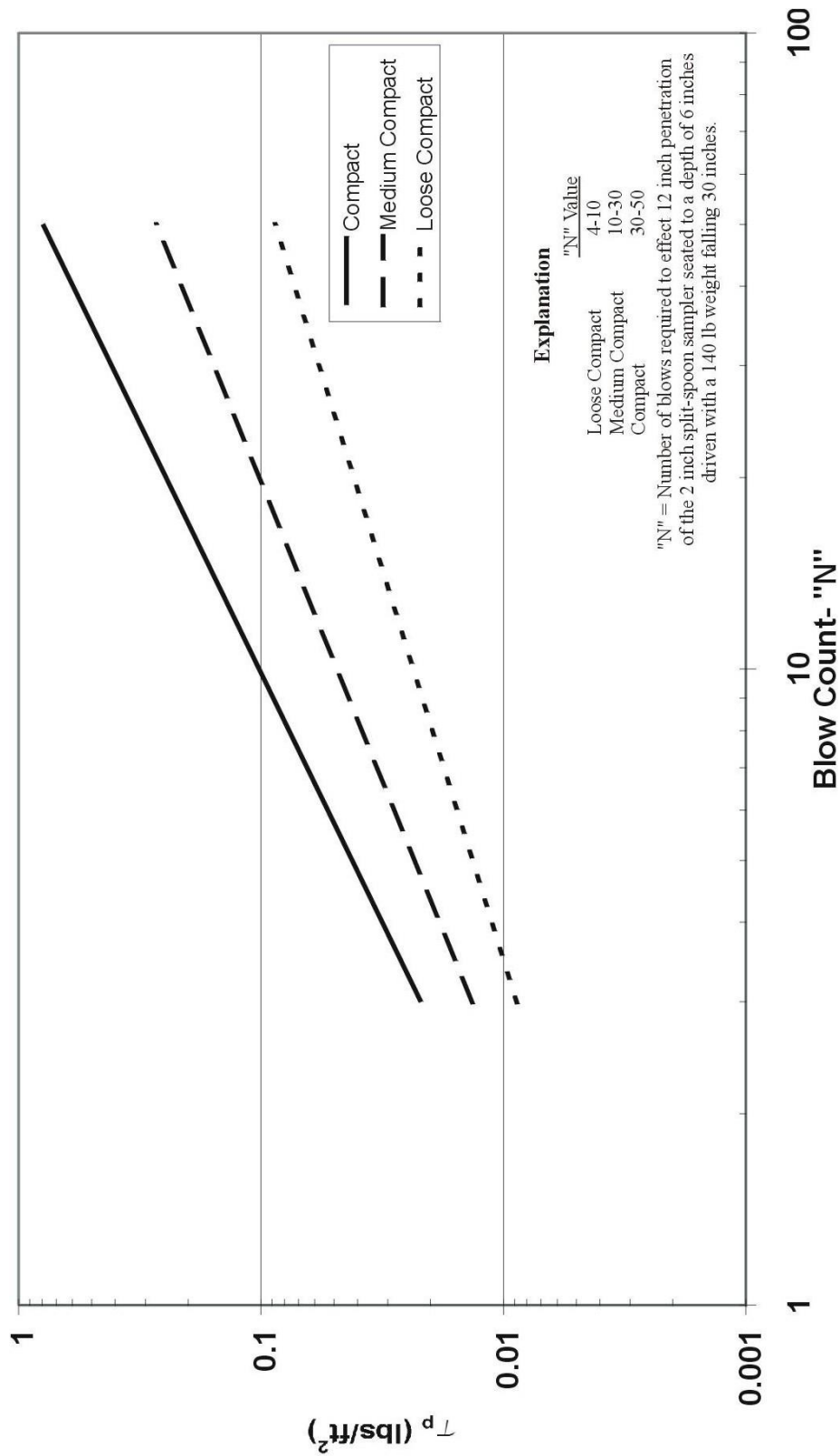


Figure 5607-2: Permissible Shear Stresses for Cohesive Soils

5607.6 Side Slopes

A. Side slopes shall have a vegetated or other lining material cover. Bare soil is not permitted.

~~A.~~B. Side slopes shall not be steeper than:

1. 3:1 (~~horizontal to 1 vertical~~) for vegetative ~~turf~~ lining; 4:1 is preferred.
2. 2.5 horizontal to 1 vertical for all other lining materials, unless a geotechnical analysis indicates a steeper slope can be used.
3. Flatter if necessary to stabilize slopes.

5607.7 Alignment Changes

Alignment changes shall be achieved by curves having a minimum radius of:

$$R = \frac{V^2 \cdot W}{8D}$$

Where:

R = Minimum radius on centerline in feet

V = Design velocity of flow in feet per second

W = Width of channel at water surface in feet

D = Depth of flow in feet

5607.8 Vertical Wall Channels

Vertical walls may be used for structural lining of improved channels when site conditions warrant; subject to the following special requirements:

- A. Walls shall be designed and constructed to act as retaining walls.
- B. Adequate provisions shall be made for pedestrian entry/exit from the channel.

5607.9 Energy Management

- A. Use of grade control structures can be used to manage boundary shear.
- B. Energy dissipation structures should be designed in accordance with Section 5606.

SECTION 5608 STORMWATER RETENTION AND DETENTION ~~AND RETENTION~~

5608.1 ~~Scope~~ Design Criteria

This section governs the requirements and design of stormwater detention and retention facilities.

- A. **Retention:** Stormwater retention shall be provided for the 0.5-inch design storm over the tributary impervious area from the site, calculated as follows:

$$\text{Retention Volume, } V_R = \frac{P_R * I * A}{12}$$

Where:

P_R = Retention rain event, 0.5 inches

I = Impervious percentage (%)

A = Project drainage area (acres)

- B. **Detention:** Stormwater detention shall be provided for peak runoff control of the 2-, 10, and 100-year design storms. Post-improvement peak discharge rates from the site shall not exceed the allowable release rates expressed in discharge rate per tributary area in Table 5608-1.

Table 5608-1: Allowable Release Rate by Tributary Area

Design Storm Average Recurrence Interval	Temporal Distribution	Allowable Release Rate by Tributary Area (cfs/acre)
2-Year	Median (50%)	0.1
10-Year	Median (50%)	0.2
10-Year	10%	2.0
100-Year	10%	3.0

5608.2 Access and Easements

Permanent access and buffers must be provided for maintenance of ~~a~~ detention and retention facilities~~y~~ with the following minimum requirements:

- A. The water surface of the 100-year design storm storage pool shall be a minimum of ~~20~~-10 feet from ~~property lines and~~ building structures ~~unless impermeable liners are used~~. A greater distance may be necessary when the retention/detention facility might compromise foundations or slope stability ~~is a consideration~~.
- B. A ~~15-foot wide~~ 15-foot-wide access strip, with slopes less than 5 horizontal to 1 vertical, shall be provided around the perimeter of the facility, unless it can be demonstrated that all points of the facility can be maintained with less access provided.
- C. The property owner shall also maintain a minimum ~~15-foot wide~~ 15-foot-wide access route to the ~~detention~~ facility(ies) from a street or parking lot with slopes no greater than 5:1 (~~horizontal: vertical~~) in any direction.
- D. Structures, inlet pipes, outlet pipes, spillways, and appurtenances required for the operation of the facility shall also be provided access which is no less than easement widths established in ~~Sections~~ Paragraphs 5606.4.2 and 5607.2.
- ~~D.~~E. Provisions shall be made to permit access and use of auxiliary equipment to facilitate emptying, cleaning, maintenance, or for emergency purposes.
- ~~E.~~F. ~~Easements are frequently not required for detention facilities, because a~~ Detention and retention facilities shall ~~be~~ ~~is typically~~ maintained by the property owner. If the detention facility is not maintained by the property owner or involves multiple ownerships, easements must be dedicated to the party responsible for

maintenance. All drainage easements shall allow the City right of entry per the City of Warsaw Code of Ordinances Chapter §700.270. At a minimum the dedicated easements shall include: 1) the detention pond ~~per se, which extends to the 100-year design storm storage pool elevation and~~ extending 15-feet from top of embankment or 15-feet from the exterior toe of the embankment slope; 2) appurtenances; and 3) access required by ~~Items~~ Paragraphs 5608.2.B through 5608.2.D ~~above~~.

5608.3 Maintenance and Continued Performance

Maintenance responsibility for all elements of the detention ~~and retention~~ facility should be designated prior to construction ~~of any detention facility~~. However, when no designation is made the property owner shall be considered the responsible party. Annual or more frequent inspections shall be made by the responsible party to ~~assure~~ document that all inlet and outlet structures are ~~fully~~ functional as per the design and the ~~detention basin~~ facility has full storage capacity as designed.

~~5608.4~~ 5608.4 Performance Criteria

~~A.~~ General Provisions

- ~~1.—Detention/retention facilities shall have 1,000 acres or less area tributary to the facility.~~
- ~~2.—Dams which are greater than 10 feet in height but do not fall into State or Federal requirement categories shall be designed in accordance with latest edition of SCS Technical Release No. 60, "Earth Dams and Reservoirs", as Class "C" structures.~~
- ~~3.—All lake and pond development must conform to local, state, and federal regulations. Legal definitions and regulations for dams and reservoirs can be found in the Missouri Code of State Regulations, Division 22, and the State of Kansas Rules and Regulations, KSA 82a-301 through 305a.~~

~~B.~~ Computational Methods

- ~~1.—Time of Concentration and Travel Time: Refer to Section 5602 for acceptable hydrology methods.~~
- ~~2.—Temporary Storage Volume: A preliminary value of the storage requirement may be obtained through methods outlined in (SCS, 1986, Chapter 6) or other acceptable methods. The storage shall be checked during routing of design hydrographs through the basin and adjusted appropriately.~~

3. ~~Hydrograph Routing: The storage indication method (Modified Puls) of routing a hydrograph through a detention basin may be utilized. Reference: (Chow, 1964). Under the Comprehensive and Frequent Event Strategies, the water quality orifice is designed to store the water quality storm and drain it within 40 hours. Routing of the other larger storms is then done independently, assuming the water quality storm is not present, but using the water quality orifice as part of the rating curve.~~

C. ~~Release Rates:~~ The maximum release rate from any development under the runoff control strategies outlined in Section 5601.5.A.4 shall be as follows:

1. ~~Comprehensive Control~~

- a. ~~Post-development peak discharge rates from the site shall not exceed those indicated below:~~

~~50% storm peak rate less than or equal to 0.5 cfs per site acre~~

~~10% storm peak rate less than or equal to 2.0 cfs per site acre~~

~~1% storm peak rate less than or equal to 3.0 cfs per site acre~~

- b. ~~40-hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). See Chapter 6 of the MARC/APWA BMP Manual for calculating this volume.~~

2. ~~Frequent Event Control~~

- a. ~~Post-development peak discharge rates from the site shall not exceed those indicated below:~~

~~50% storm peak rate less than or equal to 0.5 cfs per site acre~~

~~10% storm peak rate less than or equal to 2.0 cfs per site acre~~

- b. ~~40-hour extended detention of runoff from the local 90% mean annual event (1.37"/24-hour rainfall). See Chapter 6 of the MARC/APWA BMP Manual for calculating this volume.~~

3. ~~Extreme Flood Event Control~~

- a. ~~Post-development peak discharge rates from the site shall not exceed those indicated below:~~

~~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~~

~~Note: If known flooding occurs downstream in flood events more frequent than the 1% event, the local authority may require control of these events.~~

D. ~~Detention Basin Size~~

1. ~~Owners/engineers may utilize methodology outlined in (SCS, 1986). A 24-hour Type II rainfall distribution shall be the required storm hyetograph. Hydrologic simulation models shall be based on not less than Antecedent Moisture Condition II (see Section 5602.2). Maximum detention storage shall be based upon the allowable release rate and upon the developed condition for the site. Cities and Counties may establish additional standards for other storm sizes in order to provide stream channel and water quality protection.~~

2. **Detention Storage Reduction with Upstream BMPs:** When volumetric control BMPs are implemented on a site, the volume captured by these BMPs may be deducted from the site detention volume required for the 90% mean annual event under the "Frequent Event" and "Comprehensive" control designs. Volumetric BMPs are defined as those BMPs in the MARC/APWA BMP Manual that infiltrate or provide 40-hour extended detention of the 90%

mean annual event runoff (or water quality volume, WQ_v). Volumetric BMPs (per Chapter 4 of the MARC/APWA BMP Manual) include:

- ~~Bioretention~~
- ~~Rain gardens~~
- ~~Infiltration basins and trenches~~
- ~~Bio-swales and wetland swales~~
- ~~Extended detention facilities (including wetlands)~~
- ~~Permeable pavement~~

E. ~~Primary Outlet Works:~~ The primary outlet shall be designed to meet the following requirements:

- ~~1. The outlet shall be designed to function without requiring attendance or operation of any kind or requiring use of equipment or tools, or any mechanical devices.~~
- ~~2. All discharge from the detention facility when inflow is equal to or less than the maximum design storm under the required Strategy shall be via the Primary outlet system.~~
- ~~3. The design discharge rate via the outlet shall continuously increase with increasing head and shall have hydraulic characteristics similar to weirs, orifices or pipes.~~
- ~~4. For dry detention basins not providing extended detention, the design shall allow for discharge of at least 80 percent of the detention storage volume within 24 hours after the peak or center of mass of the inflow has entered the detention basin.~~
- ~~5. Ponds shall be designed with a non-clogging outlet such as a reverse slope pipe, or a weir outlet with a trash rack. A reverse slope pipe draws from below the permanent pool extending in a reverse angle up to the riser and establishes the water elevation of the permanent pool. Because these outlets draw water from below the level of the permanent pool, they are less likely to be clogged by floating debris.~~
- ~~6. All openings shall be protected by trash racks, grates, stone filters, or other approved devices to insure that the outlet works will remain functional. Minimum orifice size shall be per the current version MARC/APWA BMP Manual. See MARC/APWA BMP Manual Sections 8.6, 8.10 and 8.12 for design guidance and typical details for low flow outlets and trash rack designs. Note that multiple design options are available for non-clogging low flow outlets and debris collection and designers are encouraged to select the best design for their site.~~

F. ~~Emergency Spillways:~~ The emergency spillway may either be combined with the outlet works or be a separate structure or channel meeting the following criteria:

- ~~1. **Elevation:** Emergency spillways shall be designed so that their crest elevation is 0.5 feet or more above the maximum water surface elevation in the detention facility attained by the maximum design storm under the required Strategy for the facility.~~
- ~~2. **Capacity:** In cases where the impoundment/emergency spillway is not regulated by either State or Federal agencies, the emergency spillway shall be designed to pass the 1% storm with 1 foot of freeboard from the design stage to the top of dam, assuming zero available storage in the basin and zero flow through the primary outlet. This design provides an added level of protection in the event of a clogged primary outlet or a subsequent 1% storm event that~~

~~occurs before the flood pool from the initial storm event recedes to the principal outlet elevation.~~

- ~~3. **Drawdown Provision:** Drain works consisting of valves, gates, pipes, and other devices as necessary to completely drain the facility in 72 hours or less when required for maintenance or inspection shall be provided.~~
- ~~4. **Erosion Control:** Primary outlet works, emergency spillways, and drain works, as well as conveyance system entrances to detention basins, shall be equipped with energy dissipating devices as necessary to limit shear stresses on receiving channels. See Tables 5605-2 and 5606-2 for shear stress criteria.~~

5608.4 Retention Criteria

- A. Retention-based facilities are designed to either capture and infiltrate or re-use the required retention volume with no discharge from the site for the minimum design event. Retention shall be provided in the form of GSI/stormwater BMPs, as defined in Section 8 of the MARC BMP Manual. For detailed design and construction guidance of GSI practices/stormwater BMPs, see the KCMO GSI Manual. The KCMO GSI Manual includes design guidance for sizing of GSI practices, design considerations and checklists for GSI components, design detail templates, construction specification templates, as well as establishment and maintenance recommendations.
- B. To the maximum extent practicable, retention facilities shall be designed and constructed to use vegetative, rather than mechanical, measures.

~~G.—~~

- ~~H.C.~~ Retention volume shall be provided such that surface ponding is limited to a maximum of 12 inches and draws down within 48 hours after the rain event. Drawdown time may be calculated as follows:

$$t_{drawdown} = \frac{V_{ponding}}{A_{inf} * \left(\frac{k_{sat}}{12}\right)}$$

Where:

$t_{drawdown}$ = Time to draw down surface ponding (hours)

$V_{ponding}$ = Volume of surface ponding layer (acre-ft)

A_{inf} = Infiltration area of retention facility interface with in-situ soils (acres)

K_{sat} = saturated hydraulic conductivity of in-situ soils (inches per hour)

- D. Retention requirements may be achieved in conjunction with detention storage, or independently.

~~5608.4~~5608.5 Detention ~~Methods~~Criteria:

In addition to the foregoing criteria, the following shall be applicable, depending on the detention alternative(s) selected:

- A. **Wet Detention Facility:** For ~~basins~~ detention facilities designed with permanent pools:
 1. Sediment Forebay: A sediment forebay shall be provided to trap coarse particles. Refer to the ~~"Mid-America Regional Council and American Public Works Association; Manual for Best~~

~~Management Practices for Stormwater Quality~~ MARC BMP Manual for typical design specifications and configurations of sediment forebays.

2. Minimum Depth: The minimum normal depth of water before the introduction of excess stormwater shall be four feet plus a sedimentation allowance of not less than 5 years accumulation. Sedimentation shall be determined in accordance with the procedures shown in Figure 5608-1.
3. Depth for Fish: If the pond is to contain fish, at least one-quarter of the area of the permanent pool must have a minimum depth of 10 feet plus sedimentation allowance.
4. Side Slopes: The side slopes shall conform as closely as possible to regraded or natural land contours, and should not exceed three horizontal to one vertical with four to one side slopes being preferred. Slopes exceeding this limit shall require erosion control and safety measures and a geotechnical analysis.
5. ~~Refer to the MARC /APWA BMP Manual for design requirements on~~when designing wet detention facilities ~~providing control of the WQv (Comprehensive and Frequent Event Strategies)~~ for stormwater detention and retention.

6.5.

B. Dry Detention Facility: For ~~basins~~ detention facilities designed to be normally dry:

1. Interior Drainage for non-BMP ~~basins~~ Facilities: ~~Provisions~~ Grading must be incorporated to facilitate interior drainage to outlet structures. Grades for drainage facilities shall not be less than ~~two~~ 0.5 percent on turf. Interior drainage design should not facilitate short circuiting of the facility for the design events.
2. Earth Bottoms: Earth bottoms shall be vegetated.
3. Side Slopes: The side slopes of dry ~~ponds~~ detention facilities should be relatively flat to reduce safety risks and help to lengthen the effective flow path. Slopes shall not be steeper than ~~three~~ 3 (horizontal) to ~~one~~ 1 (vertical), with four to one side slopes being preferred ~~and at least 25% of the perimeter shall have a slope of 5 to 1 or flatter.~~
4. ~~Refer to the MARC/APWA BMP Manual for design requirements on~~when designing dry detention facilities ~~providing control of the WQv (Comprehensive and Frequent Event Strategies)~~ for stormwater detention and retention.

4.

C. Underground Detention: Underground detention facilities consisting of subsurface storage chambers may be allowed at the discretion of the City/County Engineer. Requests for underground detention must be submitted as a Request for Variance in the Drainage Permit and shall meet the following requirements:

1. A minimum of two (2) access points shall be provided for maintenance and inspection activities.
2. Maintenance access points should be located at opposite ends of the system, and horizontal bends in the alignment greater than 45 degrees.
3. Maintenance access points shall be sized accordingly for maintenance activities.
4. Maintenance access points should be at least 6 inches in any dimension for 45-degree vertical bends.

5. Maintenance access points should be at least 8 inches in any dimension for 90-degree vertical bends.

C.D. Green Roof/Rooftop Storage: Detention storage may be met in ~~total or in~~ part by detention on roofs, ~~as a green roof~~. Details of such designs shall include the depth and volume of storage, details of outlet devices and down drains, elevations and details of overflow scuppers, and emergency overflow provisions. Connections of roof drains to sanitary sewers are prohibited. Design loadings and special building and structural details shall ~~be~~ subject to approval by the City/County Engineer.

D.E. Parking Lot Storage: Paved parking lots may be designed to provide temporary detention storage of stormwater on a portion of their surfaces. Generally, such detention areas shall be in the more remote portions of such parking lots. Depths of storage shall be limited to a maximum depth of nine inches, and such areas shall be located so that access to and from parking areas is not impaired.

~~E. Other Storage: All or a portion of the detention storage may also be provided in underground or surface detention areas, including, but not limited to, oversized storm sewers, vaults, tanks, swales, etc.~~

F. General Provisions

1. Detention/~~retention~~ facilities shall have 1,000 acres or less area tributary to the facility.
2. If the detention facility embankment meets state classification parameters for a dam, then facility shall be designed per state requirements. Dams shall permitted through the state following state guidelines. ~~Dams which are greater than 10 feet in height but do not fall into State or Federal requirement categories shall be designed in accordance with latest edition of SCS Technical Release No. 60, "Earth Dams and Reservoirs", as Class "C" structures.~~
3. All lake and pond development must conform to local, state, and federal regulations. Legal definitions and regulations for dams and reservoirs can be found in the Missouri Code of State Regulations, Division 22, ~~and the State of Kansas Rules and Regulations, KSA 82a-301 through 305a.~~

G. Computational Methods

1. Time of Concentration and Travel Time: Refer to Section 5602 for acceptable hydrology methods.
- ~~2. Temporary Storage Volume: A preliminary value of the storage requirement may be obtained through methods outlined in (SCS, 1986, Chapter 6) or other acceptable methods. The storage shall be checked during routing of design hydrographs through the basin and adjusted appropriately.~~
- ~~3.2.~~ Hydrograph Routing: The storage indication method (Modified Puls) of routing a hydrograph through a detention ~~basin facility~~ may be utilized. Reference: (Chow, 1964). ~~Under the Comprehensive and Frequent Event Strategies, the water quality orifice is designed to store the water quality storm and drain it within 40 hours.~~ If retention and detention are provided within the same facility, the retention component shall be designed to store the retention volume with no outflow from the facility. Routing of the other larger storms is then done independently, assuming the ~~water quality storm is not present, but~~ retention volume is available and using the ~~water quality orifice as~~ modeling all outlet orifices as part of the rating curve.

H. Detention ~~Basin Facility~~ Size: Owners/engineers may utilize methodology outlined in (SCS, 1986). 6-hour duration, first quartile temporal distributions for Region 3 from NOAA Atlas 14 Volume 8 shall be the required storm hyetograph as defined in Table 5602-2. ~~A 24-hour Type II rainfall distribution shall be the required storm hyetograph. Hydrologic simulation models shall be based on not less than Antecedent~~

~~Moisture Condition II (see Section 5602.2).~~ Maximum detention storage shall be based upon the allowable release rate ~~defined in Table 5608-1~~ and upon the developed condition for the site. ~~Cities and Counties may establish additional standards for other storm sizes in order to provide stream channel and water quality protection.~~

~~1. **Detention Storage Reduction** with Upstream BMPs: When volumetric control BMPs are implemented on a site, the volume captured by these BMPs may be deducted from the site detention volume required for the 90% mean annual event under the "Frequent Event" and "Comprehensive" control designs. Volumetric BMPs are defined as those BMPs in the MARC/APWA BMP Manual that infiltrate or provide 40-hour extended detention of the 90% mean annual event runoff (or water quality volume, WQ_v). Volumetric BMPs (per Chapter 4 of the MARC/APWA BMP Manual) include:~~

- ~~• Bioretention~~
- ~~• Rain gardens~~
- ~~• Infiltration basins and trenches~~
- ~~• Bio-swales and wetland swales~~
- ~~• Extended detention facilities (including wetlands)~~
- ~~• Permeable pavement~~

I. **Primary Outlet Works:** The primary outlet shall be designed to meet the following requirements:

~~1. The outlet shall be designed to function without requiring attendance or operation of any kind or requiring use of equipment or tools, or any mechanical devices.~~

~~2.1.~~ All allowable discharge from the detention facility when inflow is equal to or less than the 2-year and 10-year design storms with 50% ~~(-)~~ median (50%) temporal distribution ~~maximum design storm under the required Strategy~~ shall be via the ~~Primary~~ primary outlet system.

~~3.2.~~ The design discharge rate via the outlet shall continuously increase with increasing head and shall have hydraulic characteristics similar to weirs, orifices or pipes.

~~4.3.~~ ~~For dry detention basins facilities not providing extended detention, the design shall allow for discharge of at least 80 percent of the detention storage volume within 24 hours~~ Detention time for any design storm shall not exceed 72 hours after the peak or center of mass of the inflow has entered the detention ~~basin~~ facility.

~~5.4.~~ ~~Ponds~~ Wet detention facilities shall be designed with a non-clogging outlet such as a reverse-slope pipe, or a weir outlet with a trash rack. A reverse-slope pipe draws from below the permanent pool extending in a reverse angle up to the riser and establishes the water elevation of the permanent pool. Because these outlets draw water from below the level of the permanent pool, they are less likely to be clogged by floating debris.

~~6.5.~~ All openings shall be protected by trash racks, grates, stone filters, or other devices approved ~~devices to insure that the outlet works will remain functional by the City/County Engineer.~~

Minimum orifice size shall be per the current version MARC BMP Manual. See MARC BMP Manual Sections 8.6, 8.10 and 8.12 for design guidance and typical details for low-flow outlets and trash rack designs. Note that multiple design options are available for non-clogging low

flow outlets and debris collection and designers are encouraged to select the best design for their site.

- J. **Emergency-Primary Spillways:** The ~~emergency-primary~~ spillway may either be combined with the outlet works or be a separate structure or channel meeting the following criteria:
1. **Elevation:** ~~Emergency-Primary~~ spillways shall be designed so that ~~their crest elevation~~ the top of the embankment is 0.5 feet or more above the maximum water surface elevation in the detention facility attained by the maximum design storm ~~under the required Strategy~~ for the facility. The 10-year and 100-year design storms with 10% temporal distribution may utilize the primary spillway to safely pass the peak discharge but shall not exceed the maximum release rates and shall not overtop the embankment.
 2. **Capacity:** In cases where the impoundment/~~emergency-primary~~ spillway is not regulated by either State or Federal agencies, the ~~emergency-primary~~ spillway shall be designed to pass the ~~4%100-year design storm with 10% temporal distribution storm~~ with ~~4-0.5 foot-feet~~ of freeboard from the design stage to the top of dam, assuming zero available storage in the ~~basin~~ facility and zero flow through the primary outlet. This design provides an added level of protection in the event of a clogged primary outlet or a subsequent ~~4%100-year design storm event~~ that occurs before the flood pool from the initial storm event recedes to the principal outlet elevation.
- K. **Drawdown Provision:** Drain works consisting of valves, gates, pipes, and other devices as necessary to completely drain the facility in 72 hours or less when required for maintenance or inspection shall be provided.
- L. Retention facilities shall be designed with sufficient volume to capture the required Retention Volume (V_R) tributary to the facility. Multiple facilities may be required to meet retention requirements for the entire site. Retention facilities may provide storage capacity in the surface ponding layer, subsurface soil, aggregate or piping layers, or a combination thereof. The provided retention volume may be calculated as follows:

$$V_{provided} = \sum_{layer} n \cdot V_{layer}$$

Where:

$V_{provided}$ = Retention volume provided by the green stormwater infrastructure/post-construction permanent stormwater BMP facility

n = porosity of layer material (decimal) per Table 5608-2

V_{layer} = Volume of layer material (acre-ft)

Table 5608-2: Porosity Assumptions for Common Materials

Material	Description	Porosity (n)
Clean ¹ Gravel	ASTM C33 Coarse Aggregates	0.40
	No. 2	
	No. 3	
	No. 56 No. 57	
Clean ¹ Pea Gravel	ASTM C33 Coarse Aggregates	0.35
	No. 8	
	No. 89 No. 9	
Sand	ASTM C33 Fine Aggregate	0.32

Bioretention Soil Media (BSM)	Sandy Clay Loam (NRCS Soil Texture Classification)	0.30
Notes: (1) "Clean" shall indicate washed aggregates, free of fines, as determined by less than 1% passing the No. 200 sieve.		

L.M. Erosion Control: Primary outlet works, emergency spillways, and drain works, as well as conveyance system entrances to detention ~~basins~~ facilities, shall be equipped with energy dissipating devices as necessary to limit shear stresses on receiving channels. See Tables 5605-2 and 5606-2 for shear stress criteria.

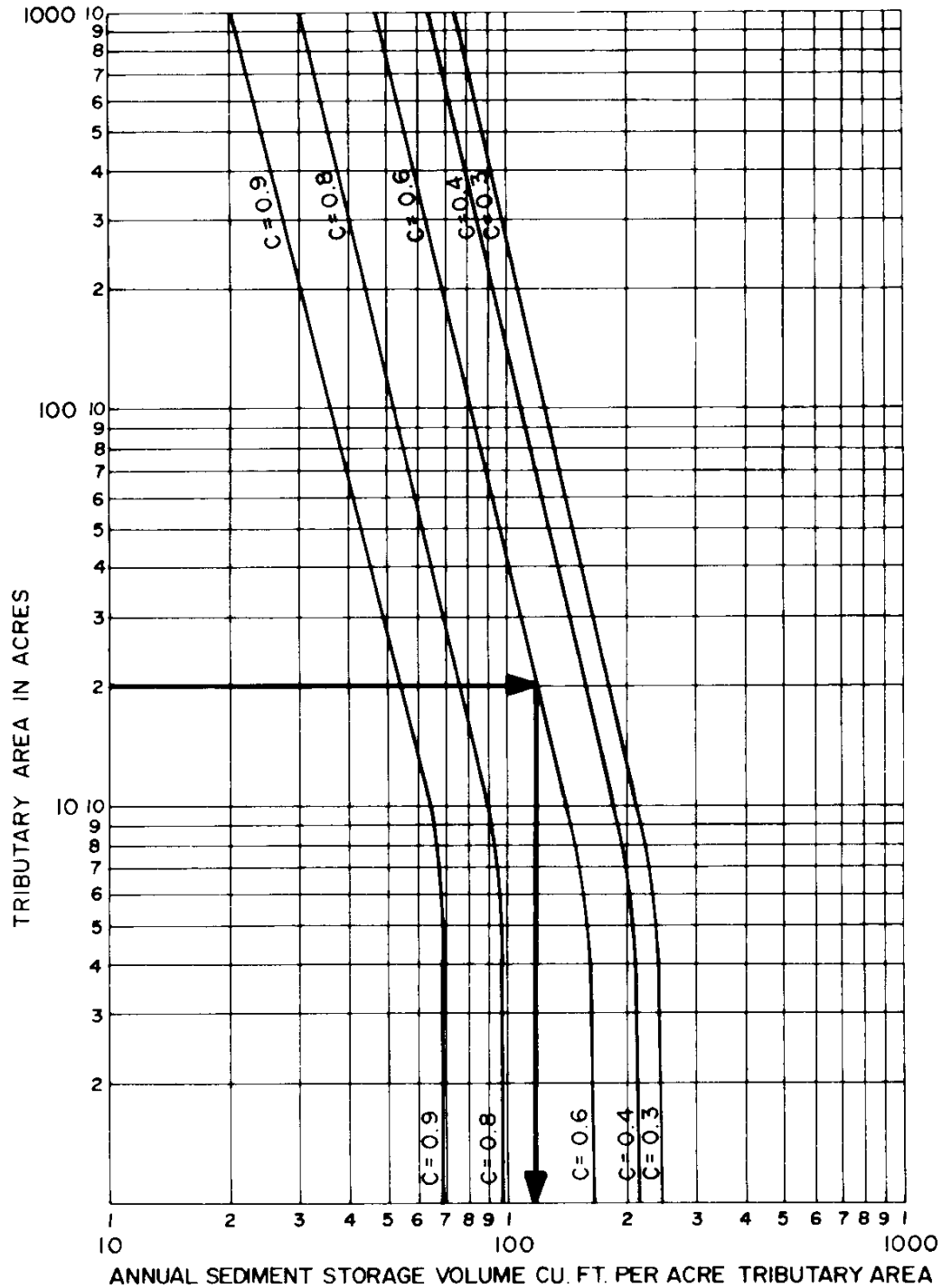
EXAMPLE:

TRIBUTARY AREA = 20 ACRES

RATIONAL METHOD RUNOFF COEFFICIENT "C" = 0.6

SEDIMENT STORAGE = 120 CU. FT. PER ACRE PER YEAR

TOTAL SEDIMENT STORAGE = $120 \times 20 = 2400$ CU. FT. PER YEAR.



5608.5

Figure 5608-1: Annual Sediment Storage

5608.6 Required Submittals:

- ~~A. The Owner shall submit the following information and data to the City/County Engineer.~~
- ~~1. Elevation-area-volume curves for the storage facility including notation of the storage volumes allocated to runoff, sediment, and permanent residual water storage for other uses (wet basins only).~~
 - ~~2. Inflow hydrographs for all (1, 10, and 50 percent) design storms.~~
 - ~~3. Stage-discharge rating curves for each emergency spillway, primary outlet works and combined outlets and overflows.~~
 - ~~4. Routing curves for all (1, 10 and 50 percent) design storms with time plotted as the abscissa and the following plotted as ordinates:
Cumulative inflow volume
Cumulative discharge
Stage elevation
Cumulative storage.~~
 - ~~5. Drainage Study when a waiver is requested by the Developer. See Section 5609 for minimum requirements.~~

5608.7 Additional Requirements

- ~~A. **Access:** Provisions shall be made to permit access and use of auxiliary equipment to facilitate emptying, cleaning, maintenance, or for emergency purposes.~~
- ~~— **Underground Storage:** Underground detention facilities shall be designed with adequate access for maintenance (cleaning and sediment removal). Such facilities shall provide with positive gravity outlets. Venting shall be sufficient to prevent accumulation of toxic or explosive gases.~~

SECTION 5609~~PLAN~~ SUBMITTAL REQUIREMENTS

5609.1 Scope

The section governs the preparation of the Stormwater Drainage Permit and construction plans for the stormwater ~~system~~ management components of projects.

5609.2 ~~General~~ Stormwater Drainage Permit Requirements

A Stormwater Drainage Permit per the City of Warsaw Code of Ordinances Chapter §405.020 is required to demonstrate compliance with this design criteria. The purpose of the drainage permit is to identify existing and potential drainage issues and delineate required stormwater infrastructure early in the development process so that stormwater management is proactively planned for with improvements. The Stormwater Drainage Permit shall include the following items and associated project details:

- A. **Watershed Location Map:** designer shall develop a watershed location map to identify the project's location within the watershed, which shall depict the following:
 - 1. Watershed boundary and area (acres)
 - 2. Delineated drainage area to the project (acres)
 - 3. Natural drainage paths (may reference Appendix A Warsaw Natural Drainage Paths, 2016 LiDAR-based delineation)
 - 4. Water bodies (lakes, rivers, streams, creeks, wetlands, etc.)
 - 5. Stormwater retention/detention facility location(s) in watershed affecting stormwater management at project site (if applicable)
 - 6. Conveyance route for overflow system to downstream destination of runoff
- B. **Existing and Proposed Site Conditions Maps:** the designer shall develop a Site Conditions Map to compare existing site drainage with proposed site drainage. This map is used to verify that proposed site conditions mimic natural topography, maintain overland drainage paths, and provide appropriate stormwater drainage setbacks to protect natural resources. The following shall be depicted on the Site Conditions Map:
 - 1. Existing Site Conditions
 - a. Existing contours
 - b. Aerial imagery
 - c. Water bodies (lakes, rivers, streams, creeks, wetlands, etc.)
 - d. Utilities, including existing stormwater infrastructure
 - e. Natural drainage paths
 - f. Parcel boundaries
 - g. Impervious surfaces and types (i.e. building, parking lot, etc.)
 - h. Key statistics (areas of boundaries, area of impervious surfaces, etc.)
 - 2. Proposed Site Conditions
 - a. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information
 - b. Utilities, including existing stormwater infrastructure

- c. Overland drainage paths
 - d. Parcel boundaries
 - e. Impervious surfaces and types (i.e. building, parking lot, etc.)
 - f. Stormwater improvements (i.e. detention/retention facilities, open and enclosed conveyance systems, storm drainage structures, etc.)
 - g. Drainage easements depicting maintained stormwater drainage setbacks and dimensions
- C. Stormwater Improvement Calculation Tables:** include the following calculation tables for applicable stormwater drainage system components, detailed in the Stormwater Drainage Permit application.
- 1. Hydrology
 - 2. Conveyance
 - 3. Collection (Inlets)
 - 4. Retention
 - 5. Detention

~~The plans shall include all information necessary to build and check the design of storm drainage systems and related appurtenances. The plans shall be arranged as required by the City Engineer of local governing agency. Applicable standard plans of the local governing agency may be included in whole or by reference. Plans shall be sealed by a Registered Professional Engineer in the state of the City or governing agency and shall be submitted to the local governing agency for review.~~

~~5609.2~~5609.3 Type of Sheets in Construction Plans

The plans shall include all information necessary to build and check the design of storm drainage systems and related appurtenances. The plans shall be arranged as required by the City/County Engineer. Applicable standard plans of City/County may be included in whole or by reference.

Plans shall be sealed by a Registered Professional Engineer in the state of Missouri and shall be submitted to the City/County for review.

The plans shall consist of:

- A. Title sheet
- B. General layout sheets
- C. Plan and profile sheets
- D. Cross-section sheets including GSI/stormwater BMP section details
- E. Drainage area map and table
- F. Standard and special detail sheets
- G. Traffic control plans (if required)
- H. Temporary erosion control plans including control and protection plans for GSI/stormwater BMPs
- I. Grading plans (if required) including retention and detention design parameters
- J. Property line and easement sheets (if required)
- K. Each sheet shall contain a sheet number, including the individual sheet number and the total number of sheets, proper project identification and all revision dates. ~~The~~

- L. Engineer's seal shall appear on the title sheet and other sheets as required by the State licensing requirements.

~~5609.3~~5609.4 Sheet Sizes

The suggested sheet size is 22 inches by ~~36~~34 inches (full-size) with all text legible when printed to half-size scale (11 inches by 17 inches) ~~with 2 inch binding margin along the left end of the sheets~~. All sheets in a given set of plans shall be of the same size. Plan and profile shall be drawn on combined or separate plan and profile sheets to minimum scales indicated herein.

~~5609.4~~5609.5 Scales

Plans shall be drawn at the minimum scales indicated in Table 5609-1. Other scales may be needed to clearly present the design. Bar Scales shall be shown on each sheet for each scale.

Table 5609-1: Drawing Scales

<u>Drawing Type</u>	<u>Scale</u>
Plan	1 inch = 20 feet
Profile	
Horizontal	1 inch = 5 feet
Vertical	1 inch = 20 feet
Cross Sections	
Horizontal	1 inch = 5 feet
Vertical	1 inch = 10 feet
Drainage Area Map	
Onsite	1 inch = 5 feet
Offsite	1 inch = 10 feet
Structural Plans	¼ inch = 1 foot

~~5609.5~~5609.6 Required Information for Title Sheet:

- A. Name of project
- B. Project number
- C. Index to sheets
- D. A location map adequately showing the project location in relation to major streets, with north arrow and scale. Map shall be oriented with north arrow up
- E. A signature block for ~~local governing agency~~City/County approval
- F. Name, address and telephone number of the consulting engineer and owner/developer as well as signature block for the owner/developer
- G. A legend of symbols shall be shown that apply to all sheets
- H. List containing name and telephone number of each utility company and state One-Call system
- I. Engineer's seal, signed and dated
- J. Other information as per ~~local governing agency~~City/County requirements

~~5609.6~~5609.7 Required Information for General Layout Sheet:

- A. General Notes: Minor construction notes shall appear on the proper plans and profile sheets

- B. North arrow and bar scale. North arrow shall be oriented up or to the right
- C. Surveyed or aerial base map detail indicating existing man-made or natural topographical features, such as buildings, fences, trees, channels, ponds, streams, etc... and proposed and existing utilities
- D. Subdivision information including, but not limited to, rights-of-way; property and lot lines; existing and proposed easements; subdivision nomenclature; street names; and other pertinent information impacting the project
- E. Identification and location of all existing and proposed drainage features
- F. Elevation and location of all applicable benchmarks: ~~NGVD datum shall be or~~ as required by ~~local governing agency~~ ~~the City/County~~. A minimum of two (2) benchmarks are required for each project
- G. Survey control line or base line with adequate ties to land lines
- H. Locations of test borings if taken
- I. Existing and finish grade contours at intervals of 2.0 feet or less in elevation; or equivalent detail indicating existing and finish grades and slopes
- J. A uniform set of symbols subject to the approval of the ~~local governing agency~~ ~~C-city/County~~
- K. Addresses of homes abutting the projects, and current homeowner names associated with properties impacted by the project

5609.75609.8 Required Information for Plan and Profile Sheets:

- A. North arrow and bar scale. North shall be oriented ~~such that profile alignments are shown from downstream to upstream, left to right, respectively.~~ ~~up or to the right~~
- B. Ties to permanent reference points for each system
- C. A uniform set of symbols subject to the approval of the ~~local governing agency~~ ~~City/County~~
- D. Existing man-made and natural topographic features, such as buildings, fences, trees, channels, ponds, streams, etc., and all existing and proposed utilities
- E. Identification and location of each storm drainage segment and existing utilities affecting construction
- F. Length, size and slope of each line or channel segment. The profile shall indicate the hydraulic grade line of the underground as well as the overland design flows
- G. Right-of-Way, property, easement lines and street names
- H. The 1 percent floodplain and setback from the top of bank of an open channel to any building
- I. Location of test borings
- J. Existing and finish grade contours at intervals of ~~2~~1.0 feet or less in elevation; or equivalent detail in profiles and cross-sections indicating existing and finish grading
- K. Headwater elevation at the inlet end of each culvert
- L. Invert elevations in and out and top elevations of each structure shall be shown. ~~At least two elevations shall be shown for inlet tops matching sloped grades~~
- M. Each utility line crossing the alignment shall be properly located and identified as to type, size and material. This information shall be to the best information available and provided through records, field prospecting and or excavation
- N. Test borings representing depth of drilled hole and refusal elevation if applicable
- O. All station and invert elevations of manholes, junction boxes, inlets and other significant structures

- P. The profile shall show existing grade above the centerline as a dashed line, proposed Finish grades or established street grades by solid lines; and shall show the flow line of any drainage channel, either improved or unimproved, within 50-feet of either side of centerline. Each line shall be properly identified. The proposed sewer shall be shown as double solid lines properly showing the top and bottom of pipe
- Q. All structures shall be shown and labeled with appropriate drawing references

~~5609.8~~5609.9 Cross-Section Sheets

Cross-sections shall be drawn for all open channels and GSI/stormwater BMPs. Sections for channels shall be at appropriate intervals not greater than 50 feet or at any changes to the section geometry. Additional cross sections shall be drawn at all structures and intersecting drainage systems. Cross sections shall also provide for overflow drainage paths that are designated to convey overland flows in excess of underground system capacity. The following shall be indicated on each section:

- A. Ties from centerline to base line.
- B. Existing and proposed grades.
- C. Elevation of proposed flow-lines.
- D. Cut and fill end areas if required for bid quantities.
- ~~D.~~E. GSI/stormwater BMPs sections shall specify media depths and pertinent piping/structure configurations and elevations. A summary table shall be included summarizing GSI/stormwater BMP target and provided storage volumes. This information may be included with the cross-sections, or, the grading plan sheets per Paragraph 5609.14. See the KCMO GSI Manual for additional recommendations and details to include for GSI components.

~~5609.9~~5609.10 Drainage Area Map

The drainage area map shall be supported by a drainage table tabulating the physical properties of the drainage sub-basins, as well as the hydrologic and hydraulic properties of the design. The drainage map shall have the following.

- A. North arrow and bar scale. North shall be oriented up or to the right.
- B. Drainage area boundaries for all watersheds including sub-watersheds of analysis including pass through waters, inlet drainage areas, culvert drainage areas and other points of interest.
- ~~B.~~C. Natural drainage paths (may reference Appendix A Warsaw Natural Drainage Paths, 2016 LiDAR-based delineation).
- ~~C.~~D. Drainage system nomenclature matching that on the "designed" systems shown in the plans.

~~5609.10~~5609.11 Standard and Special Detail Sheets

Detail sheets shall be included to show all details of appurtenances, materials and construction. Details shall conform to the requirements of the ~~local governing agency~~ City/County and are to be drawn clearly and neatly with proper identifications, dimensions materials and other information necessary guide desired construction. Details shall be provided for all GSI/stormwater BMP components specified in the cross sections (Paragraph 5606.9) and grading plans (Paragraph 5609.14). See the KCMO GSI Manual for additional recommendations and details to include for GSI components.

~~5609.11~~5609.12 Traffic Control Plans (if required)

Traffic control plans shall conform to design and principals contained the most recent copy of Manual of Uniform Traffic Control Devices (MUTCD).

~~5609.12~~5609.13 Temporary Erosion Control Plan Sheets

- A. Each temporary erosion control feature designation shall be shown in its proper location on the plans
- B. Temporary erosion control devices shall be detailed in the plans as necessary.
- C. Notes shall be included in the plans indicating that the erosion control systems shall be monitored throughout the project life and maintained and adjusted as necessary to control erosion.
- D. Erosion control plans shall be shown and be designed specific to each phase of development or construction.
- ~~D.~~E. Erosion control plans shall provide for internal site erosion control and protection for all green stormwater infrastructure/post-construction permanent stormwater BMPs. Internal erosion control plans shall include identification and protection of areas and soil/aggregate media intended for infiltration with notes describing maintenance requirements for protection measures, timing for installation, replacement, and permanent removal.

~~5609.13~~5609.14 Grading Plan Sheets (if required)

Grading plan sheets shall be included as required by the ~~local governing agency~~City/County. The grading plans shall incorporate information concerning the changes in the land geometry to accommodate the development. It shall include but not be limited to:

- A. ~~e~~Existing and proposed contours
- B. Contour and/or spot elevations for all retention/detention facilities, including GSI/stormwater BMPs. Include a summary table specifying facility stage (elevation), storage, and discharge relationships with associated design storm water surface elevations.
- C. ~~b~~Building and finished floor elevations
- D. ~~e~~Curb elevations
- E. ~~r~~Retaining wall elevations ~~and other information pertinent to the site.~~
- ~~A.~~F. Sufficient spot elevations to verify storage depths, slope and finished grade elevation requirements meet the design criteria specified herein.

~~5609.14~~5609.15 Property Line and Easement Sheets

Separate property line and easement sheets may be required ~~by the local governing agency~~to adequately show required stormwater drainage setbacks. The information on this sheet shall be sufficient to display the existing and proposed property line and easement changes relative to the project.

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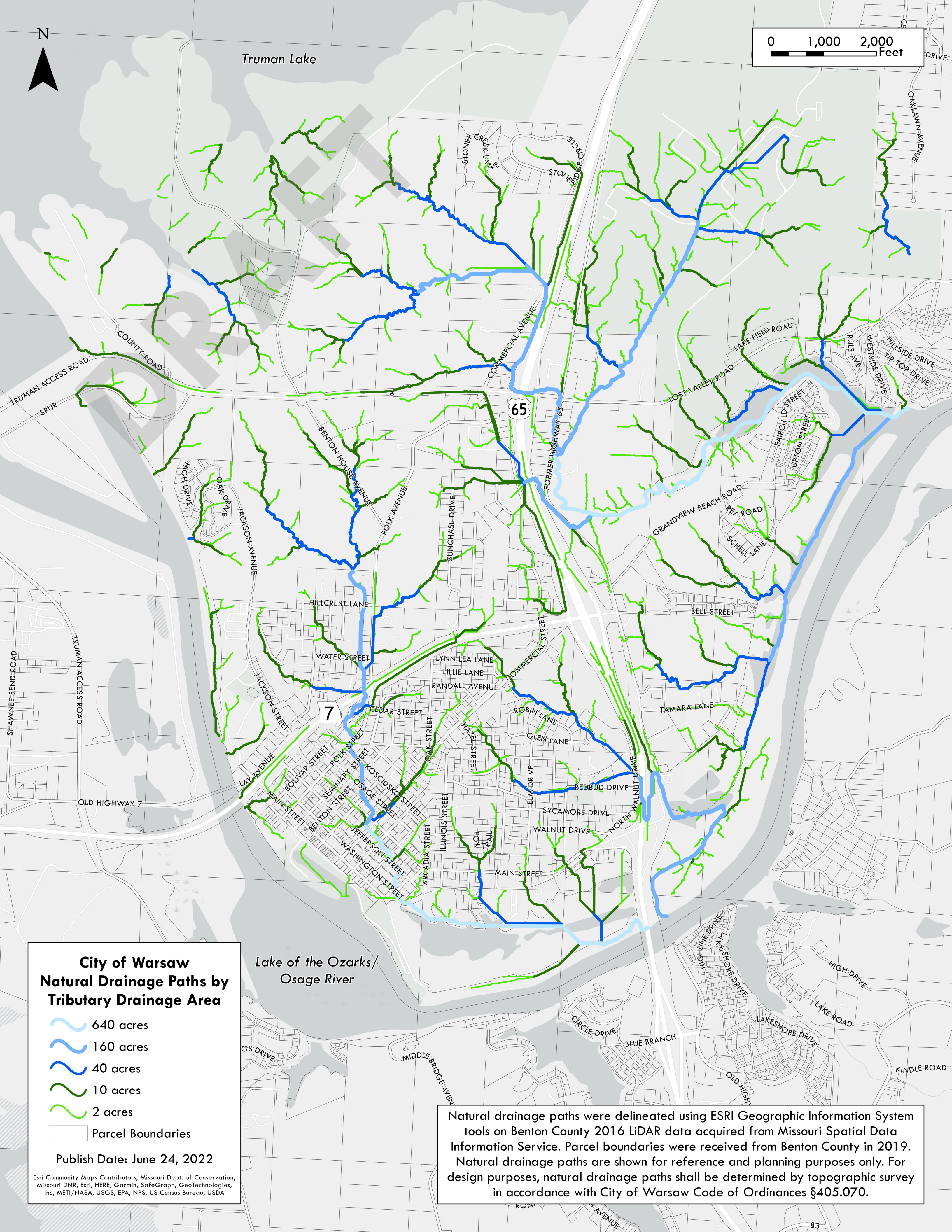
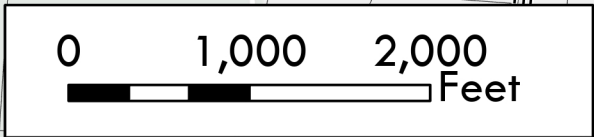
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APPENDIX A

~~Microsoft Visual Basic Function for Inlet Interception Calculations~~
Warsaw Natural Drainage Paths
(2016 LiDAR-based delineation)



City of Warsaw Natural Drainage Paths by Tributary Drainage Area

- 640 acres
- 160 acres
- 40 acres
- 10 acres
- 2 acres

Parcel Boundaries

Publish Date: June 24, 2022

Esri Community Maps Contributors, Missouri Dept. of Conservation, Missouri DNR, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA

Natural drainage paths were delineated using ESRI Geographic Information System tools on Benton County 2016 LiDAR data acquired from Missouri Spatial Data Information Service. Parcel boundaries were received from Benton County in 2019. Natural drainage paths are shown for reference and planning purposes only. For design purposes, natural drainage paths shall be determined by topographic survey in accordance with City of Warsaw Code of Ordinances §405.070.

The following is a Microsoft Visual Basic function that can be added to a Microsoft Excel (97 or later) worksheet or template for inlet intercept calculations.

```
Function InletIntercept(slope, Qt, Optional CrossSlope = 2, _
    Optional Length = 4#, Optional CurbType = "A",
    Optional Metric = False)
'
' InletIntercept Macro
' Determine the intercept ratio for setback curb
' inlets given length of opening, q, slope and cross slope
' All inputs in english units.
' Function written 04/19/1999 by Michael S. Ross
'
Dim a As Double, b As Double, c As Double, d As Double
Dim x As Double, Qo As Double, Qa As Double
Dim strAlert As String

CurbType = UCase(CurbType)
If CurbType <> "A" And CurbType <> "B" Then
    strAlert = "Curb type must be one of 'A' or 'B'. 'A' assumed. "
    CurbType = "A"
End If
If slope >= -0.00001 And slope <= 0.00001 Then
    InletIntercept = Qt
Else
    Select Case CurbType
    Case "A"
        Select Case CrossSlope
        Case 2
            If Metric Then
                a = -0.12
                b = 0.03
                c = 1.07
                d = 0.24
                x = -0.7
            Else
                a = -0.4
                b = 0.1
                c = 3.5
                d = 0.8
                x = -0.7
            End If
        Case 4
            If Metric Then
                a = -0.09
                b = 0.09
                c = 1.31
                d = 0.76
                x = -0.8
            Else

```

```

        a = -0.3
        b = 0.3
        c = 4.3
        d = 2.5
        x = -0.8
    End If
Case Else
    strAlert = strAlert & "Cross slope must be either 2% or 4%," &
-
    "other cross slopes were not modelled. Assuming 2%."
"
    If Metric Then
        a = -0.12
        b = 0.03
        c = 1.07
        d = 0.24
        x = -0.7
    Else
        a = -0.4
        b = 0.1
        c = 3.5
        d = 0.8
        x = -0.7
    End If
End Select
Case "B"


---


    Select Case CrossSlope
    Case 2
        If Metric Then
            a = 0.3
            b = 0#
            c = 0.98
            d = 0.52
            x = -0.5
        Else
            a = 1#
            b = 0#
            c = 3.2
            d = 1.7
            x = -0.5
        End If
    Case 4
        If Metric Then
            a = 0.46
            b = 0.15
            c = 0.79
            d = 0.58
            x = -0.5
        Else
            a = 1.5
            b = 0.5

```



```

        c = 2.6
        d = 1.9
        x = -0.5
    End If
Case Else
    strAlert = strAlert & "Cross slope must be either 2% or 4%," &
-
    "other cross slopes were not modelled. Assuming 2%."
"
    a = 1#
    b = 0#
    c = 3.2
    d = 1.7
-
    x = -0.5
End Select
End Select
Qo = (a + (b * Length)) * (slope) ^ x
Qa = (c + (d * Length)) * (slope) ^ x
If Qt <= Qo Then
    InletIntercept = Qt
Else
    InletIntercept = Qo + (Qa - Qo) * (1 - Exp(-((Qt - Qo) / (Qa -
Qo))))
End If
End If
If strAlert <> "" Then MsgBox strAlert, vbExclamation
End Function

```

APPENDIX C: DRAINAGE PERMIT APPLICATION

Instructions

All information should be entered into the light blue cells. Gray cells contain formulas that should not be changed.

City of Warsaw Stormwater Drainage Permit: General Requirements		
General Project Information		
General Information		
Engineer of Record:		
MO PE Number:		
Project Name:		
Date:		
Project Location		
Address:		
Nearest Intersection:		
Type of Construction		
<input type="checkbox"/> Redevelopment, Expansion, Renovation, Repair and/or Maintenance		
<input type="checkbox"/> New Construction (individual construction of one single family or duplex dwelling unit)		
<input type="checkbox"/> New Construction (all other types, including subdivision development, commercial, industrial, etc.)		
Site Parameters		
Total Site Drainage Area (acres)		acres
Existing Impervious Area (square feet)		square feet
Proposed Impervious Area (square feet)		square feet
Difference in Impervious Area (square feet)		square feet
Effective FEMA floodplain?		(Select Yes/No)
Describe Known Stormwater Issues:		
Permit Requirements/Variance		
Drainage Permit Required?	-	
Request for Variance?		(Select Yes/No)
Why? Explain:		

City of Warsaw Stormwater Drainage Permit: General Requirements	
Required Maps	
<input type="checkbox"/>	Watershed Location Map. Describes the project's location within the greater watershed depicting: <ol style="list-style-type: none"> 1. Watershed boundary and area (acres) 2. Delineated drainage area to the project (acres) 3. Natural drainage paths 4. Water bodies (lakes, rivers, streams, creeks, wetlands, etc.) 5. Stormwater retention/detention facility location(s) in watershed affecting stormwater management at project site (if applicable) 6. Conveyance route for overflow system to downstream destination of runoff
<input type="checkbox"/>	Existing Site Conditions Map. Demonstrates existing conditions of the site depicting: <ol style="list-style-type: none"> 1. Existing contours 2. Aerial imagery 3. Water bodies (lakes, rivers, streams, creeks, wetlands, etc.) 4. Utilities, including existing stormwater infrastructure 5. Natural drainage paths 6. Parcel boundaries 7. Impervious surfaces 8. Key statistics (areas of boundaries, area of impervious surfaces, etc.)
<input type="checkbox"/>	Proposed Site Conditions Map. Demonstrates proposed conditions of the site depicting: <ol style="list-style-type: none"> 1. Proposed contours including finished floor elevation (FFE) and lowest opening elevation (LOE) information 2. Utilities, including existing stormwater infrastructure overland drainage paths 3. Parcel boundaries 4. Impervious surfaces and types (i.e. building, parking lot, etc.) 5. Stormwater improvements (i.e. detention/retention facilities, open and enclosed conveyance systems, storm drainage structures, etc.) 6. Drainage easements depicting maintained stormwater drainage setbacks and dimensions

Designer Verification of Compliance with Design Criteria				
Retention				
Requirements Met?		Design Criteria	Retention Volume (CF)	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Easement(s) provided?	<i>Required</i>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	0.5" design storm over impervious area of the site	<i>Designed</i>
Detention				
Requirements Met?		Design Criteria	Release Rates (cfs)	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Easement(s) provided?	<i>Maximum Allowable</i>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	2-year (50% temporal distribution)	<i>Designed</i>
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	10-year (50% temporal distribution)	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	10-year (10% temporal distribution)	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	100-year (10% temporal distribution)	
Conveyance				
Requirements Met?		Design Criteria		
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Easement(s) provided?	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Natural Drainage Path Preservation / Overflow System per Section 5605	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Open system, ditches, swales per Section 5607	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Enclosed System, Gravity per Section 5606	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Enclosed System, Pressure per Section 5606	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Street Crossings / Culverts per Section 5606	
Collection				
Requirements Met?		Design Criteria		
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Inlet placement and gutter spread per Section 5604 (street applications only)	
<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	Inlets placed in low or sump areas on the site	

Instructions

All information should be entered into the light blue cells. Gray cells contain formulas that should not be changed.

Copy a blank row of the table and paste to the bottom as needed for additional inlets.

1. Input all inlet IDs generally organized from upstream to downstream. Inlet IDs should match the structure ID input in the Hydrology table.
2. Input type of inlet as curb opening, grate, or combination inlet.
3. Verify accuracy of the tributary area to the inlet and incremental runoff flow rate based on inputs made in the Hydrology table are correct. If not, correct inputs in Hydrology table.
4. Calculate Total Peak Runoff Flowrate (Q_c) based on incremental Peak Runoff Flowrate plus bypass flow rate received from upstream inlet.
5. Input roadway and inlet geometric parameters per design and Table 5604-1.
6. Calculate the gutter spread for composite gutter sections, T , per HEC-22, Section 4.3, and compare it to the allowable gutter spread.
7. Calculate depth of flow in gutter.
8. Calculate the inlet interception capacity, Q_i , per HEC-22, Section 4.4. Inlet intercept should take into account the total peak runoff flowrate, Q_c , including bypass from upstream inlet(s).
9. Determine inlet sizing and placement so that calculated gutter spread does not exceed allowable gutter spread.

NOTE: For a detailed step-by-step procedure refer to HEC-22 pages 4-68 through 4-71.

[illegible]

Instructions

- All information should be entered into the light blue cells. Gray cells contain formulas that should not be changed.
- Copy a blank row of the table and paste to the bottom as needed for additional retention facilities. Ensure that the SUM formulas in the total row are including the pasted rows in the volume total.
1. Input retention facility ID and description for type of stormwater management practice.
 2. Input the tributary drainage area to each retention facility.
 3. Input the impervious area for the delineated tributary area to each retention facility.
 4. The percent impervious area, I, and required retention volume, V_R , are autocalcualted per Section 5608.1.
 5. Input geometric parameters and porosity for each storage layer of the retention facility; note, if subsurface storage chambers are used, input design volume.
 6. Verify the retention facility has sufficient volume to capture the required tributary retention volume, V_R . Note that each retention facility must be sized for the appropriate tributary area; untreated area/volume to one facility cannot be substituted with excess storage at

City of Warsaw Stormwater Drainage Permit: Retention																											
Retention Facility ID	Description	Tributary Drainage Area A (acres)	Impervious Tributary Drainage Area A _{imp} (acres)	Percent Impervious I (%)	Retention Volume V _R (ac-ft)	Ponding			Material 1				Material 2				Material 3				Material 4				Storage Chamber	Provided Volume (ft ³)	Provided Volume (ac-ft)
						Area A _{layer} (ft ²)	Height h _{layer} (ft)	Volume V _{layer} (ft ³)	Area A _{layer} (ft ²)	n	Height h _{layer} (ft)	Volume V _{layer} (ft ³)	Area A _{layer} (ft ²)	n	Height h _{layer} (ft)	Volume V _{layer} (ft ³)	Area A _{layer} (ft ²)	n	Height h _{layer} (ft)	Volume V _{layer} (ft ³)	Area A _{layer} (ft ²)	n	Height h _{layer} (ft)	Volume V _{layer} (ft ³)	Volume V _{layer} (ft ³)		
BIO-01 <i>(example)</i>					0			0				0				0				0				0		0	0
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Instructions

All information should be entered into the light blue cells. Gray cells contain formulas that should not be changed.

NOTE: The tables in this sheet are for the design of one detention facility. If there is more than one detention facility for the site, then rows 12 to 25 should be copied and pasted below for each additional detention facility.

1. Verify tributary drainage area for the site is correct. If not, correct tributary drainage area on General tab.
2. Enter the drainage area tributary to the detention facility.
3. Review allowable discharge for each design storm, calculated based on requirements defined in Section 5608.1.
4. Input design parameters for primary outlet, spillway, and top of embankment/dam.
5. Determine the detention facility Peak Discharge, Maximum Stage, and Maximum Storage Volume for each design storm and input into appropriate column.
6. Verify that the system meets design criteria for both peak discharge rate and maximum water surface elevation requirements. Adjust design and re-model until all criteria is satisfied.

City of Warsaw Stormwater Drainage Permit: Detention

Drainage Area	
Tributary Drainage Area to Site (acres)	
Drainage Area Tributary to Detention (acres)	
Design Parameters	
Invert Elevation of Primary Outlet (ft)	
Spillway Crest Elevation (ft)	
Top of Embankment Elevation (ft)	

Design Storm by ARI	Peak Discharge Criteria		Modeled Performance Results			Design Criteria Check	
	Allowable Discharge per Acre Drainage Area (cfs/acre)	Allowable Discharge (cfs)	Modeled Peak Discharge (cfs)	Modeled Maximum Water Surface Elevation (ft)	Modeled Maximum Storage Volume (acre-ft)	Peak Discharge (yes/no)	Water Surface Elevation (yes/no)
2-year (50% temporal distribution)	0.1						
10-year (50% temporal distribution)	0.2						
10-year (10% temporal distribution)	2						
100-year (10% temporal distribution)	3						

APPENDIX D: SUMMARY RECOMMENDATIONS FOR FUTURE CODE OF ORDINANCES REVISIONS

APPENDIX D

FUTURE RECOMMENDATIONS

This Appendix includes a summary of recommendations the City may consider implementing in the future. Some recommendations may help to improve stormwater management (for example, our recommendation to review parking requirements can help to reduce impervious area) and others will help the City with the review of stormwater management design (for example, implementing the planning process and establishing decisionmakers).

GENERAL COMMENTS

DEFINITIONS

A general recommendation we have that applies to the entire code is to review and consolidate definitions into one logical place. We found that the existing location of various definition sections were hard to find, either because they were at the end or hidden as a subsection. This is the case for main definition section for Chapter 405, which we overlooked several times before finding in [Section 405.180, Rules of Construction; Interpretation; Definitions, Subsection \(C\)](#).

We also found that definitions were not always located in the most logical chapter. For example, the definitions for Chapter 400 Planning and Zoning Commission in [Section 400.080](#) only include “board”, “streets”, and “subdivision”, whereas the actual definition for “Planning and Zoning Commission” is in [Section 405.180\(C\)](#).

Another reason we recommend moving definitions to one logical place is so that the definitions will apply to all relevant code sections, instead of just the code section they are located in. For example, definitions are included in [Section 405.040\(I\), Waterfront Overlay District, \(2\)](#) that should apply broadly, not just to the overlay district. At a minimum, the same rationale applies to [Chapter 415 Floodplain Management](#) and [Chapter 705 Sewers](#).

If the definitions are consolidated, there are only two cross references in the code that would need to be revised: [Section 405.040\(E\)\(4\)\(f\), Mobile Home Use Limitations](#) and [Section 405.050\(A\), Use Table](#).

DUPLICATION BETWEEN CHAPTER 400 & CHAPTER 405

While we did not perform a detailed review of Sections [405.160 Planning and Zoning Commission](#) and [405.170 Board of Adjustment](#), these sections seem to duplicate language from [Chapter 400 Planning and Zoning Commission](#). We recommend these sections be reviewed and potentially removed from Chapter 405.

SECTION 400.240 COMPLETE STREETS POLICY

Require for Private Development. This policy encourages the City itself to implement complete streets, rather than directing the private development community to build complete streets. It may be in the City’s best interest to make complete streets a requirement so that private developers are also contributing towards meeting the City’s complete streets goals. For example, if a large subdivision is built in an area lacking roadway infrastructure, the complete streets requirements should also apply to privately built, public streets to provide high-quality multimodal transportation for the residents.

The current mechanism to encourage private developers to follow the complete street policy is found in [Subsection \(C\), Study/Analysis To Be Undertaken As Part Of Public Transportation Project, \(3\)](#):

3. *This policy is intended to cover all development and redevelopment in the public domain within Warsaw.... This also includes privately built roads intended for public use. As such, compliance with these principles may be factored into decisions related to the City's participation in private projects and whether the City will accept possession of privately built roads constructed after the passage of this Section. The City Administrator, on a case-by-case basis, may exclude routine maintenance from these requirements.*

The incentive to follow the policy is relatively low if the last sentence of that paragraph, "...may exclude routine maintenance from these requirements", means that the City may still do routine maintenance on the roads, even if they are not City-owned assets because the developer did not follow the policy recommendations. If that is not the intent, then this language should be clarified. If the City decides to make this policy a requirement for private developers, then it is recommended that the private development meets the requirement as a condition of constructed streets becoming a publicly-maintained asset.

Add Development Standards. If in the future the City decides to make complete streets a requirement for private developers, it is recommended that clear standards be added for what components different street types will require with direction as to how those components should be designed. For example, components may include bike lanes, sidewalks, signage, stormwater infrastructure, and crosswalks. Additionally, when these standards are included, it would make sense organizationally to move part or all of this policy from Chapter 400 *Planning and Zoning Commission* to Chapter 405 *Unified Development Code*. An updated complete streets policy would need to be reviewed alongside the current standards found in Section 405.080, *Mobility and Connectivity Development Standards* to evaluate potential conflicting or overlapping direction.

SECTION 405.020 COMMON DEVELOPMENT REVIEW PROCEDURES

Implement the Planning Process. Section 405.020 provides requirements for a typical planning application procedure that the City is not currently implementing to its fullest extent. The code indicates that an applicant (developer) must attend a preapplication meeting, host a neighborhood meeting, and provide public notice. Per discussions with the City, in reality the applicant rarely meets with City staff and likely is not currently hosting a neighborhood meeting or providing public notice. The City should consider implementing the planning process as outlined in the code in order to more formally document development that is occurring the city, especially as it is anticipated that development will increase as land is annexed and the economy expands.

Clearly Define City Roles. To help implement the planning process, we recommend that the City define on their website who fills each role that the code references as decisionmakers. Roles referenced in the code include:

- Planning Director
- Director of Public Works
- City Engineer
- City Traffic Engineer
- Board of Aldermen
- Planning and Zoning Commission

- Board of Adjustment

Create Application Forms. [Subsection \(D\)\(1\), Form of application, \(a\)](#) states that, “application submittal requirements, contents and fees shall be established in the individual application forms provided by the City.” As the City starts to implement its planning process, it will also need to develop application forms with the desired submittal requirements for each application type listed in Table 405.020-1. A drainage permit application is included in our immediate recommendations.

Require Technical Studies. Per discussions with the City, it is desired to have a mechanism to require different types of technical studies with improvement projects, including traffic studies and geotechnical studies. The code does currently provide this mechanism in [Subsection \(D\)\(1\), Form of application, \(b\)](#):

- b. *“In addition to the information required by the application form, the Director may require applicants for rezoning, conditional use permit, preliminary or final development plan, or preliminary plat to submit any technical studies that the Director deems necessary to enable the Planning and Zoning Commission, Board of Aldermen, or Board of Adjustment to fully evaluate the application. Examples of technical studies include, but are not limited to: traffic studies, engineering studies, geologic or hydrogeologic studies, flood studies, environmental impact assessments, noise studies, photometric (lighting) studies, or surface water management/drainage studies.”*

As the code reads, the City can only require an additional technical study if it is for an application for rezoning, conditional use permit, preliminary or final development plan, or preliminary plat. If majority of development is not occurring within one of these application types, then it is recommended that this language be revised to include more application types, or potentially be moved to a section that includes specific development standards, therefore removing the tie to specific applications, such as to Sections 405.080, *Mobility and Connectivity Development Standards*, 405.090, *Commercial and Mixed-Use Design and Development Standards*, 405.100, *Multifamily and Townhouse Design Standards*, and 405.140, *Subdivision Design Standards*. As part of our immediate recommendations, a drainage report is required as part of the drainage permit for all applicable improvements.

Change Section Name. Consider renaming this section to [Application Process](#) or equivalent so the title better represents the content. This section really defines the planning process from beginning to end.

SECTION 400.030 SPECIFIC PROCEDURES

Revise Section G, Planned Development. We recommend that this section be reviewed and revised to present the procedures and requirements more clearly. Initially we understood this section to requirements for development plans and procedures for approval, required for projects zoned as planned districts. However on closer inspection, the section uses “development plans” and “site plans” interchangeably, but also seems to describe a “PD” rezoning process at times. During our review, we could not follow along with what process the section was describing. We strongly recommend that this section be revised to describe only the planned development process and let the rezoning and site plan processes be left to their respective sections.

Split Permits into Individual Subsections. The existing [Subsection \(O\), Permits](#) groups both building permits and land use permits together. Having them grouped together makes it unclear which standards apply to which permit. We recommend that these be split into separate subsections to make each clear. Each type of permit can then be added to Table 405.020-1, Specific Procedures, Table 405.020-2, Notice Requirements, and Table 405.030-1, *Summary of Administrative Review Procedures*.

Implement Review & Approval Procedures. Similar to the Section 405.020, Section 405.030 seems to provide for a very thorough review and approval process for each application type that details the purpose of the application, actions the applicant needs to take, and how the application gets approved. Per discussions with the City, the procedures listed are not currently implemented to its fullest extent. It is our understanding that the Planning and Zoning Commission only approves rezoning applications, comprehensive plan amendments, and Unified Development Code amendments, while all other approvals are given at the administrative level. It is recommended that Chapter 89 of the Missouri Statutes be reviewed and compared to the City's current operating procedure. Depending on state requirements, it may make sense for the City to revise this section to better reflect review and approval procedures that are currently in place.

Change Section Name. Consider renaming this section to [Review Procedures](#) or equivalent so the title better represents the content. This section mainly includes specific criteria for each application type that an application will be reviewed against.

SECTION 405.040 ZONING DISTRICTS

Resolve Different Names for Open Space (O) District. [Table 405.040-1, Zoning Districts](#) and [Table 405.040-11, Open Space District Dimensions](#) calls this district Open Space (O). However [Subsection \(L\), Rural Holding and Open Space \(RH-O\)](#) and various other sections refers to this district using the different name and abbreviation listed in L. The zoning map on the city website shows this district as "O" Open. The two different names should be resolved to be the same across the code and zoning map.

Add Maximum Lot Coverage for All Districts. Currently, there are no standards for maximum lot coverage for the districts listed below. Consider adding a maximum to these districts so that a lot cannot be developed in the future that is 100% impervious:

- R-4: Mobile Home
- M-1: Light Industrial
- M-2: Heavy Industrial
- RH-O: Rural Holding and Open Space

Define Boundaries of the Waterfront Overlay District. For [Subsection \(I\), Waterfront Overlay District](#), what are the boundaries of this district? The zoning map was on the building permits page of the city website does not show this district. Consider either defining the limits within the code or updating the map online. Additionally, consider how will this overlay district interact with the new Marina District. Will they be one and the same?

SECTION 405.110 PARKING AND LOADING

Review Parking Requirements. This section was reviewed in an effort to understand if high parking requirements are causing an unnecessary increase in imperviousness through the city. We compared

Warsaw's parking requirements to Kansas City, Missouri's requirements, with the assumption that Warsaw should not require as much parking as a larger city. While theoretically Kansas City is more urbanized and therefore less reliant on cars, the reality is that there is a large commuter population in the Metro Area that requires parking.

Our general observation was that Warsaw actually requires more parking than Kansas City. Below is a table with a few one-to-one comparisons based on use:

Use	Warsaw	Kansas City
Nursing Home	1 per 2 beds plus 1 per 100 sq ft of assembly area	1 per 3 dwelling units
Religious Assembly	1 per 5 seats, plus 1 per 50 sq ft of gross floor area of assembly area without seats	1 per 7 seats in main assembly area
Elementary & Middle School	2 per classroom	1 per 4 employees
Office, Business, & Professional	3 per 1,000 sq ft of floor area	1 per 1,000 sq ft
Retail	1 per 250 sq ft (which equals 4 per 1,000 sq ft)	2.5 per 1,000 sq ft

Per discussions with the City, some tourism related businesses are actually experiencing a parking shortage. We recommend a more thorough review be done on the parking requirements to see where some could potentially be lowered, particularly for uses focused on local service, and others be increased for tourism related service. Another thing to consider implementing would be a minimum and maximum for each use, rather than a blanket requirement. This would allow the City and developer to decide the required amount of parking on a case-by-case basis.

Resolve Discrepancy Between Off-Site Parking Allowance. There is one conflict we found within this section between two different standards. Under [Subsection \(C\)\(4\)\(b\), On-street parking](#) it states, "The use of legal, on-street parking to meet a portion of the minimum off-street parking requirements is permitted." [Subsection \(E\)\(4\), On-street parking](#) then states, "Except as permitted elsewhere in this Code, on-street parking shall not be used to satisfy the off-street parking standards of this Subsection." The language in Subsection (C)(4)(b) seems to broadly allow the use of on-street parking to meet parking standards, therefore Subsection (E)(4) will never be applied. Consider removing the Subsection (E)(4) or revising Subsection (C)(4)(b) so that it only applies to certain uses, if that is desired.

SECTION 415.150 GENERAL STANDARDS

Align Floodplain Regulations with New Maps. As discussed with the City, a more thorough review of [Chapter 415 Floodplain Management](#) should be done when preliminary studies are ready from the state floodplain mapping project. With updated maps, the City can consider stricter standards for floodplain development in an effort to preserve natural drainage patterns and reduce risk for property owners. As it stands now, the language provided in the code is fairly typical and provides adequate standards.

SECTION 705.010 DEFINITIONS

Natural Outlet Definition. In Chapter 705 Sewers, consider revising the definition for [Natural Outlet](#): "Any outlet into a watercourse, pond, ditch, lake or other surface or ground water." There is nothing in this definition that defines the outlet type as natural, such as a drainage path converging

with a stream, which could potentially lead to outfalls to be built under this definition. Also, consider if this nomenclature is used in other sections of the code.

APPENDIX E: WARSAW STORMWATER HYDROLOGIC ANALYSIS AND HYDRAULIC REVIEW

WARSAW STORMWATER STUDY

HYDROLOGIC ANALYSIS & HYDRAULIC
REVIEW

CITY OF
Warsaw



Revision 1
September 30, 2020



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ABBREVIATIONS

Abbreviation	Description
APWA	American Public Works Association
CFS	Cubic feet per second
FEMA	Flood Emergency Management Agency
GIS	Geographic Information System
GPS	Global Positioning System
NRCS	Natural Resource Conservation Service
SCS	Soil Conservation System
SSURGO	Soil Survey Geographic
USGS	United States Geological Survey
DEM	Digital Elevation Model
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
GNSS	Global Navigation Satellite System
HEC	Hydrologic Engineering Center
HEC-RAS	Hydrologic Engineer Center River Analysis System
LOMA	Letter of Map Amendment
LOMR	Letter of Map Revision
NED	National Elevation Dataset
Route 7	Missouri Route 7
RTK	Real time kinematic
TR-55	USDA NRCS Technical Release 55, Urban Hydrology for Small Watersheds
US 65	U.S. Route 65
USDA	United States Department of Agriculture

SECTION 1

INTRODUCTION

1.1 BACKGROUND

The City of Warsaw is located in Benton County, Missouri along the upstream-most portion of the Osage River, between the state's two largest lakes: Truman Lake and Lake of the Ozarks (Figure 1-1). The City is located on the 90-mile marker of the Lake of the Ozarks, and just one mile downstream of Truman Dam and Reservoir. Due to its unique location, the small rural town has been gaining momentum for new and re-development opportunities both along the waterfront as well as in other commercially and residentially-zoned areas north of the downtown. Currently the City has very limited enclosed stormwater conveyance systems. Instead the stormwater management system is characterized by overland drainage to open roadside ditches and small culverts that ultimately discharge to larger open channels or the Osage River/Lake of the Ozarks. As development opportunities expand, Warsaw has identified the need for a better understanding of how stormwater is currently managed within the City. Warsaw has observed how development expansion can cause flooding and stream degradation, and aims to instead promote healthy and sustainable growth that is not detrimental to the community and its waterfront assets.

The City of Warsaw entered into an agreement with Burns & McDonnell Engineering, Inc. (Burns & McDonnell) in May 2019 under Ordinance Number 373 to conduct a stormwater study for the Town Branch Creek watershed.

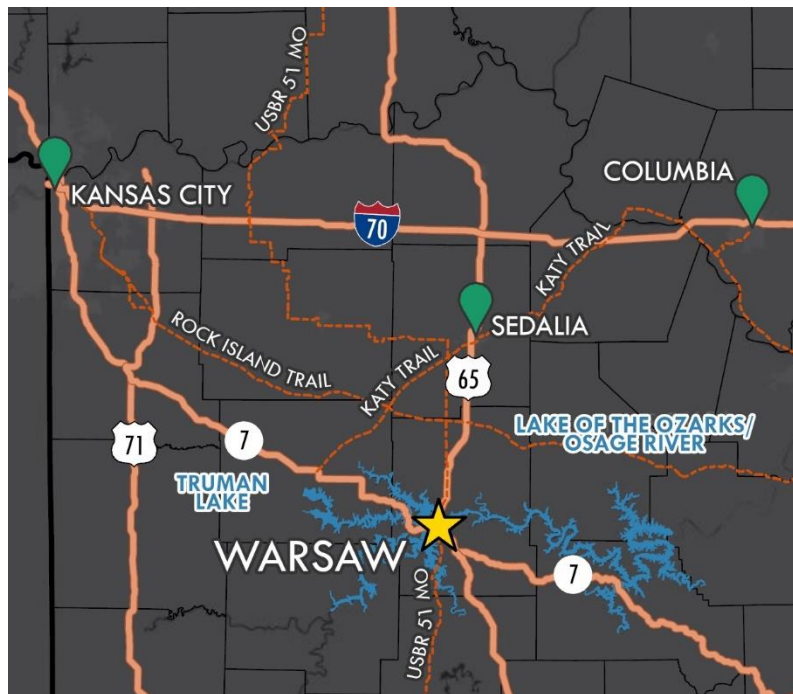


Figure 1-1: Location Map

1.2 PURPOSE

The purpose of this study is to develop the existing hydrologic parameters to better understand how stormwater is conveyed within the Town Branch Creek Watershed. The goal of the study is to provide peak stormwater runoff flow rates from areas tributary to Town Branch Creek and provide a baseline for future improvements within the City. Because Town Branch Creek serves as the primary stormwater conveyance system, the City's central stormwater issues and flood risk is located along the creek corridor. Understanding the current hydraulic performance of the creek will be a critical component necessary for calculating the impacts of future stormwater improvements. For this reason, this analysis also provides a review of the Town Branch Creek Flood Emergency Management Agency (FEMA) current effective models, to evaluate data needs to complete a full hydraulic analysis in the future.

This report outlines the analysis conducted as part of this stormwater study, including the data sources used, a summary of the existing conditions, the methodologies and assumptions for the hydrologic analysis, the FEMA hydraulic model review, and recommended next steps for the City.

1.3 STUDY AREA

This study is focused on the Town Branch Creek watershed. Town Branch Creek encompasses the majority of Warsaw's downtown commercial and residential areas, as well as the developable open space north of Missouri Route 7 (Route 7). The Study Area is shown in Figure 1-2.

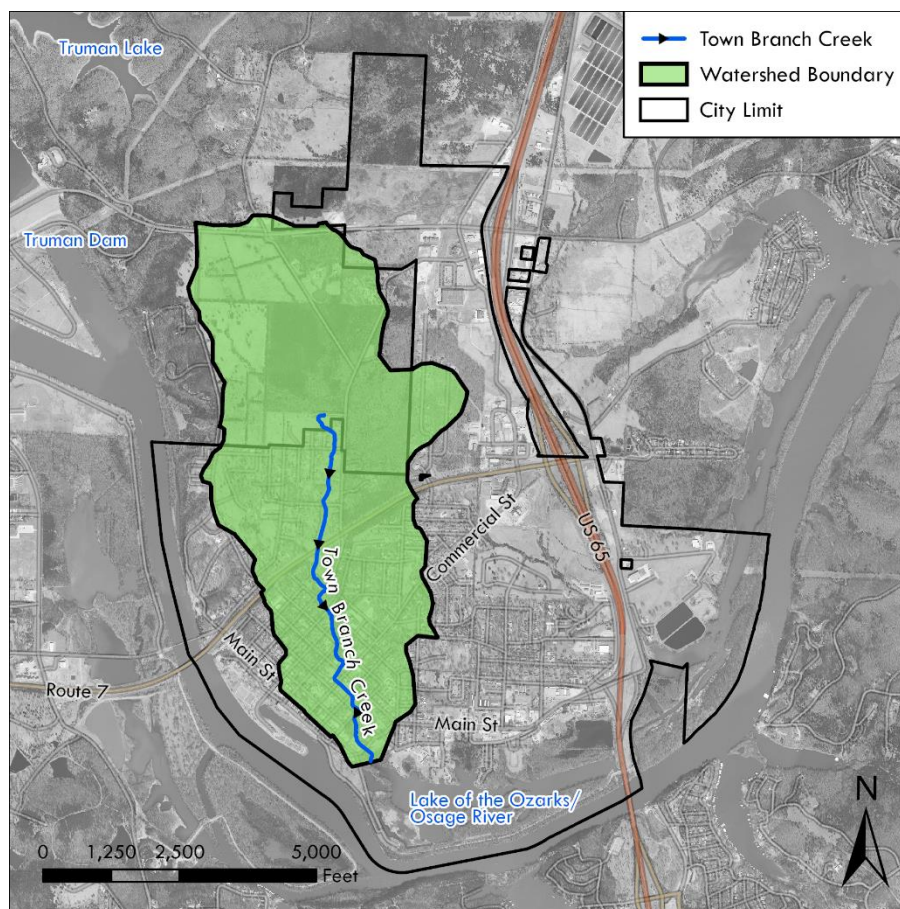


Figure 1-2: Study Area

1.4 EXISTING DATA SOURCES

Geographic Information System (GIS) data was primarily used for this analysis. County-wide available GIS data was purchased from the Benton County assessor in June 2019. United States Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS), United States Geological Survey (USGS), and FEMA flood mapping data was also downloaded from the applicable websites in fall of 2019. The FEMA Flood Insurance Study (FIS) hydrologic and hydraulic data was requested and provided in September 2019. Lastly, available Warsaw-specific data was shared primarily in PDF or hard-copy formats.

Table 1-1: Data Sources




Data Source	Data Reference Title	Description
Benton County Assessor	Cadastral <ul style="list-style-type: none"> Parcel Search 	GIS Parcel boundaries, ownership, and land/improvement assessment information
	Jurisdiction <ul style="list-style-type: none"> Corporate Limit 	GIS City boundaries
	Planimetric <ul style="list-style-type: none"> Contours 	GIS contour lines at 10-foot intervals
	Transportation <ul style="list-style-type: none"> Road Centerline 	GIS Roadway lines, names and types
USDA NRCS	Web Soil Survey <ul style="list-style-type: none"> Soil Survey Geographic (SSURGO) database Hydrologic Soil Group report 	GIS database with polygons of digital soil survey for Benton County with information on the kinds and distribution of soil. Report included soil map unit names and hydrologic soil group rating
USGS National Elevation Dataset (NED)	USGS NED n39w094 1/3 arc-second 2013 1 x 1-degree ArcGrid	2013 Digital Elevation Model (DEM) with approximately 10-meter resolution, NAD83
FEMA	Flood Hazard Zones	GIS FEMA effective flood hazard area boundaries
	Town Creek & Osage River FIS data request (Appendix B): <ul style="list-style-type: none"> FIS 29015C0407D Effective FIRM Digitized Data Index Case Number 290030-19900716 	Benton County, Missouri & Incorporated Areas Flood Insurance Study FEMA Effective FIRM Panel Effective Model Output (7/16/1990)
City of Warsaw	City of Warsaw Zoning Map (Rev. 3/12/2019)	PDF map of residential, commercial, industrial, open, and other zoning extents

1.5 TOWN BRANCH CREEK GPS-SURVEYED DATA COLLECTION

In order to better understand the existing geometry of Town Branch Creek, the project team conducted a stream walk and collected Global Positioning System (GPS) data points of the channel cross section at varying intervals along the creek alignment. Points were also collected at culvert crossing, with data collected on the size, shape and material of the culvert. Figure 1-3 shows the locations of the stream cross sections and the culvert crossings collected during this effort in June 2019.

An Arrow 200 Global Navigation Satellite System (GNSS) – High-Accuracy GIS Package was used to collect GPS location and altitude data. The Arrow 200 unit was selected due to its ability to provide up to 1-centimeter real time accuracy, and its ability to easily interface with a GIS-based data collection application. The Arrow 200 unit was used with a 2-meter carbon fiber range pole and bubble level to provide consistent vertical GPS readings. The ‘Collector’ application for ArcGIS mobile devices was used as the primary interface during the data collection effort. The Collector application works in conjunction with an EOS Tools Pro application. The EOS Tools Pro application allows for configuration of the EOS Arrow 200 GPS unit. It provides a way to connect to a real time kinematic (RTK) network and gives advanced GNSS information for tracking and improving GPS accuracy, as well as satellites tracked and used during collection. For this data collection effort, Burns & McDonnell connected to the MODOT RTK network to increase the horizontal and vertical accuracy of the data.

The cross-section geometry of a stream and road crossings are parameters that significantly impact hydraulic performance. The GPS surveyed cross sections were collected for comparison with the geometry used in the current FEMA effective model. The GPS points were integrated with USGS DEM elevation data to supplement elevation information extending beyond the primary stream corridor. Data collection summary figures and tables can be found in Appendix C. While the scope of this storm study does not include additional hydraulic modeling, the data collected as part of this effort can be used to support future hydraulic modeling efforts for Town Branch Creek.

 Town Branch Creek
 Survey Cross Sections
 Survey Culverts



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SECTION 2

EXISTING CONDITIONS

The following subsections provide background on the existing conditions of the Study Area, including watershed characteristics, the existing drainage system, and historical flooding locations.

2.1 WATERSHED CHARACTERISTICS

2.1.1 GENERAL

The Town Branch Creek watershed encompasses an approximately 700-acre drainage area. Town Branch Creek generally flows from northwest to southeast through the center of the watershed, eventually reaching the Osage River and Lake of the Ozarks. Stormwater runs off the surrounding areas from the east and west towards the creek in the center, generally following the road alignments. Slopes vary significantly throughout the drainage area, ranging from approximately 1-12%, with a median and average slope near 5%, and an average 1.2% slope throughout the creek alignment. Figure 2-1 shows the primary overland drainage paths, demonstrating how stormwater runoff travels through the Town Branch Creek watershed.

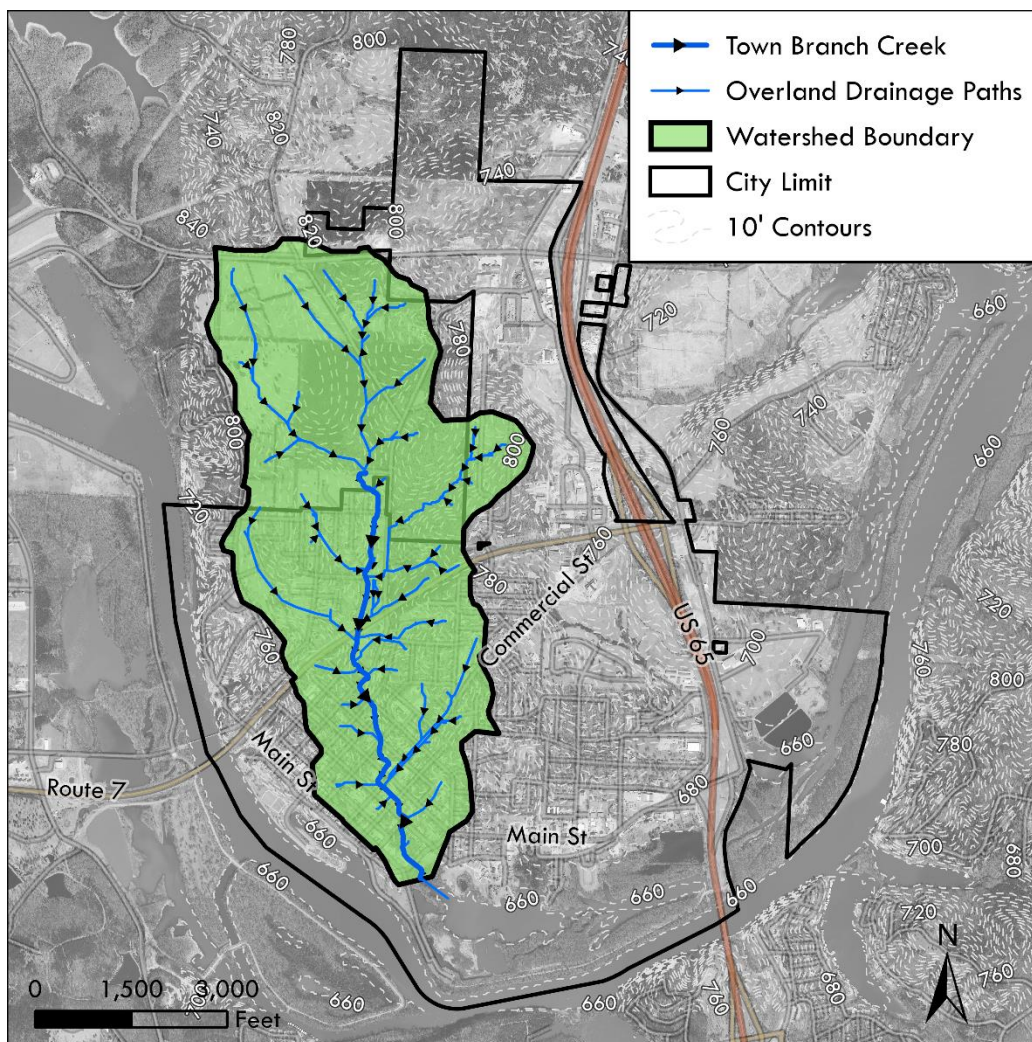


Figure 2-1: Town Branch Creek Watershed Overland Drainage

The City identified and provided locations of known drainage issues and flooding within the Study Area. Overland drainage paths were developed from USGS Digital Elevation Model (DEM) data, defining the path that stormwater travels through the watershed. The defined overland drainage paths begin at the point where 1.5-acres of area collects and continues downstream based on the DEM-defined topography.

2.1.2 LAND USE AND ZONING

The watershed is primarily made up of residential, commercial, and open space-zoned land uses, including the City's historic downtown. Figure 2-2 shows the zoning designations based on the 2019 City of Warsaw zoning map.

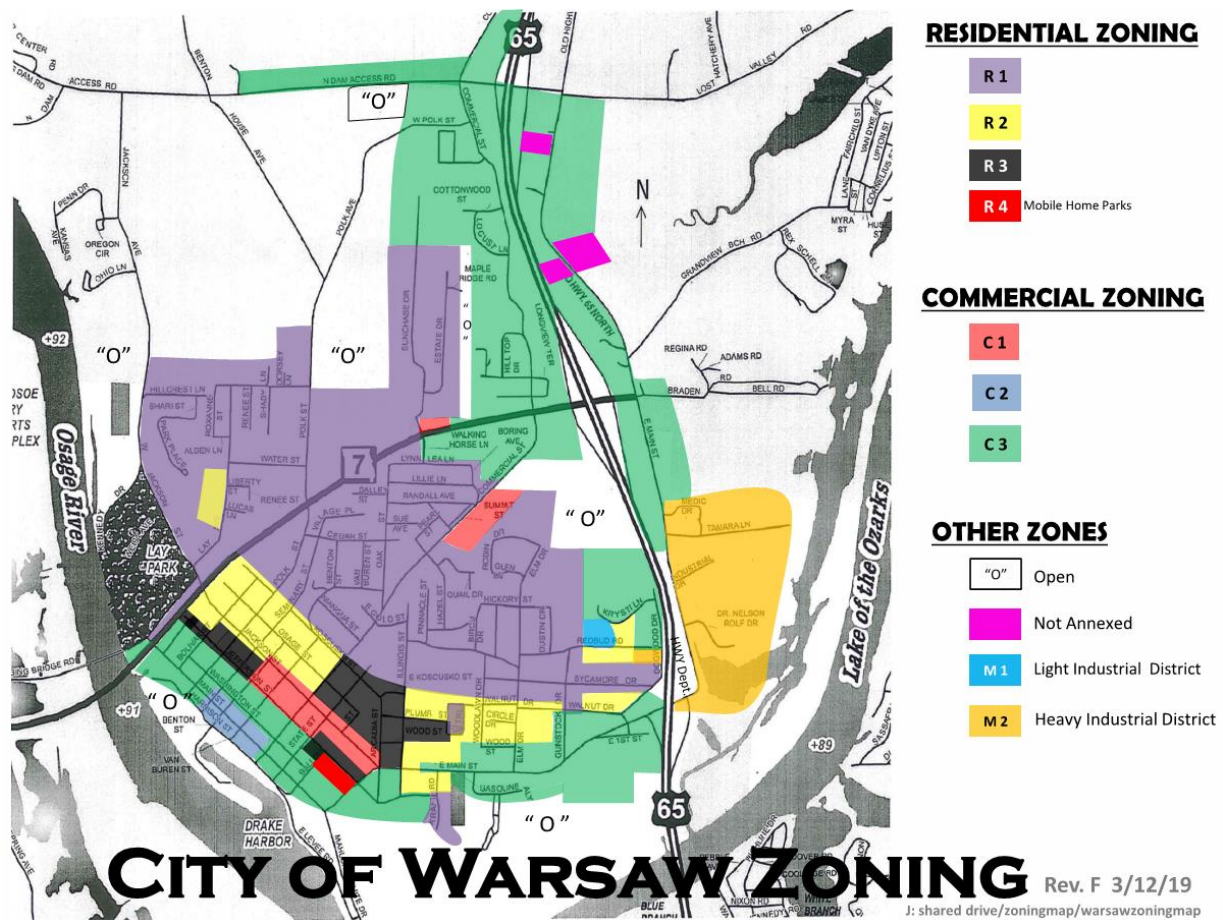


Figure 2-2: City of Warsaw Zoning Map

2.1.3 SOILS

Soil types vary between hydrologic soil group B, C, and D-type soils throughout the watershed. The well-draining soils are primarily focused in the vicinity of the creek itself, and along the Osage River waterfront. Figure 2-3 demonstrates the soil patterns within the watershed.

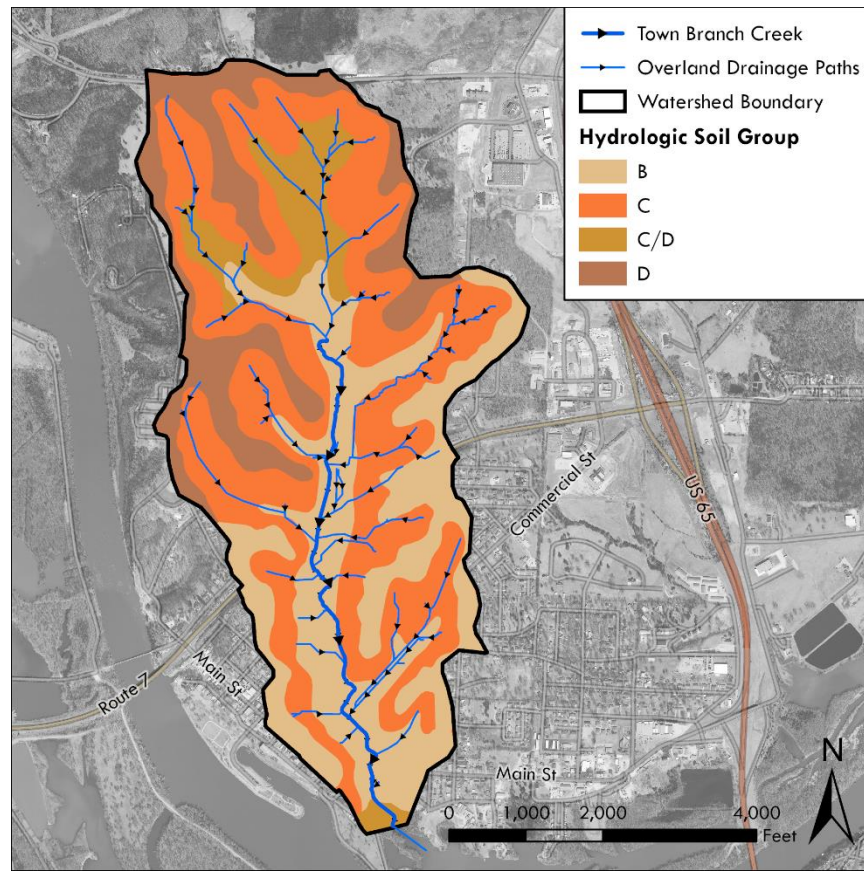


Figure 2-3: Town Branch Creek Hydrologic Soil Conditions

2.2 EXISTING DRAINAGE SYSTEM

Town Branch Creek serves as the primary conveyance system through the watershed. Warsaw was originally platted in 1837 and incorporated in 1843. It was not the practice at the time to integrate stormwater management into urban planning and design. Therefore, the drainage systems in the older parts of the City are characterized by roadside ditches, driveway culverts, and culverts at street crossings. Town Branch Creek extends diagonally through the City's roadway grid system, concentrating flows primarily through private properties along the creek.

Limited enclosed storm sewer was constructed with the Downtown Revitalization Phase I in the early 2000s. This enclosed storm sewer was constructed in an approximately three block area of Main Street directly adjacent and discharging to the Osage River/Lake of the Ozarks waterfront. Figure 2-4 shows examples of the existing roadside ditch systems for three of the primary roadways through Warsaw.



Figure 2-4: Existing Roadside Ditch Conveyance System

2.3 KNOWN FLOODING LOCATIONS

Flooding has been observed along Town Branch Creek during large rain events over the last several years and has reportedly impacted private property and roadways. Figure 2-5 shows an example of flooding observed during a large rain event in July 2018r, near the intersection of Jackson and Commercial Street.



Figure 2-5: Town Branch Creek Flooding (Jackson & Commercial Street Intersection)

(Source: <https://www.ky3.com/content/news/PICTURES-Heavy-rains-flood-roads-Wednesday-in-Benton-County-Mo-488504871.html>)

The city-identified flooding locations relative to the overland drainage paths are shown on Figure 2-6. The majority of the identified flood prone locations are situated along a primary overland drainage path with a significant amount of upstream area tributary to the identified location. When looking at the flood prone locations in relation to the overland drainage paths the upstream sources for the drainage issues can be identified. Ultimately this information can be used to identify stormwater improvement location, to mitigate the frequency and risk of flooding in the future..

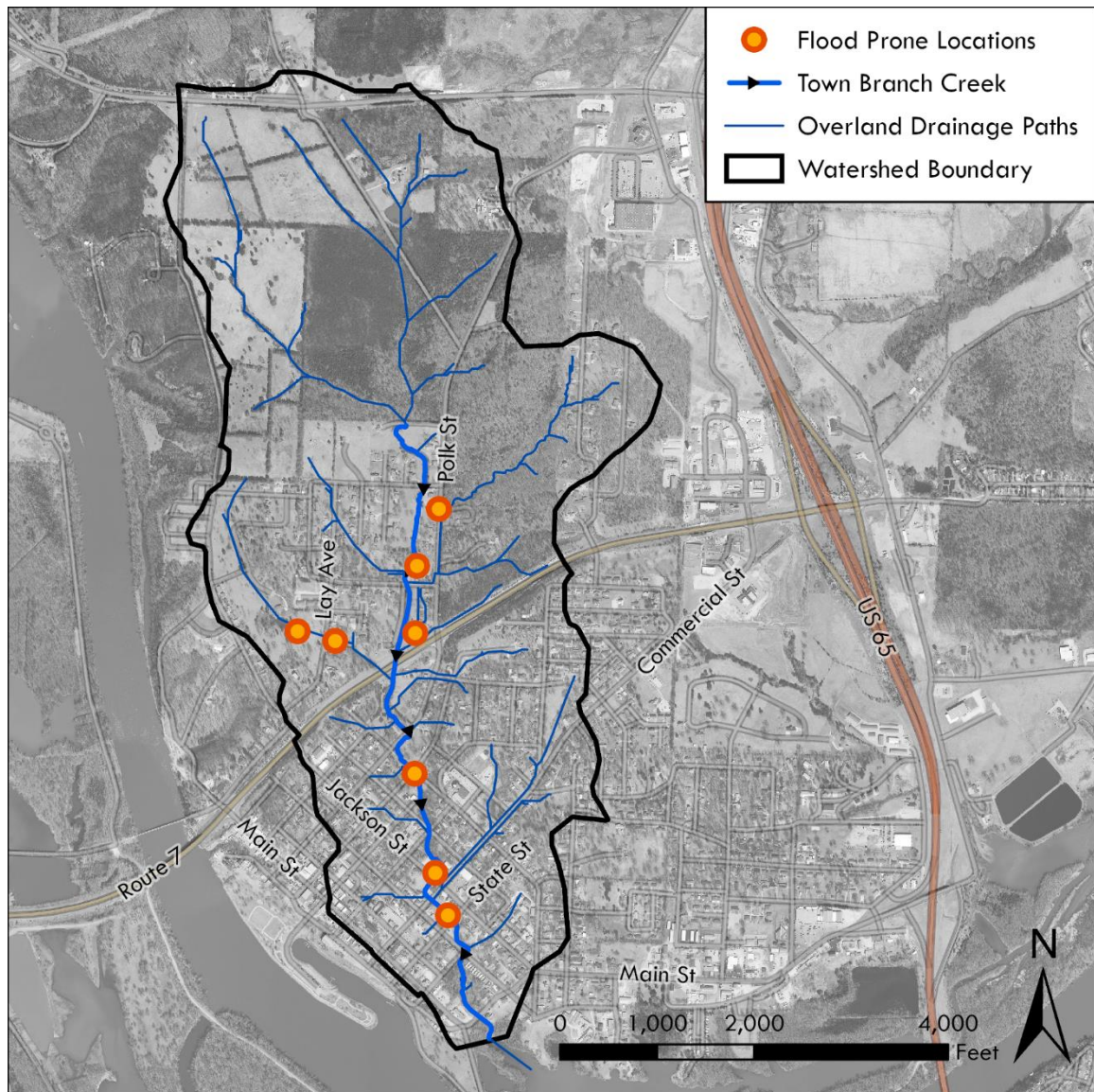


Figure 2-6: City-Identified Flooding Locations

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SECTION 3

HYDROLOGIC ANALYSIS

The hydrologic analysis was conducted using Bentley CivilStorm® CONNECT Edition, Update 3 Version 10.03.00.77. The following subsections provide the rainfall, hydrologic and hydraulic parameters used to develop the model, as well as the results of this analysis.

3.1 CURRENTLY ADOPTED STORMWATER STANDARDS

The City's currently adopted design criteria is the 1997 Edition of the Kansas City Metro Chapter of the American Public Works Association (APWA) standard specifications and design criteria¹ (Ord. No. 2004-03 §1, 2-17-2004). The stormwater criteria and requirements for this reference are included in Section 5600 Storm Drainage Systems and Facilities, Adopted March 21, 1990. Because the currently adopted standards are relatively dated, Warsaw has received funding to complete updates to their stormwater policies and design through the Missouri Department of Natural Resources (MDNR) Section 604(b) Water Quality Management grant program. For this reason, this analysis considered other methodologies beyond those defined in the adopted standards.

3.2 RAINFALL PRECIPITATION

3.2.1 RAINFALL DEPTH

Rainfall depths were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation Frequency Data Server² for the location of Warsaw, Missouri (Latitude: 38.2516°, Longitude: -93.3745°). Table 3-1 shows the point precipitation frequency values acquired from the NOAA PFDS server. Partial duration precipitation frequency estimates for 6-hour and 24-hour rainfall durations were primarily used for this analysis.

Table 3-1: NOAA Atlas 14 (Volume 8, Version 2) Precipitation Frequency Estimates for Warsaw, Missouri

DURATION	AVERAGE RECURRENCE INTERVAL (YEARS)						
	1	2	5	10	25	50	100
5-min:	0.412	0.476	0.58	0.664	0.778	0.865	0.95
10-min:	0.603	0.697	0.849	0.972	1.14	1.27	1.39
15-min:	0.735	0.85	1.04	1.19	1.39	1.54	1.7
30-min:	1.03	1.2	1.47	1.69	1.98	2.21	2.42
60-min:	1.36	1.58	1.95	2.25	2.67	2.98	3.3
2-hr:	1.69	1.97	2.43	2.82	3.35	3.76	4.17
3-hr:	1.91	2.23	2.75	3.2	3.83	4.33	4.83
6-hr:	2.3	2.67	3.31	3.87	4.68	5.33	6.01
12-hr:	2.7	3.13	3.87	4.54	5.53	6.35	7.21
24-hr:	3.15	3.62	4.47	5.23	6.38	7.34	8.37

¹ Kansas City Metropolitan Chapter American Public Works Association (APWA); 1997; *Standard Specifications and Design Criteria*

² Hydrometeorological Design Studies Center (HDSC); 2017; *Precipitation Frequency Data Server NOAA Atlas 14 Point Precipitation Frequency Estimates*; https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_conf.html?bkmrk=mo

In addition to the typical storm recurrence intervals, the 90% mean annual storm event was also included in this analysis. This event is based on the 1.37-inch Water Quality Storm defined in the Manual of Best Management Practices for Stormwater Quality, published by the Mid-America Regional Council and American Public Works Association³. The Water Quality Storm is defined as the event that produces less than or equal to 90% of the stormwater runoff volume of all 24-hour storms on an annual basis in the Kansas City Metropolitan area. This 24-hour was converted to a 6-hour depth of 1.03 inches using methods defined in the Precipitation Frequency Estimates for the Kansas City Metropolitan Area⁴.

3.2.2 RAINFALL DISTRIBUTIONS

For the purpose of modeling, synthetic rainfall distributions are used to approximate a wide range of rainfall events. Rainfall distribution describes how rainfall occurs over a defined time period, representing the cumulative rainfall from the beginning to the end of a storm, and describing the variability of rainfall intensity throughout the event. Rainfall distributions define how intense a storm event is, which has a significant impact on peak stormwater runoff flow rates throughout the watershed. Historically, the Soil Conservation System (SCS) Type II, 24-hour rainfall distribution has been applied to most of the United States except Pacific maritime regions and coastal areas impacted by tropical storms⁵, this is the current method as outlined adopted design criteria. More recent rainfall analyses have been conducted both regionally and across the country based on recent and historical rainfall data. For this reason, two different rainfall distributions were evaluated as part of this hydrologic analysis.

3.2.2.1 SCS TYPE II

The City's current ordinances references the 1990 version of APWA 5600, which requires the use of the SCS Type II, 24-hour rainfall distribution for all computations that employ the use of rainfall mass (APWA 5600, March 1990). CivilStorm includes an Engineering Library featuring built-in dimensionless rainfall curves, which include the SCS Type II 24-hour incremental and cumulative distributions. Using this tool, the rainfall depths for the average recurrence intervals defined in Table 3-1 were input for the 24-hour duration events. The cumulative rainfall depth over the 24-hour event duration is shown in Figure 3-1.

³ Mid-America Regional Council (MARC); 2012; *Manual of Best Management Practices for Stormwater Quality*; http://kcmetro.apwa.net/content/chapters/kcmetro.apwa.net/file/Specifications/BMPManual_Oct2012.pdf

⁴ Young, C.B., McEnroe, B.M.; 2002; *Precipitation Frequency Estimates for the Kansas City Metropolitan Area*; American Public Works Association (APWA); University of Kansas; Lawrence, Kansas

⁵ National Resources Conservation Service (NRCS) United States Department of Agriculture (USDA); 1986; Technical Release 55 Urban Hydrology for Small Watersheds

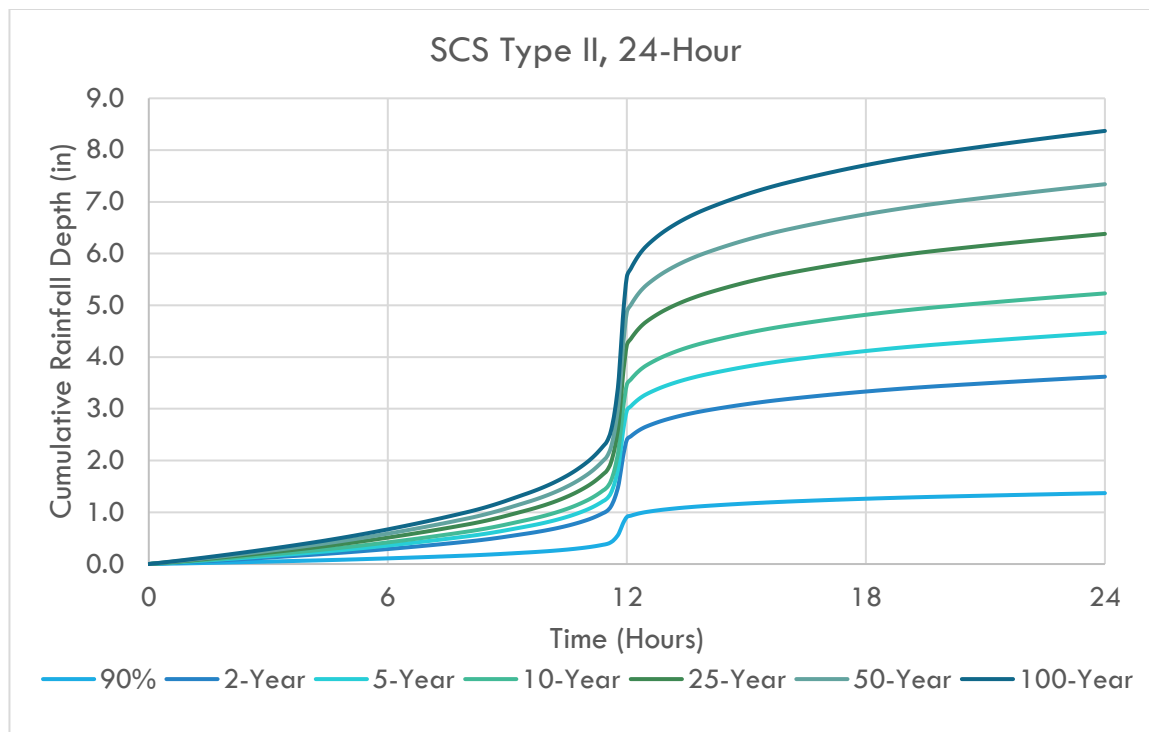


Figure 3-1: SCS Type II 24-hr Cumulative Hyetograph

An SCS Type II distribution assumes that over 40% of a 24-hour rainfall occurs in a 1-hour period, resulting in very high peak rainfall intensities and subsequent peak runoff flow rates.

3.2.2.2 NOAA ATLAS 14

NOAA Atlas 14 Volume 8 *Precipitation Frequency Atlas of the United States for Midwestern States*, herein referred to as NOAA Atlas 14, updates precipitation frequency estimates for Colorado, Iowa, Kansas, Michigan, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Wisconsin⁶. The NOAA Atlas 14 precipitation frequency estimates supersede those from the following historically referenced technical documents:

- Technical Paper No. 40: Rainfall Frequency Analysis of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years⁷
- Technical Paper No. 49: Two- to Ten-Day Precipitation for Return Periods of 2 to 100 years in the Contiguous United States⁸

⁶ National Oceanic and Atmospheric Administration (NOAA); 2013; NOAA Atlas 14: Precipitation-Frequency Atlas of the United States; Volume 8, Version 2.0: Midwestern States (Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, Wisconsin); https://www.nws.noaa.gov/oh/hdsc/PF_documents/Atlas14_Volume8.pdf

⁷ National Weather Service (NWS); 1961; Technical Paper No. 40: Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years; https://www.nws.noaa.gov/oh/hdsc/PF_documents/TechnicalPaper_No40.pdf

⁸ National Weather Service (NWS); 1964; Technical Paper No. 49, Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States; https://www.nws.noaa.gov/oh/hdsc/Technical_papers/TP49.pdf

- Technical Memorandum HYDRO-35: Five- to 6-Minute Precipitation Frequency for the Eastern and Central United States⁹

With this update, NOAA Atlas 14 developed temporal rainfall distributions by categorizing rainfall events for varying regions throughout the country. This analysis collected data from over 16,000 precipitation measurement stations to study how rainfall accumulated during historical rain events, allowing the user to understand how rainfall events most commonly occur in their region for varying duration events. NOAA Atlas 14 temporal distributions were analyzed for 6-, 12-, 24-, and 96-hour duration rainfall events. The analysis defines the rainfall event categories by quartile of the event which accumulated the largest percentage of the total rainfall. The following were assumed to develop the NOAA Atlas 14 rainfall distributions for this analysis:

- Region 3: Warsaw is located in the South Plains region, or Region 3.
- First Quartile: Temporal distributions for Region 3 show that 48% of the rainfall events analyzed receive the majority of total rainfall in the first quartile of the event, making the first quartile representative of the most common accumulation pattern for the region.
- 10% and Median Probability of Occurrence: the median probability of occurrence curve signifies that 50% of events had an equivalent or more intense distribution, and 50% had an equivalent or less intense distribution. Whereas the 10% probability of occurrence signifies that 90% of events were equal to or less intense.

Both 6-hour and 24-hour duration and 10% and median probability of occurrence events were modeled. The cumulative rainfall depth over the 24- and 6-hour event durations are shown in Figure 3-2 and Figure 3-3, respectively. The 10% probability events are shown in dashed shades of orange and red while the median events are shown in solid shades of blue and green. The 10% events have more intense rainfall earlier in the storm, as is indicated from the steeper slope in the dashed lines. Though the 24-hour event depth is higher than the 6-hour depth, the percent accumulation is less condensed over the longer event duration and results in lower peak intensities. Reviewing the 100-year median rainfall events for example, the 6-hour depth and duration accumulates 4.5 inches of rain by hour two. Whereas for the 24-hour depth and duration, only 2.5 inches of rain has accumulated by hour two. Additionally, the maximum rainfall intensity for the 6-hour event is approximately 2.35 inches/hour compared to a lower 1.5 inches/hour intensity for the 24-hour event. For this reason, the 6-hour duration event actually produces higher peak flows because it assumes more rainfall in a shorter period of time, resulting in more runoff reaching the creek at one time.

⁹ National Weather Service (NWS); 1977; Technical Memorandum HYDRO-35: Five- to 60-Minute Precipitation Frequency for the Eastern and Central United States; https://www.nws.noaa.gov/oh/hdsc/PF_documents/TechnicalMemo_HYDRO35.pdf

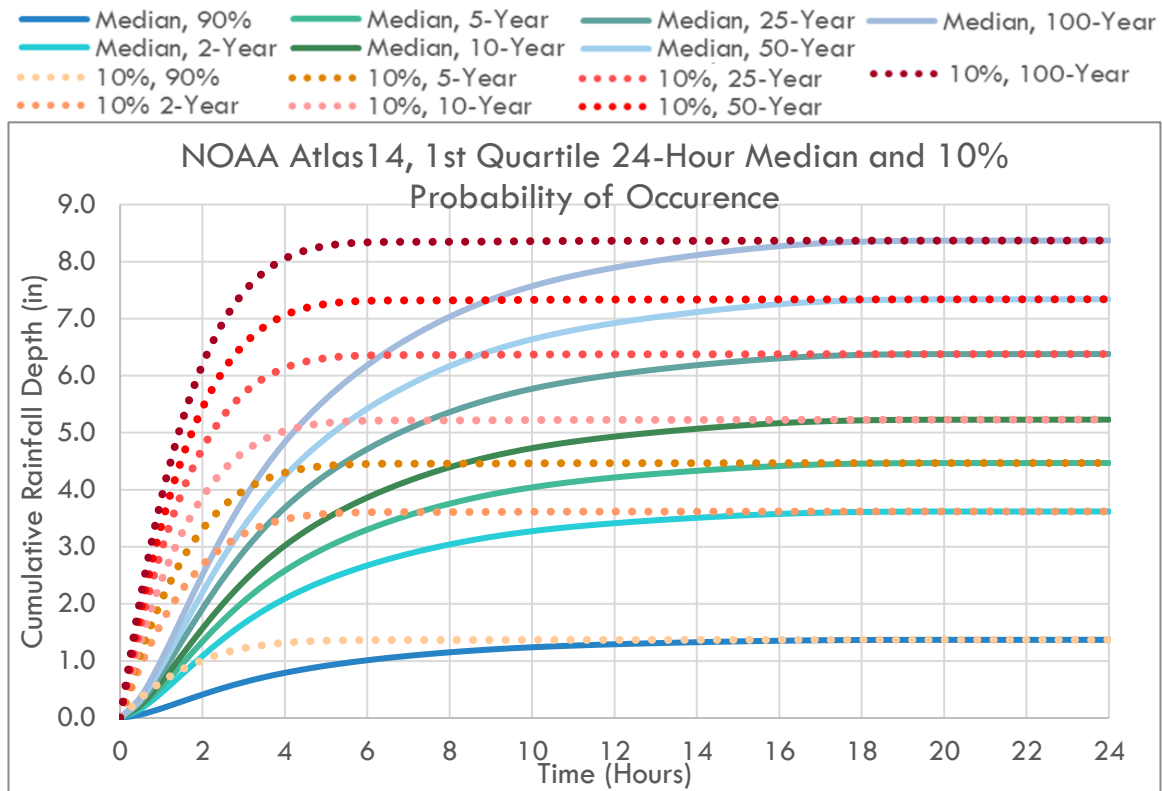


Figure 3-2: NOAA Atlas 14 First-Quartile 24-hr Cumulative Hyetograph

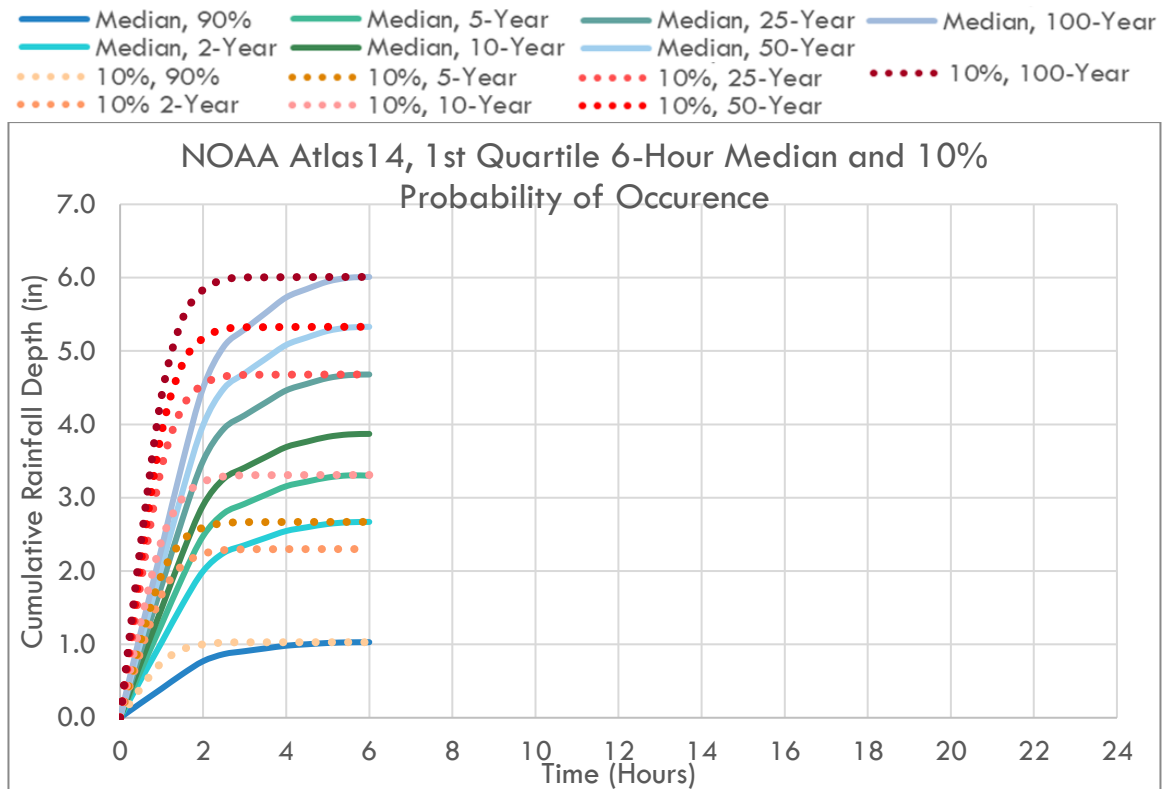


Figure 3-3: NOAA Atlas 14 Median and 10%, First-Quartile 6-hr Cumulative Hyetograph

3.3 RUNOFF PARAMETERS

The size of the drainage area, soil types, impervious cover, and time it takes for stormwater to move through an area are all parameters that impact the amount of stormwater flowing through different portions of the watershed. The SCS runoff curve number method defined in the USDA NRCS Technical Release 55, Urban Hydrology for Small Watersheds, referenced herein as TR-55, was used to estimate stormwater runoff for this analysis⁵. A detailed summary of hydrologic parameters developed for this analysis can be found in Appendix A.

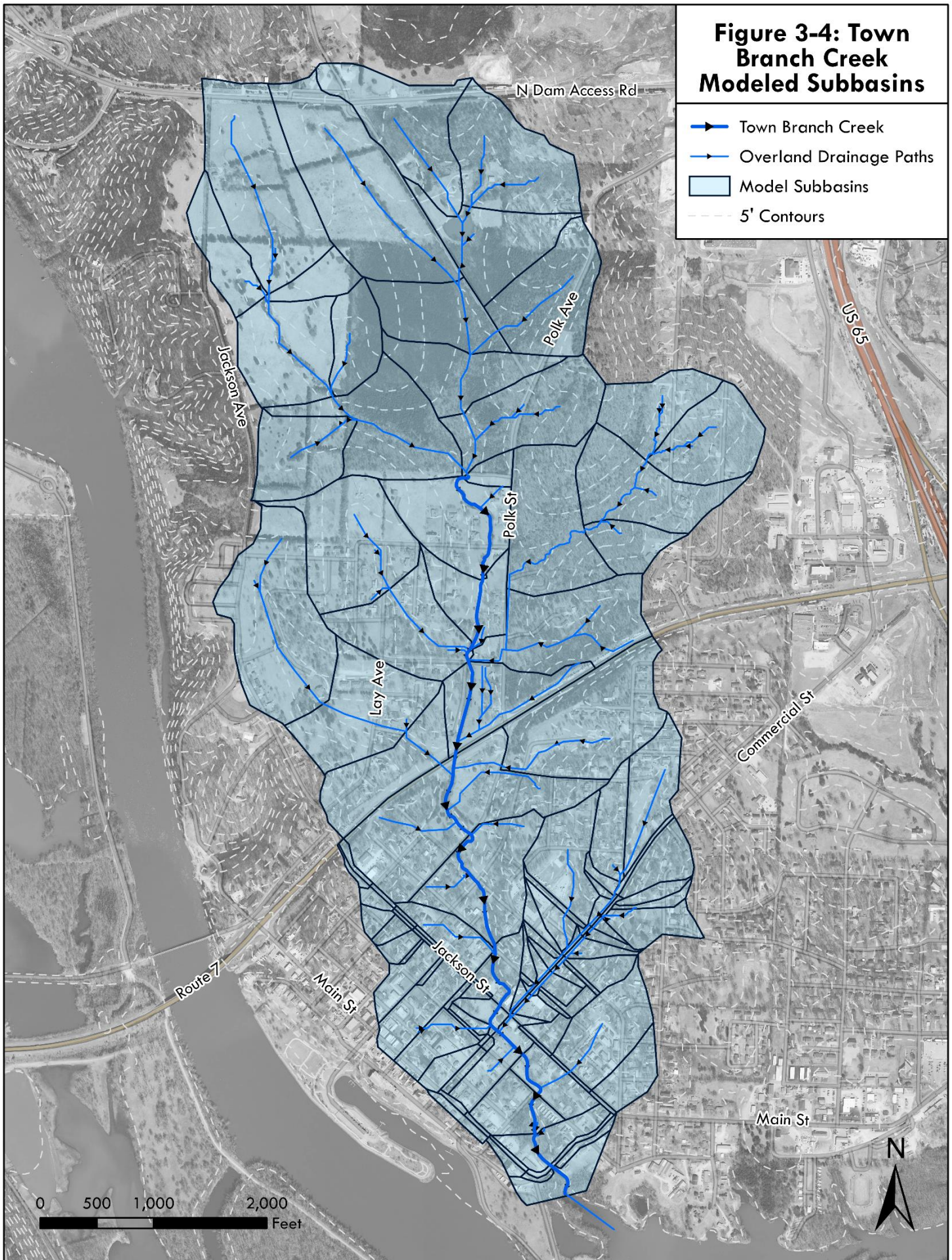
3.3.1 DRAINAGE AREAS

The Town Branch Creek watershed was subdivided into smaller drainage areas primarily using contours developed from the USGS DEM. Because of the coarse resolution of the available elevation data, often the existing roadside ditches were not apparent in the elevation model. For this reason, some engineering judgement was used in the delineation process. Drainage areas were modified based on observed ridgelines along major roadway centerlines and at roadway crossings along Town Branch Creek to more accurately represent stormwater runoff to a given conveyance component.

Town Branch Creek was subdivided into 112 smaller drainage areas, or subbasins, ranging in areas up to 34 acres. The smaller subbasins are primarily located along Jackson, Commercial, and Main Street corridors, between Route 7 and US 65. These roadways are the focus of a larger transportation project and were defined in greater detail to design conceptual stormwater improvement needs, as is documented in the *Stormwater Management and Environmental Protection Preliminary Engineering Study: Warsaw Livable Community Transportation Project*¹⁰. Modeled subbasins are shown in Figure 3-4; full size figures are included in Appendix A.

¹⁰ Burns & McDonnell; 2019; Stormwater Management and Environmental Protection Preliminary Engineering Study: Warsaw Livable Community Transportation Project

Figure 3-4: Town Branch Creek Modeled Subbasins



3.3.2 CURVE NUMBER

Curve number is defined based on the type of cover and the hydrologic condition of the drainage area. The type of cover represents the land use such as residential districts, commercial and business districts, open space, woods, and more. Hydrologic condition is indicative of the ability of the ground cover to infiltrate stormwater or produce stormwater runoff and is determined by the hydrologic soil group and condition of the vegetative cover. Curve numbers for this analysis were developed using a combination of available data, as discussed further in the following subsections.

3.3.2.1 HYDROLOGIC SOIL GROUP

The USDA NRCS Web Soil Survey¹¹ was used to define the hydrologic soil conditions of the Study Area. This online tool provides a soil report classifying the Study Area by hydrologic soil group rating A, B, C, D, or a combination of multiple. The hydrologic soil conditions for Town Branch Creek were discussed in Section 2.1 and the Web Soil Survey results can be found in Appendix A. The hydrologic soil group designations were summarized by size within each subbasin, and the hydrologic soil group representing the largest portion of the total subbasin was assigned.

3.3.2.2 CITY OF WARSAW ZONING

The Benton County parcel data did not include land use designations. Because of this, the City of Warsaw zoning map (Figure 2-2) was used to approximate cover type. Per the City zoning map, all area within the Town Branch Creek watershed is defined as commercial, residential, or open. TR-55 Tables 2-2a Runoff curve numbers for urban areas and Table 2-2c Runoff curve numbers for other agricultural lands were used to correlate Warsaw defined zoning with defined cover types⁵.

Four residential zone classifications exist in the Warsaw zoning designations: Single-Family Dwelling (R-1), Two-Family Dwelling (R-2), Multiple-Family Dwelling (R-3), and Mobile Home District (R-4). In order to correlate the residential zone designations to the TR-55 cover types, each zone needed to be classified by average size. The Benton County parcels were intersected with the zoning boundaries, assigning a zone designation to each parcel. The zones were then summarized by total parcel size, and a median and average size per zone designation was calculated. The four Warsaw-designated residential zone types were then assigned an average lot size correlating with those defined in TR-55. Additionally, type of vegetative coverage of open areas impacts how quickly water moves through a drainage area. For this reason, aerial imagery was used to further differentiate open areas characterized by dense trees versus grass-type vegetative coverage. "Fair condition" was assumed for both lawn and wooded open space. Table 3-2 summarizes the results of these calculations, and assumptions made to correlate the Warsaw zoning with TR-55 defined cover types.

¹¹ Soil Survey Staff, Natural Resources Conservation Service (NRCS), United States Department of Agriculture (USDA); Web Soil Survey. Accessed 5/30/2019 at the following link: <http://websoilsurvey.sc.egov.usda.gov/>

Table 3-2: Warsaw Zoning Cover Type Assumptions

Warsaw Zoning		TR-55 Cover Type Assumed
Commercial Districts	C1 - Local Business District	Commercial and Business
	C2 - Central Business District	Commercial and Business
	C3 - Commercial District	Commercial and Business
Residential Districts	R1 - Single-Family Dwelling District	1/3 Acre
	R2 - Two-Family Dwelling District	1/4 Acre
	R3 - Multiple-Family Dwelling District	1/4 Acre
	R4 - Mobile Home District	1/2 Acre
Open Space District	O - Open Space	Fair Condition (grass cover 50% to 75%)
		Woods, Fair Condition

3.3.2.3 CURVE NUMBER DEVELOPMENT

To calculate the SCS curve number for each subbasin, the cover type was intersected with the hydrologic soil group-defined subbasins. This intersection provided an area-based coverage for the hydrologic soil group and cover type parameters. Curve numbers for each soil group and cover type were defined based on TR-55 tables 2-2a Runoff curve numbers for urban areas and 2-2c Runoff curve numbers for other agricultural lands, as summarized in Table 3-3. A weighted average curve number was then calculated for each subbasin. The resulting curve numbers for each subbasin are summarized in Appendix A.

Table 3-3: TR-55 Curve Numbers

Cover Type & Hydrologic Condition	Curve Numbers for Hydrologic Soil Groups				
	A	B	C	C/D	D
Commercial and Business	89	92	94	94.5	95
Residential Districts, 1/3 Acre Average Lot Size	57	72	81	83.5	86
Residential Districts, 1/4 Acre Average Lot Size	61	75	83	85	87
Residential Districts, 1/2 Acre Average Lot Size	54	70	80	82.5	85
Open Space, Fair Condition (grass cover 50% to 75%)	49	69	79	81.5	84
Woods, Fair Hydrologic Condition	36	60	73	76	79

3.3.3 TIME OF CONCENTRATION

The time it takes for stormwater runoff to flow from the upstream end of the watershed to the outlet dictates how much stormwater is reaching a given point at one time, and thereby affects the peak runoff flow rates. The SCS empirical formula was used to calculate the lag time for each subbasin. The lag time is the time between the maximum rainfall intensity of a storm and the point of maximum discharge at the downstream end of the subbasin. The equation includes the SCS curve number as a roughness factor as well as the length and slope of the longest overland drainage path

in each subbasin. Longest flow paths and slopes were based on USGS DEM data. The model uses time of concentration for hydrology calculations, which is defined as 5/3rds of the calculated lag time. Calculated times of concentration for subbasins generally ranged between 2 and 36 minutes, depending on the watershed size and characteristics. In accordance with APWA 5600, a minimum time of concentration of 5 minutes was used. Time of concentration calculations for each subbasin are summarized in Appendix A. Equations used are summarized as follows

$$T_{lag} = \frac{L^{0.8}[(1000/CN) - 9]^{0.7}}{1900 * \sqrt{S}}$$

$$T_c = \frac{5}{3}T_{lag}$$

Where:

T_{lag} = Lag Time (hours)

L = length of the longest flow path in the watershed (ft)

CN = SCS Curve Number

S = average slope of the watershed along L (%)

T_c = Time of concentration (hours)

3.4 STORMWATER ROUTING

Hydrologic and hydraulic modeling software routes stormwater runoff flows for each subbasin using “Link” and “Node” features. In the CivilStorm software, a Link can be defined as a conduit (pipe), channel, gutter, or lateral. Nodes are located at the upstream and downstream junctions of the links and can represent numerous components of a typical storm system, such as a catch basin, manhole, channel cross section, or outfall. The scope of this study did not include detailed hydraulic modeling, and therefore detailed geometry for stormwater routing was not developed on a watershed-wide basis. Instead, available and developed data within the project scope was used to define reasonable routing parameters. The parameters developed and assumed for stormwater routing within the CivilStorm model are discussed in the following subsections.

3.4.1 CHANNEL LINKS

Because the existing stormwater drainage system in the study area consists primarily of roadside ditches and Town Branch Creek, channels were used for all links within the model. Links were defined primarily using the overland drainage paths developed as part of this analysis. Model links and subbasin routing are shown in Figure 3-5. The dashed black lines show the link to which each subbasin was routed.

Channel links require inputs to define the assumed physical geometry. DEM elevations were used to define the upstream and downstream elevation of the channels so that CivilStorm could calculate channel slope. The cross section of the channel is then defined by the upstream node geometry, discussed in the following subsection.

Creek provided a data source to approximate the geometry of the creek. Ten GPS cross sections were merged with cross sections developed from the DEM to use within the model to represent Town Branch Creek. A generic cross section was assumed for links outside of Town Branch Creek where geometry was not known. This generic section was intended to represent a typical 2-foot deep trapezoidal roadside ditch in Warsaw, with a 2:1 side slope. So not to overtop the ditch during larger storm events, the section extended an additional 8 feet on either side of the trapezoidal section and 6 feet vertically at each end. Figure 3-6 shows the plan view location of the modeled cross section assumptions. The cross section geometry for the GPS-surveyed/DEM defined sections of Town Branch Creek are shown in Figure 3-7. The generic channel cross section representing roadside ditches is shown in Figure 3-8.

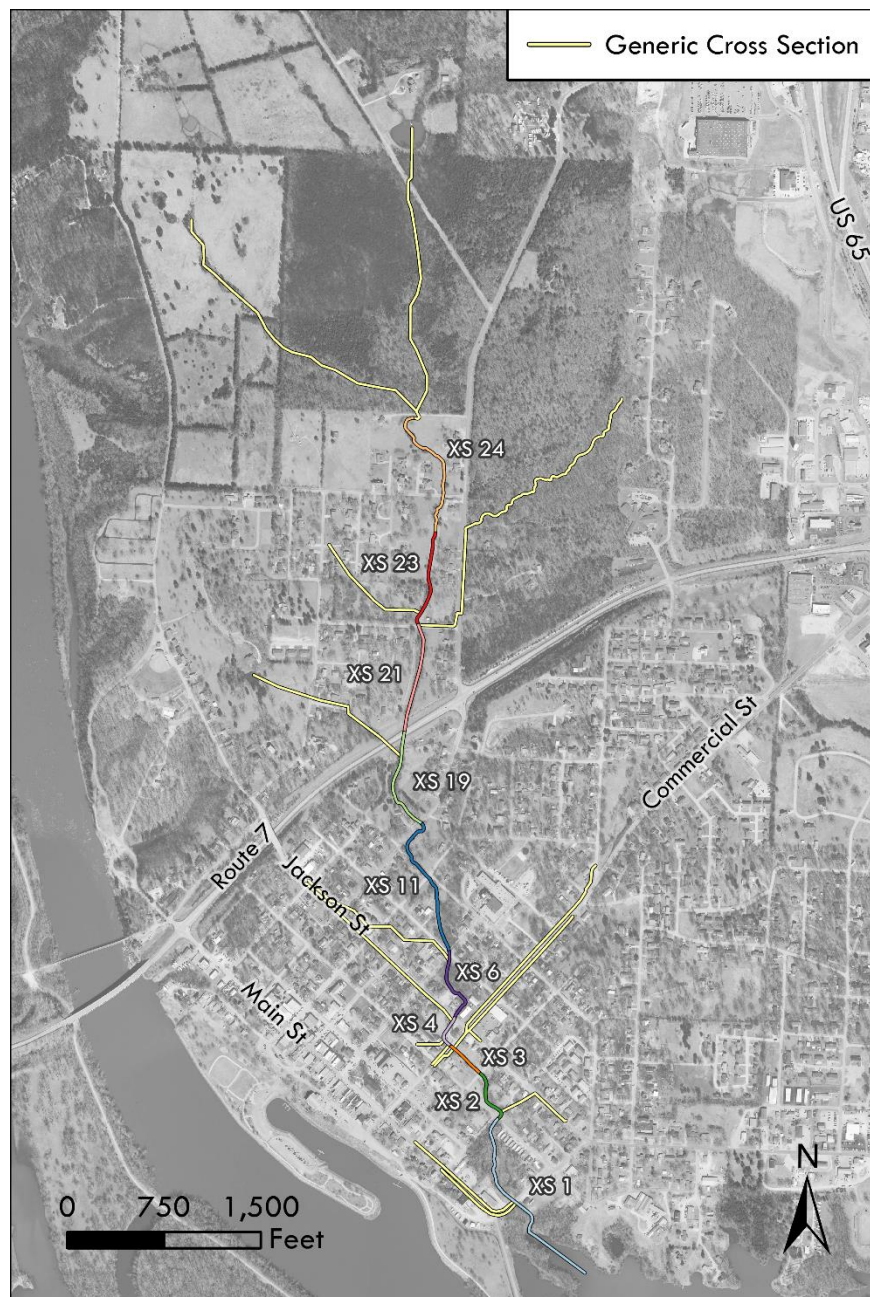


Figure 3-6: Modeled Cross Section Plan View Locations

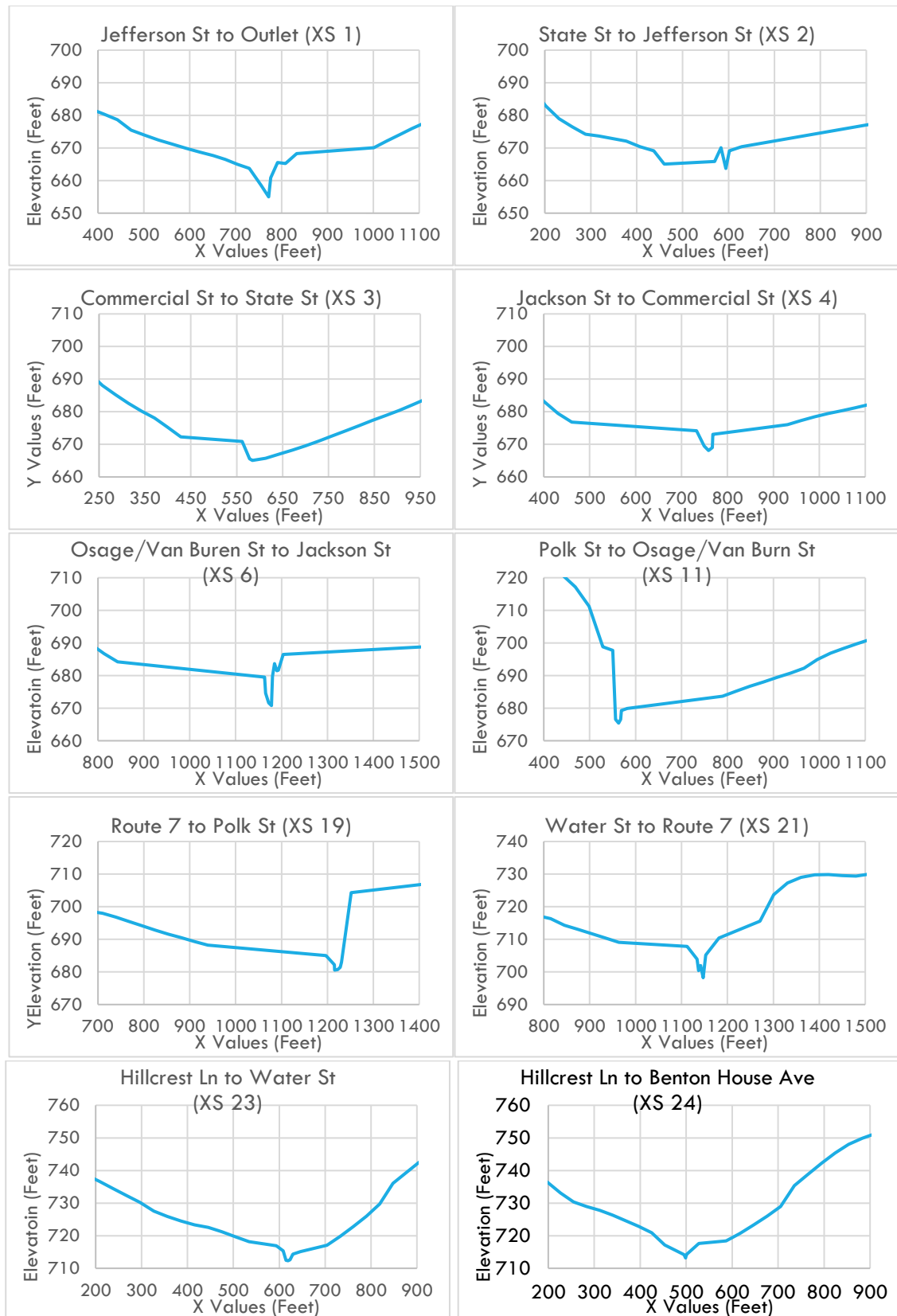


Figure 3-7: Town Branch Creek Modeled Cross Sections

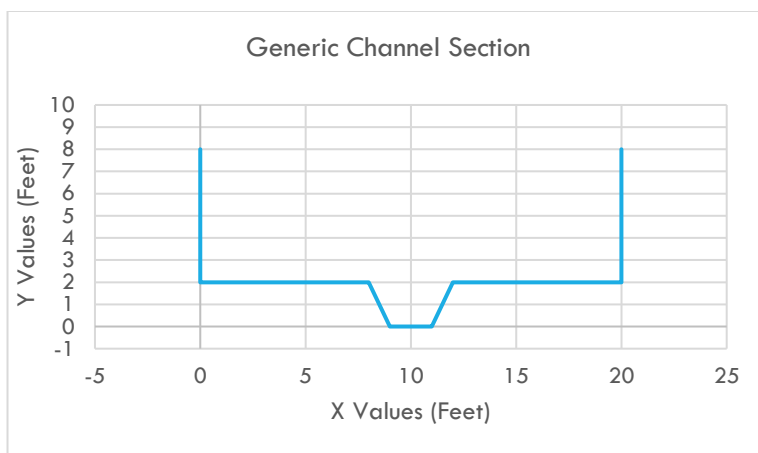


Figure 3-8: Generic Roadside Ditch Modeled Cross Section

All cross sections were built into the CivilStorm “Conduit Catalog” as an “Irregular Channel” conduit shape. The cross section data was then input to define the geometry of each cross section. A channel material was selected to define the manning’s roughness coefficient using the Material Library within the CivilStorm catalogues. For all Town Branch Creek cross sections, “Natural stream, weedy” with a corresponding roughness coefficient of 0.045 was selected. For all generic sections representing roadside ditches, “Rough channel, with grass” assuming a roughness coefficient of 0.30 was selected. The cross sections were assigned to the appropriate node(s), to complete the channel geometry inputs.

3.5 MODEL CALIBRATION AND VERIFICATION

No stream gages exist within the Town Branch Creek Watershed. Therefore, the model prepared for this analysis could not be calibrated to observed data. To verify the model was producing reasonable results, peak discharges were compared to values published in the Flood Insurance Study¹² and StreamStats¹³. For a visual comparison of the modeled flows related to these verification points, the graph shown in Figure 3-9 was developed showing the trends of how flows per unit drainage area decrease as the total tributary area increases.

¹² Flood Emergency Management Agency (FEMA); June 2, 2009; Flood Insurance Study Benton County, Missouri and Incorporated Areas; https://msc.fema.gov/portal/downloadProduct?filepath=/29/S/PDF/29015CV000A.pdf&productTypeID=FINAL_PRODUCT&productSubTypeID=FIS_REPORT&productID=29015CV000A

¹³ U.S. Geological Survey; 2016; The *StreamStats* program online; accessed on August 11, 2020; <http://streamstats.usgs.gov>

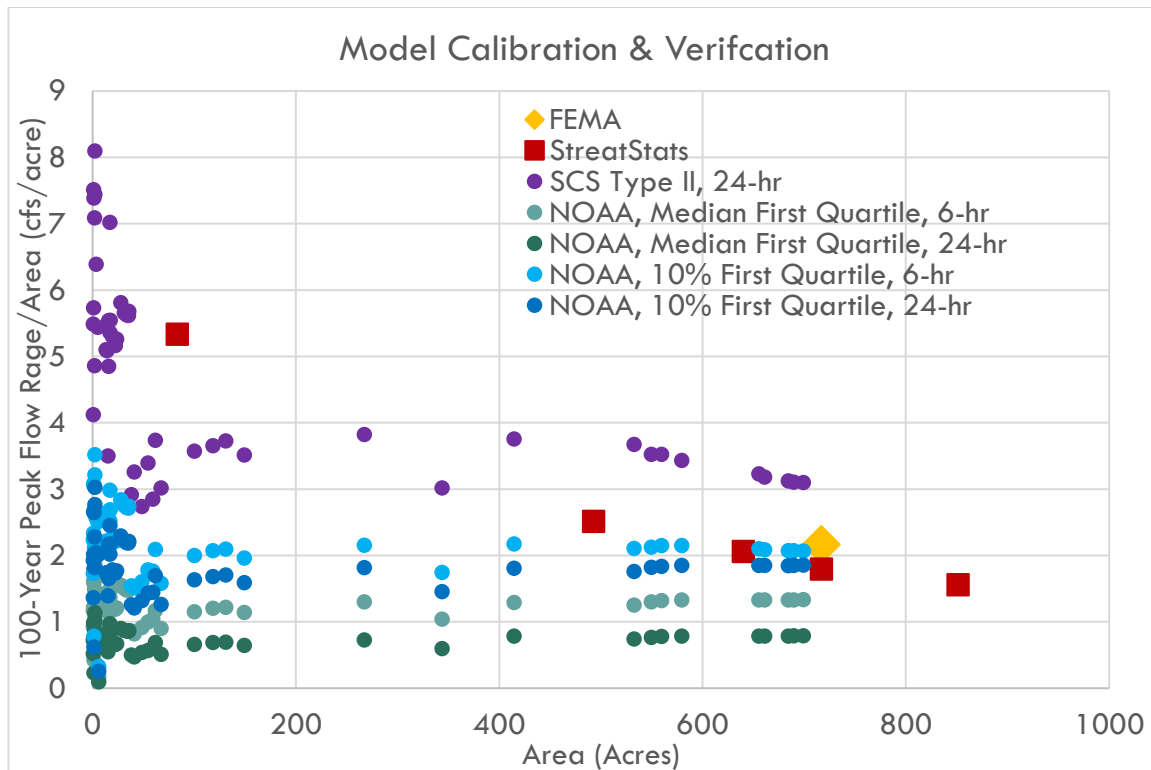


Figure 3-9: 100-Year Flow Rate per Area (CFS/Acre) Model Calibration

The comparison of results shows that the City's current standards typically yield higher peak flow rates than either of the sources used for comparison. It should be noted that both the Flood Insurance Study and Stream Stats used USGS runoff regression equations to estimate peak flows, which is a different methodology than prescribed by the City's current standards for hydrology calculations. Regression equations are independent of storm duration or rainfall data altogether. Instead they are developed using flood frequency analysis based on stream gage data and best-fit characteristics of the drainage areas to those gages. Considering that all modeled storm events are based on rainfall data and assumed durations/distributions, the StreamStats and FEMA flows provide suitable data validation points that are independent of those assumptions.

3.6 HYDROLOGIC ANALYSIS RESULTS

The hydrologic model was run for 90% mean annual, 2-, 5-, 10-, 25-, 50-, and 100-year storm events for the SCS Type II and NOAA Atlas 14 distributions discussed in Section 3. The resulting peak flow at the outlet of Town Branch Creek to the Lake of the Ozarks/Osage River is summarized in Table 3-4. Peak flows from the FEMA effective FIS and USGS StreamStats online program are also shown for reference to the modeled rainfall distributions. The outflow hydrographs for the 100-year events are shown in Figure 3-10, demonstrating how those peak flows accumulate over the duration of the rain event. Detailed model output for individual links and subbasins for each rainfall distribution model run can be found in Appendix A.

Table 3-4: Hydrologic Analysis Peak Flow Results

Duration	Hydrology Method	Peak Flow Rate at Town Branch Creek Outlet (CFS)						
		90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
6 Hours	NOAA Atlas 14, 10% 1st Quartile	33	451	671	871	1,181	1,447	1,774
	NOAA Atlas 14, Median 1st Quartile	19	298	442	578	773	932	1,105
	SCS Type II	42	675	973	1,257	1,727	2,166	2,656
24 Hours	NOAA Atlas 14, 10% 1st Quartile	49	426	613	782	1,055	1,298	1,562
	NOAA Atlas 14, Median 1st Quartile	17	248	169	323	445	553	673
N/A	StreamStats		239	463	643	898	1,090	1,290
	FEMA Flood Insurance Study							1,550

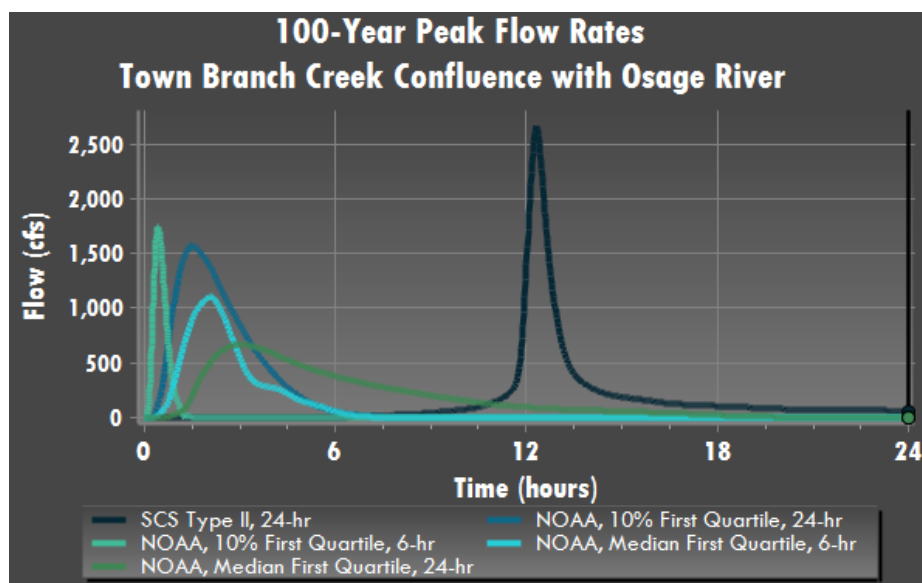


Figure 3-10: 100-Year Peak Outflow Hydrograph

In accordance with the City's currently adopted stormwater standards, the SCS Type II distribution results are documented as the resulting flow rates for this study. The results of the other rainfall distributions analyzed as they relate to the FEMA and StreamStats model calibration and verification flows should be considered as the City pursues updates to stormwater policy and design criteria in the future. The following summarizes major findings for consideration:

- Results of the hydrologic analysis show that the SCS Type II distribution results in 32-34% higher peak flow rates when compared to the next highest peak flow of all other methods analyzed for the 2- thru 100-year storm events.

- The SCS Type II distribution is almost two to three times higher than the FEMA and StreamStats calibration values, respectively.
- Town Branch Creek is a smaller watershed, and is more likely to experience shorter duration storm events than full 24-hour storm events.
- NOAA Atlas 14 Median First Quartile 6-hour distribution resulted in the most statistically similar peak flow rates as the StreamStats for the majority of storm events; however, it resulted in slightly lower flow rates than both StreamStats and FEMA methods.
- The NOAA Atlas 14 10% First Quartile 6-hour distribution resulted in peak flow rates that are close to, but still higher than the referenced calibration flows from the FEMA and StreamStats methods

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SECTION 4

HYDRAULIC MODEL REVIEW

The City of Warsaw participates in the National Flood Insurance Program. Town Branch Creek is one of the watercourses that has been mapped by FEMA as a flood risk. The creek is mapped as a Zone AE with base flood elevations established between Route 7 and the Osage River/Lake of the Ozarks. The Flood Insurance Rate Map (FIRM) show a significant number of homes and businesses along the creek to be at risk from flooding during the 1-percent chance annual flood risk. The Study Area can be found in FIRM panel 29015C0407D, Panel 407 of 625 effective June 2, 2009, included in Appendix B.

Because Town Branch Creek serves as a primary stormwater conveyance system through Warsaw, the hydraulic performance of the creek is a primary factor that impacts flooding in the watershed. The FEMA effective model represents the only hydraulic analysis that has been conducted to date on Town Branch Creek. For this reason, review of this model can provide an understanding of how representative this hydraulic analysis is as it compares to current conditions. The primary purpose of this hydraulic model review was to determine if the FEMA effective model assumptions were appropriate to evaluate the existing hydraulic capacity and performance of Town Branch Creek, or if additional data and updated hydraulic analysis would be necessary.

4.1 FEMA EFFECTIVE MODEL

A Category 1 FIS data request was submitted to FEMA in September 2019. The fulfilled request included Hydrologic Engineering Center (HEC) HEC-2 model output for Town Branch Creek dated November 29, 1988.

4.1.1 FLOOD INSURANCE STUDY

The FIS covers the geographic area of Benton County, Missouri and detailed study of flooding sources including Lake of the Ozarks and Osage River from the western county line in Warsaw near mile marker 92.5 to the eastern county line near mile marker 71¹². The study reports a single value of 1,550 cfs for the 1% annual chance discharges for Town Branch Creek at the mouth of the Osage River. FEMA updated the flood insurance study in 2009. However, Town Branch Creek was not restudied at this time. The effective model and flood risk shown on the FIRM is based on topographic data and analyses that were done prior to 1988. According to this original analysis, the peak flow rate was estimated from regression analysis for ungagged drainage basins for the State of Missouri¹⁴.

4.1.2 HEC-2 FEMA EFFECTIVE MODEL CONVERSION

The FEMA effective model was obtained by the Engineering Library for the sole purpose of obtaining cross section geometry and locations. The information obtained from FEMA was a scanned printout of a HEC-2 model, included in Appendix B. HEC-2 is a modeling software that was last updated in 1990. The software has been replaced with HEC-RAS and will not run using modern

¹⁴ Flood Emergency Management Agency (FEMA); July 16, 1990; *Flood Insurance Study City of Warsaw, Missouri*; https://msc.fema.gov/portal/downloadProduct?filepath=/29/S/PDF/290030V000.pdf&productTypeID=FINAL_PRODUCT&productSubTypeID=FIS_REPORT&productID=290030V000

operating systems. Therefore, the model must be converted in order to be used. The effective model was converted from HEC-2 to HEC-RAS, Version 5.0.7.

Because no location-specific data was included with the HEC-2 information, the cross-section locations for the HEC-2 model had to be approximated based on information in the FIS. The approximate locations of cross sections were determined using the downstream reach lengths from the model. The cross-section locations were also compared with the FEMA cross sections in the FIRM Panel as shown in Figure 4-1.

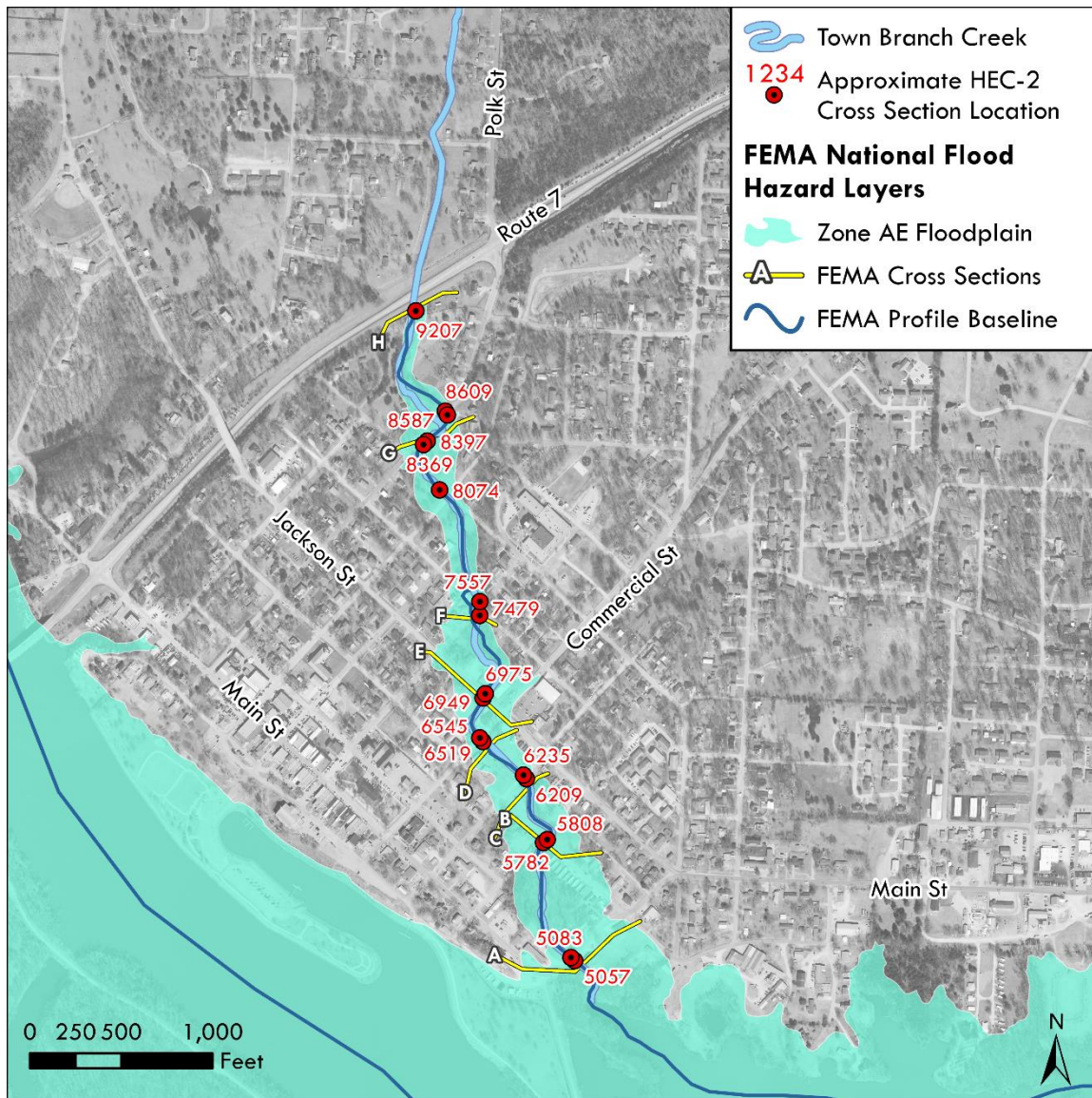


Figure 4-1: FEMA HEC-2 Town Creek Cross Section Locations

4.2 TOWN BRANCH CREEK CROSS SECTION COMPARISON

The channel cross section inputs in the model set the basis for the ground profile of the stream as well as the area in which stormwater flows are concentrated. This geometry controls how the model assumes stormwater flows through the creek, and therefore the flood elevations and extents that it

reaches during different modeled storm events. For instance, a narrow channel will generally force the water surface elevation higher than a wider channel that allows the stormwater flow to spread out. Additionally, the invert elevations assumed will directly impact the modeled water surface elevation, velocity and flow rate. The inverts not only dictate the slope of the channel, but the starting elevation on which the water surface elevation is built. For example, if looking at two models with identical channel cross section geometry but one assumes an invert 2 feet higher than the other, the resulting water surface elevation will also be 2 feet higher. The more representative the cross sections are of the actual geometry of the stream, the more realistic the modeled flood elevation and extents will be.

In order to compare the FEMA effective HEC-2 geometry assumptions to existing conditions of Town Branch Creek, the HEC-2 cross sections assumed were compared to the GPS-surveyed and DEM developed cross sections discussed in Section 1.5 and Section 3.4.2 . A plan view of the approximate locations of the HEC-2 cross sections as they relate to the GPS-surveyed cross sections is shown in Figure 4-2.

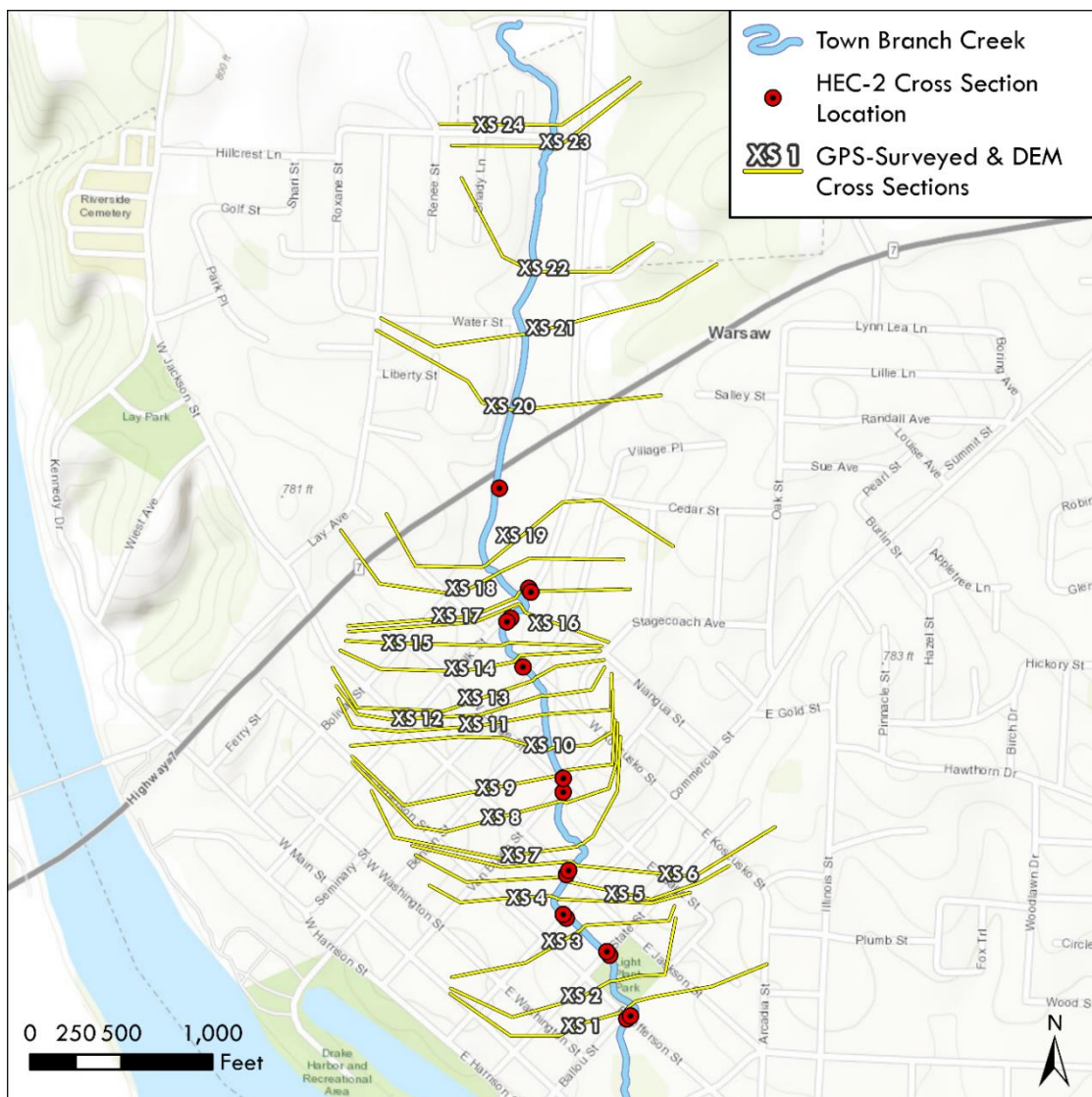


Figure 4-2: Plan View of HEC-2 and GPS-Surveyed Cross Sections

The channel profiles for the HEC-2 and GPS-surveyed cross sections were evaluated. As shown in Figure 4-3, the HEC-2 cross sections vary by up to 2.8 feet from the GPS-surveyed cross sections. Because the location of the cross sections between the two sources are not the same, a linear interpolation was used to approximate elevations between the two locations.

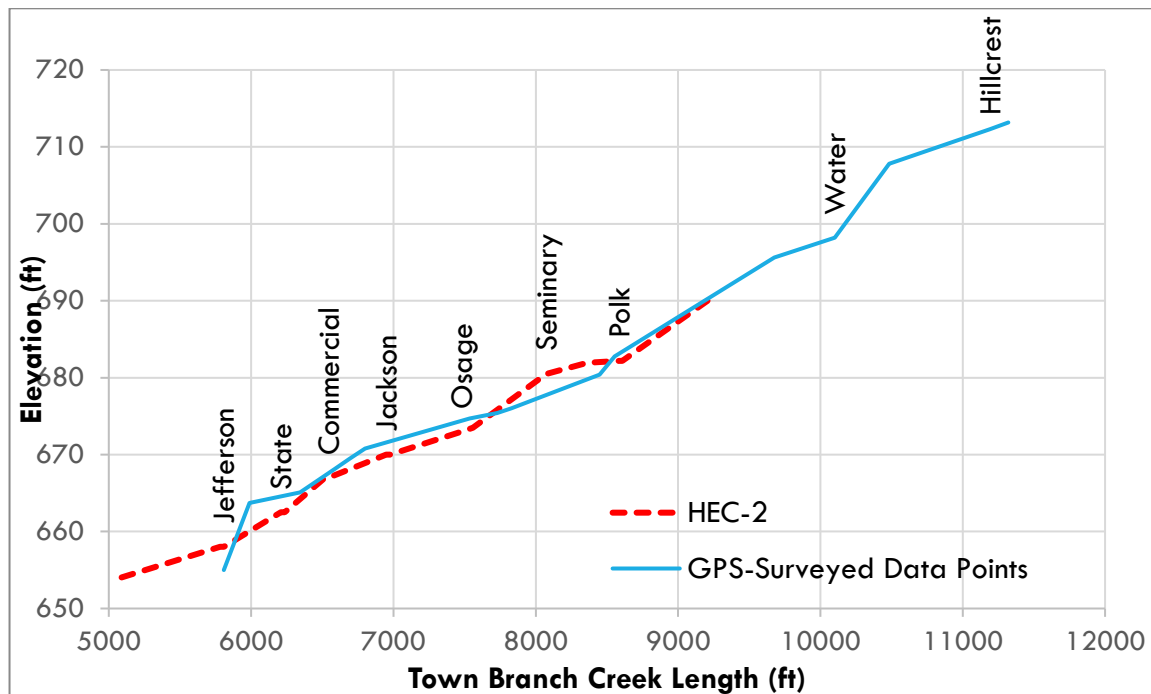


Figure 4-3: Town Branch Creek Profile HEC-2 and GPS-Surveyed Invert Assumptions

The cross-section geometry used in the FEMA effective model was compared to the GPS-surveyed cross sections. Because the GPS-surveyed cross sections were not at the same location as those in the effective model, some engineering judgement was used for the comparison. In general, a cross section from the effective model was compared to the closest GPS-survey cross section. In order to view the geometry on a more 1:1 basis, the minimum elevation of GPS surveyed sections was aligned with the minimum elevation of the HEC-2 cross sections. The results of this comparison are shown in Figure 4-4.

As indicated from the comparison, a significant difference exists between the geometry of the FEMA effective model from 1988 and the GPS-surveyed cross-sections from 2019. This difference could result in an inaccurate depiction of the flood risk currently mapped for Town Branch Creek. In order to more accurately represent hydraulic performance and flood risk, it is recommended that an updated flood study be prepared for Town Branch Creek.

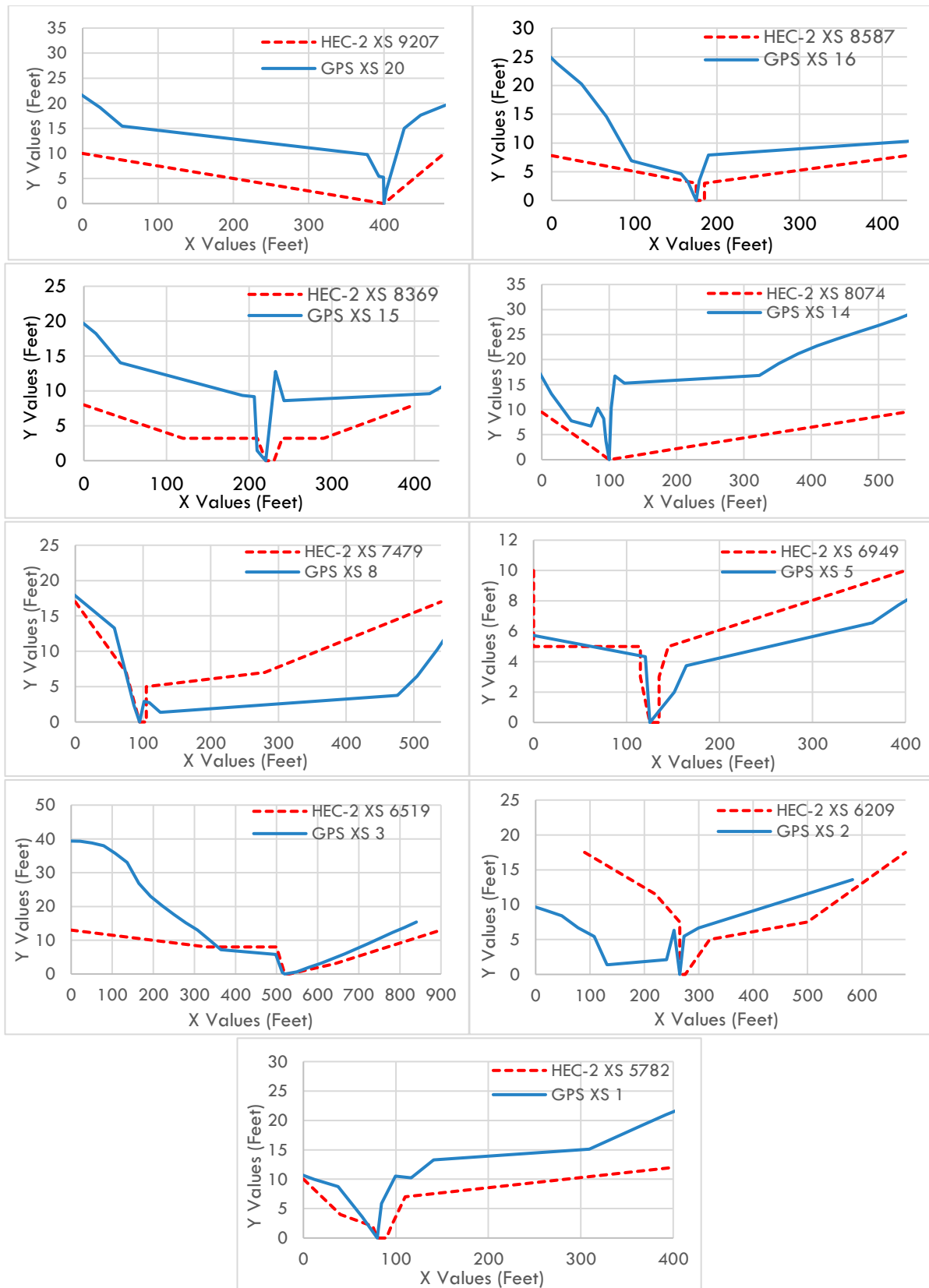


Figure 4-4: HEC-2 Cross Sections Comparison with GPS-Surveyed Cross Sections

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SECTION 5

STORMWATER TOOLS

The project team developed Google Earth-based Stormwater Tools to summarize the results of the hydrologic analysis. These tools can be integrated into the Google Earth on web or Google Earth Pro on desktop applications for use by the City. Both Google Earth applications are free and can be accessed or downloaded from the following website <https://www.google.com/earth/versions/>.

5.1 LIMITATIONS OF USE

The Stormwater Tools provide a graphical and interactive representation of the stormwater study and are not intended to for direct reuse on other projects. The Stormwater Tools are intended to serve as conceptual analysis and verification only and should not be used directly for detailed design. Design requires detailed topographic data that is beyond the level of accuracy of the data used in this analysis. Detailed hydrologic and hydraulic engineering analysis and design should still be performed independent of these calculates for each respective project.

5.2 TOWN BRANCH CREEK STORMWATER TOOLS

The stormwater tools are packaged as a single Google Earth Keyhole Markup Language Zipped (KMZ) file with a series of interactive layers. Figure 5-1 provides a preview of how the stormwater tools appear when the KMZ file is pulled into Google Earth. The following subsections summarize the stormwater tool layers that are provided, and a description of the data fields that are included with each. Example applications of how these tools can be used is discussed in Section 6.

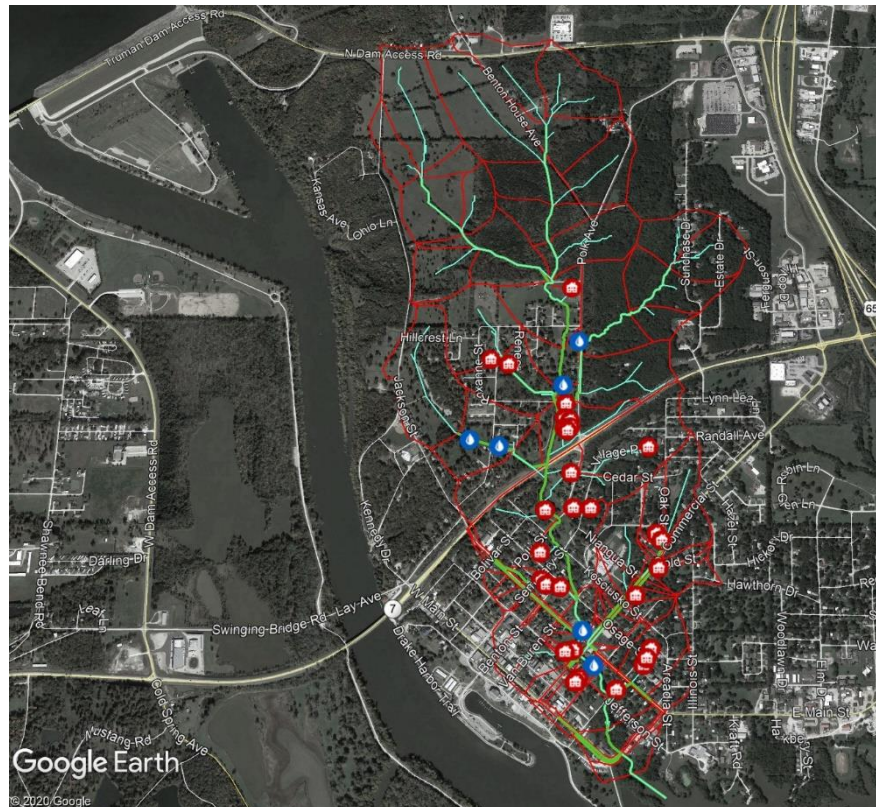


Figure 5-1: Google Earth Stormwater Tools Desktop Preview

5.2.1 OVERLAND DRAINAGE PATHS

The overland drainage path demonstrates the path that stormwater runoff will take as it moves through the watershed, based on the topography provided by the USGS DEM. Often times engineered drainage systems, like roadside ditches and pipes, do not directly align with the overland drainage path but instead follow the City's gridded street system. In these instances, the engineered system will convey stormwater flows until those flows exceed the capacity of the engineered system, at which time stormwater will continue down the overland drainage path. The drainage paths are included for reference only, and do not have any data attributes associated with them. An example of how the Overland Drainage Path tool appears in the Google Earth Platform is shown in Figure 5-2.

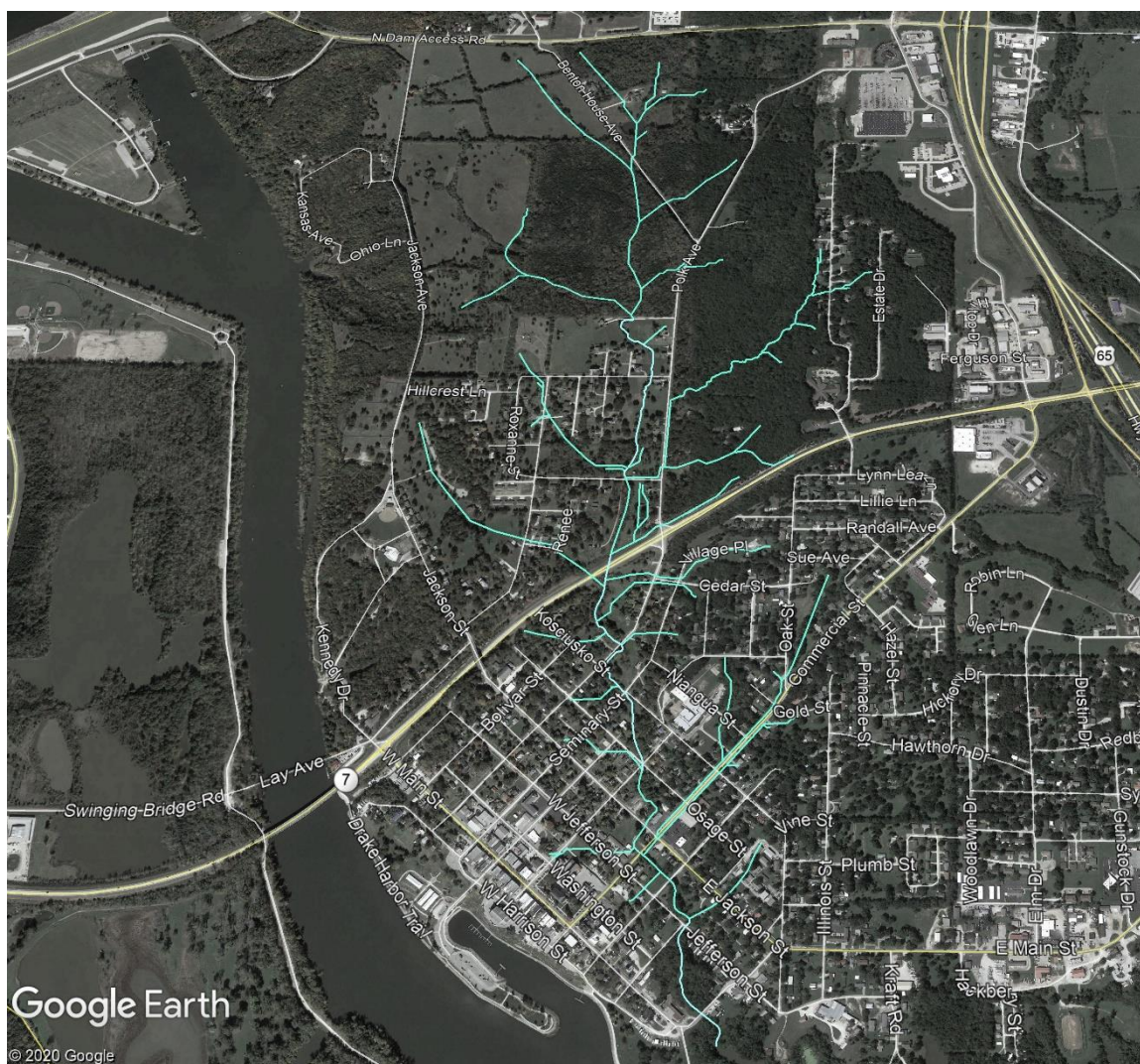


Figure 5-2: Stormwater Tools – Overland Drainage Paths

5.2.2 DRAINAGE AREAS

The drainage area layer represents the modeled subbasin boundaries and the stormwater runoff that is generated from that area. Data fields included with the drainage area layer include

stormwater flow rates for that area as well as the hydrologic parameters that are used to calculate that runoff, including the following:

- Basin ID: unique identification code
- Drainage Area (acres): total land area
- Approximate % Impervious: percent impervious area approximated for the subbasin
- SCS Curve Number: weighted average SCS curve number for the subbasin
- Time of Concentration (min): calculated time for stormwater runoff to flow from the upstream-most point of the subbasin, to the subbasin outlet
- 90% Mean Annual, 2-, 5-, 10-, 25-, 50-, or 100-Year Peak Flow Rate (CFS): calculated stormwater runoff flow rate for the subbasin based on the SCS Type II rainfall distribution per current City policy, in cubic feet per second
- 90% Mean Annual, 2-, 5-, 10-, 25-, 50-, or 100-Year Peak Runoff Volume (gal): calculated stormwater runoff volume for the subbasin the SCS Type II rainfall distribution per current City policy, in gallons
- Downstream Link ID: unique identification code correlating with the stormwater runoff link to which the drainage area contributes

An example of how The Drainage Areas tool and data fields appear in the Google Earth platform is shown in Figure 5-3. Reference Section 3.3 for additional information on how these parameters were developed.

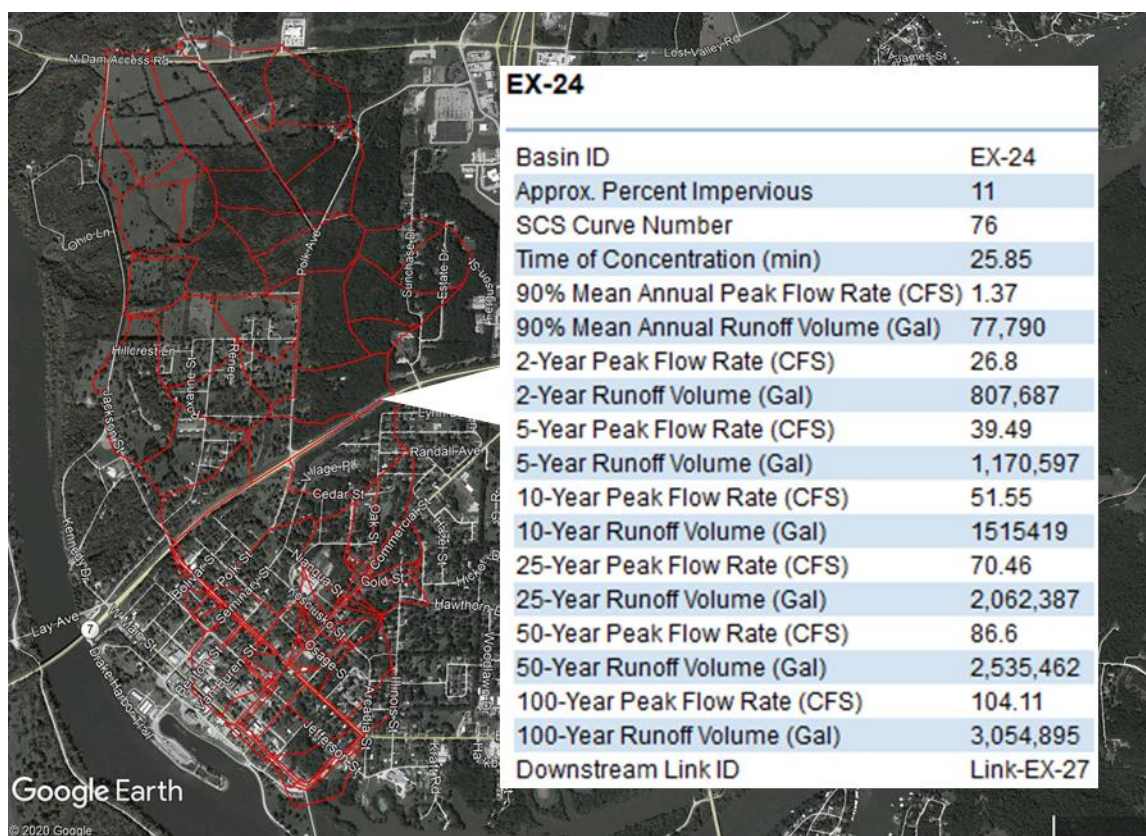


Figure 5-3: Stormwater Tools – Drainage Areas

5.2.3 CITY-IDENTIFIED DRAINAGE ISSUES & POTENTIAL OBSTRUCTIONS

The City-identified flooding locations were digitized and included as points in the stormwater tools. Additionally, locations where a building, home, garage, or other structure is located within the overland drainage path were identified. These existing structures are designated as “potential drainage obstructions” due to their potential to obstruct stormwater as it flows overland. The drainage obstructions are included for reference only, and do not have any data attributes associated with them. An example of how the Drainage Issues and Drainage Obstruction tools appears in the Google Earth Platform is shown in Figure 5-4.

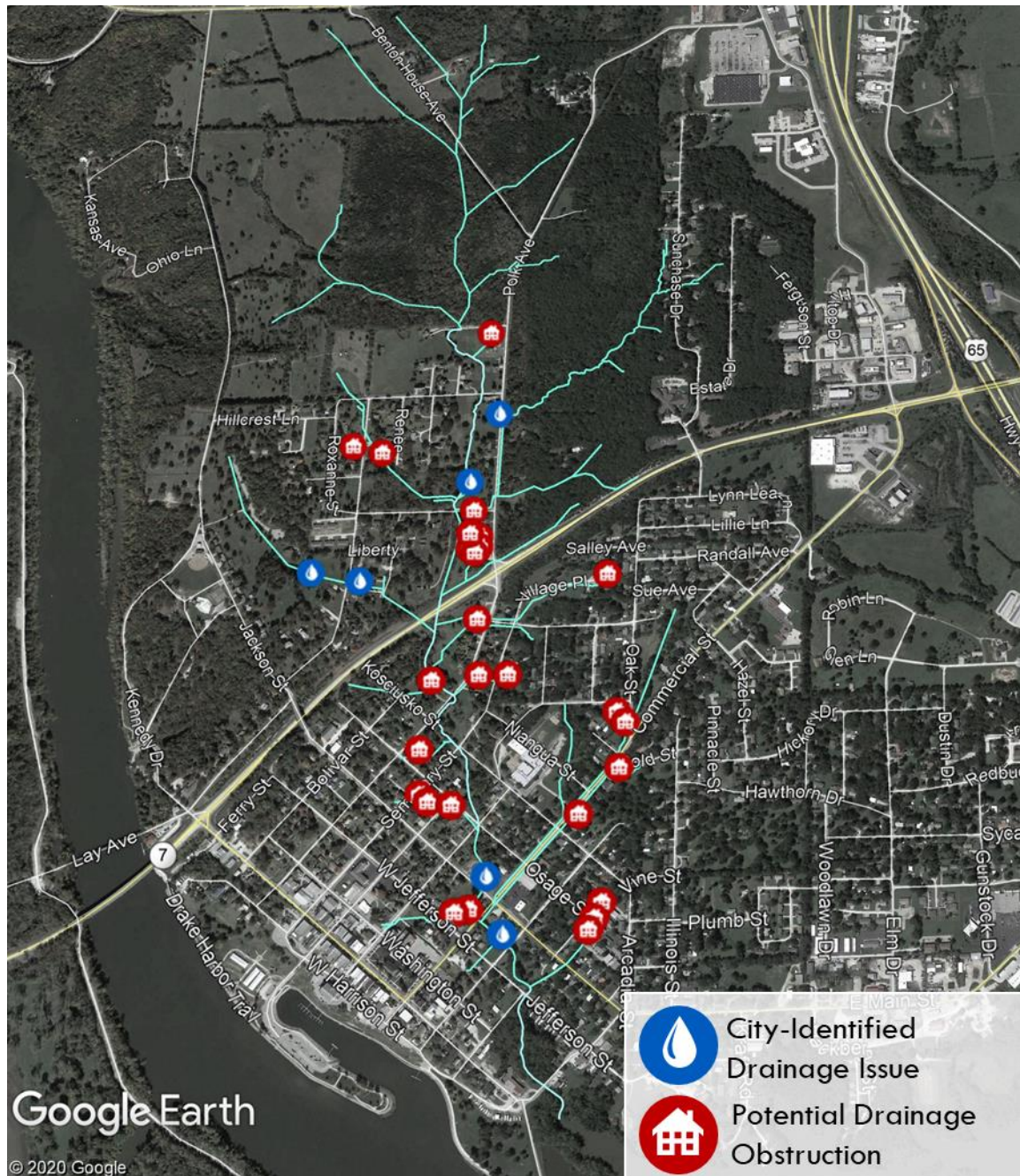


Figure 5-4: Stormwater Tools – Drainage Issues & Potential Obstructions**5.2.4 STORMWATER RUNOFF LINKS**

The stormwater runoff link layer quantitatively shows how stormwater runoff starts to accumulate as it moves through the watershed. The paths shown represent the model links that dynamically route stormwater from the upstream contributing drainage areas to the next downstream link. The user can start to see how stormwater accumulates through the Town Branch Creek watershed. Data fields included with the stormwater runoff links layer include cumulative stormwater flow rates for the entire upstream area:

- Link ID: unique identification code for the link, typically corresponding with the drainage area through which the link alignment extends
- Downstream Link ID: unique identification code correlating with the stormwater runoff link to which the drainage area contributes
- 90% Mean Annual, 2-, 5-, 10-, 25-, 50-, or 100-Year Peak Flow Rate (CFS): cumulative stormwater runoff flow rate for the selected portion of the channel based on the SCS Type II rainfall distribution per current City policy, in cubic feet per second.
- Total Tributary Area (acres): total drainage area upstream of the selected channel that contributes stormwater runoff to that path.

An example of how the Stormwater Runoff Links and data fields appear in the Google Earth platform is shown in Figure 5-5. Reference Section 3.4 for additional information on how these parameters were developed.

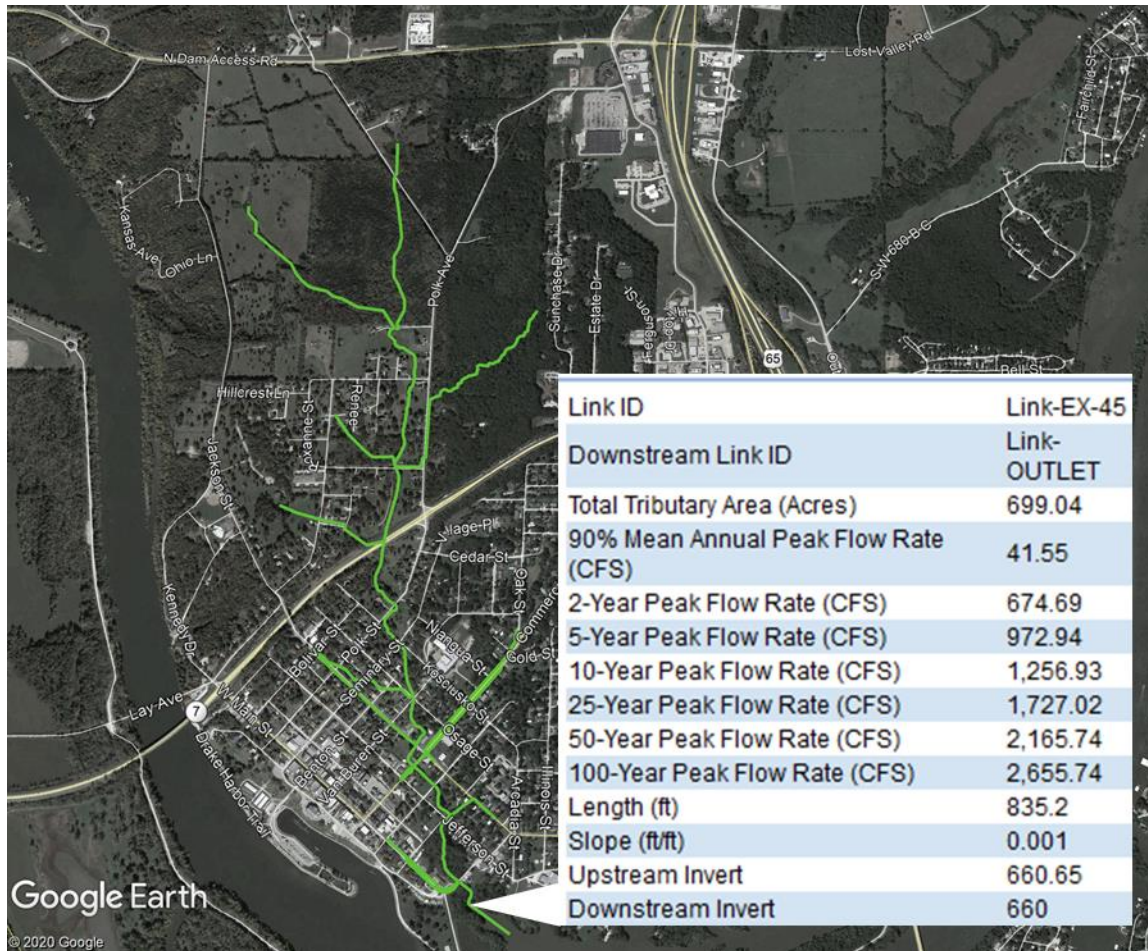


Figure 5-5: Stormwater Tools – Stormwater Runoff Links

SECTION 6

RECOMMENDATIONS & NEXT STEPS

A stormwater study typically consists of two primary components: hydrologic and hydraulic analyses. This stormwater study completed the hydrologic analysis component for the Town Branch Creek watershed. The next step to understanding the performance of the existing stormwater system is to refine in the hydraulic component to be representative of the stormwater conveyance system in the watershed. With the hydrologic and hydraulic analysis complete, stormwater improvements can be proposed and impacts of those improvements on known flooding can be evaluated as compared to these existing conditions. This section summarizes the recommended next steps for stormwater management in Warsaw.

6.1 HYDRAULIC ANALYSIS

The hydrology provides information on the stormwater runoff and flows produced by the watershed, the hydraulics will provide a more realistic representation of the flooding extents along Town Branch Creek during those modeled storms. In order to estimate the impacts of future stormwater improvements, it is important to understand what types of storms cause the creek to flood currently. The hydraulic component can be added to the already-built CivilStorm model and run with the hydrologic component completed as part of this study.

As discussed previously, the City's conveyance system in this area consists primarily of roadside ditches draining to Town Branch Creek. The 1988 FEMA effective HEC-2 model is the only hydraulic analysis that has been completed to date on Town Branch Creek. The review of the HEC-2 model compared to GPS-surveyed cross sections taken of the creek in 2019 showed that a significant difference exists between the HEC-2 channel geometry and the current conditions of the creek. The more representative the cross sections are of the actual geometry of the stream, the more realistic the modeled flood elevation and extents will be. Because of this, it is not recommended to use the FEMA HEC-2 hydraulic model for the hydraulic analysis component. Instead, it is recommended to refine the hydraulic components of the CivilStorm model with the following additional topographic surveyed data:

- Major culvert crossings: verify size, shape, and invert data collected during the 2019 field effort; collect additional culvert data for major road crossings
- Major culvert crossing street elevations: survey street elevations and extents at culvert crossings
- Town Branch Creek elevation survey: refine cross section geometry and resulting flood extents with detailed survey along the creek

Once this data is collected, it can be added to the CivilStorm model completed during this phase, and the model re-run to complete the hydraulic analysis

Completing the hydraulic analysis has two primary benefits:

1. Baseline performance of Town Branch Creek to evaluate impacts of future improvements
2. Better understanding of flood risk for properties along Town Branch Creek

With a better understanding of the flood risk under current conditions, the City is better equipped to plan for future improvements. If the hydraulic analysis shows the base flood elevations for the 1% annual chance flood is significantly different than those shown on the FEMA effective maps, the City

can submit a Letter of Map Amendment (LOMA) or a Letter of Map Revisions (LOMR) to address through FEMA's National Flood Insurance Program. If flood elevations are lower than currently mapped, a LOMA can be used to remove properties from the regulatory floodplain allowing property owners the option to opt out of paying for flood insurance. Alternatively, if flood elevations are higher than currently mapped and show that more properties are likely at risk of flooding during the 1% annual chance flood, a LOMR may be submitted referencing to the hydrologic and hydraulic analysis as a more detailed and current data source. Either way, the City is better equipped to know and communicate their flood risk to the community.

6.2 STORMWATER IMPROVEMENTS & IMPACTS

Using the Stormwater Tools, feasible locations for stormwater improvements can be identified. With the hydrologic complete and upon completion of hydraulic analysis, impacts from those recommended stormwater improvement projects can be readily evaluated and simulated using the CivilStorm model. Following completion of the hydraulic analysis, the City can identify priority flooding areas to address with future stormwater improvements. It is recommended that potential improvements be evaluated and prioritized based on other capital and private improvement projects planned in the area. For example, if the City moves forward with public street improvements, stormwater management concepts for those improvements can be evaluated to verify that the project does not negatively impact performance of the drainage system downstream. It is recommended that identification of specific stormwater improvement projects outside of other planned public improvements be evaluated following completion of the hydraulic analysis. This will provide the City with the decision-making tools to prioritize projects that are most beneficial and cost-effective for their community at that time.

6.3 STORMWATER DESIGN CRITERIA AND POLICY

Current City stormwater design criteria requires the use of the SCS Type II rainfall distribution. The City has expressed that one of their goals is to review and update their stormwater design standards and policy. As the City pursues stormwater policy updates, it is recommended that the results of the hydrologic analysis be considered in determining appropriate rainfall assumptions for design in the future. A summary of the findings for consideration is included in Section 3.6

SECTION 7

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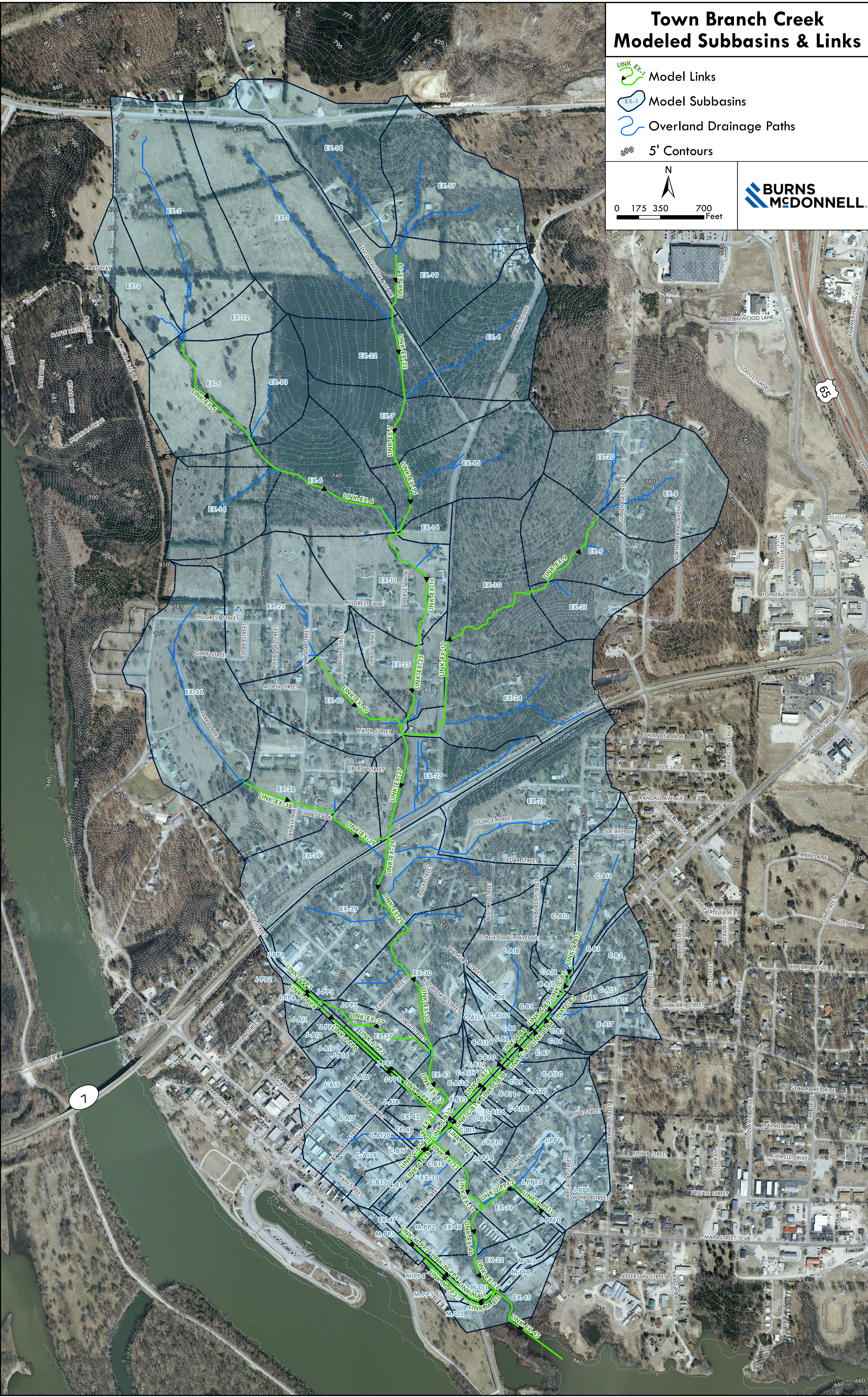
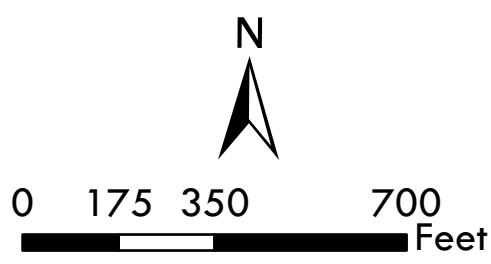
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APPENDIX A: HYDROLOGIC ANALYSIS & RESULTS

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Town Branch Creek Modeled Subbasins & Links

-  Model Links
-  Model Subbasins
-  Overland Drainage Paths
-  5' Contours



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Location Description	Subbasin ID	Area	Hydrologic Soil Group	Weighted Curve Number	Percent Impervious	Time of Concentration
		(acres)		(CN)	(%)	(min)
Area North of Town Branch Creek, North of Hillcrest Ln	EX-1	34.09	C	78	5%	36.34
	EX-18	19.31	C	78	10%	25.91
	EX-17	20.42	C	76	5%	17.92
	EX-19	14.66	C	76	5%	21.58
	EX-4	17.33	C	75	5%	23.28
	EX-22	12.72	C/D	76	5%	23.41
	EX-7	12.52	B	61	5%	17.54
	EX-15	18.33	C	74	5%	24.93
	EX-16	2.17	B	72	30%	8.71
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave	EX-2	29.43	C	79	5%	34.68
	EX-3	8.56	D	84	5%	18.63
	EX-12	4.65	C	79	0%	12.17
	EX-5	16.57	C	79	0%	23.03
	EX-13	8.19	C	75	0%	14.96
	EX-14	12.58	C	79	1%	14.79
	EX-6	20.01	C	74	5%	30.35
	EX-11	15.88	B	72	25%	23.82
Town Branch Creek at Water St & area East of Polk Ave	EX-20	10.79	C	77	16%	16.58
	EX-8	13.66	C	77	16%	15.37
	EX-9	16.64	C	76	10%	32.81
	EX-21	5.96	B	63	8%	14.07
	EX-10	20.45	C	74	5%	28.20
	EX-25	8.70	B	72	30%	19.78
	EX-24	20.47	C	76	11%	25.85
Town Branch Creek at Route 7 & area North of Water St & West of Polk	EX-23	21.68	C	81	27%	21.81
	EX-40	16.36	C	81	30%	21.25
	EX-27	12.59	B	70	25%	28.39
Area West of Town Branch Creek at Route 7	EX-26	29.98	C	81	28%	28.35
	EX-38	18.64	C	81	30%	14.81
	EX-39	13.25	B	72	30%	18.80
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St	EX-28	25.09	B	72	30%	14.77
	EX-29	31.07	C	82	33%	17.18
	EX-30	16.94	B	74	35%	36.47
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St	J-PP1	0.53	B	75	38%	10.39
	J-PP3	0.24	B	75	38%	5.38
	J-PP5	0.19	C	83	38%	3.92
	J-PP7	0.61	B	86	68%	10.84
	J-PP14	0.25	B	92	85%	2.59
	EX-37	5.18	B	76	42%	14.88
	EX-43	4.18	C	85	47%	13.21

Location Description	Subbasin ID	Area	Hydrologic Soil Group	Weighted Curve Number	Percent Impervious	Time of Concentration
		(acres)		(CN)	(%)	(min)
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St	J-PP2	0.38	B	75	38%	12.83
	J-PP4	0.83	B	75	38%	5.93
	J-AI1	1.23	B	75	38%	7.67
	J-AI2	1.02	C	83	38%	5.99
	J-PP6	0.16	C	83	38%	3.97
	J-AI3	1.41	C	83	38%	9.19
	J-AI4	0.21	C	83	38%	4.23
	J-AI5	3.72	B	85	65%	13.31
	J-AI6	0.30	C	94	85%	2.87
	J-AI7	6.42	C	94	85%	7.95
	J-AI8	0.32	B	92	85%	4.50
	J-PP8	0.98	B	89	75%	9.57
	EX-42	1.83	B	92	85%	6.86
Area Southwest of Town Branch Creek at Commercial St & Jackson St	C-AI19	4.76	B	92	85%	11.21
	C-AI20	0.28	B	92	85%	3.86
	EX-48	0.78	B	92	85%	4.72
	C-B15	2.23	B	92	85%	7.67
	C-B17	0.11	B	92	85%	1.86
	C-B16	0.87	B	92	85%	5.29
	C-B18	0.18	B	92	85%	2.02
Area Northwest of Commercial St, North of Jackson St	C-AI1	9.27	C	81	30%	17.94
	C-AI2	5.73	C	81	30%	15.63
	C-AI4	0.82	C	81	30%	6.98
	C-AI3	0.38	C	81	30%	5.82
	C-B1	0.65	C	81	30%	11.74
	C-B5	0.64	C	81	30%	5.68
	C-AI8	10.06	C	81	30%	17.79
	C-AI9	0.78	B	72	30%	10.61
	C-B6	0.14	B	72	30%	5.94
	C-AI12	2.28	C	81	30%	9.37
	C-B8	0.30	B	73	32%	7.77
	C-AI13	1.31	B	74	35%	11.52
	C-AI14	0.63	C	83	38%	6.90
	C-B10	0.56	C	83	38%	3.48
	C-AI17	0.79	C	83	38%	6.22
	C-AI18	0.15	C	83	38%	2.51
	C-B12	0.77	C	83	38%	6.84
	C-B13	0.46	B	78	46%	6.08

Location Description	Subbasin ID	Area	Hydrologic Soil Group	Weighted Curve Number	Percent Impervious	Time of Concentration
		(acres)		(CN)	(%)	(min)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St	C-B2	5.16	B	72	30%	13.37
	C-AI5	1.48	C	81	30%	9.24
	C-AI6	1.08	B	72	30%	11.17
	C-AI7	5.00	B	72	30%	12.99
	C-B3	0.69	B	72	30%	8.39
	C-B4	0.78	B	72	30%	9.32
	C-B7	1.57	B	72	31%	11.10
	C-AI10	2.68	B	74	34%	8.33
	C-AI11	0.34	B	75	38%	6.28
	C-B9	0.68	B	75	38%	5.79
	C-AI15	1.06	B	75	38%	10.05
	C-AI16	0.37	B	75	38%	4.90
	C-B11	1.49	B	75	38%	7.76
	C-B14	1.31	B	77	44%	6.66
	J-PP13	1.63	C	88	61%	5.07
	C-CI1	0.38	B	89	76%	3.29
	EX-33	5.23	B	92	85%	7.96
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St	J-PP9	4.75	B	78	47%	15.01
	J-PP10	0.23	B	92	85%	7.93
	J-PP11	11.76	B	77	43%	16.89
	J-PP12	0.32	B	92	85%	3.51
	EX-31	5.41	B	92	85%	5.23
	EX-46	6.38	B	86	69%	10.57
	EX-32	5.25	B	87	70%	17.04
Main Street from Commercial St to Town Branch Creek	EX-47	0.35	B	92	85%	4.15
	M-PP2	0.23	B	92	85%	4.79
	M-PP4	0.35	C	94	85%	4.89
	M-CI1	0.23	C/D	95	85%	4.32
	M-PP1	1.07	B	92	85%	7.83
	M-PP3	0.79	C	93	78%	5.24
	M-CI2	0.31	C/D	92	70%	5.26
Main Street from E Jackson St to Town Branch Creek	M-CI3	0.57	B	84	64%	11.89
	M-CI4	0.83	B	87	71%	9.79
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks	EX-45	4.68	C/D	89	51%	11.29

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Link ID	Downstream Link ID	Total Tributary (ACRES)	Length (FT)	Upstream Invert (FT)	Downstream Invert (FT)	Slope (%)
Town Branch Creek at Route 7 & area North of Water St & West of Polk						
Link-EX-19	Link-EX-22	54.38	420.8	763.03	753.52	2.3%
Link-EX-22	Link-EX-7	118.52	766.8	753.52	740.12	1.7%
Link-EX-7	Link-EX-15	131.04	539.1	740.12	728.55	2.1%
Link-EX-15	Link-EX-11	149.37	663.3	728.55	722.22	1.0%
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave						
Link-EX-5	Link-EX-6	59.21	1028.3	768.85	748.62	2.0%
Link-EX-6	Link-EX-11	100.00	1458.7	748.62	722.22	1.8%
Link-EX-11	Link-EX-25	267.43	1111.8	722.22	710.19	1.1%
Town Branch Creek at Water St & area East of Polk Ave						
Link-EX-9	Link-EX-10	41.09	727.1	751.3	743.66	1.1%
Link-EX-10	Link-EX-27	67.50	2176.9	743.66	707.81	1.6%
Link-EX-25	Link-EX-27	343.63	750.8	710.19	707.81	0.3%
Town Branch Creek at Route 7 & area North of Water St & West of Polk						
Link-EX-40	Link-EX-27	38.04	1013.9	737.78	707.81	3.0%
Link-EX-27	Link-EX-29	414.73	859.8	707.81	695.65	1.4%
Area West of Town Branch Creek at Route 7						
Link-EX-38	Link-EX-39	48.62	774	729.68	707.65	2.8%
Link-EX-39	Link-EX-29	61.87	552.7	707.65	695.65	2.2%
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St						
Link-EX-29	Link-EX-30	532.76	825.9	695.65	680.14	1.9%
Link-EX-30	Link-EX-43	549.70	1141.2	680.14	678.7	0.1%
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St						
Link-J-PP3	Link-EX-37	0.77	259.9	732.71	718.54	5.5%
Link-EX-37	Link-EX-43	6.14	1060.5	718.54	678.7	3.8%
Link-J-PP7	Link-EX-42	0.61	1016.2	702.75	667.32	3.5%
Link-EX-43	Link-EX-42	560.63	633.3	678.7	667.32	1.8%
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St						
Link-J-PP4	Link-J-PP6	1.21	291.5	733.24	717.54	5.4%
Link-J-PP6	Link-J-PP8	3.63	245.3	717.54	703.87	5.6%
Link-J-PP8	Link-EX-42	16.99	1018.6	703.87	667.32	3.6%
Link-EX-42	Link-EX-33	579.45	268.1	667.32	666.51	0.3%
Area Southwest of Town Branch Creek at Commercial St & Jackson St						
Link-C-B17	Link-EX-33	2.34	201.4	674.89	666.51	4.2%
Link-C-B18	Link-EX-33	1.05	214.1	674.74	666.51	3.8%
Area Northwest of Commercial St, North of Jackson St						
Link-C-A12	Link-C-B1	15.00	120.7	720.59	717.31	2.7%
Link-C-B1	Link-C-B5	15.65	134.5	717.31	714.76	1.9%
Link-C-B5	Link-C-B6	17.49	321.6	714.76	700.4	4.5%
Link-C-B6	Link-C-B8	27.69	112.7	700.4	698.84	1.4%
Link-C-B8	Link-C-B10	31.05	239.5	698.84	690.06	3.7%
Link-C-B10	Link-C-B12	33.54	177.9	690.06	682.51	4.2%
Link-C-B12	Link-C-B13	35.25	276.1	682.51	676.33	2.2%
Link-C-B13	Link-EX-33	35.70	445.2	676.33	666.51	2.2%

Link ID	Downstream Link ID	Total Tributary	Length	Upstream Invert	Downstream Invert	Slope
		(ACRES)	(FT)	(FT)	(FT)	(%)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St						
Link-C-B3	Link-C-B4	13.40	139.3	703.22	701.83	1.0%
Link-C-B4	Link-C-B7	14.18	117	701.83	699.07	2.4%
Link-C-B7	Link-C-B9	15.74	237.7	699.07	690.27	3.7%
Link-C-B9	Link-C-B11	19.45	177.4	690.27	681.49	5.0%
Link-C-B11	Link-C-B14	22.36	273.3	681.49	676.19	1.9%
Link-C-B14	Link-EX-33	23.66	436.4	676.19	666.51	2.2%
Link-C-C11	Link-EX-33	2.01	305.7	675.48	666.51	2.9%
Link-EX-33	Link-EX-31	655.52	311.7	666.51	665.2	0.4%
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St						
Link-J-PP10	Link-J-PP12	4.99	77.5	686.26	685.76	0.6%
Link-J-PP12	Link-EX-46	17.06	601.5	685.76	661.49	4.0%
Link-EX-31	Link-EX-46	660.93	437.8	665.2	661.49	0.8%
Link-EX-46	Link-EX-32	684.36	382.2	661.49	660.75	0.2%
Link-EX-32	Link-EX-45	689.61	354.2	660.75	660.65	0.0%
Main Street from Commercial St to Town Branch Creek						
Link-M-PP2	Link-M-PP4	0.58	288.8	690.97	683.73	2.5%
Link-M-PP4	Link-M-C11	0.93	451.5	683.73	665.28	4.1%
Link-M-C11	Link-EX-45	1.16	261.1	665.28	660.65	1.8%
Link-M-PP3	Link-M-C12	1.86	442.9	683.66	666.87	3.8%
Link-M-C12	Link-EX-45	2.17	308.2	666.87	660.65	2.0%
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks						
Link-EX-45	OUTLET	699.03	835.2	660.65	660	0.1%

Link ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-19	2.12	29.40	44.39	58.30	79.45	96.87	115.37
Link-EX-22	5.22	72.73	110.60	146.26	200.24	245.40	293.34
Link-EX-7	5.76	81.36	123.96	163.83	224.59	275.06	328.94
Link-EX-15	5.75	83.99	129.43	172.28	238.17	292.92	351.67
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
Link-EX-5	3.31	33.37	49.17	63.93	86.21	104.54	124.01
Link-EX-6	5.73	63.18	93.64	123.32	165.85	199.86	237.05
Link-EX-11	12.66	172.99	263.79	350.14	469.84	575.98	690.62
Town Branch Creek at Water St & area East of Polk Ave							
Link-EX-9	1.40	19.49	29.11	38.00	51.30	62.27	73.93
Link-EX-10	1.99	30.40	46.95	62.78	86.60	106.57	127.94
Link-EX-25	12.68	178.94	272.54	359.29	488.15	599.09	718.81
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-40	2.04	20.07	28.91	37.01	48.99	58.75	69.12
Link-EX-27	19.15	280.15	428.89	537.01	734.33	902.03	1,109.09
Area West of Town Branch Creek at Route 7							
Link-EX-38	2.71	26.08	37.83	48.66	64.78	77.94	91.88
Link-EX-39	4.51	43.54	63.10	80.93	107.53	129.34	152.37
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
Link-EX-29	23.16	336.56	515.84	667.98	920.36	1,123.36	1,400.86
Link-EX-30	24.88	353.54	535.94	695.91	961.14	1,168.68	1,411.62
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
Link-J-PP3	0.02	0.40	0.61	0.80	1.09	1.33	1.58
Link-J-PP7	0.03	0.22	0.30	0.37	0.48	0.57	0.66
Link-EX-37	0.03	0.59	0.89	1.17	1.59	1.94	2.31
Link-EX-43	25.34	365.14	553.02	719.10	983.14	1,204.34	1,455.13
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
Link-J-PP4	0.02	0.28	0.43	0.57	0.77	0.95	1.13
Link-J-PP6	0.24	3.08	4.51	5.80	7.73	9.31	10.97
Link-J-PP8	4.59	21.17	28.19	34.41	43.45	50.72	58.32
Link-EX-42	26.98	381.61	574.92	746.09	1,015.61	1,245.29	1,508.47
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
Link-C-B17	0.93	3.51	4.52	5.52	7.03	8.25	9.51
Link-C-B18	0.37	1.37	1.78	2.18	2.77	3.24	3.74
Area Northwest of Commercial St, North of Jackson St							
Link-C-A12	0.89	8.95	12.80	16.30	21.49	25.71	30.18
Link-C-B1	1.44	14.57	20.83	26.52	34.93	41.79	49.03
Link-C-B5	1.63	16.36	23.42	29.87	39.38	47.09	55.21
Link-C-B6	2.67	27.12	38.95	49.74	65.69	78.65	92.28
Link-C-B8	2.90	29.52	42.43	54.15	71.47	85.53	100.31
Link-C-B10	3.03	31.36	45.18	57.71	76.24	91.30	107.14
Link-C-B12	3.22	33.07	47.53	60.63	80.00	95.72	112.27
Link-C-B13	3.31	33.94	48.74	62.14	81.94	98.01	114.96

Link ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
Link-C-B3	0.35	8.40	13.05	17.45	24.14	29.69	35.61
Link-C-B4	0.37	8.84	13.75	18.39	25.45	31.30	37.54
Link-C-B7	0.38	9.33	14.54	19.45	26.91	33.10	39.70
Link-C-B9	0.52	12.53	19.51	26.05	35.97	44.18	52.92
Link-C-B11	0.62	14.17	21.97	29.27	40.32	49.46	59.19
Link-C-B14	0.68	15.34	23.73	31.56	43.42	53.22	63.66
Link-C-C11	0.48	2.29	3.03	3.68	4.62	5.44	6.36
Link-EX-33	30.36	426.89	638.43	827.70	1,119.68	1,376.86	1,728.23
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
Link-J-PP10	0.32	4.05	5.96	7.72	10.34	12.49	14.77
Link-J-PP12	1.04	13.64	20.28	26.39	35.52	43.00	50.94
Link-EX-31	30.89	427.00	638.43	828.76	1,124.58	1,379.96	1,707.95
Link-EX-46	31.83	439.61	656.52	852.28	1,156.74	1,419.99	1,754.69
Link-EX-32	32.11	443.51	661.62	859.21	1,165.48	1,429.94	1,755.40
Main Street from Commercial St to Town Branch Creek							
Link-M-PP2	0.15	0.55	0.71	0.88	1.11	1.30	1.50
Link-M-PP4	0.25	0.92	1.20	1.47	1.86	2.18	2.51
Link-M-C11	0.42	1.50	1.98	2.41	3.05	3.56	4.09
Link-M-PP3	0.44	1.68	2.16	2.64	3.37	3.95	4.56
Link-M-C12	0.81	2.97	3.84	4.72	5.98	6.99	8.04
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
Link-EX-45	32.74	450.92	671.41	871.33	1,180.51	1,447.19	1,774.15

Link ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-19	1.05	17.59	25.91	33.54	44.97	54.29	64.14
Link-EX-22	2.68	45.39	67.36	87.59	117.94	142.85	169.26
Link-EX-7	2.94	50.68	75.24	97.91	131.86	159.73	189.27
Link-EX-15	2.94	52.37	78.72	103.17	139.93	170.31	202.53
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
Link-EX-5	1.88	21.11	30.40	38.83	51.40	61.62	72.45
Link-EX-6	3.14	38.76	56.06	71.94	95.94	115.16	135.61
Link-EX-11	6.57	107.89	160.47	209.21	282.87	347.53	415.99
Town Branch Creek at Water St & area East of Polk Ave							
Link-EX-9	0.66	11.12	16.30	20.97	28.01	33.72	40.11
Link-EX-10	0.99	18.74	28.18	36.90	50.14	60.98	72.48
Link-EX-25	6.60	112.22	167.34	217.68	294.72	358.29	423.68
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-40	1.28	11.64	16.46	20.80	27.18	32.72	38.63
Link-EX-27	10.55	177.20	264.98	347.78	467.17	536.41	636.36
Area West of Town Branch Creek at Route 7							
Link-EX-38	1.66	15.76	22.40	28.40	37.29	44.52	52.50
Link-EX-39	2.75	25.91	36.74	46.49	60.86	72.51	85.46
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
Link-EX-29	12.92	214.89	319.25	420.73	560.51	668.31	795.81
Link-EX-30	14.14	229.51	339.99	446.67	592.06	714.81	854.18
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
Link-J-PP3	0.01	0.22	0.33	0.43	0.58	0.71	0.84
Link-J-PP7	0.02	0.11	0.16	0.20	0.26	0.31	0.36
Link-EX-37	0.01	0.33	0.49	0.63	0.85	1.03	1.22
Link-EX-43	14.31	236.96	351.60	462.19	612.75	738.17	875.94
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
Link-J-PP4	0.01	0.16	0.24	0.31	0.42	0.51	0.60
Link-J-PP6	0.13	1.68	2.42	3.09	4.08	4.93	5.87
Link-J-PP8	2.52	11.34	15.32	18.86	24.04	28.23	32.62
Link-EX-42	15.25	246.96	366.62	480.81	637.35	770.49	914.61
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
Link-C-B17	0.50	1.94	2.52	3.03	3.77	4.36	4.97
Link-C-B18	0.20	0.76	0.98	1.18	1.47	1.70	1.93
Area Northwest of Commercial St, North of Jackson St							
Link-C-A12	0.57	5.04	7.11	8.96	11.72	14.13	16.68
Link-C-B1	0.93	8.18	11.52	14.52	19.03	22.93	27.04
Link-C-B5	1.04	9.21	12.96	16.34	21.34	25.73	30.37
Link-C-B6	1.70	15.32	21.60	27.26	35.60	42.96	50.74
Link-C-B8	1.85	16.64	23.46	29.61	38.64	46.63	55.10
Link-C-B10	1.91	17.66	24.96	31.53	41.18	49.68	58.76
Link-C-B12	2.03	18.56	26.22	33.09	43.18	52.09	61.58
Link-C-B13	2.10	19.03	26.86	33.89	44.21	53.34	63.04

Link ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
Link-C-B3	0.14	4.81	7.31	9.64	13.16	16.06	19.14
Link-C-B4	0.14	5.06	7.70	10.15	13.86	16.92	20.17
Link-C-B7	0.15	5.34	8.13	10.72	14.65	17.88	21.32
Link-C-B9	0.24	7.13	10.85	14.30	19.52	23.81	28.37
Link-C-B11	0.26	8.03	12.18	16.04	21.85	26.64	31.71
Link-C-B14	0.67	8.66	13.13	17.27	23.51	28.64	34.08
Link-C-C11	0.26	1.22	1.64	2.02	2.56	3.00	3.45
Link-EX-33	17.16	279.71	417.71	544.53	724.55	873.56	1,034.87
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
Link-J-PP10	0.17	2.28	3.30	4.23	5.60	6.74	8.03
Link-J-PP12	0.52	7.81	11.36	14.60	19.41	23.32	27.76
Link-EX-31	17.48	280.92	418.20	546.27	728.65	879.32	1,041.94
Link-EX-46	18.10	289.90	431.37	563.77	753.24	908.89	1,076.91
Link-EX-32	18.30	292.58	435.53	568.99	760.81	918.02	1,087.73
Main Street from Commercial St to Town Branch Creek							
Link-M-PP2	0.10	0.30	0.39	0.47	0.59	0.68	0.77
Link-M-PP4	0.20	0.51	0.66	0.79	0.99	1.14	1.30
Link-M-C11	0.33	0.83	1.08	1.29	1.60	1.84	2.09
Link-M-PP3	0.24	0.93	1.21	1.45	1.81	2.09	2.38
Link-M-C12	0.43	1.64	2.13	2.56	3.17	3.66	4.17
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
Link-EX-45	18.76	297.51	442.35	577.87	772.96	932.32	1,104.69

Link ID	SCS TYPE II, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-19	3.60	59.03	86.15	111.50	151.00	184.57	220.89
Link-EX-22	8.01	136.84	200.20	260.08	353.59	433.19	519.75
Link-EX-7	8.87	154.24	226.03	293.19	398.49	488.69	587.07
Link-EX-15	8.85	160.31	238.18	311.49	426.44	525.31	634.22
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
Link-EX-5	5.58	57.89	82.28	104.72	139.41	168.72	200.32
Link-EX-6	10.10	118.60	171.62	220.13	294.31	357.05	424.75
Link-EX-11	20.17	327.58	469.97	611.32	833.09	1,022.53	1,227.89
Town Branch Creek at Water St & area East of Polk Ave							
Link-EX-9	2.78	43.40	63.02	81.32	109.77	133.92	160.02
Link-EX-10	3.07	62.09	92.27	120.75	165.48	203.76	245.70
Link-EX-25	19.47	325.75	474.46	614.22	838.60	1,036.61	1,262.02
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-40	4.28	39.47	55.24	69.77	92.11	110.89	131.08
Link-EX-27	26.99	481.91	703.49	916.71	1,259.31	1,557.31	1,892.38
Area West of Town Branch Creek at Route 7							
Link-EX-38	5.01	47.00	65.94	83.48	110.47	133.20	157.64
Link-EX-39	8.56	81.70	114.72	145.13	191.89	231.26	273.59
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
Link-EX-29	32.78	595.85	870.51	1,141.49	1,578.24	1,957.21	2,368.41
Link-EX-30	34.32	598.49	862.02	1,131.90	1,531.31	1,936.78	2,362.18
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
Link-J-PP3	0.05	0.98	1.45	1.89	2.58	3.17	3.81
Link-J-PP7	0.08	0.57	0.78	0.98	1.27	1.52	1.78
Link-EX-37	0.07	1.44	2.12	2.76	3.76	4.62	5.55
Link-EX-43	34.74	612.91	882.81	1,141.96	1,566.76	1,973.55	2,427.66
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
Link-J-PP4	0.03	0.67	0.99	1.30	1.77	2.17	2.61
Link-J-PP6	0.66	7.68	11.05	14.19	19.06	23.18	27.64
Link-J-PP8	10.75	49.34	65.13	79.40	101.10	119.24	138.69
Link-EX-42	36.46	626.32	900.19	1,161.62	1,594.74	1,988.79	2,454.93
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
Link-C-B17	2.23	8.56	10.96	13.10	16.30	18.96	21.80
Link-C-B18	0.94	3.58	4.58	5.46	6.80	7.90	9.09
Area Northwest of Commercial St, North of Jackson St							
Link-C-A12	2.08	18.83	26.31	33.16	43.66	52.48	61.96
Link-C-B1	3.45	30.94	43.29	54.64	72.06	86.70	102.43
Link-C-B5	3.84	34.81	48.62	61.28	80.70	97.01	114.53
Link-C-B6	6.18	57.34	80.30	101.36	133.70	160.89	190.11
Link-C-B8	6.78	62.62	87.57	110.45	145.79	175.65	207.75
Link-C-B10	7.05	66.64	93.47	118.32	156.55	188.73	223.34
Link-C-B12	7.45	70.10	98.39	124.38	164.33	197.94	234.09
Link-C-B13	7.72	72.04	101.01	127.61	168.49	202.87	239.84

Link ID	SCS TYPE II, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
Link-C-B3	0.64	20.12	30.32	40.00	55.27	68.37	82.64
Link-C-B4	0.66	21.23	31.99	42.19	58.29	72.09	87.23
Link-C-B7	0.68	22.48	33.87	44.67	61.71	76.39	92.55
Link-C-B9	0.95	30.35	45.53	60.09	83.18	103.02	124.62
Link-C-B11	1.15	34.20	51.28	67.62	93.39	115.48	139.54
Link-C-B14	1.30	36.98	55.50	73.08	100.77	124.51	150.34
Link-C-C11	1.22	6.00	7.90	9.60	12.16	14.28	16.55
Link-EX-33	40.11	671.54	959.82	1,237.38	1,698.20	2,117.94	2,614.19
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
Link-J-PP10	0.70	9.08	13.02	16.67	22.32	27.11	32.27
Link-J-PP12	2.10	29.99	43.34	55.77	75.09	91.47	109.16
Link-EX-31	40.49	659.88	949.61	1,224.81	1,682.84	2,102.54	2,601.21
Link-EX-46	41.09	669.03	964.70	1,245.30	1,710.96	2,138.94	2,644.38
Link-EX-32	41.14	670.42	966.67	1,247.95	1,712.95	2,142.12	2,651.35
Main Street from Commercial St to Town Branch Creek							
Link-M-PP2	0.38	1.44	1.85	2.20	2.74	3.19	3.66
Link-M-PP4	0.63	2.42	3.09	3.69	4.59	5.34	6.13
Link-M-C11	1.08	3.94	5.02	5.97	7.41	8.60	9.88
Link-M-PP3	1.06	4.09	5.24	6.26	7.79	9.06	10.42
Link-M-C12	1.96	7.34	9.39	11.20	13.92	16.18	18.60
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
Link-EX-45	41.55	674.69	972.94	1,256.93	1,727.02	2,165.74	2,655.74

Link ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-19	2.61	24.67	35.38	45.36	62.52	77.90	94.84
Link-EX-22	6.66	63.99	92.40	118.99	160.65	199.41	243.19
Link-EX-7	7.38	71.46	103.23	133.01	179.58	223.43	272.61
Link-EX-15	7.38	74.46	108.62	140.80	191.34	237.27	290.73
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
Link-EX-5	3.81	29.14	41.12	52.24	69.56	85.56	103.40
Link-EX-6	6.65	53.66	75.92	97.33	131.61	163.53	195.90
Link-EX-11	15.93	152.17	219.96	285.07	394.34	486.22	590.49
Town Branch Creek at Water St & area East of Polk Ave							
Link-EX-9	1.67	15.52	22.08	28.81	40.06	49.79	60.40
Link-EX-10	2.52	26.44	38.73	50.24	68.25	85.14	104.62
Link-EX-25	16.31	159.05	230.88	297.60	403.54	500.38	609.00
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-40	2.23	15.96	22.34	28.86	39.11	47.85	57.39
Link-EX-27	25.92	252.08	366.57	470.02	604.67	749.35	906.90
Area West of Town Branch Creek at Route 7							
Link-EX-38	3.02	21.72	30.27	38.58	52.34	64.14	76.97
Link-EX-39	4.95	35.55	49.39	63.02	85.68	105.09	126.30
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
Link-EX-29	31.07	308.05	443.38	566.92	755.79	937.07	1,133.22
Link-EX-30	33.68	325.70	471.19	598.27	810.45	1,001.14	1,206.03
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
Link-J-PP3	0.03	0.32	0.46	0.60	0.84	1.05	1.28
Link-J-PP7	0.03	0.16	0.23	0.29	0.38	0.46	0.54
Link-EX-37	0.04	0.46	0.66	0.87	1.23	1.53	1.87
Link-EX-43	34.71	336.78	487.43	619.02	835.15	1,027.50	1,240.21
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
Link-J-PP4	0.02	0.22	0.33	0.42	0.60	0.75	0.91
Link-J-PP6	0.27	2.31	3.34	4.38	6.01	7.41	8.93
Link-J-PP8	3.39	16.59	22.20	27.31	35.15	41.72	49.34
Link-EX-42	37.60	352.88	509.14	646.96	872.01	1,073.87	1,295.32
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
Link-C-B17	0.67	2.82	3.66	4.56	5.94	7.09	8.32
Link-C-B18	0.27	1.10	1.46	1.81	2.34	2.80	3.28
Area Northwest of Commercial St, North of Jackson St							
Link-C-A12	0.97	6.88	9.78	12.62	17.08	20.88	24.99
Link-C-B1	1.57	11.16	15.91	20.53	27.77	33.91	40.55
Link-C-B5	1.76	12.55	17.86	23.06	31.13	38.05	45.54
Link-C-B6	2.90	20.90	29.65	38.34	51.88	63.48	76.05
Link-C-B8	3.15	22.70	32.23	41.64	56.40	68.99	82.61
Link-C-B10	3.30	24.12	34.21	44.26	60.09	73.55	88.18
Link-C-B12	3.49	25.34	35.88	46.47	63.00	77.15	92.51
Link-C-B13	3.59	25.97	36.80	47.63	64.53	79.03	94.74

Link ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
Link-C-B3	0.54	6.84	10.08	13.13	18.45	23.34	28.73
Link-C-B4	0.57	7.19	10.61	13.83	19.44	24.59	30.26
Link-C-B7	0.60	7.59	11.21	14.61	20.55	25.99	31.99
Link-C-B9	0.80	10.15	14.95	19.47	27.44	34.66	42.62
Link-C-B11	0.91	11.41	16.77	21.80	30.75	38.82	47.75
Link-C-B14	1.00	12.30	18.06	23.46	33.11	41.81	51.39
Link-C-C11	0.35	1.79	2.39	2.94	3.76	4.59	5.48
Link-EX-33	44.14	397.99	573.75	731.29	986.74	1,213.66	1,462.21
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
Link-J-PP10	0.37	3.16	4.47	5.87	8.10	10.01	12.09
Link-J-PP12	1.22	10.84	15.37	20.04	27.76	34.44	41.72
Link-EX-31	45.07	400.98	577.57	736.62	993.80	1,223.11	1,473.20
Link-EX-46	46.91	414.47	597.04	761.74	1,027.75	1,264.76	1,523.24
Link-EX-32	47.59	418.87	602.91	769.58	1,038.10	1,277.87	1,538.46
Main Street from Commercial St to Town Branch Creek							
Link-M-PP2	0.11	0.44	0.59	0.73	0.94	1.12	1.32
Link-M-PP4	0.19	0.74	0.98	1.22	1.58	1.88	2.20
Link-M-C11	0.32	1.22	1.64	2.01	2.59	3.08	3.60
Link-M-PP3	0.32	1.35	1.75	2.18	2.84	3.39	3.99
Link-M-C12	0.59	2.39	3.16	3.91	5.06	6.02	7.05
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
Link-EX-45	48.85	426.44	613.08	782.37	1,054.86	1,298.47	1,562.02

Link ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-19	0.81	13.66	9.17	18.01	24.87	30.92	37.87
Link-EX-22	2.11	35.83	24.16	47.37	65.65	81.40	99.44
Link-EX-7	2.34	39.99	26.94	52.89	73.34	90.96	111.20
Link-EX-15	2.33	41.51	27.82	55.35	77.40	96.51	117.87
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
Link-EX-5	1.26	16.52	11.33	21.40	29.05	35.71	43.29
Link-EX-6	2.14	30.10	20.50	39.15	53.33	65.94	80.67
Link-EX-11	5.08	85.17	57.34	112.73	156.54	194.63	238.28
Town Branch Creek at Water St & area East of Polk Ave							
Link-EX-9	0.50	8.52	5.69	11.20	15.42	19.31	23.60
Link-EX-10	0.79	14.68	9.82	19.62	27.53	34.34	41.98
Link-EX-25	5.22	89.21	60.01	118.29	165.16	204.49	248.53
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
Link-EX-40	0.72	8.90	6.21	11.40	15.55	19.13	23.03
Link-EX-27	8.57	141.58	95.35	187.41	260.85	326.03	396.94
Area West of Town Branch Creek at Route 7							
Link-EX-38	0.99	12.21	8.49	15.67	21.26	26.20	31.59
Link-EX-39	1.62	19.89	13.83	25.52	34.63	42.68	51.46
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
Link-EX-29	10.47	171.99	116.07	227.51	315.61	393.98	479.06
Link-EX-30	11.50	184.44	124.82	243.43	336.26	419.82	510.01
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
Link-J-PP3	0.01	0.17	0.11	0.23	0.32	0.40	0.49
Link-J-PP7	0.00	0.09	0.06	0.11	0.15	0.18	0.21
Link-EX-37	0.01	0.25	0.16	0.33	0.46	0.58	0.71
Link-EX-43	11.82	191.20	129.30	252.45	348.44	435.84	529.65
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
Link-J-PP4	0.01	0.12	0.08	0.16	0.23	0.28	0.35
Link-J-PP6	0.08	1.25	0.85	1.64	2.26	2.82	3.43
Link-J-PP8	1.23	8.63	6.38	10.69	13.85	16.55	19.60
Link-EX-42	12.89	201.32	136.26	264.85	364.36	455.09	553.98
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
Link-C-B17	0.25	1.45	1.10	1.77	2.26	2.66	3.09
Link-C-B18	0.10	0.56	0.43	0.69	0.88	1.04	1.21
Area Northwest of Commercial St, North of Jackson St							
Link-C-A12	0.31	3.82	2.67	4.89	6.69	8.23	9.90
Link-C-B1	0.50	6.19	4.33	7.94	10.85	13.34	16.05
Link-C-B5	0.57	6.96	4.86	8.91	12.19	14.99	18.03
Link-C-B6	0.93	11.59	8.08	14.85	20.31	25.01	30.12
Link-C-B8	1.01	12.58	8.77	16.12	22.06	27.15	32.69
Link-C-B10	1.05	13.35	9.28	17.13	23.45	28.90	34.83
Link-C-B12	1.11	14.02	9.75	17.99	24.60	30.31	36.53
Link-C-B13	1.14	14.37	10.00	18.42	25.19	31.04	37.40

Link ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
Link-C-B3	0.16	3.69	2.42	5.00	7.08	8.90	10.98
Link-C-B4	0.16	3.88	2.55	5.26	7.46	9.37	11.56
Link-C-B7	0.17	4.10	2.69	5.55	7.88	9.90	12.22
Link-C-B9	0.29	5.46	3.59	7.39	10.49	13.18	16.25
Link-C-B11	0.37	6.14	4.03	8.30	11.75	14.75	18.20
Link-C-B14	0.70	6.62	4.35	8.94	12.65	15.86	19.58
Link-C-C11	0.12	0.92	0.68	1.14	1.47	1.77	2.09
Link-EX-33	15.11	228.81	157.67	299.71	413.12	514.88	626.16
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
Link-J-PP10	0.11	1.74	1.17	2.27	3.11	3.88	4.73
Link-J-PP12	0.37	5.96	4.01	7.81	10.71	13.40	16.35
Link-EX-31	15.48	231.66	158.38	303.10	417.19	519.80	632.40
Link-EX-46	16.20	240.22	163.51	313.86	431.98	537.95	654.44
Link-EX-32	16.48	243.12	165.45	317.39	436.75	543.71	661.42
Main Street from Commercial St to Town Branch Creek							
Link-M-PP2	0.08	0.23	0.17	0.28	0.35	0.42	0.48
Link-M-PP4	0.28	0.38	0.29	0.46	0.59	0.70	0.81
Link-M-C11	0.54	0.62	0.48	0.76	0.96	1.13	1.31
Link-M-PP3	0.12	0.69	0.53	0.85	1.08	1.28	1.48
Link-M-C12	0.22	1.23	0.94	1.50	1.91	2.24	2.61
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
Link-EX-45	17.02	247.97	168.86	323.34	444.56	553.06	672.70

Subbasin ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Area North of Town Branch Creek, North of Hillcrest Ln							
EX-1	1.87	23.26	34.90	45.96	62.74	76.63	91.41
EX-18	1.17	14.62	21.83	28.51	38.73	47.17	56.14
EX-17	0.96	15.11	22.91	30.14	41.01	50.02	59.64
EX-19	0.66	10.38	15.83	20.91	28.58	34.96	41.80
EX-4	0.62	11.31	17.47	23.28	32.22	39.66	47.61
EX-22	0.56	8.81	13.43	17.83	24.48	29.99	35.85
EX-7	0.00	2.84	5.61	8.72	13.82	18.27	23.17
EX-15	0.51	11.04	17.30	23.32	32.58	40.30	48.56
EX-16	0.05	1.42	2.22	2.97	4.12	5.07	6.09
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
EX-2	1.92	21.68	32.21	41.93	56.89	69.31	82.51
EX-3	1.28	9.45	13.13	16.47	21.36	25.31	29.44
EX-12	0.36	4.29	6.22	7.99	10.59	12.72	14.95
EX-5	1.19	13.67	20.10	26.09	35.09	42.47	50.28
EX-13	0.33	5.93	9.04	11.93	16.32	19.96	23.82
EX-14	0.97	11.31	16.47	21.16	28.15	33.87	39.93
EX-6	0.51	11.34	17.86	24.05	33.77	41.92	50.67
EX-11	0.24	8.48	13.66	18.71	26.50	33.05	40.08
Town Branch Creek at Water St & area East of Polk Ave							
EX-20	0.61	8.58	12.80	16.70	22.55	27.40	32.53
EX-8	0.79	11.00	16.39	21.35	28.78	34.93	41.45
EX-9	0.65	10.43	16.00	21.29	29.49	36.32	43.62
EX-21	0.00	1.71	3.33	4.98	7.60	9.87	12.35
EX-10	0.54	11.88	18.68	25.14	35.24	43.69	52.78
EX-25	0.14	4.88	7.86	10.69	15.02	18.68	22.64
EX-24	0.87	13.80	21.12	27.96	38.45	47.25	56.63
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
EX-23	2.04	20.09	28.93	37.05	49.10	58.90	69.22
EX-40	1.54	15.28	22.01	28.11	37.15	44.56	52.41
EX-27	0.08	5.49	9.22	12.84	18.54	23.45	28.78
Area West of Town Branch Creek at Route 7							
EX-26	2.71	26.10	37.95	48.76	64.85	77.97	91.88
EX-38	1.84	18.48	26.33	33.44	43.98	52.53	61.53
EX-39	0.22	7.54	12.12	16.48	23.16	28.73	34.75
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
EX-28	0.45	15.04	23.99	32.46	45.41	56.18	67.70
EX-29	3.49	31.66	44.79	56.70	74.33	88.60	103.58
EX-30	0.40	9.03	14.23	19.19	27.03	33.62	40.69
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
J-PP1	0.02	0.40	0.61	0.80	1.09	1.33	1.58
J-PP3	0.01	0.19	0.29	0.38	0.51	0.62	0.73
J-PP5	0.03	0.22	0.30	0.37	0.48	0.57	0.66
J-PP7	0.13	0.77	1.04	1.28	1.63	1.91	2.20
J-PP14	0.11	0.40	0.52	0.64	0.81	0.95	1.10
EX-37	0.25	3.97	5.98	7.84	10.64	12.96	15.42
EX-43	0.78	5.02	6.88	8.53	10.93	12.86	14.88

Subbasin ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
J-PP2	0.02	0.28	0.43	0.57	0.77	0.95	1.13
J-PP4	0.04	0.66	0.99	1.30	1.76	2.13	2.53
J-AI1	0.06	0.97	1.45	1.90	2.58	3.13	3.72
J-AI2	0.17	1.19	1.64	2.05	2.64	3.11	3.61
J-PP6	0.03	0.19	0.27	0.33	0.43	0.50	0.58
J-AI3	0.22	1.60	2.22	2.77	3.58	4.24	4.92
J-AI4	0.03	0.25	0.34	0.42	0.54	0.64	0.74
J-AI5	0.69	4.45	6.10	7.56	9.70	11.42	13.21
J-AI6	0.15	0.52	0.69	0.83	1.03	1.20	1.37
J-AI7	3.17	10.72	14.15	17.15	21.49	24.96	28.57
J-AI8	0.14	0.51	0.66	0.82	1.03	1.21	1.39
J-PP8	0.30	1.39	1.83	2.22	2.78	3.24	3.79
EX-42	0.77	2.89	3.72	4.57	5.81	6.81	7.85
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
C-AI19	1.93	7.40	9.56	11.43	14.57	17.11	19.79
C-AI20	0.12	0.45	0.58	0.72	0.91	1.06	1.23
EX-48	0.33	1.24	1.61	1.98	2.51	2.93	3.38
C-B15	0.93	3.51	4.52	5.52	7.03	8.25	9.51
C-B17	0.05	0.17	0.23	0.28	0.35	0.41	0.48
C-B16	0.37	1.37	1.78	2.19	2.78	3.25	3.75
C-B18	0.08	0.29	0.38	0.46	0.59	0.69	0.79
Area Northwest of Commercial St, North of Jackson St							
C-AI1	0.89	8.95	12.80	16.30	21.51	25.75	30.22
C-AI2	0.56	5.64	8.07	10.26	13.49	16.10	18.85
C-AI4	0.10	0.87	1.23	1.55	2.02	2.40	2.80
C-AI3	0.05	0.41	0.58	0.72	0.94	1.12	1.31
C-B1	0.07	0.66	0.93	1.18	1.55	1.85	2.16
C-B5	0.08	0.69	0.97	1.22	1.59	1.88	2.19
C-AI8	0.97	9.71	13.91	17.70	23.33	27.94	32.78
C-AI9	0.02	0.50	0.78	1.05	1.46	1.80	2.16
C-B6	0.00	0.09	0.14	0.19	0.26	0.32	0.39
C-AI12	0.25	2.37	3.35	4.24	5.53	6.58	7.68
C-B8	0.01	0.21	0.33	0.43	0.60	0.73	0.87
C-AI13	0.05	0.93	1.43	1.89	2.59	3.17	3.79
C-AI14	0.10	0.73	1.00	1.25	1.61	1.90	2.21
C-B10	0.09	0.65	0.90	1.12	1.44	1.70	1.97
C-AI17	0.13	0.92	1.27	1.58	2.03	2.40	2.78
C-AI18	0.02	0.17	0.24	0.30	0.38	0.45	0.52
C-B12	0.12	0.89	1.23	1.53	1.97	2.32	2.69
C-B13	0.03	0.43	0.62	0.79	1.05	1.26	1.48

Subbasin ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
C-B2	0.10	3.15	5.01	6.76	9.44	11.66	14.04
C-AI5	0.17	1.54	2.18	2.75	3.59	4.28	4.99
C-AI6	0.02	0.68	1.07	1.44	2.00	2.47	2.98
C-AI7	0.09	3.07	4.88	6.58	9.17	11.34	13.65
C-B3	0.01	0.45	0.71	0.94	1.31	1.61	1.93
C-B4	0.02	0.50	0.79	1.06	1.47	1.81	2.17
C-B7	0.03	0.99	1.56	2.10	2.92	3.60	4.33
C-AI10	0.10	1.98	3.03	4.00	5.45	6.65	7.92
C-AI11	0.02	0.27	0.41	0.53	0.72	0.87	1.04
C-B9	0.03	0.54	0.82	1.07	1.44	1.75	2.07
C-AI15	0.05	0.81	1.22	1.60	2.18	2.65	3.15
C-AI16	0.02	0.30	0.45	0.58	0.79	0.95	1.13
C-B11	0.07	1.17	1.76	2.30	3.12	3.79	4.50
C-B14	0.08	1.15	1.69	2.18	2.91	3.50	4.13
J-PP13	0.48	2.29	3.03	3.68	4.62	5.45	6.38
C-CI1	0.12	0.56	0.73	0.88	1.11	1.32	1.54
EX-33	2.18	8.21	10.58	12.91	16.45	19.28	22.25
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
J-PP9	0.32	4.06	5.96	7.73	10.36	12.52	14.79
J-PP10	0.10	0.37	0.47	0.57	0.73	0.86	0.99
J-PP11	0.67	9.28	13.88	18.15	24.55	29.80	35.35
J-PP12	0.14	0.50	0.65	0.80	1.02	1.19	1.37
EX-31	2.30	8.57	11.11	13.65	17.32	20.27	23.35
EX-46	1.40	8.09	10.96	13.49	17.16	20.10	23.16
EX-32	1.18	6.65	9.00	11.09	14.11	16.53	19.06
Main Street from Commercial St to Town Branch Creek							
EX-47	0.15	0.55	0.72	0.88	1.11	1.30	1.50
M-PP2	0.10	0.37	0.48	0.59	0.75	0.88	1.01
M-PP4	0.18	0.60	0.79	0.95	1.19	1.38	1.58
M-CI1	0.13	0.42	0.55	0.66	0.81	0.94	1.07
M-PP1	0.45	1.68	2.17	2.65	3.37	3.95	4.56
M-PP3	0.37	1.29	1.71	2.08	2.62	3.05	3.50
M-CI2	0.13	0.49	0.64	0.78	1.00	1.16	1.34
Main Street from E Jackson St to Town Branch Creek							
M-CI3	0.10	0.67	0.92	1.14	1.47	1.74	2.01
M-CI4	0.21	1.10	1.48	1.81	2.29	2.67	3.07
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
EX-45	1.42	6.60	8.73	10.59	13.28	15.43	17.90

Subbasin ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Area North of Town Branch Creek, North of Hillcrest Ln							
EX-1	1.02	14.92	22.04	28.63	38.47	46.55	55.20
EX-18	0.60	8.86	12.96	16.70	22.28	26.86	31.69
EX-17	0.45	8.77	13.00	16.89	22.70	27.45	32.46
EX-19	0.32	6.19	9.21	11.99	16.15	19.58	23.20
EX-4	0.29	6.87	10.37	13.61	18.47	22.50	26.77
EX-22	0.27	5.32	7.93	10.34	13.97	16.94	20.08
EX-7	0.00	1.76	3.53	5.31	8.15	10.61	13.31
EX-15	0.22	6.83	10.43	13.82	18.93	23.15	27.64
EX-16	0.02	0.79	1.22	1.61	2.21	2.70	3.23
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
EX-2	1.07	13.70	19.98	25.76	34.36	41.39	48.90
EX-3	0.80	5.26	7.22	9.01	11.79	14.04	16.42
EX-12	0.22	2.37	3.38	4.30	5.65	6.84	8.12
EX-5	0.66	8.09	11.68	14.94	19.76	23.68	28.02
EX-13	0.15	3.39	5.07	6.62	8.93	10.82	12.83
EX-14	0.56	6.34	9.07	11.55	15.21	18.35	21.80
EX-6	0.23	7.21	11.12	14.78	20.32	24.91	29.84
EX-11	0.10	5.27	8.28	11.12	15.43	19.01	22.85
Town Branch Creek at Water St & area East of Polk Ave							
EX-20	0.29	4.90	7.18	9.26	12.35	14.87	17.67
EX-8	0.38	6.23	9.12	11.76	15.68	18.87	22.47
EX-9	0.33	6.65	10.01	13.13	17.84	21.75	25.91
EX-21	0.00	1.08	2.00	2.90	4.33	5.55	6.88
EX-10	0.24	7.48	11.47	15.24	20.93	25.64	30.64
EX-25	0.06	2.96	4.62	6.17	8.55	10.52	12.62
EX-24	0.43	8.47	12.67	16.55	22.35	27.13	32.21
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
EX-23	1.28	11.65	16.47	20.81	27.18	32.72	38.63
EX-40	0.97	8.80	12.44	15.71	20.52	24.72	29.17
EX-27	0.04	3.56	5.79	7.94	11.26	14.03	17.01
Area West of Town Branch Creek at Route 7							
EX-26	1.66	15.76	22.40	28.40	37.31	44.53	52.50
EX-38	1.19	10.24	14.40	18.13	23.81	28.68	33.82
EX-39	0.09	4.54	7.08	9.46	13.07	16.07	19.26
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
EX-28	0.17	8.81	13.67	18.21	25.08	30.75	36.82
EX-29	2.25	17.69	24.67	30.92	40.60	48.72	57.30
EX-30	0.18	5.91	9.13	12.20	16.87	20.75	24.88
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
J-PP1	0.01	0.22	0.33	0.43	0.59	0.71	0.84
J-PP3	0.00	0.10	0.15	0.20	0.27	0.32	0.39
J-PP5	0.02	0.11	0.16	0.20	0.26	0.31	0.36
J-PP7	0.08	0.41	0.56	0.70	0.90	1.06	1.23
J-PP14	0.06	0.22	0.29	0.35	0.43	0.50	0.57
EX-37	0.12	2.26	3.34	4.33	5.80	7.01	8.31
EX-43	0.46	2.71	3.69	4.63	6.01	7.12	8.29

Subbasin ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
J-PP2	0.01	0.16	0.24	0.31	0.42	0.51	0.60
J-PP4	0.02	0.36	0.53	0.69	0.93	1.12	1.33
J-AI1	0.02	0.53	0.78	1.02	1.37	1.65	1.97
J-AI2	0.09	0.63	0.86	1.09	1.42	1.70	1.98
J-PP6	0.02	0.10	0.14	0.18	0.23	0.27	0.32
J-AI3	0.13	0.86	1.18	1.48	1.94	2.31	2.71
J-AI4	0.02	0.13	0.18	0.22	0.29	0.35	0.41
J-AI5	0.41	2.41	3.28	4.11	5.33	6.32	7.36
J-AI6	0.08	0.28	0.36	0.43	0.53	0.61	0.69
J-AI7	1.67	5.96	7.63	9.09	11.18	12.85	14.59
J-AI8	0.07	0.28	0.37	0.44	0.55	0.63	0.72
J-PP8	0.17	0.75	1.00	1.23	1.55	1.81	2.08
EX-42	0.41	1.59	2.07	2.49	3.10	3.58	4.08
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
C-AI19	1.05	4.09	5.34	6.43	8.00	9.25	10.55
C-AI20	0.06	0.25	0.32	0.39	0.48	0.55	0.63
EX-48	0.18	0.68	0.89	1.07	1.32	1.53	1.74
C-B15	0.50	1.94	2.52	3.03	3.77	4.36	4.97
C-B17	0.02	0.10	0.13	0.15	0.19	0.22	0.25
C-B16	0.20	0.76	0.98	1.18	1.47	1.70	1.93
C-B18	0.04	0.16	0.21	0.25	0.31	0.36	0.41
Area Northwest of Commercial St, North of Jackson St							
C-AI1	0.57	5.05	7.11	8.96	11.72	14.13	16.68
C-AI2	0.36	3.14	4.42	5.57	7.31	8.80	10.39
C-AI4	0.06	0.47	0.65	0.82	1.08	1.30	1.53
C-AI3	0.03	0.22	0.30	0.38	0.50	0.60	0.71
C-B1	0.04	0.36	0.50	0.63	0.83	1.00	1.18
C-B5	0.05	0.37	0.51	0.64	0.85	1.02	1.19
C-AI8	0.62	5.47	7.71	9.73	12.74	15.35	18.12
C-AI9	0.01	0.28	0.43	0.58	0.79	0.97	1.16
C-B6	0.00	0.05	0.08	0.10	0.14	0.17	0.20
C-AI12	0.15	1.28	1.79	2.25	2.96	3.56	4.20
C-B8	0.00	0.12	0.18	0.23	0.32	0.39	0.46
C-AI13	0.02	0.52	0.79	1.03	1.40	1.70	2.02
C-AI14	0.06	0.38	0.53	0.66	0.87	1.04	1.21
C-B10	0.05	0.34	0.47	0.59	0.78	0.93	1.08
C-AI17	0.07	0.49	0.67	0.84	1.10	1.31	1.53
C-AI18	0.01	0.09	0.12	0.16	0.21	0.24	0.29
C-B12	0.07	0.47	0.65	0.81	1.06	1.27	1.48
C-B13	0.02	0.23	0.33	0.42	0.55	0.67	0.79

Subbasin ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 6-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
C-B2	0.04	1.82	2.82	3.76	5.17	6.35	7.59
C-AI5	0.10	0.83	1.16	1.46	1.93	2.32	2.73
C-AI6	0.01	0.39	0.60	0.79	1.09	1.33	1.59
C-AI7	0.03	1.77	2.74	3.65	5.03	6.16	7.37
C-B3	0.00	0.25	0.39	0.51	0.70	0.86	1.02
C-B4	0.01	0.28	0.43	0.58	0.79	0.97	1.15
C-B7	0.01	0.56	0.87	1.15	1.58	1.94	2.32
C-AI10	0.04	1.09	1.64	2.15	2.91	3.53	4.18
C-AI11	0.01	0.15	0.22	0.28	0.38	0.46	0.55
C-B9	0.01	0.29	0.44	0.57	0.76	0.92	1.09
C-AI15	0.02	0.45	0.67	0.87	1.17	1.41	1.68
C-AI16	0.01	0.16	0.24	0.31	0.41	0.50	0.60
C-B11	0.03	0.64	0.95	1.23	1.66	2.00	2.38
C-B14	0.04	0.62	0.90	1.16	1.53	1.85	2.21
J-PP13	0.26	1.22	1.64	2.02	2.56	3.00	3.45
C-CI1	0.07	0.30	0.40	0.49	0.62	0.72	0.82
EX-33	1.17	4.53	5.91	7.10	8.83	10.20	11.63
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
J-PP9	0.17	2.29	3.31	4.23	5.60	6.74	8.03
J-PP10	0.05	0.20	0.26	0.32	0.39	0.45	0.52
J-PP11	0.32	5.33	7.82	10.09	13.46	16.20	19.24
J-PP12	0.07	0.28	0.36	0.43	0.54	0.62	0.71
EX-31	1.22	4.72	6.14	7.38	9.16	10.58	12.06
EX-46	0.80	4.31	5.89	7.34	9.46	11.16	12.94
EX-32	0.70	3.63	4.93	6.12	7.85	9.25	10.70
Main Street from Commercial St to Town Branch Creek							
EX-47	0.08	0.30	0.39	0.47	0.59	0.68	0.77
M-PP2	0.05	0.20	0.27	0.32	0.40	0.46	0.52
M-PP4	0.09	0.33	0.42	0.50	0.61	0.70	0.80
M-CI1	0.07	0.22	0.28	0.34	0.41	0.47	0.53
M-PP1	0.24	0.93	1.21	1.45	1.81	2.09	2.38
M-PP3	0.19	0.72	0.92	1.10	1.36	1.57	1.79
M-CI2	0.07	0.27	0.35	0.42	0.53	0.61	0.69
Main Street from E Jackson St to Town Branch Creek							
M-CI3	0.06	0.36	0.49	0.62	0.80	0.96	1.12
M-CI4	0.12	0.58	0.80	0.99	1.27	1.49	1.72
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
EX-45	0.79	3.57	4.79	5.87	7.42	8.67	9.97

Subbasin ID	SCS TYPE II, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Area North of Town Branch Creek, North of Hillcrest Ln							
EX-1	2.84	39.87	57.60	74.12	99.77	121.54	145.06
EX-18	2.01	28.04	40.47	52.04	70.00	85.23	101.68
EX-17	1.73	32.78	48.20	62.66	85.25	104.49	125.33
EX-19	1.10	21.31	31.31	40.80	55.67	68.39	82.18
EX-4	0.95	22.96	34.32	45.04	61.89	76.31	91.98
EX-22	0.91	17.74	26.13	34.01	46.33	56.84	68.25
EX-7	0.01	6.97	13.47	20.18	31.38	41.44	52.77
EX-15	0.72	22.10	33.41	44.13	61.06	75.58	91.40
EX-16	0.07	3.58	5.45	7.24	10.10	12.57	15.28
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
EX-2	3.05	37.30	53.36	68.25	91.31	110.81	131.85
EX-3	2.86	19.25	26.17	32.44	42.05	50.12	58.77
EX-12	0.92	10.01	14.21	18.10	24.11	29.18	34.64
EX-5	2.27	26.91	38.39	49.01	65.44	79.31	94.27
EX-13	0.60	13.60	20.09	26.29	36.00	44.29	53.29
EX-14	2.27	25.36	35.96	45.87	61.17	74.13	88.10
EX-6	0.71	21.50	32.44	42.82	59.23	73.33	88.68
EX-11	0.31	17.52	27.17	36.41	51.11	63.80	77.69
Town Branch Creek at Water St & area East of Polk Ave							
EX-20	1.22	18.79	27.29	35.25	47.64	58.16	69.54
EX-8	1.60	24.67	35.74	46.07	62.13	75.76	90.48
EX-9	0.96	18.72	27.57	35.89	49.14	60.48	72.80
EX-21	0.01	4.55	8.14	11.77	17.83	23.23	29.26
EX-10	0.75	22.74	34.47	45.62	63.22	78.34	94.82
EX-25	0.18	10.70	16.51	22.09	30.96	38.62	46.99
EX-24	1.37	26.80	39.49	51.55	70.46	86.60	104.11
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
EX-23	4.30	39.76	55.61	70.13	92.43	111.17	131.31
EX-40	3.32	30.48	42.73	53.97	71.25	85.78	101.39
EX-27	0.11	10.99	17.59	23.99	34.25	43.19	53.02
Area West of Town Branch Creek at Route 7							
EX-26	5.01	47.29	66.46	84.09	111.19	134.01	158.55
EX-38	4.67	41.04	57.27	72.13	94.91	114.04	134.58
EX-39	0.29	16.67	25.77	34.47	48.29	60.21	73.25
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
EX-28	0.61	35.36	54.32	72.44	101.19	125.96	153.00
EX-29	8.30	67.03	92.78	116.30	152.37	182.61	215.05
EX-30	0.54	15.99	24.29	32.18	44.66	55.39	67.09
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
J-PP1	0.05	0.99	1.46	1.90	2.59	3.18	3.82
J-PP3	0.03	0.51	0.75	0.98	1.34	1.65	1.98
J-PP5	0.08	0.57	0.78	0.98	1.27	1.52	1.78
J-PP7	0.32	1.79	2.39	2.93	3.75	4.44	5.17
J-PP14	0.28	1.06	1.35	1.61	2.01	2.34	2.69
EX-37	0.50	9.06	13.27	17.25	23.45	28.73	34.45
EX-43	1.85	11.21	15.10	18.64	24.02	28.51	33.30

Subbasin ID	SCS TYPE II, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
J-PP2	0.03	0.67	0.99	1.30	1.77	2.17	2.61
J-PP4	0.10	1.72	2.54	3.32	4.55	5.59	6.73
J-AI1	0.13	2.43	3.59	4.69	6.42	7.90	9.50
J-AI2	0.43	3.05	4.19	5.22	6.79	8.11	9.53
J-PP6	0.07	0.51	0.70	0.87	1.13	1.35	1.58
J-AI3	0.55	3.85	5.27	6.57	8.56	10.22	11.99
J-AI4	0.09	0.65	0.89	1.11	1.44	1.72	2.02
J-AI5	1.64	9.91	13.37	16.50	21.25	25.22	29.47
J-AI6	0.39	1.33	1.68	2.00	2.46	2.85	3.27
J-AI7	7.55	25.77	32.57	38.61	47.69	55.24	63.31
J-AI8	0.35	1.34	1.72	2.05	2.56	2.97	3.42
J-PP8	0.71	3.27	4.28	5.17	6.53	7.65	8.85
EX-42	1.88	7.21	9.23	11.02	13.72	15.95	18.35
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
C-AI19	4.39	16.71	21.41	25.59	31.86	37.07	42.63
C-AI20	0.31	1.18	1.51	1.80	2.25	2.61	3.00
EX-48	0.85	3.25	4.17	4.98	6.19	7.20	8.28
C-B15	2.24	8.58	11.00	13.14	16.36	19.04	21.89
C-B17	0.12	0.46	0.59	0.70	0.87	1.02	1.17
C-B16	0.94	3.58	4.58	5.47	6.81	7.92	9.10
C-B18	0.20	0.77	0.98	1.17	1.46	1.69	1.95
Area Northwest of Commercial St, North of Jackson St							
C-AI1	2.09	18.86	26.31	33.16	43.66	52.48	61.96
C-AI2	1.39	12.37	17.27	21.76	28.63	34.41	40.62
C-AI4	0.26	2.19	3.06	3.86	5.08	6.11	7.21
C-AI3	0.13	1.06	1.47	1.86	2.45	2.95	3.48
C-B1	0.18	1.53	2.14	2.69	3.54	4.26	5.03
C-B5	0.21	1.78	2.49	3.13	4.13	4.96	5.85
C-AI8	2.27	20.39	28.54	36.02	47.52	57.17	67.55
C-AI9	0.02	1.24	1.88	2.50	3.49	4.34	5.27
C-B6	0.01	0.24	0.37	0.49	0.69	0.86	1.04
C-AI12	0.68	5.70	7.95	10.02	13.18	15.84	18.69
C-B8	0.02	0.54	0.81	1.07	1.48	1.84	2.23
C-AI13	0.08	2.25	3.36	4.41	6.06	7.48	9.01
C-AI14	0.26	1.82	2.50	3.11	4.05	4.84	5.69
C-B10	0.24	1.72	2.36	2.93	3.81	4.55	5.35
C-AI17	0.33	2.34	3.22	4.01	5.22	6.23	7.31
C-AI18	0.06	0.45	0.62	0.78	1.01	1.20	1.41
C-B12	0.32	2.23	3.06	3.82	4.97	5.93	6.96
C-B13	0.10	1.09	1.57	2.01	2.70	3.28	3.91

Subbasin ID	SCS TYPE II, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
C-B2	0.13	7.60	11.64	15.50	21.61	26.86	32.60
C-AI5	0.45	3.72	5.18	6.53	8.59	10.32	12.17
C-AI6	0.03	1.67	2.56	3.40	4.74	5.89	7.15
C-AI7	0.13	7.43	11.37	15.13	21.07	26.18	31.78
C-B3	0.02	1.14	1.74	2.31	3.23	4.02	4.88
C-B4	0.02	1.26	1.92	2.56	3.56	4.43	5.38
C-B7	0.04	2.45	3.73	4.96	6.90	8.58	10.42
C-AI10	0.20	4.97	7.40	9.73	13.38	16.51	19.91
C-AI11	0.04	0.70	1.04	1.35	1.85	2.27	2.74
C-B9	0.08	1.42	2.10	2.74	3.75	4.60	5.53
C-AI15	0.10	1.98	2.92	3.81	5.20	6.38	7.67
C-AI16	0.05	0.79	1.17	1.53	2.09	2.57	3.08
C-B11	0.16	2.93	4.34	5.67	7.74	9.52	11.44
C-B14	0.23	2.93	4.25	5.48	7.40	9.02	10.79
J-PP13	1.22	6.00	7.91	9.61	12.19	14.32	16.60
C-CI1	0.32	1.46	1.91	2.32	2.92	3.42	3.96
EX-33	5.20	19.95	25.55	30.52	38.00	44.20	50.82
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
J-PP9	0.70	9.11	13.08	16.77	22.49	27.32	32.54
J-PP10	0.23	0.89	1.14	1.36	1.69	1.96	2.26
J-PP11	1.31	20.35	29.45	38.06	51.47	62.86	75.18
J-PP12	0.35	1.32	1.69	2.02	2.51	2.92	3.36
EX-31	5.84	22.31	28.56	34.12	42.47	49.40	56.80
EX-46	3.39	18.84	25.20	30.94	39.63	46.86	54.59
EX-32	2.59	13.69	18.22	22.29	28.44	33.56	39.03
Main Street from Commercial St to Town Branch Creek							
EX-47	0.38	1.45	1.85	2.21	2.75	3.20	3.68
M-PP2	0.26	0.97	1.25	1.49	1.85	2.16	2.48
M-PP4	0.45	1.53	1.94	2.29	2.83	3.28	3.76
M-CI1	0.32	1.04	1.31	1.55	1.90	2.20	2.52
M-PP1	1.07	4.10	5.25	6.27	7.81	9.09	10.45
M-PP3	0.93	3.36	4.27	5.09	6.31	7.32	8.40
M-CI2	0.34	1.28	1.64	1.96	2.44	2.84	3.26
Main Street from E Jackson St to Town Branch Creek							
M-CI3	0.23	1.53	2.08	2.57	3.32	3.96	4.63
M-CI4	0.50	2.59	3.44	4.20	5.35	6.30	7.32
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
EX-45	3.29	15.03	19.66	23.80	30.03	35.20	40.72

Subbasin ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Area North of Town Branch Creek, North of Hillcrest Ln							
EX-1	2.39	21.10	30.30	38.96	52.64	64.67	78.21
EX-18	1.41	12.41	17.69	22.59	30.94	38.35	46.58
EX-17	1.21	12.30	17.74	22.80	31.98	39.94	48.77
EX-19	0.85	8.73	12.63	16.25	22.48	28.11	34.32
EX-4	0.89	9.80	14.33	18.57	25.37	31.86	39.13
EX-22	0.73	7.53	10.90	14.06	19.28	24.14	29.51
EX-7	0.01	3.30	5.39	7.80	11.78	15.36	19.36
EX-15	0.83	9.79	14.50	18.94	25.91	32.38	39.91
EX-16	0.08	1.13	1.68	2.20	3.12	3.96	4.89
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
EX-2	2.34	19.18	27.26	34.86	46.91	57.78	69.79
EX-3	1.17	7.28	10.21	12.93	17.14	20.69	24.51
EX-12	0.41	3.25	4.67	6.09	8.31	10.20	12.26
EX-5	1.38	11.21	15.80	20.29	27.85	34.44	41.62
EX-13	0.43	4.78	6.93	8.94	12.62	15.83	19.36
EX-14	1.09	8.72	12.40	16.19	22.13	27.25	32.81
EX-6	0.89	10.46	15.52	20.35	28.00	34.59	42.40
EX-11	0.54	7.70	11.60	15.35	21.28	26.43	32.82
Town Branch Creek at Water St & area East of Polk Ave							
EX-20	0.73	6.83	9.74	12.67	17.61	21.91	26.61
EX-8	0.94	8.69	12.39	16.17	22.45	27.92	33.89
EX-9	0.94	9.50	13.86	17.96	24.48	30.19	36.81
EX-21	0.02	1.80	2.96	4.17	6.16	7.91	9.87
EX-10	0.92	10.79	16.00	20.95	28.74	35.57	43.74
EX-25	0.30	4.29	6.46	8.51	11.75	14.82	18.37
EX-24	1.17	12.01	17.45	22.52	30.64	38.33	46.82
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
EX-23	2.23	15.96	22.36	28.86	39.14	47.91	57.41
EX-40	1.68	12.06	16.92	21.88	29.61	36.23	43.46
EX-27	0.30	5.35	8.28	11.14	15.71	19.69	24.10
Area West of Town Branch Creek at Route 7							
EX-26	3.02	21.72	30.27	38.60	52.34	64.14	76.98
EX-38	1.97	13.95	20.06	25.82	34.84	42.51	50.80
EX-39	0.46	6.57	9.87	12.99	17.93	22.72	28.16
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
EX-28	0.90	12.67	18.96	24.91	34.64	44.10	54.55
EX-29	3.56	24.04	34.41	44.07	59.17	71.98	85.81
EX-30	0.74	8.64	12.85	16.89	23.33	28.93	35.15
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
J-PP1	0.03	0.32	0.46	0.60	0.84	1.05	1.28
J-PP3	0.01	0.15	0.21	0.28	0.39	0.49	0.59
J-PP5	0.03	0.16	0.23	0.29	0.38	0.46	0.54
J-PP7	0.11	0.59	0.81	1.01	1.32	1.57	1.84
J-PP14	0.08	0.32	0.43	0.53	0.69	0.82	0.96
EX-37	0.31	3.16	4.54	5.90	8.26	10.32	12.57
EX-43	0.66	3.87	5.35	6.70	8.78	10.53	12.41

Subbasin ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
J-PP2	0.02	0.23	0.33	0.42	0.60	0.75	0.91
J-PP4	0.05	0.50	0.72	0.96	1.35	1.68	2.04
J-AI1	0.07	0.74	1.07	1.41	1.98	2.47	3.01
J-AI2	0.14	0.90	1.26	1.59	2.10	2.53	2.99
J-PP6	0.02	0.15	0.20	0.26	0.34	0.41	0.48
J-AI3	0.18	1.21	1.70	2.16	2.86	3.44	4.07
J-AI4	0.03	0.19	0.26	0.33	0.43	0.52	0.62
J-AI5	0.58	3.43	4.74	5.95	7.79	9.35	11.01
J-AI6	0.11	0.43	0.57	0.70	0.89	1.04	1.21
J-AI7	2.38	8.86	11.77	14.39	18.36	21.65	25.19
J-AI8	0.10	0.41	0.55	0.68	0.88	1.04	1.22
J-PP8	0.22	1.09	1.45	1.78	2.26	2.73	3.26
EX-42	0.56	2.32	3.04	3.78	4.91	5.86	6.87
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
C-AI19	1.40	5.94	7.70	9.38	12.23	14.65	17.25
C-AI20	0.09	0.36	0.48	0.59	0.77	0.92	1.08
EX-48	0.24	0.99	1.32	1.64	2.12	2.53	2.96
C-B15	0.67	2.82	3.66	4.56	5.94	7.09	8.32
C-B17	0.03	0.14	0.19	0.23	0.30	0.36	0.42
C-B16	0.27	1.10	1.46	1.82	2.35	2.80	3.29
C-B18	0.06	0.23	0.31	0.39	0.50	0.59	0.70
Area Northwest of Commercial St, North of Jackson St							
C-AI1	0.97	6.88	9.79	12.62	17.08	20.88	24.99
C-AI2	0.60	4.28	6.14	7.92	10.68	13.03	15.58
C-AI4	0.09	0.65	0.93	1.19	1.60	1.94	2.31
C-AI3	0.04	0.30	0.44	0.56	0.75	0.91	1.08
C-B1	0.07	0.49	0.71	0.91	1.22	1.49	1.78
C-B5	0.07	0.51	0.73	0.94	1.25	1.52	1.81
C-AI8	1.05	7.48	10.63	13.71	18.53	22.66	27.13
C-AI9	0.03	0.40	0.60	0.79	1.11	1.41	1.74
C-B6	0.01	0.07	0.11	0.14	0.20	0.25	0.31
C-AI12	0.25	1.77	2.54	3.26	4.37	5.32	6.33
C-B8	0.01	0.17	0.24	0.32	0.45	0.57	0.70
C-AI13	0.06	0.74	1.08	1.40	1.99	2.50	3.06
C-AI14	0.08	0.55	0.77	0.97	1.28	1.55	1.83
C-B10	0.08	0.49	0.69	0.87	1.15	1.38	1.63
C-AI17	0.11	0.69	0.97	1.23	1.62	1.95	2.31
C-AI18	0.02	0.13	0.18	0.23	0.30	0.37	0.43
C-B12	0.10	0.67	0.94	1.19	1.57	1.89	2.23
C-B13	0.04	0.31	0.46	0.60	0.82	1.00	1.21

Subbasin ID	NOAA ATLAS 14, 10% FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
C-B2	0.19	2.62	3.92	5.14	7.18	9.14	11.30
C-AI5	0.16	1.15	1.65	2.12	2.84	3.45	4.11
C-AI6	0.04	0.55	0.82	1.08	1.52	1.94	2.39
C-AI7	0.18	2.55	3.81	5.00	6.99	8.89	10.99
C-B3	0.03	0.36	0.53	0.70	0.99	1.26	1.55
C-B4	0.03	0.40	0.60	0.78	1.11	1.41	1.74
C-B7	0.06	0.81	1.20	1.57	2.22	2.82	3.48
C-AI10	0.13	1.54	2.25	2.95	4.17	5.23	6.40
C-AI11	0.02	0.21	0.30	0.40	0.55	0.69	0.84
C-B9	0.04	0.41	0.59	0.79	1.11	1.38	1.68
C-AI15	0.06	0.63	0.91	1.19	1.68	2.10	2.56
C-AI16	0.02	0.23	0.32	0.43	0.60	0.75	0.92
C-B11	0.08	0.90	1.29	1.71	2.40	2.99	3.64
C-B14	0.09	0.86	1.24	1.64	2.26	2.79	3.37
J-PP13	0.35	1.79	2.39	2.94	3.77	4.61	5.51
C-CI1	0.09	0.44	0.58	0.71	0.93	1.12	1.34
EX-33	1.58	6.60	8.56	10.66	13.88	16.57	19.46
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
J-PP9	0.37	3.16	4.47	5.88	8.11	10.03	12.11
J-PP10	0.07	0.29	0.38	0.47	0.62	0.74	0.87
J-PP11	0.80	7.45	10.62	13.76	19.17	23.83	28.93
J-PP12	0.10	0.40	0.54	0.66	0.86	1.03	1.20
EX-31	1.67	6.88	9.12	11.32	14.67	17.48	20.48
EX-46	1.12	6.26	8.56	10.65	13.82	16.49	19.35
EX-32	0.98	5.20	7.09	8.81	11.42	13.61	15.96
Main Street from Commercial St to Town Branch Creek							
EX-47	0.11	0.44	0.59	0.73	0.94	1.12	1.32
M-PP2	0.07	0.30	0.40	0.49	0.64	0.76	0.89
M-PP4	0.13	0.50	0.66	0.80	1.02	1.20	1.39
M-CI1	0.10	0.35	0.46	0.56	0.70	0.82	0.95
M-PP1	0.32	1.35	1.76	2.18	2.84	3.39	3.99
M-PP3	0.27	1.05	1.41	1.74	2.23	2.64	3.08
M-CI2	0.10	0.40	0.52	0.65	0.84	1.00	1.18
Main Street from E Jackson St to Town Branch Creek							
M-CI3	0.08	0.51	0.71	0.89	1.18	1.42	1.67
M-CI4	0.16	0.86	1.16	1.43	1.85	2.20	2.59
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
EX-45	1.07	5.21	6.93	8.48	10.82	12.88	15.38

Subbasin ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Area North of Town Branch Creek, North of Hillcrest Ln							
EX-1	0.78	12.03	8.18	15.80	21.77	26.92	32.74
EX-18	0.44	6.92	4.67	9.07	12.44	15.44	18.84
EX-17	0.37	6.76	4.51	8.97	12.45	15.54	19.09
EX-19	0.26	4.82	3.22	6.40	8.90	11.07	13.61
EX-4	0.27	5.41	3.60	7.24	10.16	12.69	15.57
EX-22	0.23	4.17	2.79	5.54	7.70	9.58	11.78
EX-7	0.00	1.85	1.05	2.70	4.23	5.62	7.25
EX-15	0.25	5.44	3.59	7.32	10.36	13.01	15.92
EX-16	0.02	0.60	0.39	0.82	1.18	1.49	1.84
Upstream Portion of Town Branch Creek, North of Hillcrest Ln & West of Polk Ave							
EX-2	0.76	10.90	7.43	14.21	19.43	23.97	29.13
EX-3	0.40	3.98	2.85	5.08	6.79	8.24	9.79
EX-12	0.12	1.79	1.22	2.31	3.18	3.94	4.77
EX-5	0.43	6.24	4.25	8.10	11.06	13.75	16.70
EX-13	0.13	2.60	1.73	3.48	4.86	6.07	7.49
EX-14	0.33	4.80	3.29	6.22	8.55	10.61	12.85
EX-6	0.27	5.92	3.90	7.92	11.24	14.12	17.31
EX-11	0.16	4.31	2.77	5.81	8.37	10.61	13.08
Town Branch Creek at Water St & area East of Polk Ave							
EX-20	0.22	3.75	2.51	4.94	6.80	8.51	10.41
EX-8	0.28	4.77	3.19	6.27	8.63	10.80	13.21
EX-9	0.29	5.37	3.61	7.15	9.98	12.44	15.17
EX-21	0.01	1.01	0.59	1.45	2.22	2.92	3.76
EX-10	0.28	6.06	3.99	8.12	11.52	14.47	17.72
EX-25	0.09	2.37	1.53	3.21	4.61	5.84	7.20
EX-24	0.36	6.68	4.48	8.87	12.37	15.39	18.86
Town Branch Creek at Route 7 & area North of Water St & West of Polk							
EX-23	0.72	8.90	6.21	11.40	15.55	19.14	23.03
EX-40	0.55	6.71	4.68	8.60	11.75	14.46	17.41
EX-27	0.09	3.08	1.93	4.20	6.10	7.83	9.75
Area West of Town Branch Creek at Route 7							
EX-26	0.99	12.21	8.49	15.67	21.27	26.20	31.59
EX-38	0.63	7.73	5.41	9.92	13.56	16.65	20.01
EX-39	0.13	3.62	2.34	4.90	7.04	8.91	10.97
Town Branch Creek Route 7 to Intersection of Van Buren St & W Osage St							
EX-28	0.25	6.90	4.46	9.35	13.43	16.98	20.89
EX-29	1.17	13.35	9.42	17.12	23.21	28.41	34.04
EX-30	0.23	4.98	3.27	6.65	9.44	11.89	14.59
Town Branch Creek at Jackson St & Commercial St & Northwest portion W Jackson St							
J-PP1	0.01	0.17	0.11	0.23	0.32	0.40	0.49
J-PP3	0.00	0.08	0.05	0.10	0.14	0.18	0.22
J-PP5	0.01	0.09	0.06	0.11	0.15	0.18	0.21
J-PP7	0.04	0.31	0.23	0.39	0.52	0.62	0.73
J-PP14	0.03	0.17	0.13	0.20	0.26	0.30	0.35
EX-37	0.09	1.73	1.15	2.29	3.18	3.97	4.87
EX-43	0.22	2.06	1.47	2.61	3.45	4.16	4.92

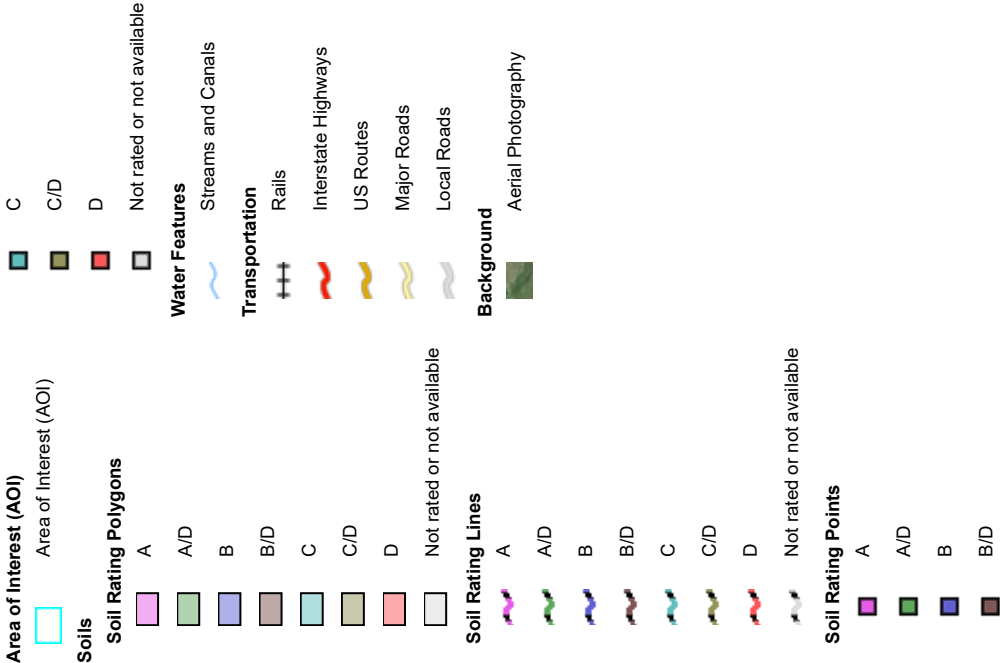
Subbasin ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at Jackson St & Commercial St, & Southwest portion of W Jackson St							
J-PP2	0.01	0.12	0.08	0.16	0.23	0.28	0.35
J-PP4	0.01	0.27	0.18	0.36	0.50	0.63	0.77
J-AI1	0.02	0.40	0.26	0.53	0.74	0.93	1.14
J-AI2	0.04	0.47	0.33	0.60	0.81	0.98	1.17
J-PP6	0.01	0.08	0.05	0.10	0.13	0.16	0.19
J-AI3	0.06	0.64	0.46	0.82	1.10	1.34	1.60
J-AI4	0.01	0.10	0.07	0.12	0.17	0.20	0.24
J-AI5	0.20	1.83	1.31	2.31	3.06	3.69	4.37
J-AI6	0.04	0.21	0.17	0.26	0.32	0.38	0.44
J-AI7	0.89	4.50	3.47	5.43	6.82	7.97	9.21
J-AI8	0.04	0.21	0.16	0.26	0.33	0.39	0.45
J-PP8	0.08	0.57	0.42	0.70	0.90	1.08	1.27
EX-42	0.21	1.19	0.91	1.45	1.85	2.19	2.54
Area Southwest of Town Branch Creek at Commercial St & Jackson St							
C-AI19	0.53	3.06	2.34	3.75	4.78	5.65	6.57
C-AI20	0.03	0.18	0.14	0.23	0.29	0.34	0.39
EX-48	0.09	0.51	0.39	0.62	0.79	0.93	1.09
C-B15	0.25	1.45	1.10	1.77	2.26	2.66	3.10
C-B17	0.01	0.07	0.05	0.09	0.11	0.13	0.15
C-B16	0.10	0.57	0.43	0.69	0.88	1.04	1.21
C-B18	0.02	0.12	0.09	0.15	0.19	0.22	0.26
Area Northwest of Commercial St, North of Jackson St							
C-AI1	0.31	3.82	2.67	4.90	6.70	8.23	9.90
C-AI2	0.19	2.37	1.66	3.05	4.16	5.12	6.15
C-AI4	0.03	0.35	0.24	0.45	0.61	0.75	0.90
C-AI3	0.01	0.16	0.11	0.21	0.28	0.35	0.42
C-B1	0.02	0.27	0.19	0.35	0.47	0.58	0.70
C-B5	0.02	0.27	0.19	0.35	0.48	0.58	0.70
C-AI8	0.34	4.15	2.90	5.32	7.27	8.94	10.75
C-AI9	0.01	0.22	0.14	0.29	0.42	0.53	0.66
C-B6	0.00	0.04	0.02	0.05	0.07	0.09	0.12
C-AI12	0.08	0.95	0.67	1.23	1.68	2.06	2.47
C-B8	0.00	0.09	0.06	0.12	0.17	0.21	0.26
C-AI13	0.02	0.40	0.26	0.54	0.75	0.94	1.17
C-AI14	0.03	0.29	0.20	0.37	0.49	0.60	0.71
C-B10	0.02	0.26	0.18	0.33	0.44	0.53	0.64
C-AI17	0.03	0.36	0.26	0.47	0.62	0.76	0.90
C-AI18	0.01	0.07	0.05	0.09	0.12	0.14	0.17
C-B12	0.03	0.35	0.25	0.45	0.60	0.73	0.87
C-B13	0.01	0.17	0.12	0.22	0.31	0.38	0.46

Subbasin ID	NOAA ATLAS 14, MEDIAN FIRST-QUARTILE, 24-HR PEAK FLOW RATE						
	90% Mean Annual	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)	(CFS)
Town Branch Creek at State St & Area Northeast of Commercial St & E Jackson St							
C-B2	0.05	1.42	0.92	1.93	2.77	3.50	4.31
C-AI5	0.05	0.62	0.44	0.80	1.09	1.34	1.60
C-AI6	0.01	0.30	0.19	0.41	0.58	0.73	0.90
C-AI7	0.05	1.38	0.89	1.88	2.69	3.40	4.18
C-B3	0.01	0.19	0.12	0.26	0.37	0.47	0.58
C-B4	0.01	0.22	0.14	0.29	0.42	0.53	0.65
C-B7	0.02	0.43	0.28	0.59	0.85	1.07	1.32
C-AI10	0.04	0.83	0.54	1.11	1.56	1.96	2.42
C-AI11	0.01	0.11	0.07	0.15	0.21	0.26	0.32
C-B9	0.01	0.22	0.15	0.29	0.41	0.52	0.63
C-AI15	0.02	0.34	0.22	0.45	0.63	0.79	0.98
C-AI16	0.01	0.12	0.08	0.16	0.22	0.28	0.35
C-B11	0.02	0.48	0.32	0.64	0.90	1.12	1.38
C-B14	0.03	0.47	0.31	0.61	0.84	1.06	1.29
J-PP13	0.12	0.92	0.68	1.14	1.47	1.77	2.09
C-CI1	0.03	0.22	0.17	0.28	0.36	0.43	0.50
EX-33	0.59	3.39	2.58	4.14	5.28	6.24	7.25
Town Branch Creek from E Jefferson St to E Main St & Area Southeast of E Jackson St & Commercial St							
J-PP9	0.11	1.74	1.17	2.27	3.11	3.89	4.73
J-PP10	0.03	0.15	0.11	0.18	0.23	0.28	0.32
J-PP11	0.24	4.09	2.74	5.38	7.41	9.27	11.33
J-PP12	0.04	0.21	0.16	0.25	0.32	0.38	0.44
EX-31	0.62	3.52	2.68	4.30	5.48	6.47	7.52
EX-46	0.38	3.29	2.37	4.14	5.43	6.51	7.69
EX-32	0.34	2.79	2.02	3.49	4.55	5.44	6.42
Main Street from Commercial St to Town Branch Creek							
EX-47	0.04	0.23	0.17	0.28	0.35	0.42	0.48
M-PP2	0.03	0.15	0.12	0.19	0.24	0.28	0.33
M-PP4	0.05	0.25	0.19	0.30	0.37	0.44	0.50
M-CI1	0.04	0.17	0.13	0.20	0.25	0.30	0.34
M-PP1	0.12	0.69	0.53	0.85	1.08	1.28	1.48
M-PP3	0.10	0.54	0.41	0.65	0.82	0.97	1.12
M-CI2	0.04	0.20	0.15	0.25	0.32	0.37	0.43
Main Street from E Jackson St to Town Branch Creek							
M-CI3	0.03	0.27	0.19	0.35	0.46	0.56	0.66
M-CI4	0.06	0.45	0.33	0.56	0.73	0.87	1.03
Town Branch Creek at Outlet to Osage River/Lake of the Ozarks							
EX-45	0.38	2.71	2.02	3.34	4.30	5.15	6.07

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MAP LEGEND



MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Benton County, Missouri
Survey Area Data: Version 22, Sep 13, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 8, 2011—Oct 1, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
10117	Sampsel silty clay loam, 5 to 9 percent slopes	C/D	34.4	0.8%
46004	Osage silty clay loam, 0 to 2 percent slopes, occasionally flooded	D	110.7	2.6%
46005	Verdigris silt loam, 0 to 1 percent slopes, occasionally flooded	B	20.8	0.5%
46101	Verdigris silt loam, 1 to 3 percent slopes, frequently flooded	B	106.4	2.5%
70024	Goss very gravelly silt loam, 15 to 35 percent slopes, very stony	C	283.7	6.6%
70039	Sacville silty clay loam, 1 to 3 percent slopes	C/D	227.7	5.3%
73000	Pomme silt loam, 3 to 8 percent slopes	B	239.5	5.6%
73019	Poynor very gravelly silt loam, 1 to 8 percent slopes	B	260.3	6.1%
73136	Union silt loam, 1 to 3 percent slopes	D	8.7	0.2%
73363	Bardley gravelly silt loam, 3 to 8 percent slopes	D	448.4	10.5%
73365	Bardley very gravelly silt loam, 8 to 35 percent slopes, stony	C	875.3	20.4%
73429	Gasconade-Rock outcrop complex, 8 to 50 percent slopes	D	235.5	5.5%
73432	Gasconade-Rock outcrop complex, 3 to 8 percent slopes	D	86.7	2.0%
73976	McGirk silt loam, 1 to 3 percent slopes	C/D	160.4	3.7%
99001	Water		486.2	11.3%
99007	Arents, earthen dam	C	14.4	0.3%
99025	Aquents, nearly level	C/D	560.8	13.1%
99030	Udorthents, clayey	C	125.0	2.9%
Totals for Area of Interest			4,284.8	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

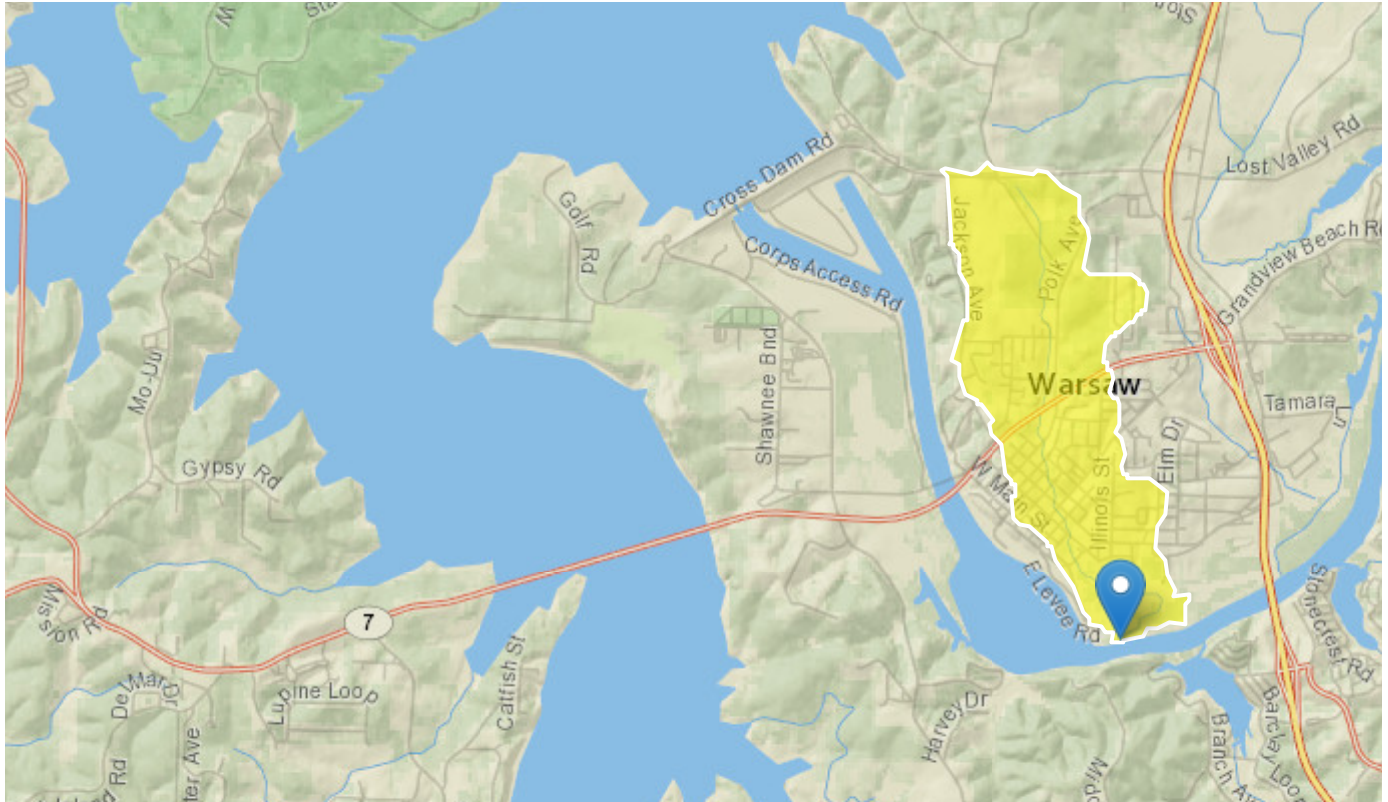
StreamStats Report

Region ID: MO

Workspace ID: MO20200817162406195000

Clicked Point (Latitude, Longitude): 38.23353, -93.37274

Time: 2020-08-17 11:24:25 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.33	square miles
BSHAPE	Basin Shape Factor for Area	6.35	dimensionless
IMPNLCD01	Percentage of impervious area determined from NLCD 2001 impervious dataset	14.5	percent

Peak-Flow Statistics Parameters[100 Percent (1.33 square miles) Peak Rural Statewide Region 2 SIR 2014 5165]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.33	square miles	0.17	4008.92
BSHAPE	Basin Shape Factor	6.35	dimensionless	2.04	26.89

Peak-Flow Statistics Parameters^[Peak Urban Statewide SIR 2010 5073]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.33	square miles	0.28	189
IMPNLCD01	Percent Impervious NLCD2001	14.5	percent	2.3	46

Peak-Flow Statistics Flow Report^[100 Percent (1.33 square miles) Peak Rural Statewide Region 2 SIR 2014 5165]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	251	ft ³ /s	43.5
5 Year Peak Flood	483	ft ³ /s	31.8
10 Year Peak Flood	666	ft ³ /s	28
25 Year Peak Flood	925	ft ³ /s	24.1
50 Year Peak Flood	1120	ft ³ /s	24.2
100 Year Peak Flood	1330	ft ³ /s	24.4
200 Year Peak Flood	1530	ft ³ /s	24.6
500 Year Peak Flood	1800	ft ³ /s	27

Peak-Flow Statistics Flow Report^[Peak Urban Statewide SIR 2010 5073]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
2 Year Peak Flood	356	ft ³ /s	226	560	26.7
5 Year Peak Flood	602	ft ³ /s	404	897	23.3
10 Year Peak Flood	801	ft ³ /s	550	1170	22.1
25 Year Peak Flood	1040	ft ³ /s	718	1510	22.1
50 Year Peak Flood	1280	ft ³ /s	864	1900	23.3
100 Year Peak Flood	1490	ft ³ /s	968	2290	25.6
500 Year Peak Flood	2070	ft ³ /s	1160	3680	35.2

Southard, R.E.,2010, Estimation of the Magnituude and Frequency of Floods in Urban Basins in Missouri: U.S. Geological Survey Scientific Investigations Report 2010-5073, 27 p. (<http://pubs.usgs.gov/sir/2010/5073/>)

Southard, R.E., and Veilleux, A.G.,2014, Methods for estimating annual exceedance-probability discharges and largest recorded floods for unregulated streams in rural Missouri: U.S. Geological Survey Scientific Investigations Report 2014-5165, 39 p. (<http://pubs.usgs.gov/sir/2014/5165/>)

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Application Version: 4.4.0

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APPENDIX B: FEMA FLOOD INSURANCE RATE MAP, RELEVANT PAGES FROM FLOOD INSURANCE STUDY, AND EFFECTIVE MODEL OUTPUT

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This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

Coastal Base Flood Elevations shown on this map apply only to landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

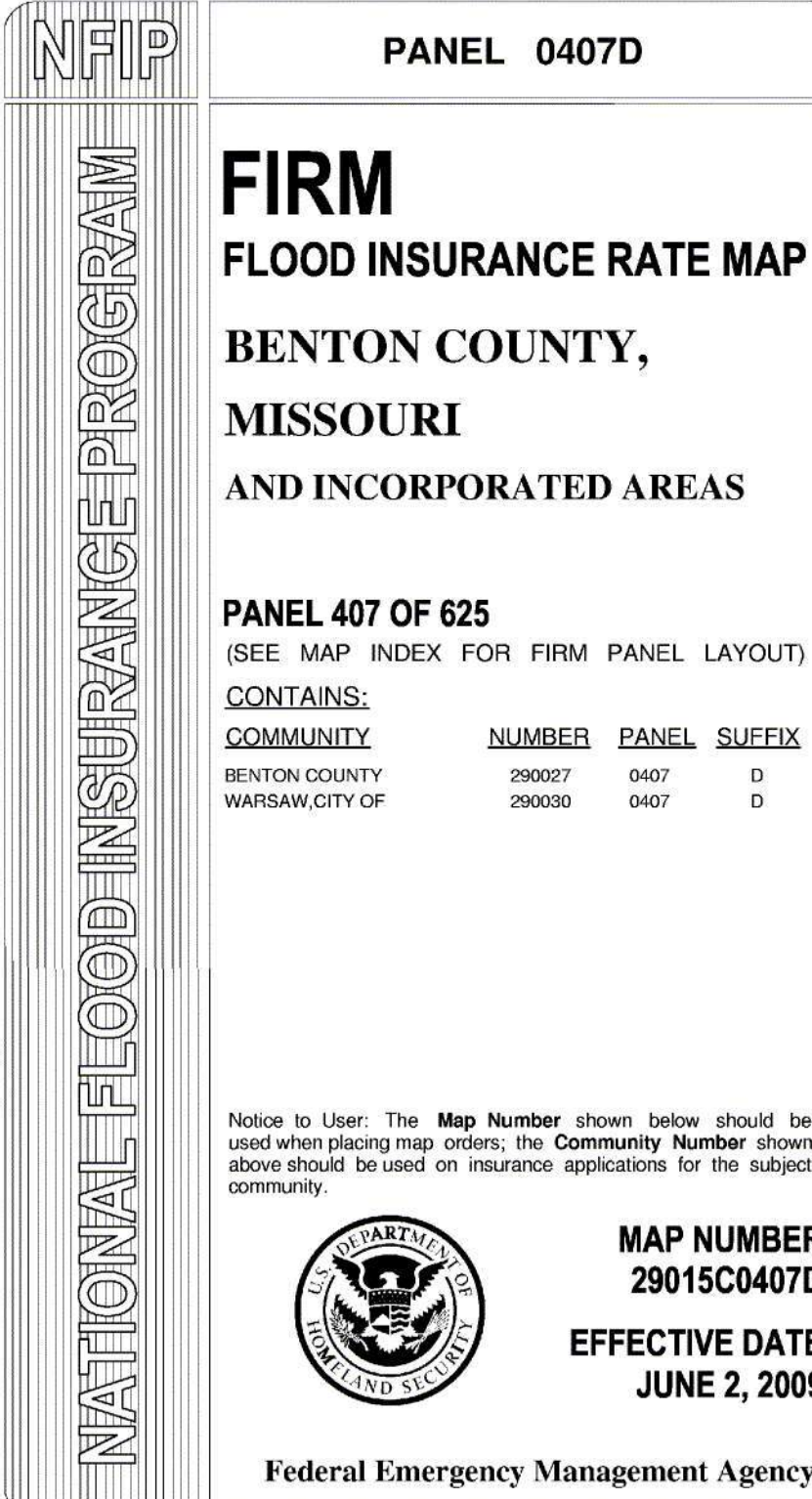
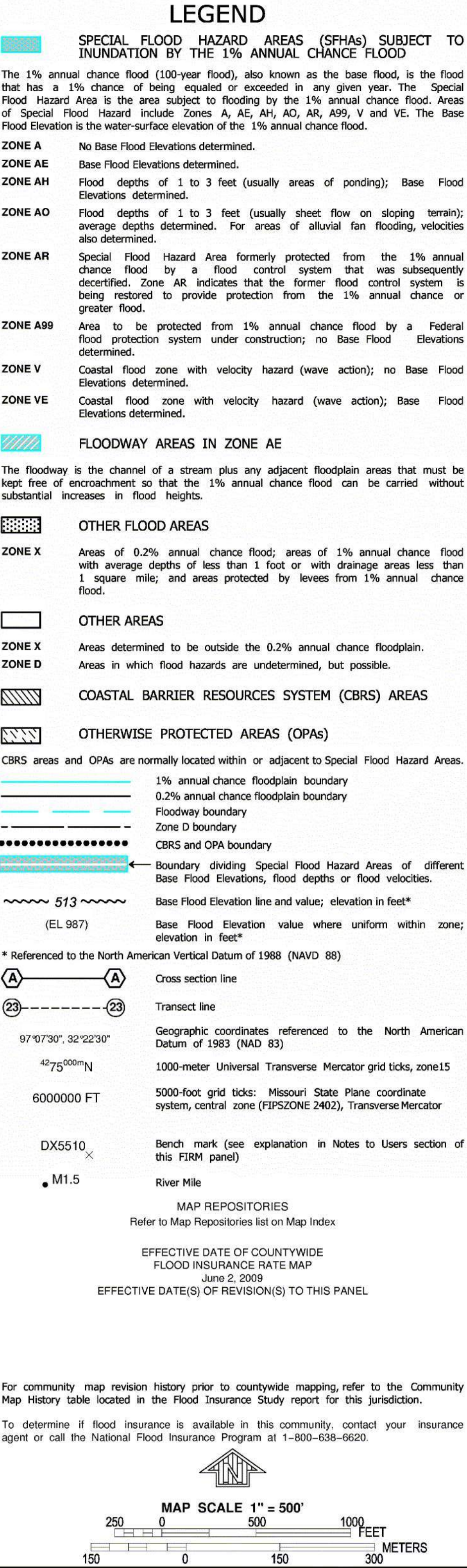
Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov/>.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the *Flood Insurance Study Report* (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/>.



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FLOOD INSURANCE STUDY



BENTON COUNTY, MISSOURI AND INCORPORATED AREAS

Community Name

Community Number

BENTON COUNTY
UNINCORPORATED AREAS

290027

COLE CAMP, CITY OF

290028

*IONIA, TOWN OF

290986

*LINCOLN, TOWN OF

290029

WARSAW, CITY OF

290030

*Non-floodprone communities



June 2, 2009



Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER

29015CV000A

**NOTICE TO
FLOOD INSURANCE STUDY USERS**

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Initial Countywide FIS Effective Date: June 2, 2009

Revised Countywide FIS Date:

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Osage River	Panels 01P-07P
Town Branch	Panels 08P-09P
Exhibit 2 – Flood Insurance Rate Map Index	
Flood Insurance Rate Map	

periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency and peak elevation-frequency relationships for each flooding source studied in detail affecting the county.

3.1.1 Detailed Methods

A hydrologic analysis was conducted to establish peak 1% annual chance discharges for each flooding source studied in the community. Separate hydrologic analyses were conducted for the Lake of the Ozarks and the major streams where detailed hydraulic analyses were performed.

The following steps were taken to complete the hydrology for the streams studied by detailed hydraulic methods:

- a. The HEC ArcHydro program was utilized to delineate 57 sub-basins that flow into the Lake of the Ozarks. Area and slope were calculated by GeoHMS for each sub-basin.
- b. Areas and slopes from Step “a” were used to calculate the 10%, 2%, 1%, and 0.2% annual chance flows at various locations in the basins using USGS regression equations.
- c. Soil Conservation Service (SCS) Dimensionless Unit Hydrographs were then developed for the mainstem and each major tributary.

TABLE 1: 1% ANNUAL CHANCE MAINSTEM UNIT HYDROGRAPH PEAKS

Upper Osage	85,000 cfs @ 28 hrs
Middle Osage	8,200 cfs @ 8 hrs
Lower Osage	13,000 cfs @ 11 hrs

- d. USACE, Kansas City District Water Management Section determined that the 1% annual chance release for Harry S Truman Reservoir Dam under typical flood conditions would be 80,000 cfs. Therefore, a base flow of 80,000 cfs was used for all model runs on the Osage River below Harry S. Truman Reservoir Dam.
- e. A Flood Frequency Analysis (FFA) was performed for the St. Thomas gauge just downstream of Bagnell Dam as a way of double checking the flows at the dam. Gauge records were obtained for the years 1932 through 1997. Regulated flows were used for the pre-Harry S Truman Reservoir era (before 1976), and actual flows were used for the post-Harry S Truman Reservoir time period, or 1977 and after. 10% annual chance flows at the dam were determined to be 81,300 cfs, 2% at 125,000 cfs, and 1% annual chance flows were confirmed at 150,000 cfs.

Table 2 presents the 10%, 2%, 1%, 0.2% annual chance discharges for each of the streams studied.

TABLE 2: SUMMARY OF DISCHARGES (CFS)

<u>Osage River</u>	<u>0.2 PCT</u>	<u>1 PCT</u>	<u>2 PCT</u>	<u>10 PCT</u>
Mile 70.0-80.0	83,000	80,000	80,000	80,000
Mile 80.0-92.0	81,000	80,000	80,000	80,000
<u>Town Branch</u>				
At Mouth	_____	1,550	_____	_____

3.1.2 Approximate Methods

The 1% annual chance discharge was calculated as follows for all watersheds with drainage areas greater than 1 square mile for all streams studied by approximate hydraulic methods:

The hydrologic analysis for the approximate zones of the study used USGS regression equations for central Missouri to estimate the 1% annual chance discharges. The main equation used is shown below.

$$Q_{100} = 170 * A^{0.794} * S^{0.471}$$

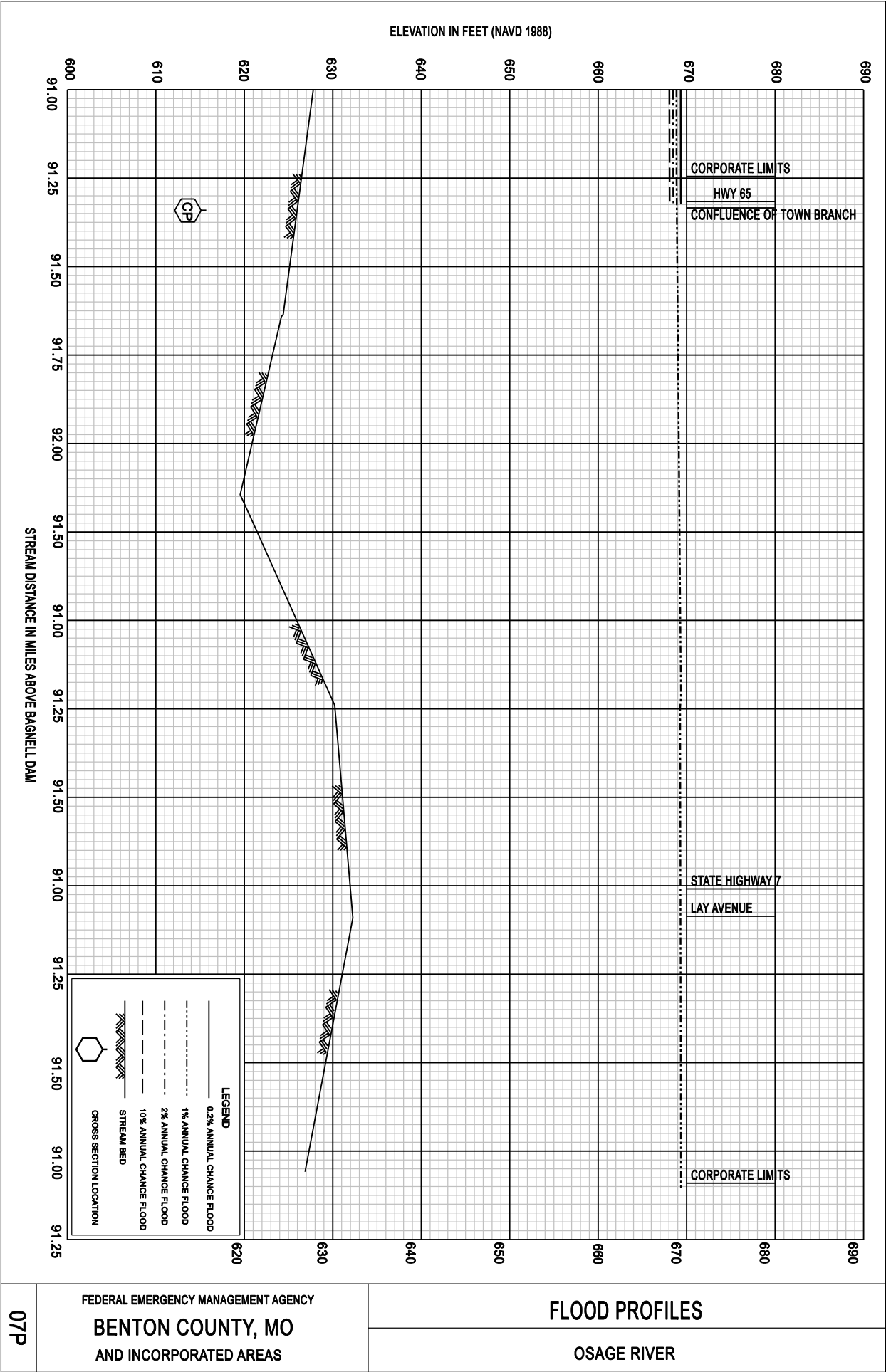
The drainage areas and slopes used to populate this equation were calculated using ArcHydro in GIS. Starting from the raw 10-meter digital elevation models (DEMs), the tools within ArcHydro were used to delineate basins, define all streams with drainage areas 1 square mile or greater, calculate subbasin areas, locate the longest flow path for each basin or flow change location, and calculate the applicable slope between the 10% and 85% points on the longest flow path. The slopes and areas generated through this process were then imported into spreadsheets and used to populate the Q100 discharge equation for each flow change location.

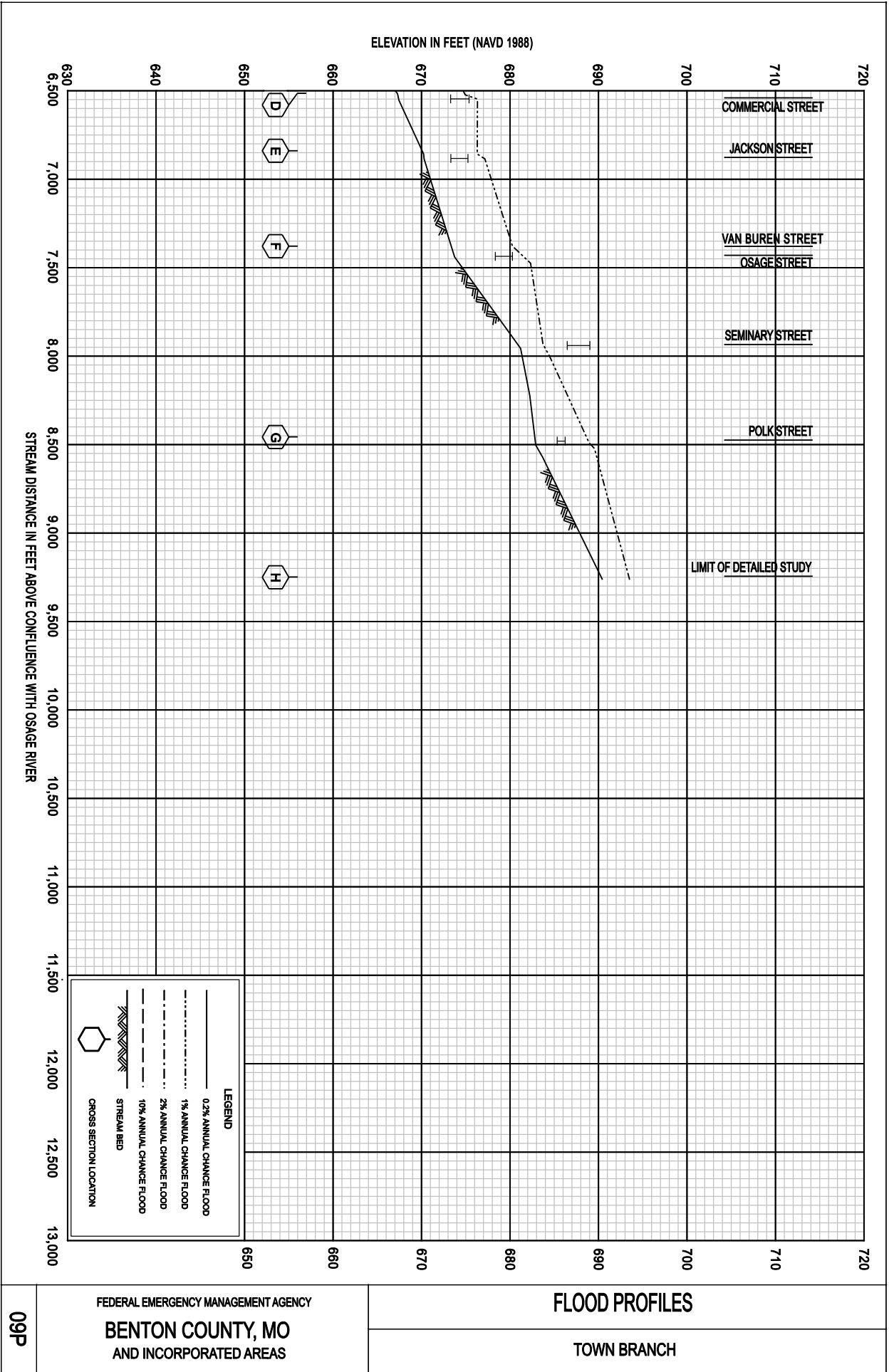
3.2 Hydraulic Analyses

The hydraulic characteristics of floodplains in the county were studied to estimate the limits of flooding as a result of the 1% annual chance flood event.

3.2.1 Detailed Method

The HEC-RAS hydraulic model was utilized to perform the detailed hydraulic analysis. Cross-sectional data for all streams studied were obtained both from GIS mapping and a survey conducted by the USACE, Kansas City District. A hydrographic survey was utilized to obtain data for portions of the cross sections below Lake of the Ozarks elevation of 656 feet. GIS mapping and GPS survey methods were utilized to obtain cross-sectional data above the 656-ft contour. Cross sections were located at close intervals upstream and





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FLOOD INSURANCE STUDY



**CITY OF WARSAW,
MISSOURI**

BENTON COUNTY



JULY 16, 1990



Federal Emergency Management Agency

COMMUNITY NUMBER - 290030

NOTICE TO
FLOOD INSURANCE STUDY USERS

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EXHIBITS

Flood Profiles

Osage River
Town Branch

Panel 01P
Panels 02P-03P

Flood Insurance Rate Map

Elevation Reference Marks

FLOOD INSURANCE STUDY

CITY OF WARSAW,
BENTON COUNTY,
MISSOURI

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study revises and supersedes a previous Flood Insurance Rate Map for the City of Warsaw, Benton County, Missouri (Reference 1). This information will be used by the community to update existing floodplain regulations as part of the regular phase of the National Flood Insurance Program. The information will also be used by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The hydrologic and hydraulic analyses for this study were performed by the U.S. Army Corps of Engineers (COE), Kansas City District (the Study Contractor) for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. EMW-87-E-2509, Project Order No. 22. This study was completed in November 1988.

1.3 Coordination

On April 3, 1987, a coordination meeting was held by telephone with representatives of FEMA, the City of Warsaw, and the Study Contractor.

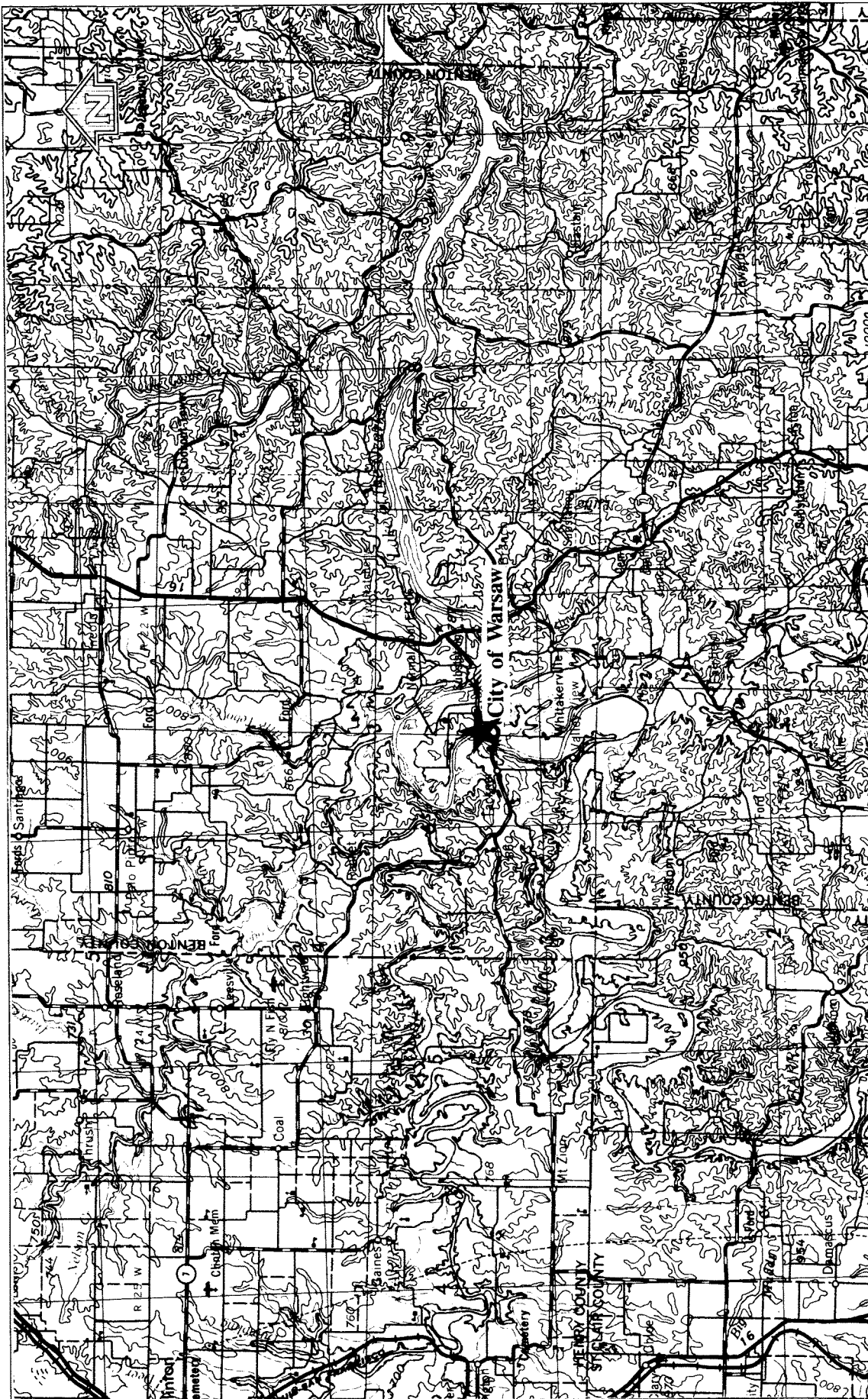
On August 31, 1989, the results of this Flood Insurance Study were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor, FEMA, and the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Warsaw, Benton County, Missouri. The area of study is shown on the Vicinity Map (Figure 1).

Flooding caused by overflow of the Osage River and Town Branch was studied in detail.



APPROXIMATE SCALE



VICINITY MAP

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF WARSAW, MO
(BENTON CO.)

FIGURE 1

The areas studied were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through November 1993. The scope and methods of study were proposed to and agreed upon by FEMA and the City of Warsaw.

2.2 Community Description

The City of Warsaw is in west-central Missouri, about 130 miles southeast of Kansas City, Missouri. Warsaw is surrounded by the unincorporated areas of Benton County and serves as the county seat. Warsaw is served by U.S. Highway 65 and State Highway 7. According to the 1980 census, Warsaw has a reported population of 1,494 (Reference 2).

Approximately 1 mile upstream from the City limits on the Osage River is the Harry S. Truman Dam and Reservoir completed in 1979. The reservoir serves the area with fishing, recreation, and wildlife.

2.3 Principal Flood Problems

The flood producing characteristics of Town Branch are typical for small watersheds in the Midwest. Flood flows are usually caused by short duration thunderstorms with high-intensity rainfall. These storms move rapidly over the area releasing cloudburst rainstorms. Flood flows from these storms are characterized by high runoff flows and high stream velocities for a short duration.

Obstructions hindering flood flows have been created by continued encroachment into the floodplain. In the study area of the Town Branch, culverts and buildings placed adjacent to the stream banks and vegetation in the channel form the most prominent obstructions.

2.4 Flood Protection Measures

The Harry S. Truman Dam and Reservoir completed in November 1979 controls 7,856 square miles of the total drainage area of 19,356 square miles at Warsaw in the Osage River basin. A levee system completed in 1984 protects both the left and right banks from flooding. The computed design top-of-levee profile approximates a steady-state flood control release of 80,000 cubic feet per second (cfs) with an initial Lake of the Ozarks pool elevation of 659.2 feet National Geodetic Vertical Datum of 1929 (NGVD) or 660 feet Union Electric Datum. This is the discharge which could be released when the Truman pool is between elevations 735.5 and 739.6 feet NGVD, and is expected to occur for floods from the 1-percent to the 5-percent chance event.

The levee in the study area provides the community with some degree of protection against flooding. However, it has been ascertained that the levee may not protect the community from rare events such as the 100-year flood. The criteria used to evaluate protection against the 100-year flood are 1) adequate design, including freeboard, 2) structural stability, and 3) proper operation and maintenance. Levees that do not protect against the 100-year flood are not considered in the hydraulic analysis of the 100-year floodplain.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedance) in any 50-year period is approximately 40-percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60-percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationship for the 100-year frequency flood; the selected recurrence interval for Town Branch and the Osage River. The peak discharge for the 100-year frequency flood was estimated from a regression analysis for ungaged drainage basins for the State of Missouri (Reference 3).

Peak discharge-drainage area relationships for the 100-year flood of each flooding source studied in detail in the community are shown in Table 1. Discharges for the Osage River are based on Phase 3 scheduled releases from Truman Reservoir.

TABLE 1 - SUMMARY OF DISCHARGES

<u>FLOODING SOURCE AND LOCATION</u>	<u>DRAINAGE AREA (SQ MILES)</u>	<u>PEAK DISCHARGE (CFS) 100-YEAR</u>
TOWN BRANCH at mouth	1.10	1,550
OSAGE RIVER	11,500 ¹	80,000
	7,856 ²	80,000

¹ Controlled by Harry S. Truman Dam and Reservoir

² Uncontrolled area below upstream reservoir

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of Town Branch and the Osage River were completed to provide estimates of the 100-year flood elevations.

The water-surface profiles for Town Branch were computed using the HEC-2 backwater computer program (Reference 4). The water-surface profiles for the Osage River were computed using a water-surface dynamic routing program formulated by the COE (Reference 5).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles and on the Flood Insurance Rate Map.

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the NGVD. Elevation reference marks used in this study are shown on the map and described in the exhibit labeled Elevation Reference Marks.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:4800, with contour intervals of 2 and 10 feet (Reference 6).

The 100-year floodplain boundaries are shown on the Flood Insurance Rate Map. On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, AO, A99, V, and VE). Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights.

Floodways have not been shown or computed for this community. Along streams where floodways have not been computed, the community must ensure that the cumulative effect of development in the floodplain will not cause more than a 1.0-foot increase in the base flood elevations at any point within the community.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 100-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shown by tints, screens, and symbols the 100- and 500-year floodplains, the floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

The Flood Insurance Rate Map printed for Benton County, Missouri (Reference 7) is in agreement with this study.

This Flood Insurance Study supersedes the previously printed Flood Insurance Rate Map for the City of Warsaw, Missouri (Reference 1).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Old Federal Office Building, Room 300, 911 Walnut Street, Kansas City, Missouri 64106.

Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To assure that any user is aware of all revisions, it is advisable to contact the map repository of flood hazard data located in the community.

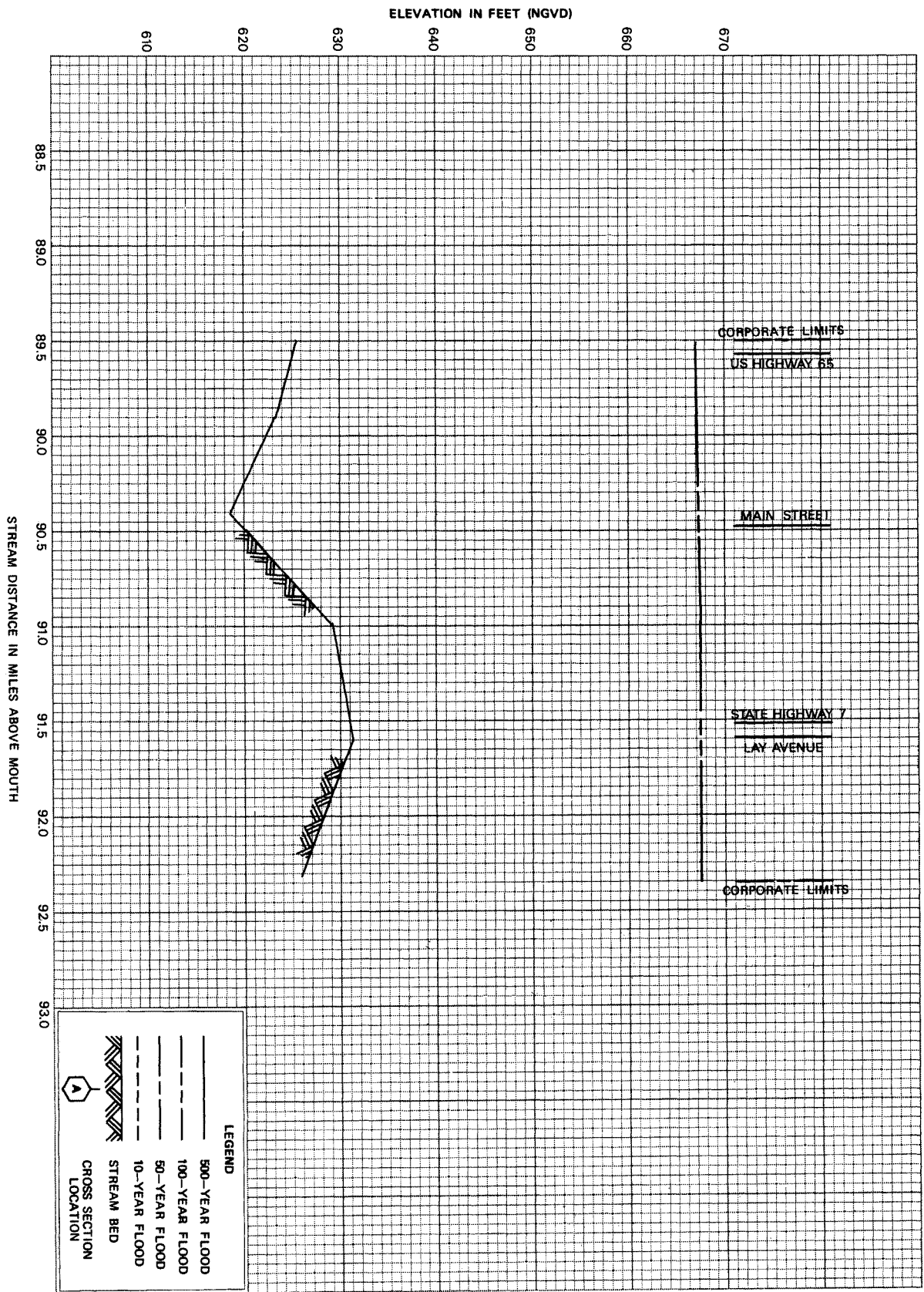
9.0 REFERENCES AND BIBLIOGRAPHY

1. Federal Emergency Management Agency, Flood Insurance Rate Map, City of Warsaw, Benton County, Missouri, August 1987.
2. U.S. Department of Commerce, Bureau of the Census, 1980 Census of Population, Number of Inhabitants, Missouri, Washington, D.C., February 1982.

3. State of Missouri, Frequency Study, Missouri River Basin, November 1979, (unpublished).
4. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, April 1986.
5. ———, Kansas City District, NSFLO, Water Surface Dynamic Routing Program, unpublished.
6. ———, Topographic Mapping City of Warsaw, Scale 1:4800, Contour Intervals 2 Feet and 10 Feet: Burton County, Missouri, from photos taken in January 1975.
7. Federal Emergency Management Agency, Flood Insurance Rate Map, Benton County, Unincorporated Areas, Missouri, March 1987.

ELEVATION REFERENCE MARKS

REFERENCE MARK	FLOOD INSURANCE RATE MAP PANEL	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
1	0001	708.56	disk stamped "WARSAW 1934" located on east side of intersection of Van Buren Street and Main Street
2	0001	668.29	chiseled square in center top of north headwall of box culvert for Town Branch, 50 feet northeast of intersection of Jefferson Street and Ballou Street



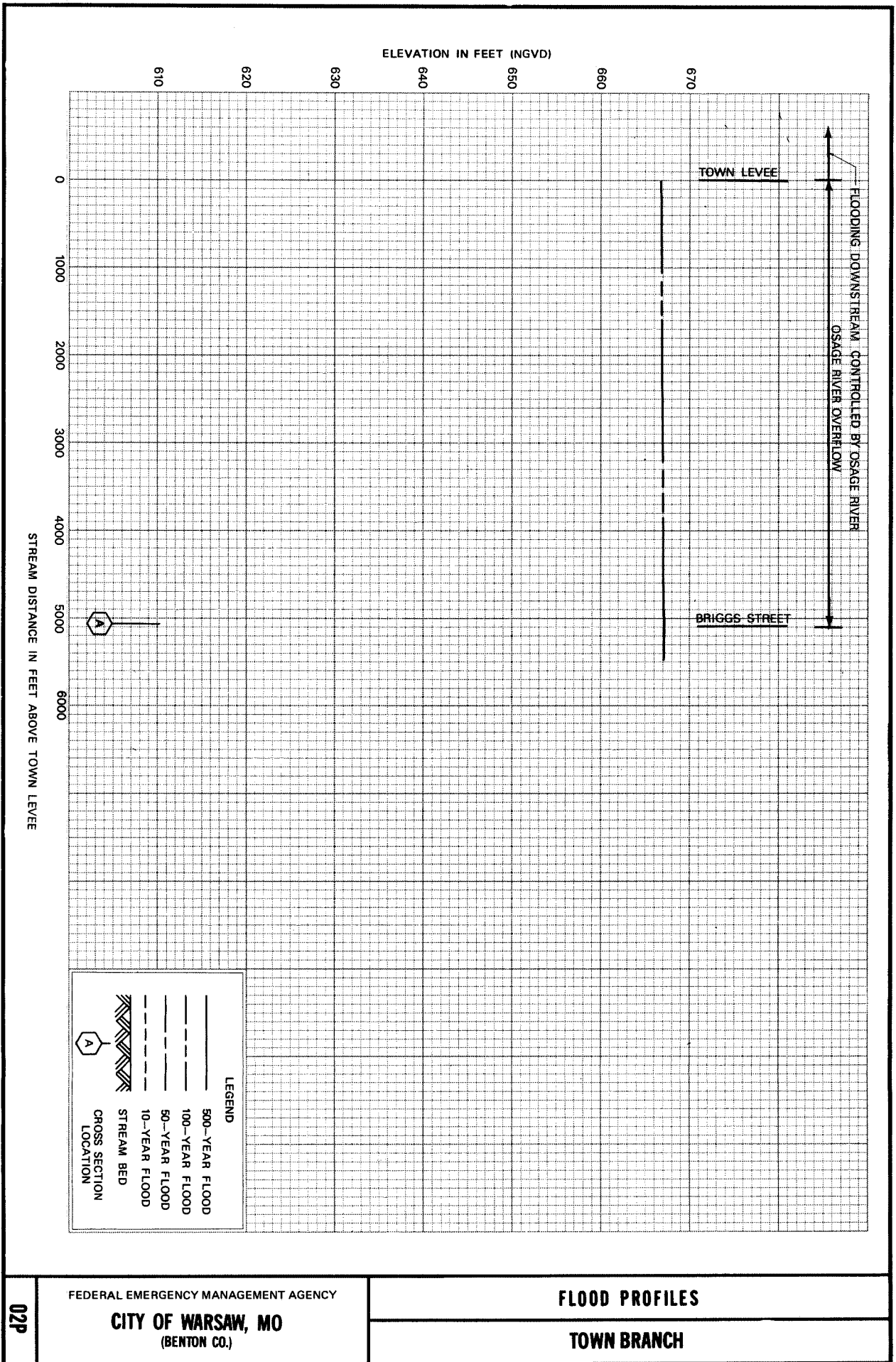
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF WARSAW, MO
(BENTON CO.)

FLOOD PROFILES

OSAGE RIVER

01P



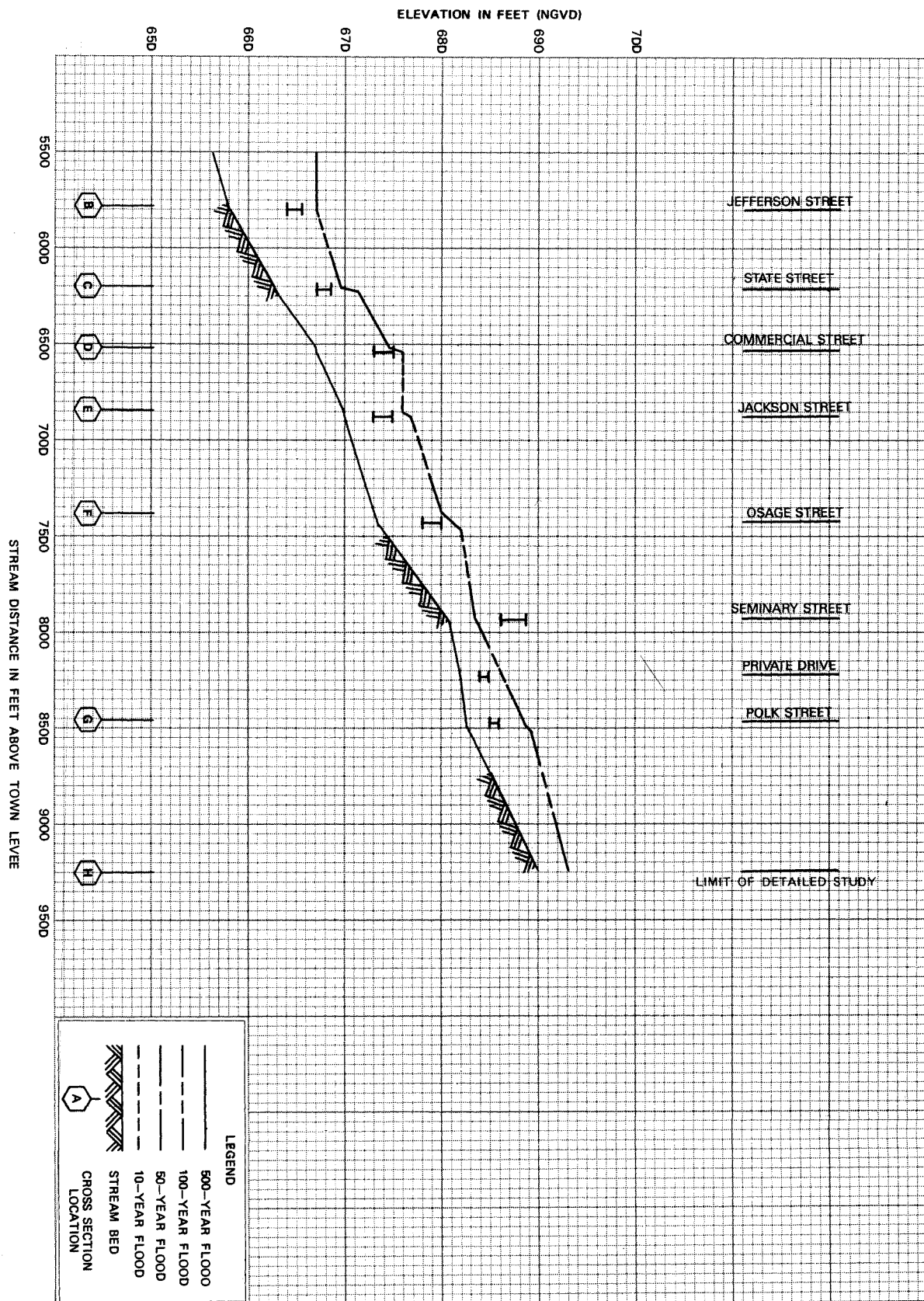
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF WARSAW, MO
(BENTON CO.)

FLOOD PROFILES

TOWN BRANCH

02P



03P

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF WARSAW, MO
(BENTON CO.)

FLOOD PROFILES

TOWN BRANCH

FEMA Engineering Library

Digitized Data Index

CID:290030

Community:WARSAW,CITY OF (BENTON COUNTY,
MISSOURI)

County:BENTON COUNTY

State:MISSOURI

Case Number:290030-19900716

Description:1e. Type 19 Restudy

Revision Status:

Flooding Source(s):Town Tributary



0486755

Effective Date:7/16/1990

Contents:09. Engineering Analysis: Hydraulics (riverine,
stillwater, LDS)

Notes:HEC-2 Effective

Scanned by:

QC Staff:

Scan Date:

QC Date:

THIS RUN EXECUTED 29 NOV 88 7:01:18

HEC2 RELEASE DATED NOV 76 UPDATED MAY 1934
ERROR CORR - 01,02,03,04,05,06
MODIFICATION - 50,51,52,53,54,55,56

T1 WARSAM MO FLOOD INSURANCE STUDY
T2 TOWN TRIBUTARY
T3 APPROXIMATE 100-YR. FLOOD PROFILE

J1	ICHECK	INQ	NIN	IDIR	STRT	METRIC	HVING	Q	WSEL	FQ
	0.	2.	0.	0.	0.000000	0.00	0.1	0.	664.000	0.000

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	-1.000	0.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	15.000

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

38.000	39.000	40.000	41.000	42.000	43.000	1.000	25.000	53.000	21.000
22.000	54.000	4.000	150.000	0.000	0.000	0.000	0.000	0.000	0.000

QT	1.000	1550.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
VC	0.060	0.080	0.050	0.300	0.500	0.500	0.000	0.000	0.000	0.000
X1	5057.000	10.000	335.000	345.000	0.000	0.000	0.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	663.500	663.500	0.000
SR	670.000	0.000	664.000	170.000	662.000	300.000	300.000	660.000	658.000	325.000
SR	654.000	335.000	654.000	345.000	660.000	660.000	370.000	660.000	400.000	660.000
SB	0.000	1.560	3.000	300.000	10.000	10.000	0.000	80.000	0.000	654.000
X1	5093.000	0.000	0.000	0.000	26.000	26.000	26.000	26.000	0.000	0.000
X2	0.000	0.000	1.000	662.000	563.500	563.500	0.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	663.500	663.500
VC	0.040	0.040	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000
X1	5782.000	9.000	80.000	90.000	699.000	699.000	699.000	699.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	665.000	665.000
SR	664.000	0.000	662.000	40.000	660.000	660.000	75.000	658.000	60.000	658.000
SR	660.000	95.000	665.000	110.000	670.000	670.000	400.000	0.000	0.000	0.000
SB	0.000	1.560	3.000	120.000	10.000	10.000	0.000	60.000	0.000	658.000
X1	5808.000	0.000	0.000	0.000	26.000	26.000	26.000	26.000	0.000	0.000
X2	0.000	0.000	1.000	664.000	665.500	665.500	0.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	665.500	665.500

K1	6203.000	8.000	253.000	401.000	401.000	401.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	559.510	663.500	0.000
SR	680.000	90.000	674.000	265.000	265.000	662.500	265.000	662.500	275.000
SR	667.500	320.000	670.000	680.000	680.000	0.000	0.000	0.000	0.000
SR	0.000	1.560	3.000	10.000	0.000	60.000	0.000	662.500	662.500
K1	6235.000	0.000	0.000	26.000	26.000	26.000	0.000	0.000	0.000
X2	0.000	0.000	1.000	670.000	0.000	0.000	0.000	0.000	0.000
X3	11.000	0.000	0.000	0.000	0.000	0.000	670.000	670.000	0.000
K1	6519.000	7.000	520.000	24.000	284.000	284.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	674.500	674.500	0.000
SR	680.000	0.000	675.000	500.000	500.000	667.000	520.000	667.000	530.000
SR	670.000	640.000	630.000	0.000	0.000	0.000	0.000	0.000	0.000
SR	0.000	1.560	3.000	10.000	0.000	60.000	0.000	667.000	667.000
K1	6545.000	0.000	0.000	26.000	26.000	26.000	0.000	0.000	0.000
X2	0.000	0.000	1.000	575.000	0.000	0.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	675.000	675.000	0.000
K1	6949.000	9.000	125.000	404.000	404.000	404.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	674.500	674.500	0.000
SR	681.000	0.000	675.000	115.000	115.000	673.000	115.000	670.000	125.000
SR	670.000	135.000	673.000	145.000	145.000	680.000	400.000	0.000	0.000
SR	0.000	1.560	3.000	10.000	0.000	30.000	0.000	670.000	670.000
K1	6975.000	0.000	0.000	26.000	26.000	26.000	0.000	0.000	0.000
X2	0.000	0.000	1.000	673.000	0.000	0.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	675.000	675.000	0.000
K1	7479.000	7.000	95.000	504.000	504.000	504.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	679.500	679.500	0.000
SR	690.000	0.000	680.000	95.000	95.000	673.000	105.000	678.000	105.000
SR	680.000	230.000	690.000	0.000	0.000	0.000	0.000	0.000	0.000
SR	0.000	1.560	3.000	10.000	10.000	50.000	0.000	673.000	673.500
K1	7557.000	0.000	0.000	78.000	78.000	78.000	0.000	0.500	0.000
X2	0.000	0.000	1.000	680.000	0.000	0.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	680.000	680.000	0.000
K1	8074.000	5.000	80.000	517.000	517.000	517.000	0.000	0.000	0.000
SR	690.000	0.000	682.500	100.000	100.000	682.500	190.000	690.000	540.000
K1	8369.000	8.000	220.000	295.000	295.000	245.000	0.000	0.000	0.000
X3	10.000	0.000	0.000	0.000	0.000	0.000	685.000	685.000	0.000
SR	690.000	0.000	685.200	210.000	210.000	682.000	220.000	682.000	230.000
SR	685.200	240.000	685.200	400.000	400.000	0.000	0.000	0.000	0.000

[illegible]

SECCO	DEPTH	CASEL	CRIAS	WSELY	EG	HV	HL	GLOSS	BANK ELEV
Q	QLOH	QCH	QROB	ALJB	ACH	AROR	VOL	TWA	LEFT/RIGHT
TIME	VLOH	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLDBL	XLCH	XLDBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

CCHV=	0.300	CEHV=	0.500
*SECNO	5057.000		
5057.00	10.00	664.00	0.00
1550.	457.	405.	688.
0.00	1.55	4.05	1.37
3.000862	0.	0.	0.

FLOW DISTRIBUTION FOR SECNO= 5057.00 CASEL= 664.00

STA=	170.	300.	320.	325.	335.	345.	370.	400.	504.
PER Q=	6.1	5.8	3.3	14.3	26.1	22.1	10.5	11.6	
AREA=	130.0	60.0	25.0	90.0	100.0	175.0	120.0	208.0	
VEL=	3.7	1.5	2.0	2.8	4.1	2.0	1.4	0.9	

SPECIAL BRIDGE

SB	XK	XKOR	COFQ	RQLEN	B4C	BWF	BAPEA	SS	ELCHJ	ELCHD
0.00	1.56	3.00	300.00	10.00	0.00	80.00	0.00	654.00	654.00	

*SECNO 5083.000
PRESSURE AND WEIR FLOW

EGPRS	EGLWC	H3	QWEIR	QPR	BAPEA	TRAPEZOID AREA	ELLC	ELTRD
673.09	564.09	0.00	1122.	424.	40.	80.	662.00	663.50

5083.00	10.62	664.62	0.00	0.00	664.68	0.06	0.59	0.00
1550.	512.	353.	685.	403.	106.	607.	1.	0.
0.00	1.27	3.32	1.13	0.060	0.050	0.080	0.000	654.00
9.000534	26.	26.	26.	2	0	5	0.000	367.90

FLOW DISTRIBUTION FOR SECNO= 5083.00 CASEL= 664.62

STA=	152.	170.	300.	320.	325.	335.	345.	370.	400.	520.
PER Q=	3.1	10.8	6.3	3.1	12.8	22.8	20.1	10.7	13.5	
AREA=	5.5	211.1	72.5	23.1	86.2	106.2	190.6	138.7	277.9	
VEL=	0.3	0.3	1.3	1.7	2.3	3.3	1.6	1.2	0.9	

SECNO	DEPTH	CWSEL	CRIMS	WSELK	EG	HV	HL	OLOSS	PANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SS'A
SLOPE	XL03L	XLCH	XL0BR	ITRIAL	IDC	ICONT	CONAR	TOPMTD	ENDST

*SECNO 5742.000

1545 INT SEC ADDED BY RAISING SEC 5742.00, -3.000FT AND MULTIPLYING BY 1.000

1.01	9.67	664.67	0.00	0.00	664.76	0.09	0.07	0.02	655.00
1550.	759.	371.	411.	334.	97.	329.	4.	1.	655.00
0.03	2.00	3.43	1.25	0.040	0.030	0.040	0.000	655.00	2.13
1.000290	175.	175.	175.	2	0	0	0.00	262.75	264.35

FLOW DISTRIBUTION FOR SECNO= 1.01 CWSEL= 664.67

STA=	2.	40.	75.	80.	90.	95.	110.	265.
PER Q=	3.7	33.9	7.1	23.9	7.1	9.1	10.3	
AREA=	107.2	233.5	43.4	96.7	43.4	77.6	207.0	
VEL=	1.3	2.2	2.5	3.8	2.5	1.8	0.8	

1645 INT SEC ADDED BY RAISING SEC 1.01, 1.000FT AND MULTIPLYING BY 1.000

3301 HV CHANGED MORE THAN HVINS

1.02	3.70	664.70	0.00	0.00	664.87	0.16	0.07	0.04	656.00
1550.	793.	428.	329.	312.	87.	186.	7.	2.	656.00
0.04	2.54	4.91	1.77	0.040	0.030	0.040	0.000	656.00	8.60
1.000549	175.	175.	175.	2	0	0	0.00	200.54	209.14

FLOW DISTRIBUTION FOR SECNO= 1.02 CWSEL= 664.70

STA=	9.	40.	75.	80.	90.	95.	110.	209.
PER Q=	7.3	35.8	8.0	27.6	8.0	8.9	4.3	
AREA=	73.9	199.8	38.5	87.1	38.5	63.1	84.7	
VEL=	1.5	2.3	3.2	4.9	3.2	2.2	0.8	

1645 INT SEC ADDED BY RAISING SEC 1.02, 1.000FT AND MULTIPLYING BY 1.000

3301 HV CHANGED MORE THAN HVINS

1.03	7.77	664.77	0.00	0.00	665.06	0.29	0.13	0.06	657.00
1550.	790.	486.	274.	249.	78.	101.	9.	3.	657.00
0.05	3.18	6.25	2.72	0.040	0.030	0.040	0.000	657.00	14.91
1.0001033	175.	175.	175.	2	0	0	0.00	140.30	155.12

29 NOV 88 7:01:18

PAGE 6

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	OLOSS	RANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	APOR	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WIN	ELMIN	SSTA
SLOPE	KLOBL	KLCH	KLOBR	IRIAL	IDC	ICONT	CCRAK	TOPWID	ENDST

FLOW DISTRIBUTION FOR SECNO= 1.03 CWSEL= 664.77

STA=	15.	40.	75.	80.	90.	95.	110.	155.
PER Q=	5.6	36.5	9.9	31.4	9.9	8.1	0.7	
AREA=	47.6	167.2	33.9	77.8	33.9	49.2	17.5	
VEL=	1.8	3.4	4.1	6.2	4.1	2.5	0.6	

1545 INT SEC ADDED BY RAISING SEC 1.03, 1.000FT AND MULTIPLYING BY 1.000

3301 HV CHANGED MORE THAN HVINS

3585 20 TRIALS ATTEMPTED WSEL,CWSEL
 3593 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

5782.00	7.06	665.06	665.06	0.00	665.50	0.45	0.23	0.08	658.00
1550.	765.	532.	254.	293.	71.	69.	11.	4.	658.00
0.06	3.76	7.54	3.63	0.040	0.030	0.040	0.000	658.00	17.61
0.001709	175.	175.	175.	20	19	0	0.00	93.75	113.36

FLOW DISTRIBUTION FOR SECNO= 5782.00 CWSEL= 665.06

STA=	20.	40.	75.	80.	90.	95.	110.
PER Q=	4.1	35.8	9.5	34.3	9.5	6.9	
AREA=	31.2	142.0	30.3	70.6	30.3	38.4	
VEL=	2.0	3.9	4.9	7.5	4.9	2.8	

SPECIAL BRIDGE

SB	XK	XKOR	COFO	ROLEN	BWC	BWP	BAREA	SS	FLCHU	ELCHD
0.00	1.56	3.00	120.00	13.00	0.00	0.00	60.00	0.00	658.00	658.00

*SECNO 5308.000

3301 HV CHANGED MORE THAN HVINS

PRESSURE AND WEIR FLOW

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLCB	VCH	VROB	XNL	KNCH	XNR	WTN	ELMIN	SSFA
SLOPE	XLGBL	KLCH	XLGBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

EGPRS	EGLWC	H3	QWEIR	QPR	BAREA	TRAPEZOID AREA	ELLC	ELTRD
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681.22	672.55	0.00	959.	593.	60.	60.	664.00	665.50
5808.00	9.31	667.31	0.00	0.00	0.11	1.92	0.00	659.00
1550.	780.	392.	378.	356.	263.	11.	4.	659.00
0.07	2.19	4.21	1.41	0.040	0.030	0.000	659.00	4.62
0.000369	26.	26.	26.	2	0	5	239.17	243.79

FLOW DISTRIBUTION FOR SECNO= 5808.00 CWSEL= 667.31

STA=	5.	40.	75.	80.	90.	95.	110.	244.
PER Q=	3.2	34.6	7.5	80.	25.3	9.1	7.8	
AREA=	33.9	220.7	41.5	93.1	41.5	72.1	154.3	
VEL=	1.4	2.4	2.8	4.2	2.8	2.0	0.8	

*SECNO 6209.000

1645 INT SEC ADDED BY RAISING SEC 6209.00, -3.000FT AND MULTIPLYING BY 1.000

1.01	7.88	667.38	0.00	0.00	0.11	0.07	0.00	667.00
1550.	0.	310.	1240.	1.	537.	13.	4.	659.50
0.03	0.36	3.93	2.31	0.040	0.030	0.000	659.50	260.73
0.000847	134.	134.	134.	3	0	0	246.10	506.84

FLOW DISTRIBUTION FOR SECNO= 1.01 CWSEL= 667.38

STA=	261.	255.	275.	320.	500.	507.
PER Q=	0.0	20.0	51.6	23.3	0.0	
AREA=	0.8	78.8	242.1	293.3	1.3	
VEL=	0.4	3.9	3.3	1.5	0.4	

1645 INT SEC ADDED BY RAISING SEC 1.01, 1.500FT AND MULTIPLYING BY 1.000

3301 HV CHANGED MORE THAN HVINS

3585 20 TRIALS ATTEMPTED WSEL,CWSEL

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SECNO	DEPTH	CWSEL	CRIMS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELWIN	SSTA
SLOPE	KLOBL	KLCH	KLOBR	ITRIAL	IDC	ICONT	COPAR	TOPWID	ENDST

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1.02	7.18	668.18	668.18	0.00	668.39	0.22	0.16	0.05	668.50
1550.	0.	37.	1171.	0.	72.	341.	15.	5.	661.00
0.09	0.00	5.24	3.07	0.000	0.030	0.040	0.000	661.00	265.00
0.001690	134.	134.	134.	20	20	0	0.00	211.73	476.73

FLOW DISTRIBUTION FOR SECNO= 1.02

CWSEL= 668.18

STA=	265.	275.	320.	477.
PER Q=	24.5	57.8	17.8	
AREA=	71.8	210.5	170.6	
VEL=	5.3	4.3	1.6	

1645 INT SEC ADDED BY RAISING SEC

1.02,

1.500FT AND MULTIPLYING BY

1.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

6209.00	7.08	669.58	669.58	0.00	669.82	0.24	0.24	0.01	670.00
1550.	0.	389.	1161.	0.	71.	362.	16.	6.	462.50
0.10	0.00	5.50	3.21	0.000	0.030	0.040	0.000	662.50	265.00
0.001852	134.	134.	134.	20	20	0	0.00	204.75	469.75

FLOW DISTRIBUTION FOR SECNO= 6209.00

CWSEL= 669.58

STA=	265.	275.	320.	470.
PER Q=	25.1	58.4	16.5	
AREA=	70.8	206.1	155.7	
VEL=	5.5	4.4	1.6	

SPECIAL BRIDGE

S3	XK	XKOR	COFQ	ROLEN	BWC	BWP	BAREA	SS	ELCHU	ELCHD
0.00	1.56	3.00	240.00	10.00	0.00	60.00	0.00	662.50	652.50	

*SECNO 6235.000

3301 HV CHANGED MORE THAN HVINS

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	GL33	QCH	QRO3	AL33	ACH	AROR	VOL	TWA	LEFT/RIGHT
SLOPE	KLOBL	KLCH	KLOBR	XNL	XNCH	XNR	WIN	ELMIN	SSIA
				ITRIAL	IDC	ICONT	CORR	TOPWID	ENDST

PRESSURE AND WEIR FLOW

EGPRS	EGLWC	H3	QWEIR	QPR	BAREA	TRAPEZOID AREA	FLIC	ELTOD
685.75	577.02	0.00	1058.	505.	60.	60.	668.50	670.00
6235.00	3.73	671.23	0.00	671.29	0.06	1.48	1.00	670.00
1550.	5.	240.	1297.	9.	741.	17.	6.	662.50
0.10	0.53	2.84	1.75	0.030	0.040	0.000	662.50	251.13
3.000387	26.	25.	26.	2	5	0.00	271.05	522.19

FLOW DISTRIBUTION FOR SECNO= 6235.00 CWSEL= 671.23

STA=	251.	265.	275.	320.	500.	522.
PER Q=	0.3	16.0	44.6	34.5	0.5	
AREA=	3.5	87.3	280.5	446.9	13.7	
VEL=	0.5	2.3	2.5	1.3	0.5	

*SECNO 6519.000

3595 20 TRIALS ATTEMPTED WSEL,CWSEL
 3593 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	GL33	QCH	QRO3	AL33	ACH	AROR	VOL	TWA	LEFT/RIGHT
SLOPE	KLOBL	KLCH	KLOBR	XNL	XNCH	XNR	WIN	ELMIN	SSIA
				ITRIAL	IDC	ICONT	CORR	TOPWID	ENDST

FLOW DISTRIBUTION FOR SECNO= 6519.00 CWSEL= 674.50

STA=	501.	520.	530.	640.	757.
PER Q=	5.1	12.1	68.6	14.2	
AREA=	70.4	75.0	660.4	263.6	
VEL=	1.1	2.5	1.6	0.8	

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SECNO	DEPTH	CWSEL	CRIMS	WSELK	EG	HV	HL	OLCSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	KNL	KNCH	KNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	KLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

SPECIAL BRIDGE

S3	XK	KKOR	COFQ	ROLEN	B4C	BWP	BAREA	SS	ELCHU	ELCHD
0.00	1.55	3.00	340.00	10.00	0.00	0.00	60.00	0.00	667.00	567.00

*SECNO 6545.000

PRESSURE AND WEIR FLOW

EGPRS	EGLWC	H3	QWEIR	QPR	BAREA	TRAPEZOID AREA	ELLC	ELYRD
690.57	541.13	0.00	1085.	466.	60.	60.	673.00	675.00

6545.00	9.95	675.95	0.00	0.00	675.97	0.02	1.43	0.00	667.00
1550.	139.	158.	1253.	293.	90.	1242.	24.	8.	667.00
0.16	0.47	1.76	0.98	0.040	0.030	0.040	0.000	667.00	266.71
0.000068	26.	26.	26.	1	0	6	0.00	528.23	794.93

FLOW DISTRIBUTION FOR SECNO= 6545.00 CWSEL= 675.95

STA=	267.	330.	500.	520.	530.	640.	795.
PER Q=	0.4	3.1	5.4	10.2	62.0	18.9	
AREA=	30.3	163.0	99.2	99.6	820.5	461.6	
VEL=	0.2	0.3	0.8	1.8	1.2	0.6	

*SECNO 6349.000

1545 INT SEC ADDED BY RAISING SEC 6349.00, -2.250FT AND MULTIPLYING BY 1.001

3301 HV CHANGED MORE THAN HVINS

1.01	9.18	675.93	0.00	0.00	676.02	0.09	0.01	0.03	667.75
1550.	340.	318.	393.	433.	82.	301.	26.	9.	670.75
0.19	1.94	3.98	1.31	0.040	0.039	0.040	0.000	667.75	0.00
0.000527	101.	101.	101.	2	0	0	0.00	307.63	307.63

FLOW DISTRIBUTION FOR SECNO= 1.01 CWSEL= 675.93

STA=	0.	115.	125.	135.	145.	300.
PER Q=	42.9	11.3	20.5	5.9	19.4	
AREA=	365.5	66.9	81.9	41.9	250.8	
VEL=	1.8	2.6	3.9	2.2	1.2	

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	GLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALB3	ACH	AROR	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	WROB	XNL	VNCH	XNR	WTN	ELMIN	SSTA
SLOPE	KLOBL	KLCH	KLOBR	ITRIAL	IDC	ICONT	COPAR	TOPWID	ENDST

1545 INT SEC ADDED BY RAISING SEC 1.01, 0.750FT AND MULTIPLYING BY 1.000

3301 HV CHANGED MORE THAN HVINS

1.02	7.46	675.16	0.00	0.00	676.13	0.17	0.07	0.04	666.50
1550.	839.	393.	317.	344.	75.	191.	28.	9.	671.50
0.19	2.44	5.26	1.67	0.340	0.030	0.040	0.000	669.50	0.0
0.001036	101.	101.	101.	2	0	0	0.00	271.17	271.17

FLOW DISTRIBUTION FOR SECNO= 1.02 CWSEL= 675.96

STA=	0.	115.	125.	135.	145.	271.
PER Q=	40.7	13.5	25.4	6.2	14.2	
AREA=	294.3	59.7	74.7	34.7	155.8	
VEL=	2.2	3.5	5.3	2.8	1.4	

1545 INT SEC ADDED BY RAISING SEC 1.02, 0.750FT AND MULTIPLYING BY 1.000

3301 HV CHANGED MORE THAN HVINS

1.03	6.77	676.02	0.00	0.00	676.39	0.37	0.16	0.10	666.25
1550.	307.	505.	238.	257.	68.	178.	29.	10.	672.25
0.13	3.14	7.45	2.21	0.040	0.030	0.040	0.000	669.25	0.00
0.002505	101.	101.	101.	3	0	0	0.00	235.50	235.50

FLOW DISTRIBUTION FOR SECNO= 1.03 CWSEL= 676.02

STA=	0.	115.	125.	135.	145.	236.
PER Q=	35.5	16.6	32.6	6.5	8.9	
AREA=	204.0	52.7	67.8	27.7	80.2	
VEL=	2.7	4.9	7.5	3.6	1.7	

1545 INT SEC ADDED BY RAISING SEC 1.03, 0.750FT AND MULTIPLYING BY 1.000

SECNO	DEPTH	CWSEL	CRIMS	WSELK	EG	LV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	KNL	XNCH	XNR	WTN	ELMIN	SSFA
SLOPE	KL03L	KLCH	KL0BR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

6949.00	6.32	676.32	676.32	0.00	677.01	0.69	0.33	0.16	670.00
1550.	755.	609.	146.	200.	63.	68.	30.	11.	673.00
0.20	3.79	9.64	2.75	0.040	0.030	0.040	0.000	670.00	0.00
1.004595	101.	191.	101.	4	10	0	0.00	212.27	212.27

FLOW DISTRIBUTION FOR SECNO= 6949.00 CWSEL= 676.32

STA=	0.	115.	125.	135.	145.	212.
PER Q=	29.4	19.3	39.3	6.5	5.5	
AREA=	151.7	48.2	63.2	23.2	44.4	
VEL=	3.0	6.2	3.6	4.4	1.8	

SPECIAL BRIDGE

33	KK	KKOR	COFQ	RDLN	B4C	BWP	BAREA	SS	ELCHU	ELCHD
0.00	1.56	3.00	145.00	10.00	0.00	30.00	0.00	670.00	670.00	

*SECNO 6975.000

3301 HV CHANGED MORE THAN HVINS

PRESSURE AND WEIR FLOW

ESPRS	EGLWC	H3	QWEIR	QPR	BAREA	TRAPEZOID AREA	ELLC	ELTRD
740.98	677.01	0.00	1368.	183.	30.	30.	673.00	675.00
6975.00	6.90	676.90	0.00	677.22	0.32	0.21	0.00	670.00
1550.	316.	481.	253.	69.	121.	30.	11.	673.00
0.20	3.00	6.37	2.09	0.030	0.040	0.000	670.00	0.00
1.002140	26.	26.	26.	3	0	0.00	241.85	241.85

FLOW DISTRIBUTION FOR SECNO= 6975.00 CWSEL= 676.90

STA=	0.	115.	125.	135.	145.	242.
PER Q=	36.7	15.9	31.0	6.5	9.9	
AREA=	213.4	54.0	69.0	23.0	92.0	
VEL=	2.6	4.6	7.0	3.4	1.7	

SECNO	DEPTH	CWSEL	CRIMS	WSELK	EG	HV	HL	LOSS	PANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROR	VOL	TWA	LEFT/RIGHT
TIME	VLJB	VCH	VROB	XNL	KNCH	NR	WTN	ELMIN	SSFL
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPRID	ENDST

*SECNO 7479.000

1545 INT SEC ADDED BY RAISING SEC 7479.00, -2.250FT AND MULTIPLYING BY 1.000

3301 HV CHANGED MORE THAN HVINS

3585 20 TRIALS ATTEMPTED WSEL,CWSEL

3593 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1.01	7.05	677.80	677.80	0.00	678.56	0.76	0.38	0.22	670.75
1550.	402.	666.	482.	71.	71.	145.	32.	11.	675.75
0.20	5.65	9.44	2.61	0.040	0.030	0.040	0.000	670.75	74.60
0.004605	126.	126.	126.	20	5	0	0.00	206.86	281.45

FLOW DISTRIBUTION FOR SECNO= 1.01 CWSEL= 677.80

STA=	75.	95.	105.	200.
PER Q=	25.9	43.0	31.1	
AREA=	71.1	70.6	184.6	
VEL=	5.7	9.4	2.6	

1545 INT SEC ADDED BY RAISING SEC 1.01, 0.750FT AND MULTIPLYING BY 1.000

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1.02	7.11	678.61	678.61	0.00	679.30	0.70	0.56	0.02	671.50
1550.	397.	649.	504.	72.	71.	194.	33.	12.	676.50
0.21	5.49	9.13	2.60	0.040	0.030	0.040	0.000	671.50	74.20
0.004272	126.	126.	126.	2	5	0	0.00	208.63	282.83

FLOW DISTRIBUTION FOR SECNO= 1.02 CWSEL= 678.61

STA=	74.	95.	105.	280.	293.
PER Q=	25.6	41.7	32.5	0.0	
AREA=	72.2	71.1	193.9	0.2	
VEL=	5.5	9.1	2.6	0.3	

SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	OLOSS	HANK ELEV
Q	QLOB	QCH	QROB	ALJB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XVL	XNCH	XNR	WIN	ELMIN	SSTA
SLOPE	XLGBL	KLCH	XLORR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

1545 INT SEC ADDED BY RAISING SEC 1.02, 0.750FT AND MULTIPLYING BY 1.000

7195 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED	679.32	0.00	680.06	0.74	0.55	0.02	672.25
1.03	7.07	679.32	493.	71.	34.	13.	677.25
1550.	400.	562.	2.51	0.040	0.000	672.25	74.42
0.22	5.61	9.36	126.	2	5	207.31	281.77
1.004517	126.	126.			0.00		

FLOW DISTRIBUTION FOR SECNO= 1.03

CWSEL= 679.32

STA=	74.	95.	105.	280.
PER Q=	25.8	42.7	31.5	
AREA=	71.4	70.7	187.0	
VEL=	5.6	9.4	2.6	

1545 INT SEC ADDED BY RAISING SEC 1.03, 0.750FT AND MULTIPLYING BY 1.000

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED	680.10	0.00	680.81	0.71	0.56	0.01	673.00
7479.00	7.10	680.10	500.	72.	34.	13.	679.00
1550.	397.	652.	2.60	0.040	0.000	673.00	74.26
0.22	5.52	9.19	126.	2	5	208.31	282.57
1.004327	126.	126.			0.00		

FLOW DISTRIBUTION FOR SECNO= 7479.00

CWSEL= 680.10

STA=	74.	95.	105.	280.	283.
PER Q=	25.6	42.1	32.3	0.0	
AREA=	72.0	71.0	192.3	0.1	
VEL=	5.5	9.2	2.6	0.3	

SPECIAL BRIDGE

S3	XK	XKOR	COFQ	ROLEN	BWC	BWP	BAPEA	SS	ELCHU	ELCHD
0.00		1.56	3.00	120.00	10.00	0.00	50.00	0.00	673.00	573.50

*SECNO 7557.000

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SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	WLOB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	WROB	XVL	XNCH	XNR	WIN	ELMIN	SSTA
SLOPE	KLOBL	XLCH	KLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	FNOST

3301 HV CHANGED MORE THAN HVINS

PRESSURE AND WEIR FLOW

EGPUS	EGLWC	H3	WEIR	3PR	BAREA	TRAPEZOID	ELLC	ELTOD
						AREA		
703.38	680.81	0.00	1102.	455.	50.	50.	678.00	680.00

7557.00	3.48	681.98	0.00	0.00	682.11	0.13	1.30	673.50
1550.	303.	390.	866.	103.	85.	462.	35.	678.50
0.23	2.81	4.49	1.88	0.040	0.030	0.040	0.000	63.82
0.000815	78.	74.	78.	2	0	5	0.00	318.40

FLOW DISTRIBUTION FOR SECNO= 7557.00 CWSEL= 681.98

STA=	64.	75.	95.	105.	230.	318.
PER Q=	0.5	19.1	24.5	54.3	1.6	
AREA=	9.2	99.5	84.8	433.5	28.4	
VEL=	0.9	3.0	4.5	1.9	0.9	

*SECNO 8074.000

1545 INT SEC ADDED BY RAISING SEC 8074.00, -5.250FT AND MULTIPLYING BY 0.327

3301 HV CHANGED MORE THAN HVINS

1.01	6.75	682.00	0.00	0.00	682.32	0.32	0.12	677.25
1550.	84.	1087.	379.	39.	207.	173.	14.	677.25
0.24	2.14	5.25	2.19	0.040	0.030	0.040	0.000	675.25
0.001103	129.	129.	129.	3	0	0	0.00	134.73

FLOW DISTRIBUTION FOR SECNO= 1.01 CWSEL= 682.00

STA=	10.	26.	62.	135.
PER Q=	5.4	70.1	24.4	
AREA=	39.4	207.1	172.6	
VEL=	2.1	5.2	2.2	

SECNO	DEPTH	CWSEL	CRIMS	WSELK	EG	HV	HL	OLCSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	KNR	WOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	ICONT	WIN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC		COPAR	TOPWD	ENDST

1645 INT SEC ADDED BY RAISING SEC 1.01, 1.750FT AND MULTIPLYING BY 1.685

1.02	5.18	682.14	0.00	0.00	682.45	0.31	0.16	0.00	679.00
1550.	57.	1241.	252.	30.	254.	131.	38.	15.	679.00
0.25	1.91	4.88	1.93	0.040	0.030	0.040	0.000	677.00	25.37
3.001446	129.	129.	129.	3	0	0	0.00	151.49	186.96

FLOW DISTRIBUTION FOR SECNO= 1.02 CWSEL= 682.18

SFA= 25. 44. 105. 147.

PER Q=	3.7	80.1	16.3
AREA=	29.9	254.1	130.8
VEL=	1.9	4.9	1.9

1645 INT SEC ADDED BY RAISING SEC 1.02, 1.750FT AND MULTIPLYING BY 1.407

3301 HV CHANGED MORE THAN HVINS

1.03	3.60	682.35	0.00	0.00	682.95	0.60	0.31	0.14	680.75
1550.	23.	1425.	102.	11.	222.	46.	39.	15.	680.75
0.25	2.19	6.43	2.20	0.040	0.030	0.040	0.000	678.75	48.14
3.004727	129.	129.	129.	3	0	0	0.00	156.42	205.25

FLOW DISTRIBUTION FOR SECNO= 1.03 CWSEL= 682.35

SFA= 49. 62. 147. 205.

PER Q=	1.5	91.9	6.6
AREA=	10.6	221.7	46.2
VEL=	2.2	6.4	2.2

1645 INT SEC ADDED BY RAISING SEC 1.03, 1.750FT AND MULTIPLYING BY 1.289

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

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SECNO	DEPTH	CWSEL	CR1WS	WSELK	EG	HV	HL	GLOSS	RANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	WLOB	WCH	WROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLDBL	XLCH	XLDBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

8074.00	2.86	683.56	683.36	0.00	694.13	0.82	0.85	0.11	612.50
1550.	8.	1506.	36.	4.	205.	17.	40.	16.	682.50
0.26	2.07	7.35	2.08	0.040	0.030	0.040	0.000	680.50	76.31
0.009635	129.	129.	129.	4	15	0	0.00	158.40	230.21

FLOW DISTRIBUTION FOR SECNO= 8074.00 CWSEL= 683.36

STA= 71. 80. 190. 230.
 PER Q= 0.5 97.1 2.3
 AREA= 4.0 294.8 17.3
 VEL= 2.1 7.4 2.1

*SECNO 8369.000

1545 INT SEC ADDED BY RAISING SEC 8369.00, -1.125FT AND MULTIPLYING BY 5.617

3301 HV CHANGED MORE THAN HVINS

1.01	3.54	684.41	0.00	0.00	684.59	0.18	0.22	0.19	680.77
1550.	366.	872.	312.	293.	199.	214.	41.	17.	680.17
0.26	1.25	4.38	1.45	0.040	0.030	0.040	0.000	680.87	625.31
0.001444	74.	74.	74.	3	0	0	0.00	1048.21	1673.53

FLOW DISTRIBUTION FOR SECNO= 1.01 CWSEL= 684.41

STA= 625. 574. 1180. 1236. 1292. 1348. 1629. 1674.
 PER Q= 0.2 7.9 15.5 56.3 15.5 4.4 0.2
 AREA= 8.4 175.2 109.3 199.2 109.3 97.4 7.7
 VEL= 0.4 0.7 2.2 4.4 2.2 0.7 0.4

1545 INT SEC ADDED BY RAISING SEC 1.01, 0.375FT AND MULTIPLYING BY 0.726

3301 HV CHANGED MORE THAN HVINS

1.02	3.00	684.25	0.00	0.00	685.16	0.92	0.20	0.37	681.25
1550.	237.	1075.	237.	57.	122.	57.	42.	18.	681.25
0.27	4.15	8.80	4.15	0.040	0.030	0.040	0.000	681.25	859.00
0.007311	74.	74.	74.	3	0	0	0.00	117.14	976.14

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SECNO	DEPTH	CWSEL	CRIMS	WSELK	EG	HV	HL	OLOSS	RANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	KNL	XNCH	XNR	WIN	ELMIN	SSTA
SLOPE	XLGBL	XLCH	XLGBR	ITRIAL	IDC	ICONT	COPAR	TOPWID	ENDST

FLOW DISTRIBUTION FOR SECNO= 1.02 CWSEL= 694.25

STA= 959. 997. 938. 976.
 PER Q= 15.3 69.4 15.3
 AREA= 57.2 122.2 57.2
 VEL= 4.2 8.8 4.2

1545 INT SEC ADDED BY RAISING SEC 1.02, 0.375FT AND MULTIPLYING BY 0.623

3301 HV CHANGED MORE THAN HVINS

3595 20 TRIALS ATTEMPTED WSEL,CWSEL
 3593 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
 1.03 3.82 685.45 685.45 0.00 685.83 0.45 0.38 0.14 681.63
 1550. 467. 722. 361. 211. 97. 146. 42. 19. 681.63
 0.27 2.22 7.44 2.46 0.040 0.030 0.040 0.000 681.63 265.27
 3.003781 74. 74. 74. 20 12 0 0.00 507.18 772.45

FLOW DISTRIBUTION FOR SECNO= 1.03 CWSEL= 685.45

STA= 265. 305. 533. 559. 534. 609. 736. 772.
 PER Q= 0.8 15.2 14.1 45.6 14.1 8.5 0.8
 AREA= 12.2 141.9 56.4 97.0 56.4 78.8 11.2
 VEL= 1.0 1.7 3.9 7.4 3.9 1.7 1.0

1545 INT SEC ADDED BY RAISING SEC 1.03, 0.375FT AND MULTIPLYING BY 0.394

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3593 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
 8369.00 4.55 686.55 686.55 0.00 687.20 0.66 0.34 0.11 682.00
 1550. 634. 472. 444. 173. 45. 117. 43. 19. 682.00
 0.27 3.66 10.38 3.73 0.040 0.030 0.040 0.000 682.00 86.37
 3.005834 74. 74. 74. 20 11 0 0.00 234.46 320.83

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SECNO	DEPTH	CWSEL	CRWS	WSELK	EG	HV	HL	OLSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XVL	XNCH	XNR	WTN	ELMIN	SSIA
SLOPE	XLOBL	KLCH	KLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

FLOW DISTRIBUTION FOR SECNO= 8369.00 CWSEL= 686.55

STA=	86.	120.	210.	220.	230.	240.	250.	321.
PER Q=	3.2	27.0	10.7	30.4	10.7	15.0	2.9	
AREA=	22.6	121.1	29.5	45.5	29.5	67.3	20.7	
VEL=	2.2	3.5	5.6	10.4	5.6	3.5	2.2	

SPECIAL BRIDGE

S3	XK	KKOR	COFQ	ROLEN	BWC	BWP	BARFA	SS	ELCHU	ELCHD
0.00	1.56	3.00	170.00	10.00	0.00	20.00	0.00	682.00	682.00	682.00

*SECNO 8397.000

3301 HV CHANGED MORE THAN HVINS

PRESSURE AND WEIR FLOW

EGPRS	EGLWC	H3	QWEIR	QPR	BAREA	TRAPEZOID	ELLC	ELTRD
					AREA			
832.04	697.20	0.00	1446.	110.	20.	20.	684.00	685.20

8397.00	4.92	686.92	0.00	687.28	0.36	0.08	0.00	682.00
1550.	583.	395.	471.	49.	154.	43.	19.	682.00
0.29	3.03	8.03	3.07	0.030	0.040	0.000	682.00	76.9
0.003135	28.	28.	28.	0	8	0.00	252.64	329.52

FLOW DISTRIBUTION FOR SECNO= 8397.00 CWSEL= 686.92

STA=	77.	120.	210.	220.	230.	240.	290.	330.
PER Q=	4.5	30.0	9.6	25.5	9.6	16.6	4.1	
AREA=	37.2	155.2	33.2	49.2	33.2	86.2	34.1	
VEL=	1.9	3.0	4.5	8.0	4.5	3.0	1.9	

*SECNO 8597.000

1545 INT SEC ADDED BY RAISING SEC 8587.00, -0.150FT AND MULTIPLYING BY 1.001

3301 HV CHANGED MORE THAN HVINS

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SECNO	DEPTH	CWSEL	CRIMS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CURAR	TOPMID	ENDST

3585 20 TRIALS ATTEMPTED WSEL=CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1.01	5.52	637.57	687.57	0.00	688.19	6.62	6.22	0.13	685.05
1550.	426.	524.	596.	116.	55.	163.	43.	19.	605.05
0.24	3.67	9.56	3.67	0.040	0.030	0.040	0.000	682.05	63.06
0.007144	48.	48.	48.	20	3	0	0.000	230.90	313.75

FLOW DISTRIBUTION FOR SECNO= 1.01 CWSEL= 687.57

STA=	83.	175.	185.	314.
PER Q=	27.5	34.1	30.4	
AREA=	115.1	55.3	162.6	
VEL=	3.7	9.6	3.7	

1545 INT SEC ADDED BY RAISING SEC 1.01, 0.050FT AND MULTIPLYING BY 1.000

3301 HV CHANGED MORE THAN HVINS

1.02	5.17	688.27	0.00	0.00	688.51	0.24	0.20	0.12	685.10
1550.	483.	392.	676.	183.	62.	257.	44.	19.	685.10
0.24	2.63	6.34	2.63	0.040	0.030	0.040	0.000	682.10	59.37
0.002711	48.	48.	48.	5	0	0	0.000	287.66	347.03

FLOW DISTRIBUTION FOR SECNO= 1.02 CWSEL= 688.27

STA=	59.	175.	185.	347.
PER Q=	31.1	25.3	43.6	
AREA=	193.5	61.7	256.9	
VEL=	2.6	6.3	2.6	

1545 INT SEC ADDED BY RAISING SEC 1.02, 0.050FT AND MULTIPLYING BY 1.000

1.03	5.28	693.43	0.00	0.00	688.64	0.21	0.12	0.01	685.15
1550.	490.	374.	686.	196.	63.	275.	45.	20.	685.15
0.23	2.50	5.96	2.50	0.040	0.030	0.040	0.000	682.15	55.41
0.002336	48.	48.	48.	2	0	0	0.000	297.09	352.50

SECNO	DEPTH	CWSEL	CRHS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALJB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	FIN	ELMIN	SSIA
SLOPE	KLGBL	KLCH	KLOBR	ITRIAL	IDC	ICONT	CORAR	YOFWID	ENDST

FLOW DISTRIBUTION FOR SECNO= 1.03 CWSEL= 688.43

STA= 55. 175. 135. 353.
 PER Q= 31.6 24.1 44.3
 AREA= 195.2 62.8 274.7
 VEL= 2.5 6.0 2.5

1545 INT SEC ADDED BY RAISING SEC 1.03, 0.050FT AND MULTIPLYING BY 1.000

8597.00	5.36	688.56	0.00	0.00	688.75	0.19	0.10	0.01	685.20
1550.	495.	362.	693.	206.	64.	249.	45.	20.	685.20
0.29	2.41	5.69	2.40	0.040	0.030	0.040	0.000	682.20	52.43
0.002094	48.	49.	43.	2	0	0	0.00	304.17	356.60

FLOW DISTRIBUTION FOR SECNO= 8597.00

CWSEL= 688.56

STA= 52. 175. 185. 357.
 PER Q= 31.9 23.3 44.7
 AREA= 206.0 63.6 288.4
 VEL= 2.4 5.7 2.4

SPECIAL BRIDGE

S3	XK	XKOR	COFQ	ROLEN	BWC	BWP	BAREA	SS	ELCHU	ELCHD
0.00	1.56	3.00	100.00	10.00	0.00	30.00	0.00	682.20	682.20	

*SECNO 8609.000

3301 HV CHANGED MORE THAN HVINS

PRESSURE AND WEIR FLOW

EGPRS	EGLWC	H3	QWEIR	QPR	BAREA	TRAPEZOID AREA	ELLC	ELTRD
753.22	688.75	0.00	1399.	151.	30.	30.	685.20	686.00

8609.00	5.87	689.07	0.00	0.00	689.18	0.10	0.43	0.00	685.20
1550.	522.	297.	731.	274.	69.	383.	45.	20.	685.20
0.29	1.91	4.33	1.91	0.040	0.030	0.040	0.000	682.20	33.73
0.001091	22.	22.	22.	2	0	7	0.00	349.04	352.77

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SECNO	DEPTH	CWSEL	CRIMS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLQB	VCH	VROR	XNL	XNCH	XNR	WTN	ELWIN	SSTA
SLOPE	KLJBL	KLCH	KLORR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

FLOW DISTRIBUTION FOR SECNO= 8609.00 CWSEL= 689.07

STA=	34.	175.	185.	303.
PER Q=	33.7	19.2	47.1	
AREA=	273.7	68.7	383.2	
VEL=	1.9	4.3	1.9	

*SECNO 9207.000

1545 INT SEC ADDED BY RAISING SEC 9207.00, -5.850FT AND MULTIPLYING BY 0.326

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1.01	4.86	689.01	689.01	0.00	690.39	1.38	0.34	0.64	686.65
1550.	129.	1397.	25.	36.	141.	7.	47.	21.	686.65
0.30	3.54	9.88	3.39	0.040	0.030	0.040	0.000	684.15	67.10
0.007314	150.	150.	150.	5	19	0	0.00	76.15	143.25

FLOW DISTRIBUTION FOR SECNO= 1.01 CWSEL= 689.01

STA=	67.	93.	137.	143.
PER Q=	3.3	90.1	1.6	
AREA=	35.4	141.4	7.3	
VEL=	3.5	9.9	3.4	

1645 INT SEC ADDED BY RAISING SEC 1.01, 1.950FT AND MULTIPLYING BY 1.688

3301 HV CHANGED MORE THAN HVINS

1.02	4.66	690.76	0.00	0.00	691.33	0.56	0.68	0.25	689.60
1550.	113.	1415.	22.	52.	226.	10.	48.	21.	689.60
0.30	2.19	6.27	2.16	0.040	0.030	0.040	0.000	686.10	117.60
0.003137	150.	150.	150.	2	0	0	0.00	123.33	240.93

FLOW DISTRIBUTION FOR SECNO= 1.02 CWSEL= 690.76

STA=	118.	165.	231.	241.
PER Q=	7.3	91.3	1.4	
AREA=	51.6	225.7	10.3	
VEL=	2.2	6.3	2.2	

SECNO	DEPTH	CWSEL	CRHS	WSELK	EG	HV	HL	CLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALJB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLJB	VCH	VRJB	XNL	XNCH	XNR	WTN	ELMIN	SSYA
SLOPE	XJBL	KLCH	KLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWD	ENDST

1545 INT SEC ADDED BY RAISING SEC 1.02, 1.950FT AND MULTIPLYING BY 1.405

3301 HV CHANGED MORE THAN HVINS

7185 MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

1.03	3.33	691.38	691.38	0.00	692.33	0.95	0.76	0.19	690.55
1550.	21.	1524.	4.	11.	193.	2.	49.	22.	690.55
0.31	2.02	7.83	2.00	0.040	0.030	0.040	0.000	688.05	207.01
0.009611	150.	150.	150.	3	19	0	0.00	123.81	330.2

FLOW DISTRIBUTION FOR SECNO= 1.03 CWSEL= 691.38

STA=	207.	233.	326.	331.
PER Q=	1.4	98.3	0.3	
AREA=	13.6	193.2	2.1	
VEL=	2.0	7.9	2.0	

1545 INT SEC ADDED BY RAISING SEC 1.03, 1.950FT AND MULTIPLYING BY 1.290

3301 HV CHANGED MORE THAN HVINS

9207.00	3.02	693.02	692.99	0.00	693.83	0.80	1.45	0.05	692.50
1550.	9.	1540.	2.	6.	214.	1.	49.	22.	692.50
0.32	1.52	7.21	1.51	0.040	0.030	0.040	0.000	690.00	278.71
0.009828	150.	150.	150.	4	15	0	0.00	145.46	424.24

FLOW DISTRIBUTION FOR SECNO= 9207.00 CWSEL= 693.02

STA=	279.	300.	420.	424.
PER Q=	3.6	99.3	0.1	
AREA=	5.6	213.7	1.1	
VEL=	1.5	7.2	1.5	

THIS RUN EXECUTED 29 NOV 88 7:01:26

HEC2 RELEASE DATED NOV 76 UPDATED MAY 1934
ERROR CORR - 01,02,03,04,05,06
MODIFICATION - 50,51,52,53,54,55,56

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

APPROXIMATE 100-YR. FLOOD

SUMMARY PRINTOUT

SECNO	KLCH	ELTRD	ELLCC	ELMIN	Q	CWSEL	AREA	SSTA	STCHL	STCHR	ENDST	TOPWID
5057.000	0.00	0.00	0.00	654.00	1550.00	664.00	898.00	173.00	335.00	345.00	504.00	334.00
5083.000	25.00	663.50	662.00	654.00	1550.00	664.62	1116.94	152.32	335.00	345.00	520.22	367.30
* 5782.000	699.00	0.00	0.00	658.00	1550.00	665.06	342.83	19.61	80.00	90.00	113.36	93.75
5808.000	26.00	665.50	664.00	658.00	1550.00	667.31	717.16	4.62	80.00	90.00	243.70	235.17
* 6209.000	401.00	0.00	0.00	662.50	1550.00	669.58	432.62	265.00	265.00	275.00	469.75	204.75
6235.000	26.00	670.00	668.50	662.50	1550.00	671.23	836.92	251.13	265.00	275.00	522.19	271.06
* 6519.000	234.00	0.00	0.00	667.00	1550.00	674.50	1069.41	501.24	520.00	530.00	757.09	255.84
6545.000	26.00	675.00	673.00	667.00	1550.00	675.95	1664.26	266.71	520.00	530.00	794.93	521.23
* 6949.000	404.00	0.00	0.00	670.00	1550.00	676.32	330.64	0.00	125.00	135.00	212.27	212.27
6975.000	26.00	675.00	673.00	670.00	1550.00	676.90	462.34	0.00	125.00	135.00	241.85	241.85
* 7479.000	504.00	0.00	0.00	673.00	1550.00	680.10	335.43	74.26	95.00	105.00	292.57	208.31
7557.000	78.00	680.00	678.00	673.50	1550.00	681.98	654.34	63.92	95.00	105.00	318.40	254.49
* 8074.000	517.00	0.00	0.00	680.50	1550.00	683.36	226.00	70.81	80.00	190.00	230.21	158.40
* 8369.000	245.00	0.00	0.00	682.00	1550.00	686.55	336.05	86.37	220.00	230.00	320.83	234.46
8397.000	28.00	685.20	684.00	682.00	1550.00	686.92	428.44	75.93	220.00	230.00	329.52	252.64
* 8587.000	190.00	0.00	0.00	682.20	1550.00	688.56	558.10	52.43	175.00	185.00	356.60	304.17
8609.000	22.00	686.00	685.20	682.20	1550.00	689.07	725.60	33.73	175.00	185.00	382.77	349.04

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SECNO	KLCH	ELTRD	ELLC	ELMIN	Q	CMSEL	AREA	SSTA	STCHL	STCHR	ENDST	TOP-AD
* 9207.000	598.00	0.00	0.00	690.00	1550.00	693.02	220.42	279.78	300.00	420.00	424.24	145.46

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APPROXIMATE 100-YR. FLOOD

SUMMARY PRINTOUT TABLE 150

SECNO	KLCH	ELTRD	ELLC	ELMIN	Q	CHSEL	CRWS	EG	1CK+S	VCH	AREA	.01K
A 5057.000	0.00	0.00	0.00	654.00	1550.00	664.00	0.00	664.09	0.62	4.05	898.00	527.86
5083.000	25.00	663.50	662.00	654.00	1550.00	664.62	0.00	664.63	5.34	3.32	1116.94	670.47
* 5782.000	633.00	0.00	0.00	650.00	1550.00	665.06	665.06	665.50	17.00	7.54	342.83	374.93
5808.000	26.00	665.50	664.00	650.00	1550.00	667.31	0.00	667.42	3.60	4.21	717.16	907.14
* 6209.000	401.00	0.00	0.00	652.50	1550.00	669.58	669.58	669.82	18.52	5.50	432.62	360.18
6235.000	26.00	670.00	668.50	652.50	1550.00	671.23	0.00	671.29	3.87	2.84	836.92	788.15
* 6519.000	204.00	0.00	0.00	667.00	1550.00	674.50	674.50	674.54	1.72	2.49	1069.41	1180.91
6545.000	26.00	675.00	673.00	667.00	1550.00	675.95	0.00	675.97	0.68	1.76	1664.26	1877.58
* 6949.000	404.00	0.00	0.00	670.00	1550.00	676.32	676.32	677.01	45.96	9.64	330.64	229.64
6975.000	26.00	675.00	673.00	670.00	1550.00	676.90	0.00	677.22	21.40	6.97	462.34	335.04
* 7479.000	504.00	0.00	0.00	673.00	1550.00	680.10	680.10	680.81	43.27	9.19	335.43	235.63
7557.000	78.00	680.00	678.00	673.50	1550.00	681.98	0.00	682.11	8.15	4.49	654.34	542.5
* 8074.000	517.00	0.00	0.00	680.50	1550.00	683.36	683.36	684.18	96.35	7.35	226.08	157.91
* 8369.000	235.00	0.00	0.00	682.00	1550.00	686.55	686.55	687.20	58.34	10.38	336.05	202.93
8397.000	28.00	685.20	684.00	682.00	1550.00	686.92	0.00	687.23	31.35	8.03	428.44	276.04
* 8587.000	190.00	0.00	0.00	682.20	1550.00	686.56	0.00	686.75	20.94	5.69	558.10	338.76
8609.000	22.00	686.00	685.20	682.20	1550.00	689.07	0.00	689.18	10.91	4.33	725.60	469.17
* 9207.000	503.00	0.00	0.00	690.00	1550.00	693.02	692.99	693.83	98.28	7.21	220.42	156.35

29 NOV 88 7:01:18

PAGE 27

APPROXIMATE 100-YR. FLOOD

SUMMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
5057.000	1550.00	664.00	0.00	0.00	0.00	334.00	0.00
5083.000	1550.00	664.62	0.00	0.62	0.00	367.90	26.00
* 5782.000	1550.00	665.06	0.00	0.29	0.00	93.75	699.00
5808.000	1550.00	667.31	0.00	2.25	0.00	239.17	26.00
* 6209.000	1550.00	669.58	0.00	1.40	0.00	204.75	401.00
6235.000	1550.00	671.23	0.00	1.65	0.00	271.06	26.00
* 6519.000	1550.00	674.50	0.00	3.27	0.00	255.84	284.00
6545.000	1550.00	675.95	0.00	1.45	0.00	528.23	26.00
* 6949.000	1550.00	676.32	0.00	0.30	0.00	212.27	404.00
6975.000	1550.00	676.90	0.00	0.58	0.00	241.85	26.00
* 7479.000	1550.00	680.10	0.00	0.78	0.00	208.31	504.00
7557.000	1550.00	681.98	0.00	1.88	0.00	254.48	78.00
* 8074.000	1550.00	683.36	0.00	1.01	0.00	159.40	517.00
* 8369.000	1550.00	686.55	0.00	1.10	0.00	234.46	285.00
8397.000	1550.00	686.92	0.00	0.38	0.00	252.64	28.00
* 8587.000	1550.00	688.56	0.00	0.13	0.00	304.17	190.00
8609.000	1550.00	689.07	0.00	0.51	0.00	345.04	22.00
* 9207.000	1550.00	693.02	0.00	1.65	0.00	145.46	598.00

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION	SECNO=	5752.000	PROFILE= 1	INTERPOLATED XSECTIONS USED
CAUTION	SECNO=	6209.000	PROFILE= 1	INTERPOLATED XSECTIONS USED
CAUTION	SECNO=	6519.000	PROFILE= 1	CRITICAL DEPTH ASSUMED
CAUTION	SECNO=	6519.000	PROFILE= 1	PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION	SECNO=	6519.000	PROFILE= 1	20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION	SECNO=	6949.000	PROFILE= 1	INTERPOLATED XSECTIONS USED
CAUTION	SECNO=	7479.000	PROFILE= 1	INTERPOLATED XSECTIONS USED
CAUTION	SECNO=	8074.000	PROFILE= 1	INTERPOLATED XSECTIONS USED
CAUTION	SECNO=	8369.000	PROFILE= 1	INTERPOLATED XSECTIONS USED
CAUTION	SECNO=	8587.000	PROFILE= 1	INTERPOLATED XSECTIONS USED
CAUTION	SECNO=	9207.000	PROFILE= 1	INTERPOLATED XSECTIONS USED

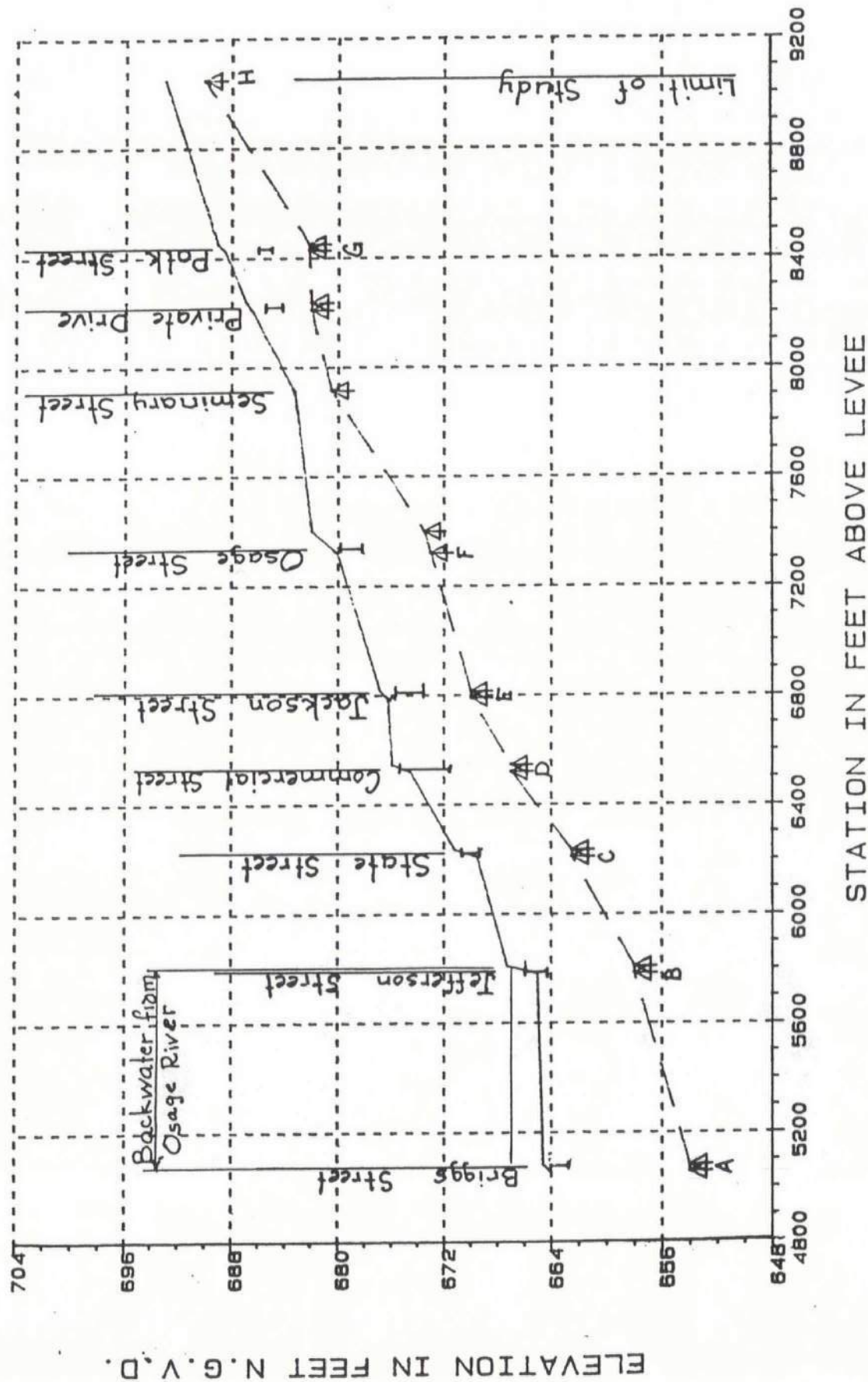
LAKE OF OZARKS SEDIMENT STUDY HYDRAULIC SIMULATION WITH 1979 X-SECT & LEVEE DATA
SIMULATION OF FLOOD CONTROL RELEASE --- 80,000 CFS AT 662

SUMMARY TABLE

***** SUMMARY TABLE *****									
***** STATION * MAXIMUM STAGE * MINIMUM STAGE * Q * MAX DISCHARGE DATA *****									
MILES	* ELEV	* TIME	* ELEV	* TIME	* Q	* ELEV	* TIME	* SLOPE	* MAXIMUM VELOCITY PROFILE

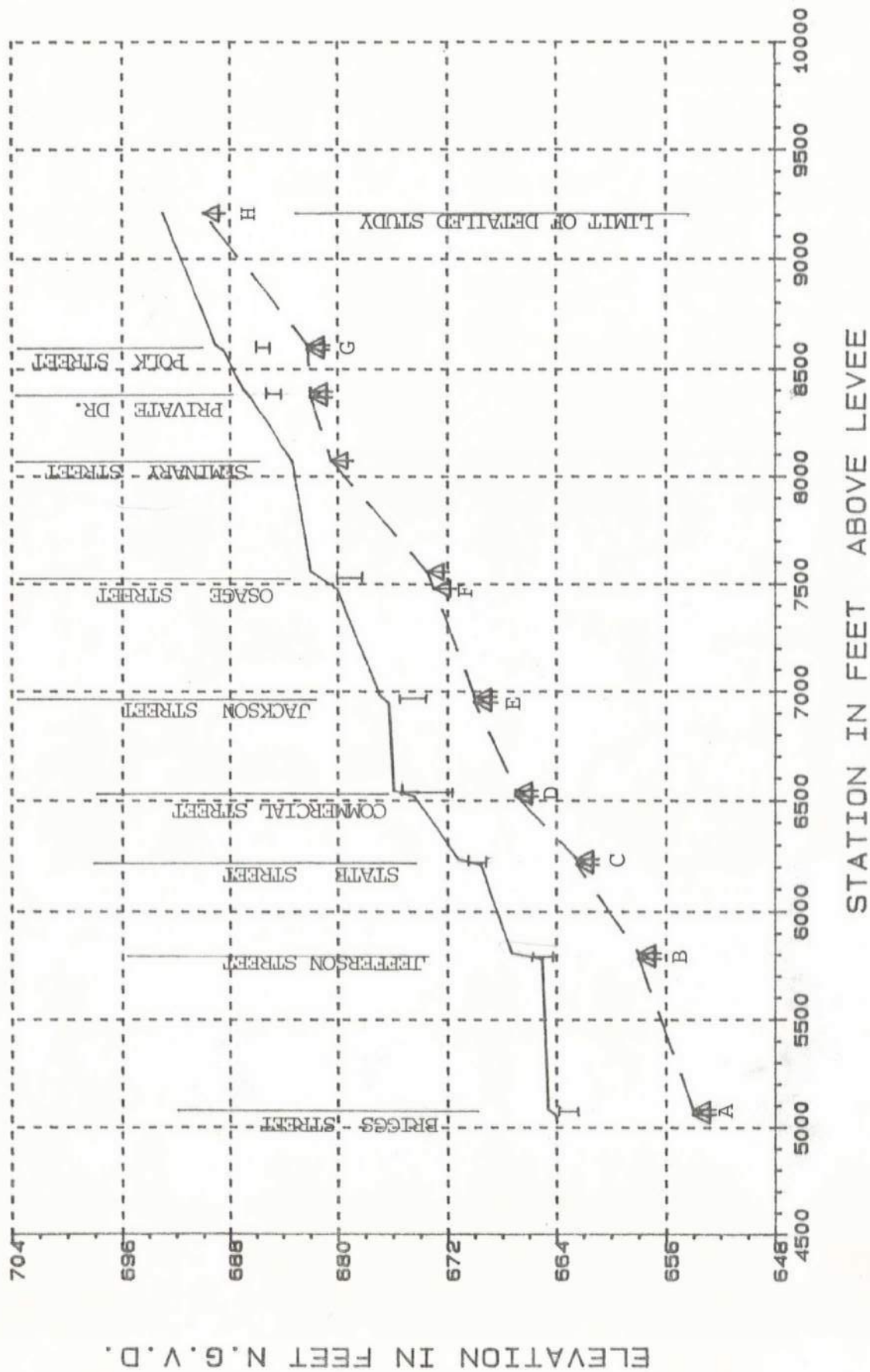
92.900	667.72	50.000	662.08	.100	80000.	667.72	50.00	.4924E-05	4.20 665.93 632.30 5.000
92.500	667.58	50.000	662.06	.100	80000.	667.58	50.00	.5452E-05	4.88 665.81 624.60 5.100
91.600	667.36	50.000	662.04	.100	80000.	667.36	50.00	.7002E-05	5.44 665.56 631.20 5.200
91.000	667.40	50.000	662.03	.100	80000.	667.40	50.00	.7959E-05	4.30 665.59 629.20 5.200
90.400	667.22	50.000	662.02	.100	80000.	667.22	50.00	.6511E-05	4.80 665.44 618.70 5.300
89.900	667.16	50.000	662.01	.100	80000.	667.16	50.00	.5176E-05	4.81 665.37 623.30 5.300
89.500	667.11	50.000	662.01	.100	80000.	667.11	50.00	.5188E-05	4.82 665.31 625.60 5.300
88.600	666.90	50.000	662.00	.100	80000.	666.90	50.00	.5620E-05	5.31 665.13 623.20 5.400
87.200	666.65	50.000	662.00	.100	80000.	666.65	50.00	.5835E-05	5.39 664.85 623.30 5.400
86.700	666.71	50.000	662.00	.100	80000.	666.71	50.00	.6446E-05	4.40 664.96 636.60 5.500
85.800	666.45	50.000	662.00	.100	80000.	666.45	50.00	.7462E-05	4.98 666.10 629.00 12.000
84.400	666.15	50.000	662.00	.100	80000.	666.15	50.00	.9490E-05	4.73 666.15 630.30 50.000
84.000	666.03	50.000	662.00	.100	79999.	666.03	50.00	.1077E-04	4.80 666.03 628.50 50.000
81.400	665.47	50.000	662.00	.200	79999.	665.47	50.00	.1140E-04	3.91 665.47 621.90 50.000
80.000	665.18	50.000	662.00	.300	79999.	665.18	50.00	.1328E-04	3.38 665.18 614.80 50.000
78.100	664.72	50.000	662.00	.400	79999.	664.72	50.00	.1266E-04	3.53 664.72 631.30 50.000
77.300	664.53	50.000	662.00	.400	79999.	664.53	50.00	.1132E-04	3.68 664.53 631.00 50.000
76.700	664.40	50.000	662.00	.100	79999.	664.40	50.00	.1147E-04	3.70 664.40 629.60 50.000
75.600	664.27	50.000	662.00	.200	79999.	664.27	50.00	.1197E-04	2.76 664.27 635.20 50.000
74.700	664.07	50.000	662.00	.400	79998.	664.07	50.00	.1259E-04	3.03 664.07 636.30 50.000
73.900	663.98	50.000	662.00	.500	79998.	663.98	50.00	.1221E-04	2.46 663.98 632.30 50.000
73.300	663.86	50.000	662.00	.500	79998.	663.86	50.00	.1202E-04	2.77 663.86 634.30 50.000
73.000	663.80	50.000	662.00	.500	79998.	663.80	50.00	.1224E-04	2.84 663.80 635.20 50.000
72.000	663.57	50.000	662.00	.300	79998.	663.57	50.00	.1348E-04	3.01 663.57 629.40 50.000
71.200	663.42	50.000	662.00	.100	79998.	663.42	50.00	.1396E-04	2.81 663.42 630.30 50.000
70.600	663.34	50.000	662.00	.100	79998.	663.34	50.00	.1288E-04	2.50 663.34 634.70 50.000
70.000	663.27	50.000	662.00	.200	79998.	663.27	50.00	.1242E-04	2.19 663.27 633.90 50.000
68.900	663.06	50.000	662.00	.100	79998.	663.06	50.00	.1150E-04	2.77 663.06 627.80 50.000
68.300	662.88	50.000	662.00	.100	79998.	662.88	50.00	.1427E-04	3.24 662.88 632.20 50.000
67.700	662.82	50.000	662.00	.100	79998.	662.82	50.00	.1453E-04	2.45 662.82 639.10 50.000
67.200	662.77	50.000	662.00	.100	79998.	662.77	50.00	.1138E-04	2.23 662.77 631.30 50.000
66.700	662.68	50.000	662.00	.100	79998.	662.68	50.00	.1098E-04	2.51 662.68 631.50 50.000
66.500	662.64	50.000	662.00	.100	79998.	662.64	50.00	.1061E-04	2.64 662.64 635.40 50.000
65.600	662.46	50.000	662.00	.100	79998.	662.46	50.00	.1086E-04	3.05 662.46 624.00 50.000
64.500	662.28	4.600	662.00	.100	79998.	662.28	50.00	.1333E-04	2.89 662.28 614.20 50.000
63.400	662.23	4.300	661.95	9.400	79998.	662.02	50.00	.1340E-04	2.87 662.02 616.20 50.000
62.500	662.20	4.200	661.88	9.400	79998.	661.92	50.00	.9672E-05	2.56 661.92 612.40 50.000
59.700	662.13	4.100	661.73	48.800	79998.	661.73	50.00	.7342E-05	1.88 661.73 620.70 50.000
57.100	662.08	4.000	661.58	50.000	79998.	661.58	50.00	.5758E-05	1.87 661.58 617.30 50.000
55.700	662.06	4.000	661.56	50.000	79998.	661.56	50.00	.3966E-05	1.42 661.56 609.60 50.000
50.600	662.00	1.200	661.49	50.000	79998.	661.49	50.00	.2533E-05	1.13 661.49 604.80 50.000
44.100	662.00	1.100	661.44	50.000	79998.	661.44	50.00	.1504E-05	.86 661.44 599.30 50.000
40.500	662.00	1.000	661.42	50.000	79998.	661.42	50.00	.1206E-05	.99 661.42 582.00 50.000
37.700	662.00	.800	661.41	50.000	79998.	661.41	50.00	.1211E-05	.78 661.41 575.40 50.000
34.800	662.00	.700	661.40	50.000	79998.	661.40	50.00	.9666E-06	.80 661.40 576.20 50.000
33.000	662.00	.600	661.40	50.000	79998.	661.40	50.00	.6672E-06	.58 661.40 580.00 50.000
28.800	662.00	.400	661.39	50.000	79998.	661.39	50.00	.5411E-06	.64 661.39 575.00 50.000
24.100	662.00	.300	661.38	50.000	81175.	661.55	7.00	.4995E-06	.65 661.55 568.30 7.000
20.000	662.00	.100	661.38	50.000	82089.	661.55	7.00	.4176E-06	.54 661.55 568.00 7.000
17.200	662.00	.100	661.38	50.000	83024.	661.54	7.00	.3271E-06	.46 661.54 562.00 7.000
13.700	662.00	.100	661.37	50.000	83303.	661.54	7.00	.3051E-06	.54 661.54 562.00 7.000

TOWN BRANCH
WARSAW MISSOURI

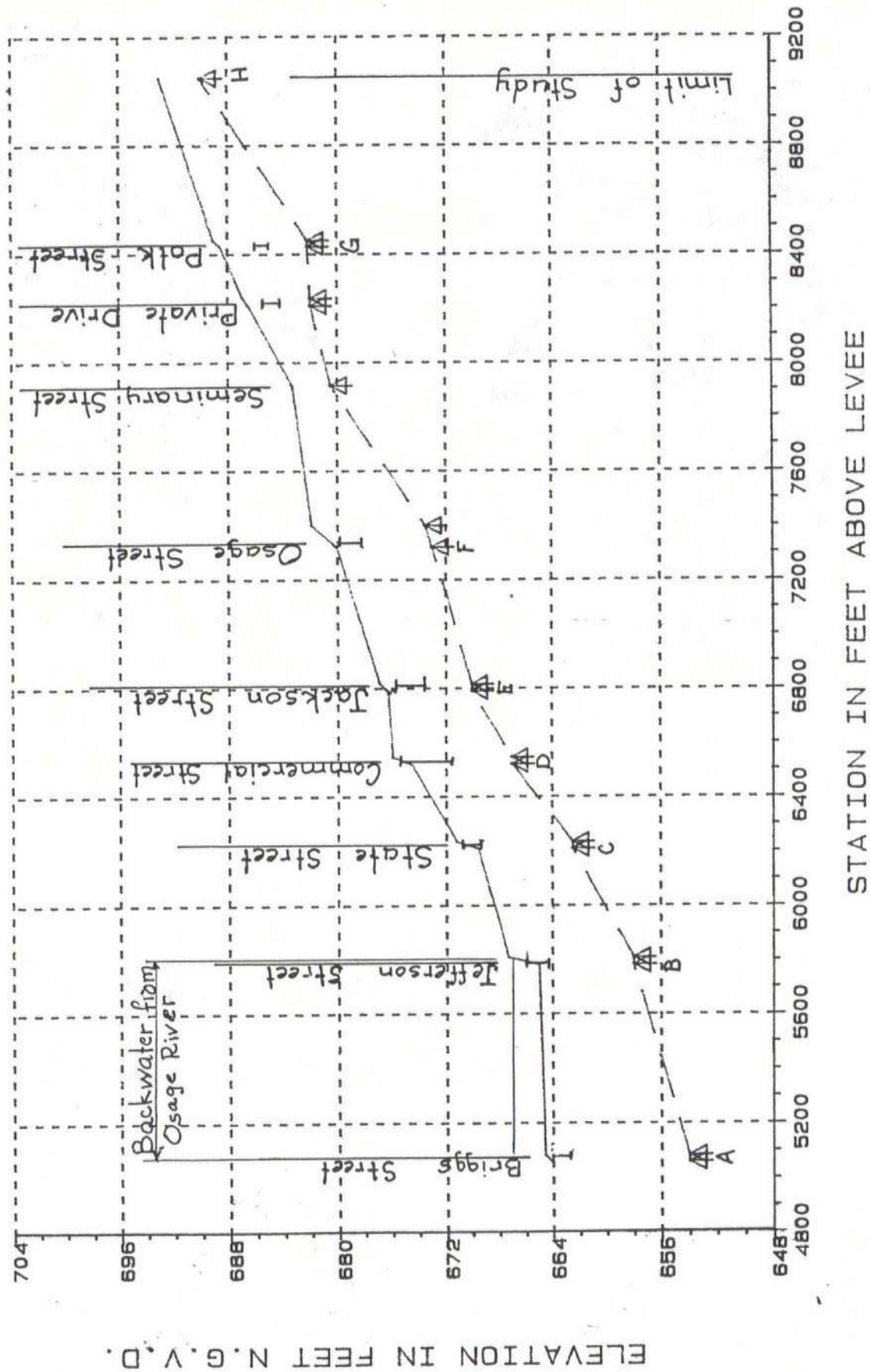


Approximate 100-Year Flood Profile

TOWN BRANCH WARSAW MISSOURI



TOWN BRANCH WARSAW MISSOURI



Approximate 100-Year Flood Profile

* U.S. ARMY CORPS OF ENGI
* THE HYDROLOGIC ENGINEE
* 609 SECOND STREET, SUIT
* DAVIS, CALIFORNIA 95616
* (916) 756-1104

END OF BANNER

3/20/89 11: 1:51

Enkel

THIS RUN EXECUTED 3/20/89 11: .

 HEC2 RELEASE DATED SEPT 83

XX

T1	WAPSAW MD FLOOD INSURANCE STUDY
T2	TWIN TRIBUTARY
T3	APPROXIMATE 100-YR. FLOOD PROFILE

[illegible]

J3 VARIABLE CODES FOR SUMMARY PRINTOUT

38 22	39. 54.	40. 4.	41. 150.	42.	43.	1.	25.	53.	21.
QT	1	1550.							
NC	.06	.05	.3	.5					
X1	5057	335.	345.						
X3	10								
GR	670	664.	170.	662.		300.	660.	663.5	663.5
GR	654	654.	345.	660.		370.	660.	300.	658.
								400.	670.
SB									
X1	1.56	3.0	300.	10.		26.	80.		654.
X2	5003	1.	662.	26.			26.		
X3	10			663.5				663.5	663.5
NC	.04	.03							
X1	5782	80.	90.	699.		699.	699.		
X3	10								
GR	668	0.	40.	660.		75.	658.	665.	90.
GR	660	95.	110.	670.		400.		80.	658.
SB									
X1	1.56	3.0	120.	10.		26.	60.		658.
X2	5003	1.	664.	26.			26.		
X3	10			665.5				665.5	665.5

3/20/89 11: 1:51

X1	6207	8.	265.	275.	401.	401.	401.	669.5	669.5	275.
X3	10							265.		
GR	680	90.	674.	220.	670.	265.	662.5	662.5		
GR	667.5	320.	670.	500.	680.	680.				
SB		1.56	3.0	240.	10.	60.	60.	662.5	662.5	662.5
X1	6235		1.	668.5	26.	26.				
X2					670.		670.	670.	670.	
X3	10									
X1	6519	7.	520.	530.	284.	284.	284.	674.5	674.5	530.
X3	10							520.	667.	
GR	680	0.	675.	330.	675.	500.	667.			
GR	670	640.	680.	900.						
SB		1.56	3.0	380.	10.	60.	60.	667.	667.	667.
X1	6545		1.	673.	26.	26.				
X2					675.		675.	675.	675.	
X3	10									
X1	6949	9.	125.	135.	404.	404.	404.	674.5	674.5	125.
X3	10							115.	670.	
GR	680	0.	675.	0.	675.	115.	673.	400.		
GR	670	135.	673.	135.	675.	145.	680.			
SB		1.56	3.0	145.	10.	30.	30.	670.	670.	670.
X1	6975		1.	673.	26.	26.	26.			
X2					675.			675.	675.	
X3	10									
X1	7479	7.	95.	105.	504.	504.	504.	679.5	679.5	105.
X3	10							105.	678.	
GR	690	0.	680.	75.	673.	95.	673.			
GR	680	280.	690.	540.						
SB		1.56	3.0	120.	10.	50.	50.	673.	673.	673.5
X1	7557		1.	678.	78.	78.	78.	.5	.5	
X2					680.			680.	680.	
X3	10									
X1	8074	5.	80.	190.	517.	517.	517.	190.	690.	540.
GR	690	0.	682.5	80.	680.5	100.	682.5			
X1	8369	8.	220.	230.	295.	295.	295.	685.	685.	230.
X3	10							220.	682.	
GR	690	0.	685.2	120.	685.2	210.	682.			
GR	685.2	240.	685.2	290.	690.	400.				

3/20/89 11: 1:51

Page

SB	1.56	3.0	170.	10.	20.	682.
X1	8697			28.	28.	
X2		1.	684.	685.2		
X3	10				685.2	685.2
X1	8537	175.	185.	190.	190.	
X3	10					
GR	690	685.2	175.	682.2	685.	685.
GR	690	430.			185.	685.2
185.						
SB	1.56	3.0	100.	10.	30.	682.2
X1	8609			22.	22.	
X2		1.	685.2	686.		
X3	10				686.	686.
X1	9207	300.	420.	788.	788.	
GR	700	692.5	300.	400.	692.5	480.
480.						

THIS RUN EXECUTED 3/20/89 11: 2:47

ACTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

LLC	ELMIN	Q	QREFL	AREA	SSTA	STOL	STOR	ENDST	TOTWID
.00	654.00	1550.00	664.00	893.00	170.00	335.00	345.00	504.00	334.00
62.00	654.00	1550.00	664.61	1111.42	152.75	335.00	345.00	519.83	367.08
.00	658.00	1550.00	665.05	341.68	19.70	80.00	90.00	112.65	92.95
64.00	658.00	1550.00	667.30	716.69	4.63	80.00	90.00	243.68	239.04
.00	662.50	1550.00	669.58	432.28	265.00	265.00	275.00	469.63	204.63
68.50	662.50	1550.00	671.23	836.88	251.13	265.00	275.00	522.19	271.05
.00	667.00	1550.00	674.50	1069.37	501.24	520.00	530.00	757.08	255.84
73.00	667.00	1550.00	675.95	1664.26	266.71	520.00	530.00	794.93	538.23
.00	670.00	1550.00	676.32	330.68	.00	125.00	135.00	212.28	212.28
73.00	670.00	1550.00	676.79	436.54	.00	125.00	135.00	236.35	236.35
.00	673.00	1550.00	680.09	334.49	74.29	95.00	105.00	282.45	208.16
78.00	673.50	1550.00	681.98	654.15	63.93	95.00	105.00	318.38	254.46
.00	680.50	1550.00	683.36	226.05	70.81	80.00	190.00	230.21	159.40
.00	682.00	1550.00	686.55	336.04	86.37	220.00	230.00	320.83	234.46
84.00	682.00	1550.00	686.71	377.28	82.05	220.00	230.00	324.79	242.74
.00	682.20	1550.00	688.59	566.63	51.41	175.00	185.00	368.02	306.61
85.20	682.20	1550.00	688.80	631.80	43.88	175.00	185.00	368.56	324.68

J.C	ELMIN	Q	QAFEL	AREA	SSTA	STOHL	STOHR	ENDST	TOPWID
.00	690.00	1550.00	693.11	232.79	275.42	300.00	420.00	424.92	149.49

ELC	ELMIN	Q	QWEL	GRUS	EG	10WKS	QCH	AREA	.01K
.00	654.00	1550.00	664.00	.00	664.00	8.62	4.05	898.00	527.86
662.00	654.00	1550.00	664.61	.00	664.67	5.40	3.34	1111.42	666.72
.00	658.00	1550.00	665.05	665.05	665.49	17.24	7.56	341.68	373.26
664.00	658.00	1550.00	667.30	.00	667.42	3.69	4.21	716.69	806.62
.00	662.50	1550.00	669.53	669.53	669.82	18.55	5.50	432.28	359.89
668.50	662.50	1550.00	671.23	.00	671.29	3.87	2.84	836.88	788.11
.00	667.00	1550.00	674.50	674.50	674.54	1.72	2.49	1069.37	1180.85
673.00	667.00	1550.00	675.95	.00	675.97	.68	1.76	1664.26	1877.98
.00	670.00	1550.00	676.32	676.32	677.01	45.95	9.64	330.68	228.67
673.00	670.00	1550.00	676.79	.00	677.15	24.50	7.38	436.54	313.12
.00	673.00	1550.00	680.09	680.09	680.81	43.55	9.21	334.49	234.88
678.00	673.50	1550.00	681.98	.00	682.11	8.16	4.49	654.15	542.64
.00	680.50	1550.00	683.36	683.36	684.18	96.37	7.35	226.05	157.89
.00	682.00	1550.00	686.55	686.55	687.20	58.34	10.38	336.04	202.92
684.00	682.00	1550.00	686.71	.00	687.21	43.52	9.19	377.23	234.96
.00	682.20	1550.00	688.59	.00	688.77	20.17	5.60	566.63	345.13
685.20	682.20	1550.00	688.80	.00	688.93	15.41	5.00	631.80	394.80
.00	690.00	1550.00	693.11	.00	693.83	83.88	6.87	232.79	169.24

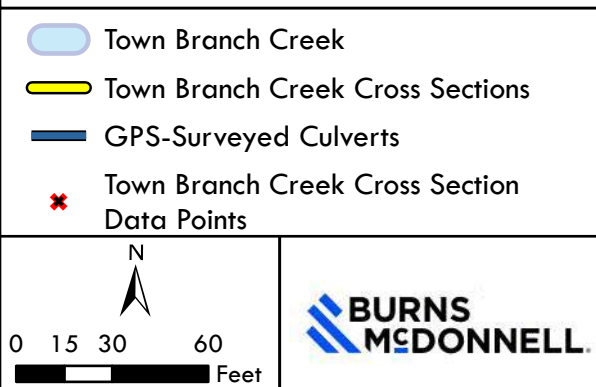
FLWP	DIFWSX	DIFWMS	TOPMID	XLCH
.00	.00	.00	334.00	.00
.00	.61	.00	367.08	26.00
.00	.29	.00	92.95	699.00
.00	2.26	.00	239.04	26.00
.00	1.40	.00	204.63	401.00
.00	1.65	.00	271.05	26.00
.00	3.27	.00	255.84	234.00
.00	1.45	.00	528.23	26.00
.00	.30	.00	212.28	404.00
.00	.47	.00	236.35	26.00
.00	.77	.00	208.16	504.00
.00	1.88	.00	254.46	78.00
.00	1.01	.00	159.40	517.00
.00	1.10	.00	234.46	295.00
.00	.17	.00	242.74	28.00
.00	.12	.00	306.61	190.00
.00	.21	.00	324.68	22.00
.00	1.51	.00	149.49	788.00

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APPENDIX C: TOWN BRANCH CREEK GPS- SURVEYED DATA COLLECTION

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APPENDIX C:
GPS-Surveyed Data Collection Points
Station 11+25 to 30+46 (start)



APPENDIX C:
GPS-Surveyed Data Collection
Points Station 30+46 to 49+93

Town Branch Creek

Town Branch Creek Cross Sections

GPS-Surveyed Culverts

Town Branch Creek Cross Section
Data Points

N

0 15 30 60

Feet

BURNS
MEDONNELL

This aerial map displays the Town Branch Creek and its associated infrastructure. The creek is shown as a blue line winding through a residential area. Key features include:

- Cross Sections (XS):** Labeled with station numbers and cross-section identifiers, such as 49+93 (XS 20), 41+18 (XS 19), 40+37 (XS 18), 38+72 (XS 17), 35+17 (XS 15), 34+07 (XS 14), 32+32 (XS 13), 31+48 (XS 12), and 30+46 (XS 11).
- Culverts:** Indicated by blue lines and labels, including an 8' X 14' RCB, a 3' X 9.66' RCB, and two 1.66' X 1.66' CMPs.
- Data Points:** Red 'x' marks with numerical values representing elevation or stationing at various points along the creek.
- Streets:** Labeled streets include LIBERTY STREET, LUCAS LANE, CEDAR STREET, VILLAGE PLACE, FOLK STREET, KOSCIUSKO STREET, SEMINARY STREET, STAGE COACH AVENUE, NAWOJA STREET, BEYTON STREET, and OSAGE STREET.
- Scale and Orientation:** A north arrow and a scale bar (0 to 60 feet) are located in the top left corner.

APPENDIX C:

GPS-Surveyed Data Collection Points

Station 49+93 to 66+38 (end)

Town Branch Creek

Town Branch Creek Cross Sections

GPS-Surveyed Culverts

Town Branch Creek Cross Section Data Points

N

0 15 30 60

Feet

BURNS

MCDONNELL

This aerial map displays the Town Branch Creek and its associated cross-section data points and culverts. The creek is highlighted in light blue, and the surrounding area is shown in grayscale. The map includes a legend, a north arrow, and a scale bar (0 to 60 feet). The creek flows from the top right towards the bottom left. Key features include:

- Cross Sections:** Four cross-sections are marked with station numbers and elevations:
 - 66+38 (XS 24):** Elevations: 717.66, 714.91, 713.47, 713.56, 714.29, 717.19.
 - 65+09 (XS 23):** Elevations: 715.09, 714.34, 712.65, 712.31, 713.35, 712.44, 716.92.
 - 58+01 (XS 22):** Elevations: 723.18, 724.36, 722.03, 722.88, 723.12, 724.64.
 - 54+19 (XS 21):** Elevations: 710.42, 705.22, 698.22, 701.65, 703.93, 700.44, 707.82.
- Culverts:** Two culverts are marked with their dimensions:
 - 4.17' X 4' RCB:** Located near Hillcrest Lane.
 - 4.75' X 9' RCB:** Located near Water Street.
- Streets:** Shady Lane, Dorsey Lane, Hillcrest Lane, Polk Avenue, Polk Street, Water Street, Liberty Street, and Renee Street are labeled.
- Station 49+93 (XS 20):** Elevations: 713.28, 710.61, 695.61, 698.4, 700.88, 705.4, 701.09.

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