



Purpose

The purpose of the Drainage Report is to document the proposed drainage design and the considerations and calculations on which the design is based. The report shall present a description of the existing drainage conditions and any impacts the proposed improvement may have. The drainage analysis and design should generally be accomplished in accordance Chapter 5 of the Pima County Roadway and Development Standards Manual.

Submittals

Preliminary Drainage Report

The preliminary drainage report should be described and documented in the submittal. In particular, the following report sections and material to be included are as follows:

1.0 Introduction

- 1.1 *Project Description:* Provide an overview of the project, including a description of the proposed roadway improvements, project limits, and vicinity and location maps.
- 1.2 *Major Drainage Features:* Identify major washes, channels, storm drains, or other significant existing drainage features in the project vicinity and generally how they will be treated.
- 1.3 *Proposed Improvements:* Provide a narrative overview of the drainage system that is proposed to deal with the drainage issues facing the project.
- 1.4 *Design Criteria:* State the design criteria to be used for the various components of the drainage design, such as return frequency, allowable spread of flow, placement of catch basins upstream of intersections, and so forth. These criteria are generally those stated in Chapter 5 of the Pima County Roadway and Development Standards Manual. Any criteria not covered in Chapter 5 but needed for the project shall be stated here as well.

2.0 Existing Conditions

- 2.1 *Overview:* Provide an overview of the drainage patterns and features that currently exist along the project limits. Describe generally the topography of the area, existing and

projected land use, vegetative and soil characteristics, and other factors affecting drainage impacting or being impacted by the project.

- 2.2 *Existing Conditions Hydrology:* Determine peak discharges and other hydrologic information needed to establish existing conditions. Provide a drainage map showing points of concentration for which information is needed, tributary areas and flow paths of offsite drainages, and existing drainage features affecting the project such as culverts, washes, and channels. Breakouts upstream that materially affect the location or amount of flow reaching the project should be accounted for.

State the hydrologic methodology used. Provide in tabular form the results of the hydrologic analysis. Include key information such as precipitation, subbasin area, runoff coefficients, times of concentration, rainfall intensity, and peak discharges for return frequencies needed. Discuss any results of particular interest or importance. Provide calculation sheets for each point of concentration, along with electronic modeling files as an appendix.

- 2.3 *Existing Conditions Hydraulics:* Determine the depth and velocity of flows crossing or adjacent to the project. Account for the capacity of existing culverts, flow overtopping the roadway, and flow breaking out along the roadway into adjacent drainage basins.

Identify the methodologies used for the existing conditions hydraulics determination. Discuss and summarize in tabular form roughness coefficients, expansion and contraction factors, culvert geometrics, and other parameters used in the calculations.

Summarize the results of the hydraulics analysis, identifying areas of flooding, flow breakout, and other key results. Present in tabular form depth and velocity of flow at key points. Provide a drainage map showing the 100-year floodplain limits and a plan and profile of floodplains if appropriate. Provide electronic modeling files as an appendix.

- 2.4 *Summary of Existing Conditions:* Provide a short narrative summary of key results and observations arising from the existing conditions analysis that should be considered during the project design.

3.0 Proposed Cross Drainage Improvements

- 3.1 *Offsite Drainage Approach:* Discuss the approaches proposed for dealing with the various offsite drainages impacting the project. Such approaches might include new or modified culvert installations; downstream channelization; drop inlets; and taking offsite drainage into the storm drain system. Include diagrams as report figures or appendices as needed to illustrate the discussion.

- 3.2 *Proposed Conditions Hydrology:* Provide any additional hydrologic calculations needed to reflect drainage basins altered or newly created by the proposed design. Such basins may include portions of the new roadway being drained by the same storm drain mains and laterals used for offsite drainage. Provide a “Proposed Conditions” drainage map, unless noted otherwise. Summarize these results in tabular form, comparing pre- and post-construction conditions where appropriate. Discuss in the narrative any results or changes from existing conditions of note. Provide electronic modeling files as an appendix.

- 3.3 *Proposed Conditions Hydraulics:* Provide hydraulic calculations used to determine the sizing and other aspects of culverts, inlet and outlet treatments, channelization, erosion protections, and other elements of the offsite drainage. Include diagrams and sketches depicting the proposed drainage system as report figures or appendices. Provide a storm drain delineation map demonstrating consistency with the drainage basins that provides the basis for the design. The delineation map will include, but not be limited to the design-year flood plain limits and the design-year discharge values. Summarize in tabular form key results, including comparison of proposed and existing water surface elevations where appropriate. Explain in the narrative any results or issues of particular concern. Include supporting calculations and electronic modeling files as an appendix.
- 3.3x *Preliminary Storm Drain:* Discuss in general the storm drain system being proposed to provide pavement drainage for this project. Note any segment of storm drain main that will also be used for offsite drainage and any special requirements that will result, such as over-sizing for a larger design storm. Provide sketches or diagrams showing the preliminary location and size of storm drain mains, including the potential for use of prefabricated structures.
- At this stage, storm drain sizing may be approximated by assuming normal flow of the conduit flowing full with appropriate allowance for minor losses. Alternatively, standard hydraulic grade calculations may be used. Summarize the results of the sizing calculations with appropriate narrative discussion and tables. Provide the preliminary sizing calculations and electronic modeling files as an appendix.
- 3.4 *Sedimentation:* Note any special consideration of sedimentation needed in the design of culverts or channels. Do not place culvert inlets below the invert elevation of the approaching drainage way without accounting for the capacity and sedimentation implications. Maintain suitable velocity of approaching flow and flow through the barrel to carry incoming sediment, accounting for downstream backwater effects if present.
- 3.5 *Channelization:* In cases where it is necessary to channelize upstream or downstream of the culvert, follow the procedures outlined in Pima County *Drainage and Channel Design Standards for Local Drainage*, 1984.
- 3.6 *Outlet Protection:* Determine if the discharge velocity warrants outlet protection downstream culvert, storm drain, and channel discharge points. Procedures for addressing culvert outlets are provided in Pima County *Drainage and Channel Design Standards for Local Drainage*, 1984 and the U.S., Department of Transportation - Federal Highway Administration, *Hydraulic Design of Energy Dissipators for Culverts and Channels - HEC-14*, 1983.
- 3.7 *Right-of-Way Requirements:* Identify any special acquisitions of right-of-way or drainage easements required to accommodate the proposed drainage improvements.
- 3.8 *Mitigation Measures:* Discuss the environmental impact of the proposed improvements. Identify proposed measures for mitigating loss of vegetation and other impacts associated with channelization and other drainage improvements.
- 3.9 *Permitting Requirements:* Identify whether an ACOE 404 permit or other permits and/or approvals are required.

Final Drainage Report

A final drainage report is to be included with the final construction drawings and shall address all comments from the preliminary drainage concept submittal and additional information supplied, as appropriate, to reflect design revisions. Revisions shall be submitted for review and approval by both Pima County and RFCD prior to being included in the final drainage report and project plans. Provide calculations and electronic modeling files as an appendix.

Additionally, the sections discussed below shall be included.

4.0 Storm Drain Inlet Design

- 4.1 *Inlet Configuration:* Discuss generally the types and locations of catch basin inlets being proposed for the pavement drainage system and for capturing offsite drainage where applicable. Provide a diagram showing proposed inlet locations and types as a report figure or an appendix. Note that catch basins shall be used in-lieu of manholes for access to the storm drain system and for cleaning purposes when possible.
- 4.2 *Inlet Design:* Determine inlet location and sizing utilizing the methods outlined in HEC-22 or other approved software or references. Provide a tabulated summary of results as a report figure, including spread data. Summarize the inlet design data on a form such as the one found in Appendix B. Place the detailed inlet design calculations and the electronic modeling files as an appendix.

5.0 Storm Drain Design

- 5.1 *Storm Drain Configuration:* Revise the preliminary storm drain design as needed to serve the proposed catch basin layout, avoid major utilities, minimize the installation of storm drains under pavement, minimize manholes within pavement, and meet other constraints that have emerged in the project design. Update report diagrams as needed.
- 5.2 *Hydraulic Grade Line Calculation:* Update the storm drain hydrology and preliminary pipe sizing developed in Section 3.3x to reflect any changes in design that have occurred since the initial submittal. Calculate the hydraulic grade line through the proposed storm drain system. Revise the pipe sizing, junction structures and other system components if necessary to meet project design criteria. Provide the hydraulic grade line calculations as an appendix, and provide a plot or table summarizing results as a report figure. Provide diagrams of the proposed storm drain configuration, a storm drain plan and profile plan, appropriate design-year hydraulics grade line, discharge values and sketches of unusual junction structures and other special components.

6.0 Bridge Analysis

This section is included if a bridge over drainage is included in the project design, or, alternatively, a separate report may be provided. Pima County shall be consulted during the project scoping to determine the form for the documentation of the bridge analysis.

The preliminary drainage concept submittal should include sufficient hydrologic and hydraulic information for the Draft Bridge Structure Selection Report to be prepared. Subsequent submittals should reflect finalized bridge geometrics, channel improvements, and other relevant design features.

- 6.1 *Overview:* Describe the nature of the drainage to be crossed by the bridge. Note the character of the surrounding area (e.g., is it natural, developed, are existing structures threatened by flooding or erosion, and other pertinent information). Note any special environmental conditions that may apply, such as the presence of riparian habitat, wildlife crossing patterns, or the need to span the entire floodplain.
- 6.2 *Design Criteria:* State the hydrologic, hydraulic, and scour criteria being applied to the design of this structure. Typically, bridges in Pima County are designed for a 100-year storm. In special cases, such as environmentally sensitive areas or roadways with low traffic volumes, other standards may apply. Pima County shall be consulted to develop the design criteria to be used for special cases.
- 6.3 *Hydraulic Modeling:* Use HEC-2, HEC-RAS, or equivalent flow-profile analysis methodology to evaluate existing conditions and to develop bridge and improved channel geometrics that meet the design criteria.
- 6.4 *Scour Analysis:* Perform appropriate scour analyses to determine the depth of bridge abutments and piers using the *Guidelines for Establishing Scour and Freeboard for Bridges in Pima County*. If soil cement or other bank protection exists along the channel to be spanned by the bridge, evaluate its long-term viability. If it appears that the bank protection is questionable, not sound or could be breached, the abutments shall be designed as piers, or appropriate remedial action shall be taken to upgrade the bank protection.

7.0 Life-Cycle Cost Analysis

This section is under development. Contact the County for status.

Acceptance Submittal

The drainage report acceptance submittal shall address Pima County's Final Design Submittal comments as well as revisions to the final project design

Table of Contents and Study References

Table 3-3 summarizes the content for the drainage report submittals. Appendix A presents a list references relevant to conducting and documenting drainage studies.

Table 3-3
Drainage Report Table of Contents

Section		Preliminary Drainage Report	Final Drainage Report
1.0	Introduction		
	1.1 Project Description	X	X
	1.2 Major Drainage Features	X	X
	1.3 Proposed Improvements	X	X
	1.4 Design Criteria	X	X
2.0	Existing Conditions		
	2.1 Overview	X	X
	2.2 Existing Conditions Hydrology	X	X
	2.3 Existing Conditions Hydraulics	X	X
	2.4 Summary of Existing Conditions	X	X
3.0	Proposed Cross Drainage Improvements		
	3.1 Offsite Drainage Approach	X	X
	3.2 Proposed Conditions Hydrology	X	X
	3.3 Proposed Conditions Hydraulics	X	X
	3.3 x Preliminary Storm Drain (Initial Design Phase)	X	–
	3.4 Sedimentation	X	X
	3.5 Channelization	X	X
	3.6 Outlet Protection	X	X
	3.7 Right-of-Way Requirements	X	X
	3.8 Mitigation Measures	X	X
	3.9 Permitting Requirements	X	X
4.0	Storm Drain Inlet Design		
	4.1 Inlet Configuration	–	X
	4.2 Inlet Design	–	X
5.0	Storm Drain Design		
	5.1 Storm Drain Configuration	–	X
	5.2 Hydraulic Grade Line Calculation	–	X
6.0	Bridge Analysis		
	6.1 Overview	X	X
	6.2 Design Criteria	X	X
	6.3 Hydraulic Modeling	X	X
	6.4 Scour Analysis	X	X

APPENDIX A

References

Note: These documents are revised periodically; therefore users should double check that they have the specific version of the document specified in this chapter, or, if the reference is undated, that they have the most recent version.

- Pima County. 1979. *Hydrology Manual for Engineering Design and Flood Plain Management*.
- U.S. Army Corps of Engineers. 1990. *Flood Hydrograph Package User's Manual*. HEC-1.
 - . 1990 (rev.). *Water Surface Profiles User's Manual*. HEC-2.
 - . 2001. *River Analysis System User's Manual, Hydraulic Reference Manual, and Applications Guide*. HEC-RAS.
- U.S. Department of Transportation. Federal Highway Administration. 1983. *Hydraulic Design of Energy Dissipators for Culverts and Channels*. HEC-14
 - . 1985. *Hydraulic Design of Highway Culverts*. HDS-5
 - . 1995. *Evaluating Scour at Bridges*. HEC 18. 3rd ed.
 - . 2001. *Urban Drainage Design Manual*. HEC-22.

