TEAM KENTUCKY TRANSPORTATION CABINET

Drainage

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INTRODUCTION

Subject

Design of This Guidance Manual

DR-101.1 ORGANIZATION & NUMBERING

"DR" Prefix—Preceding each numbered division, this prefix stands for the manual title *Highway Design Guidance Manual*.

Chapters—The content of this manual is divided into chapters. Each chapter is assigned a consecutive number by hundreds (100, 200, 300, etc.). The chapter title appears at the top of each page.

Subjects—Chapters are divided into subjects. Each subject is assigned a consecutive number within its chapter range (HD-101, HD-102, HD-103, etc.) The subject number and title appear at the top of each page.

Sections—Subjects are divided into sections. Each section is assigned a consecutive number within its subject range (HD-101.1, HD-101.2, etc.) Section numbers appear down the left side of each page. A corresponding title is to the right of each section number.

Subsections—Some sections are divided into subsections. Each subsection is assigned a consecutive number within its section range (HD-101.1.1, HD-101.1.2, etc.) Subsection numbers appear down the left side of each page. A corresponding title is to the right of each subsection number.

Date—The latest issuance date of a subject appears at the bottom of each page of the subject. This date agrees with the latest issuance date shown for the subject in the "Table of Contents."

> **NOTE:** Methodologies and technologies are constantly changing. Notification of revisions or updates are issued through Design Memorandum and are available electronically on the Drainage Branch's website at:
>
> https://transportation.ky.gov/Highway-Design/Pages/Drainage.aspx

Page Numbering—Each subject has its own page numbering, which appears at the bottom of each page.

DR-101.2 LOCATING INFORMATION

Two indexes appear at the front of the manual:

- **Table of Contents (HD-01)**—This index lists the numbers and titles of the manual's chapters, subjects, sections, and subsections, as well as other information, in numerical order. It includes the latest issuance dates of all the subjects. As the manual matures, these dates change.

  Chapters and main topics are as follows:

  - *DR 100: Introduction*. General overview, including departmental policies, responsibilities, reference materials, and the design review process.
  - *DR 200: Stormwater & Floodplain Management*. General stormwater and floodplain regulations, considerations, and management practices are discussed.
  - *DR 300: Drainage Submittals.* Preliminary and Final Drainage Submittal requirements and supporting data.
  - *DR 400: Hydrology*. Methods used for reasonable engineering estimations of peak runoff and runoff hydrographs.
  - *DR 500: Open Channels*. Guidelines, procedures, and criteria for channels, including roadway ditches and stream relocations.
  - *DR 600: Culverts and Headwalls*. Hydraulic design and physical standards of culverts, as well as end treatments and headwalls used with culverts.
  - *DR 700: Inlets and Storm Sewers*. Guidelines, analysis procedures, and design practices for storm drainage systems, including curb and gutter, inlets, manholes, junctions, and storm sewer pipes.
  - *DR 800: Bridges.* Design procedures, criteria, and environmental considerations for the hydraulic analysis of bridges.
  - *DR 900: Storage*. Design criteria and procedures for reducing peak flows via storage methods such as culvert sizing and detention/retention basins.
  - *DR 1000: Erosion*. Erosion Control measures and guidelines that are to be incorporated into roadway plans.
  - *DR 1100: Miscellaneous*. Subjects such as temporary drainage facilities, software recommendations, plan requirements, and field data collection.

- **Table of Exhibits (HD-02)**—This index lists the manual's exhibits, including forms, worksheets, diagrams, by number and title.

DR-101.3 CROSS REFERENCES

A boldfaced subject number appearing within the text is a cross reference to additional information.

DR-101.4 CONTACTS

For inquiries regarding information provided in this manual, contact:

Drainage Branch
Division of Highway Design
200 Mero Street
Frankfort, KY 40622
Phone: (502) 564-3280

To report textual errors or inaccurate links, or to request printed copies of this manual, contact:

Organizational Management Branch
Office of Human Resource Management
Transportation Cabinet Office Building, 6th Floor West
200 Mero Street
Frankfort, KY 40622

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Purpose of This Guidance Manual

The *Drainage Guidance Manual* is intended for use in the development of Kentucky Transportation Cabinet (KYTC) highway drainage design projects. This manual presents design concepts, policies, procedures, and criteria for preparing drainage designs and performing hydraulic analyses on KYTC project.

The *Drainage Guidance Manual* provides designers with a basic working knowledge of hydrology and hydraulics based on state-of-the-art practices in highway drainage design procedures. Basic design elements are included so designers can design highway drainage systems with minimal assistance. However, this manual does not provide guidance on complex hydrologic or hydraulic problems and is not a substitute for experience, formal training, or engineering judgment.

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Guiding Policies

DR-103.1 OVERVIEW

Drainage concerns are one of the most important aspects of highway design and construction; therefore, drainage designs shall:

- Meet or exceed KYTC's standard engineering practice.
- Be consistent with the recommendations of a reasonably competent and prudent designer working under similar circumstances.

To achieve an adequate drainage design, normally a hydrologic and hydraulic analysis, as well as an engineering evaluation of selected alternatives are conducted. The drainage design process includes the following policies:

- It is the drainage designer's responsibility to provide an adequate drainage structure for defined return events.

  Note: The drainage designer is not required to provide a structure that will handle all conceivable flows under all possible site conditions.

- The level of detail contained in the design should be commensurate with the risk associated with the encroachment and other economic, engineering, social or environmental concerns.

- The overtopping flood and the design flood may serve as criteria for evaluating the adequacy of a proposed design. Both may vary widely depending on the grade, alignment, and classification of the road, as well as the characteristics of the water course and floodplain.

- The predicted value of the 100-year (or "base") flood serves as the present engineering standard for evaluating flood hazards and is the basis for regulating floodplains under the National Flood Insurance Program and Kentucky Revised Statutes. The drainage designer must make a professional judgment on the degree of risk that is tolerable for the base flood on a case-by-case basis.

DR-103.2 FEDERAL

The 2014 *American Association of State Highway and Transportation Officials (AASHTO) Drainage Manual*, Chapter 2, provides a list of federal legislation impacting drainage design and construction. Topics include environmental issues, health concerns, historic and archaeological preservation, and land and water usage. For detailed information on specific federal policies, the applicable legislation should be consulted.

DR-103.3 KENTUCKY TRANSPORTATION CABINET (KYTC)

The drainage design of any highway project shall conform to KYTC policies, procedures, standards, and specifications, as well as other federal, state, and local requirements. The goals of highway drainage design include:

- Remove water from the highway.
- Prevent surface water from adversely impacting the highway.
- Drain potential ponding areas caused by highway fills.
- Consider impacts to and protection of insurable structures outside of the right-of-way.
- Drain areas undercut by highway excavation.
- Release these waters at an adequate outlet.
- Provide for the passage of existing streams through the highway.
- Minimize and mitigate environmental impacts to streams and wetlands.

To meet these goals by the most economical means while disturbing the surrounding environment as little as possible, KYTC's drainage design policies focus on the following:

- Determine the existing flow conditions at a site.
- Design a drainage system for the proposed condition that does not significantly change the quality or quantity of flow as compared to the existing condition.
- Ensure post-development discharge and velocity do not significantly exceed pre-development discharge and velocity.

  Note: In some instances, this will require the use of energy dissipaters and detention basin storage prior to discharging onto adjacent property.

- Consider potential maintenance problems and traffic hazards due to clogged inlets and sediment deposition.
- Employ careful planning and design for adequate temporary drainage measures to ensure not only the protection of the environment, but also of the project itself.

DR-103.4 LOCAL

Many local governmental bodies have ordinances, codes, guidelines, or other requirements that may influence roadway drainage design. Generally, the state is not legally required to comply with local ordinances unless compliance is required by specific state or federal statute. However, KYTC shall coordinate with local agencies to minimize specific concerns.

State and local government coordination is necessary for projects within the following jurisdictions: Louisville and Jefferson County Metropolitan Sewer District (MSD), Lexington Fayette Urban County Government (LFUCG), and other local governments with specific drainage design criteria.

DR-103.5 FLEXIBILITY

The procedures and methodologies in this manual are **guidelines** and are not comprehensive in scope. Therefore, design flexibility is emphasized and project-specific designs are encouraged, as this manual does not supersede the application of sound engineering principles by experienced design professionals.

Note: When deviations from guidelines are deemed appropriate for a particular situation, an explanation of the deviations shall be included in the drainage design documentation.

DR-103.6 PRINT & ONLINE RESOURCES

The methodologies employed in this manual have been adopted through the review of hydrologic and hydraulic programs and procedures readily available online. A drainage resource library is available at:

https://transportation.ky.gov/Highway-Design/Pages/Drainage-Resource-Materials.aspx

Designers may also find the following sources helpful:

- **American Association of State Highway & Transportation Officials (AASHTO)** AASHTO has several publications covering drainage design issues and policies found online at:

  https://store.transportation.org/

  The following publications may be particularly helpful:

  - *AASHTO Drainage Manual*, *Volume 1 – Policy; Volume 2 – Procedure* (2014), provides transportation agencies with guidelines for establishing state-specific policy and procedures for the design of highway drainage facilities.

DR-103.6 PRINT & ONLINE RESOURCES (CONT.)

- *Highway Drainage Guidelines, 4th Edition* (2007), provides a consolidated overview of highway hydraulic design and discusses possible hydrology problems.

➢ **Federal Highway Administration (FHWA)**

FHWA documents and program information related to highway drainage are available at:

https://www.fhwa.dot.gov/engineering/hydraulics/

Included on the site are HEC (Hydraulic Engineering Circulars), HDS (Hydraulic Design Series), hydrology and hydraulic software applications, and information on other topics, such as:

- Hydrology
- Highway Drainage
- Culvert Hydraulics
- Bridge Hydraulics
- Scour Technology
- Environmental Hydraulics
- Conferences
- Software
- Policy and Memos
- Publications
- Research

Specific FHWA references frequently used by designers include:

- HDS 2, Highway Hydrology
- HDS 5, Hydraulic Design of Highway Culverts
- HEC 14, Hydraulic Design of Energy Dissipators for Culverts and Channels
- HEC 15, Design of Roadside Channels with Flexible Linings
- HEC 18, Evaluating Scour at Bridges
- HEC 20, Stream Stability at Highway Structures
- HEC 22, Urban Drainage Design Manual
- HEC 23, Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance (Vol 1)
- HEC 26, Culvert Design for Aquatic Organism Passage

DR-103.6 PRINT & ONLINE RESOURCES (CONT.)

➢ **U.S. Geological Survey (USGS)**
USGS publications, including information specific to Kentucky, are summarized at:

https://pubs.er.usgs.gov/

The following downloadable publications may be of particular use:

♦ *Estimating the Magnitude of Peak Flows for Streams in Kentucky for Selected Recurrence Intervals*, Water-Resources Investigations Report 03-4180, gives estimates of, and presents techniques for, estimating the magnitude of peak flows for streams in Kentucky for various return intervals using regionalized regression equations.

♦ *Estimation of Peak-Discharge Frequency of Urban Streams in Jefferson County, Kentucky*, Water-Resources Investigations Report 97-4219, develops regression equations for estimating peak-discharge frequencies for ungauged streams in Jefferson County having a specific range of basin characteristics.

The USGS also provides the following online programs and data resources:

♦ The **National Streamflow Statistics (NSS)** program provides simple methods of estimating flood-peak discharges and low flow frequency/duration discharges. The NSS program compiles all current USGS regional regression equations for estimating streamflow statistics at ungauged sites. The program can be found online at:

https://water.usgs.gov/software/NSS/

♦ The **StreamStats** program will automatically delineate a watershed and regression equation flows at a given point for select locations. This program can be found online at:

https://streamstats.usgs.gov/ss/

♦ The **USGS National Water Dashboard** may be used as a starting point to obtain real-time and historical data for gauging stations throughout Kentucky and can be found online at:

https://dashboard.waterdata.usgs.gov/app/nwd/en/?aoi=default

DR-103.6 PRINT & ONLINE RESOURCES (CONT.)

- Using USGS software **PEAKFQ**, historical data can be exported to a data file and used for computing maximum peak flows for a range of recurrence intervals. The PEAKFQ software download and documentation can be found online at:

  https://water.usgs.gov/software/PeakFQ/

- Archived **Annual Water Data Reports** supplement direct access to real-time and historical data. Beginning with Water Year 2006, the Annual Water Data Report is available as a national report only (local and state reports were discontinued). From 1962 until 2005, reports were published by state as paper documents, although most reports since the mid-1990s are also available in electronic form. Annual Water Data Reports are available online at:

  https://wdr.water.usgs.gov/

➢ **National Resources Conservation Service (NRCS)**
NRCS has developed hydrologic and hydraulic-related programs, such as the TR-55 program, as well as several others.

Documentation for TR-55 can be found online at:

https://www.hydrocad.net/pdf/TR-55 Manual.pdf

The TR-55 program download can be found online at:

https://www.nrcs.usda.gov/resources?title=&resource_type=1970

Soil survey information is available online at:

https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

The interactive Web Soil Survey application provides online access to soil maps and data nationwide. It allows the user to define an area of interest and obtain information such as soil type, curve number (CN), pH, infiltration rates, and more.

➢ **Hydrologic Engineering Center (HEC)**
HEC is an organization within the Institute for Water Resources, and is the designated Center of Expertise for the US Army Corps of Engineers in the technical areas of hydrology and hydraulics. HEC has developed and maintains programs that compute runoff and flood profiles, the most familiar being HEC-HMS and HEC-RAS. Documentation and software download information for these programs, as well as many others, can be found online at:

https://www.hec.usace.army.mil/software/

DR-103.6 PRINT & ONLINE RESOURCES (CONT.)

- **National Oceanic and Atmospheric Administration (NOAA)**
  NOAA has developed sets of precipitation depth and intensity data for locations throughout the state. This data can be used to develop project-specific IDF curves and increase the accuracy of runoff estimates when using the Rational equation. 24-hour storm depths for given events can also be found in NRCS storm distribution models. This data can be found on NOAA's Precipitation Frequency Data Server at:

  https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ky

- **Federal Emergency Management Agency (FEMA)**
  FEMA provides National Flood Insurance Program (NFIP) Flood Maps and Flood Insurance Studies. The interactive Map Service Center on FEMA's website allows the user to browse FEMA's product catalog or to search for available information.

  FEMA map products are available online at:

  https://msc.fema.gov/portal/advanceSearch

  A digital rendering of the FEMA data may be found online at:

  https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cd

- **Kentucky Division of Water (KDOW)**
  KDOW maintains a library of detailed models, many that have been georeferenced, available online at:

  http://watermaps.ky.gov/RiskPortal/

- **Kentucky Transportation Cabinet (KYTC)**
  KYTC's Drainage Branch has compiled a hyperlinked list of recommended hydrologic tools and software, and has developed several downloadable spreadsheet solutions for runoff and hydraulic calculations. The recommendations list and KYTC downloads are available online at:

  https://transportation.ky.gov/Highway-Design/Pages/Drainage-Resource-Materials.aspx

  Upon request, the Drainage Branch will make available archived drainage folders and a library of hydraulic models for select Kentucky streams. See **DR-304** for more information about archival considerations for drainage folders.

DR-103.6 PRINT & ONLINE RESOURCES (CONT.)

KYTC's Division of Planning has a wide variety of transportation-related maps that may be useful in drainage design available online at:

https://transportation.ky.gov/Planning/Pages/default.aspx

The Kentucky Division of Geographic Information (DGI) provides online access to maps more directly related to drainage design, such as digital ortho images, USGS Quadrangle images, digital elevation models (DEM), wetland maps, and more, available at:

https://www.kentucky.gov/government/Pages/AgencyProfile.aspx?Title=Division+of+Geographic+Information

Kentucky From Above also provides additional Geographic Information Systems (GIS)-related information and data sets online at:

https://kygeonet.maps.arcgis.com/home/webmap/viewer.html?webmap=785e6040154e4050bda80049fc12d4a6

TEAM KENTUCKY TRANSPORTATION CABINET

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Chapter

INTRODUCTION

Subject

Project Development Team

DR-104.1 OVERVIEW

A project development team (PDT) composed of roadway design specialists is typically assigned to each project. This team approach allows each team member to be familiar with the responsibilities of everyone involved in the drainage design and review process. Depending upon need, the following individuals may be included as members of the PDT:

- Project manager
- Roadway design engineer
- Drainage designer
- Structural design engineer
- Drainage branch engineer
- Location branch engineer
- Structural branch engineer
- Environmental branch engineer

The roles and responsibilities of those individuals often selected as PDT members are described in the remaining portion of this chapter.

DR-104.2 CENTRAL OFFICE DRAINAGE BRANCH

The Central Office Drainage Branch includes the chief drainage engineer, other drainage engineers, and support personnel. Drainage Branch engineers are each assigned oversight of highway districts. It is the responsibility of each Drainage Branch engineer to assure that all drainage design follows current departmental practices, standards, specifications, and applicable federal, state, and local regulations.

DR-104.2.1 Purpose

The primary purpose of the Drainage Branch is to review the drainage design of all projects directly or indirectly affecting Kentucky's system of highways. This includes projects *not* directly administered by project development staff including:

- Highway Safety Improvement Projects (HSIP)
- Alternate delivery projects
- Maintenance projects directly affecting the flow or ponding of water adjacent to a roadway, or affecting drainage structures owned by others

DR-104.2.2 Drainage Branch Engineer

The assigned Drainage Branch engineer shall:

- Attend and may conduct **ALL** meetings, inspections, or other drainage related reviews during the project development process.

- Provide expertise in all areas related to the proposed project drainage design.

- Offer comments and recommendations.

- Determine where corrections should be made when current practices, methodologies, or accepted procedures are violated.

  Note: The Drainage Branch engineer shall be made aware of drainage related issues as they are encountered so design guidance may be provided in a manner that will minimize modifications at the end of the design process.

- Aid highway districts in implementation of drainage design to maintain a consistent interpretation of drainage requirements throughout the state. The level of coordination required between Drainage Branch engineers and highway districts will be determined on a project-specific basis.

- Shall maintain close communication throughout the design process with the Division of Structural Design, highway districts, and consultants to ensure coordinated and prompt review of projects.

DR-104.3 PROJECT MANAGER

The project manager is often selected from staff within the project's highway district. Situations involving unique funding or specialized scoping may arise requiring the project manager be selected from Central Office.

DR-104.3 PROJECT MANAGER (CONT.)

The project manager shall:

- Select project development team (PDT) members.
- Manage communication between all PDT members.
- Manage correspondence involving submittal, review, and approval of all drainage designs and drainage design updates.

  Note: For consultant projects, it is the project manager's responsibility to perform an initial review of all preliminary, advance, and final drainage submittals to verify completion according to requirements set forth in this manual. The project manager shall then coordinate with the Drainage Branch engineer to ensure review and approval of the drainage submittals.

- Schedule PDT meetings or other drainage reviews in coordination with the Drainage Branch engineer and in consideration of all team member schedules.

  Note: Should the Drainage Branch engineer not be available at the time of the scheduled meeting, written comments from the Drainage Branch engineer shall be submitted to the project manager for inclusion in the draft meeting minutes. The draft meeting minutes, with responses, shall be provided to the Drainage Branch engineer for review and comment.

- Ensure the Federal Highway Administration's (FHWA) involvement in the project review process, including meetings and reviews, as required.
- Include local governments and the local floodplain coordinator in the review process based on the regulatory impact of those entities on the design process.

DR-104.4 DRAINAGE DESIGNER

The drainage designer's primary responsibility is to provide an adequate drainage design. Included in this process, the drainage designer shall:

- Be familiar with the policies, procedures, and accepted methodologies as outlined in this manual, including revisions and updates issued by the Kentucky Transportation Cabinet (KYTC).

  As discussed in **DR-103.5**, flexibility in design is encouraged. However, delays in design and submittal processing may occur when the drainage designer elects to use methods unfamiliar to the Cabinet. The drainage designer shall inform and educate the Cabinet when employing drainage design procedures not covered by this manual.

DR-104.4 DRAINAGE DESIGNER (CONT.)

This is especially applicable when the drainage designer uses computer applications that are not on the Cabinet's list of recommended applications found online at:

https://transportation.ky.gov/Highway-Design/Pages/Drainage-Resource-Materials.aspx

Full documentation of all procedures that differ from those discussed in this manual shall be provided by the drainage designer at no expense to the Cabinet.

Note: The Cabinet reserves the right to reject the use of any procedures and computer applications that the Drainage Branch engineer deems inappropriate, unproven, or flawed.

- Document the drainage design by compiling and preserving all pertinent information on which the drainage design and decisions were based (**DR-300**).

- Develop documentation for applicable permits, Federal Emergency Management Administration (FEMA) "No-Rise" Certifications, FEMA map revisions, or any other special drainage requirements on a project.

DR-104.5 FEDERAL HIGHWAY ADMINISTRATION (FHWA)

The involvement of FHWA on federally funded projects is outlined in the current KYTC and FHWA stewardship agreement. While federal law allows a state transportation agency to assume certain project approvals and authorities, FHWA is ultimately accountable for ensuring the Federal-aid Highway Program is delivered consistent with established requirements.

A description of FHWA's level of involvement is available in the current KYTC and FHWA stewardship agreement found online at:

https://www.fhwa.dot.gov/federalaid/stewardship/agreements/ky.pdf

TEAM KENTUCKY TRANSPORTATION CABINET

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Chapter	Subject
INTRODUCTION	Review Process

DR-105.1 OVERVIEW

As with all aspects of project design, communication is a key component to ensure a complete and adequate design. Throughout the entire design process (**Exhibit 100-1**), the drainage designer and the Drainage Branch engineer should readily communicate project expectations, challenges, and solutions for the project drainage design. The KYTC project manager should facilitate this communication by ensuring the drainage designer and Drainage Branch engineer are aware of design issues or modifications impacting the drainage design.

The project manager shall consult the Drainage Branch engineer when scheduling project development team (PDT) meetings to ensure the engineer's attendance. It is the responsibility of the district project engineer, project location engineer, and the drainage designer to notify the Drainage Branch engineer of all PDT meetings relevant to the design process. PDT meeting minutes and documentation of discussions impacting drainage design will be provided to the Drainage Branch engineer.

The drainage review process is integrated into the project development process as described in **HD 204.13**. Key milestones in the project development process relevant to the drainage review process include:

- Pre-design conference
- Selected alternative meeting (also referred to as the preliminary line and grade inspection)
- Geometric review meeting
- Preliminary drainage submittal
- Drainage inspection and report
- Advance situation survey
- Final drainage submittal

DR-105.2 PRE-DESIGN CONFERENCE

The pre-design conference, scheduled after a consulting engineering firm is awarded the project design contract, focuses on reviewing the project's purpose and need and finalizing the consultant's scope of work.

Major drainage items requiring special attention, such as stream impacts, existing FEMA flood studies, and any anticipated advanced drainage analyses, should be identified at this time. When appropriate, goals relating to the mitigation of known flooding problems shall be listed. The primary drainage design contact should be identified, and project expectations (software to be utilized, drainage submittal requirements) should be established.

DR-105.3 SELECTED ALTERNATIVE MEETING

During the selected alternative meeting (also referred to as the preliminary line and grade inspection), the PDT meets to select a preferred alternative from the alignments studied during Phase I, the conceptual design phase.

While no formal drainage submittal is required for this meeting, key drainage issues should be identified and preliminary drainage structure sizes may be determined. The drainage designer may be required to consult with the Division of Structural Design.

The "Water-Related Impacts Summary" form is required for all projects and shall be included as an attachment to the meeting minutes. See **DR-202.18** and **Exhibit 200-3** for further explanation and discussion of this document.

DR-105.4 GEOMETRIC REVIEW MEETING

The geometric review meeting should be held before completing detailed drainage design, but after the project horizontal/vertical alignments, roadway templates, and initial roadway modelling (including entrances) are essentially complete to ensure consistency with project expectations.

Final drainage design should begin following completion of the geometric review required modifications. The location of the roadway should be detailed enough to complete the design of bridges and reinforced concrete box culverts (RCBCs) through the development of the advance situation survey (**DR 105-8**).

DR-105.6 PRELIMINARY DRAINAGE SUBMITTAL

The preliminary drainage submittal provides initial documentation for the proposed drainage design. It shall be submitted a minimum of two weeks prior to the drainage inspection to provide ample review time (**DR-300**).

DR-105.6 PRELIMINARY DRAINAGE SUBMITTAL (CONT.)

The preliminary drainage submittal shall be submitted to the project manager, who will then place it in the preliminary submittal folder in ProjectWise and forward a notification of this action to the Drainage Branch engineer.

The Drainage Branch engineer shall:

- Review the preliminary drainage submittal to ensure that the proposed drainage design is consistent with current procedures, accepted methodologies, policies, standards, and specifications. (**DR-304** contains more information related to submittal requirements and specific review responsibilities.)
- Ensure the preliminary submittal and supporting source data location is documented in the Drainage Branch archival tracking system.

DR-105.7 DRAINAGE INSPECTION & REPORT

Upon receiving the preliminary drainage submittal, the Drainage Branch engineer shall provide review comments to the drainage designer, who shall provide a reply to these comments.

If the Drainage Branch engineer and drainage designer are in agreement, the response will be included in the drainage inspection report. Otherwise, this review and approval process shall be repeated until agreement is achieved. The drainage designer shall notify the project manager once final agreement has been reached.

If appropriate, the Drainage Branch engineer may waive the drainage Inspection. In this event, the above final approved response shall be placed at the end of the final inspection report. The final inspection report shall be provided to the Project Manager.

If the drainage inspection is conducted during the final inspection, the drainage inspection report shall be included as a stand-alone component in the final inspection report. In such cases, the drainage review comments shall be placed at the end of the final inspection report, including drainage comments and recommendations made by any member of the final inspection team and previously approved comments by the drainage designer and Drainage Branch engineer.

If the drainage inspection is not conducted during the final inspection, rather at a time deemed appropriate by the project manager, the drainage inspection report shall not be included with the final inspection report. (See **HD-204** for more information about final inspections.)

DR-105.7 DRAINAGE INSPECTION & REPORT (CONT.)

The drainage inspection report shall be divided into the following categories:

- *General comments and recommendations.* These refer to the plans or drainage submittal in general. General comments may also arise from proposed designs that contradict guidance contained in this manual.

- *Specific comments and recommendations*. These refer to individual drainage structures and drainage systems. Specific comments and recommendations are obtained from a combination of the drainage submittal and plan review, from which the drainage designer or project manager shall generate the inspection report. Comments will be provided pertaining to specific drainage structures and systems as necessary. Any drainage structures not included in these comments shall be considered approved as presented on the plans.

Inspection reports shall be submitted electronically to the project manager, who shall then forward them to all inspection team members for comment and endorsement. (See **HD-204** for more details about submittal of inspection reports.)

Upon approval of the drainage inspection report, the drainage designer shall incorporate the recommendations and changes into the drainage design and drainage submittals as applicable.

DR-105.8 ADVANCE SITUATION SURVEY

The advance situation survey is considered the “order form” from the project manager to the Division of Structural Design (DSD) to begin structure design. It shall be sent to the project manager at a point in the design process where the horizontal and vertical extents of the project have been agreed upon by the PDT, usually following the geometric review meeting.

Once submitted, the project manager shall forward the advance situation survey to the Drainage Branch engineer to ensure the proposed hydraulic analysis is consistent with current procedures, accepted methodologies, policies, standards, and specifications. The Drainage Branch engineer’s approval of the advance situation survey serves as the notification to DSD that final structural design can begin. The DSD will review the advance situation survey for conformity to structural layout and design criteria.

DR-105.8 ADVANCE SITUATION SURVEY (CONT.)

While an advance situation survey is required for all bridges (wet or dry), box culverts, 3-sided culverts, retaining walls, and special structures, the Drainage Branch engineer is only required to review advance situation surveys containing drainage calculations (wet structures). Advance situation surveys shall never include small drainage structures (**DR-601.4**), ditch calculations, or other non-structural drainage calculations.

If the structural design leads to changes that could potentially affect the drainage design, the drainage designer and structural designer should coordinate prior to completion of the structural design process. Once final structural design has progressed to a point where the stream crossing geometry elements have been defined, the design shall be resubmitted to the drainage designer to update the hydraulic model for that structure. An update of that model shall then be provided to the Drainage Branch engineer as soon as possible for verification of hydraulic acceptability. The Drainage Branch engineer shall communicate any necessary revisions to the project manager to ensure completion of the appropriate updates to the structural design. Once the updates have been completed, the above-referenced review process by the Drainage Branch engineer shall be repeated until an acceptable hydraulic design has been achieved. The hydraulic design shall be completed prior to the final drainage submittal.

See **Exhibit 100-2**, **DR-304**, and **SD-202** for additional information on the advance situation survey, submittal requirements, and specific review responsibilities.

DR 105.9 FINAL DRAINAGE SUBMITTAL

The final drainage submittal (**DR-300**) is the archived legal document for the project drainage design, and shall be submitted with the check prints submittal.

The final drainage submittal shall be reviewed similarly to the preliminary submittal. As part of the review, the project manager and Drainage Branch engineer shall ensure the following:

- Content compliance
- Review process comments addressed
- Drainage design modifications not identified in the joint inspection or drainage inspection report (such as changes made during right-of-way acquisition) reviewed

DR-304 contains additional information related to submittal requirements, specific review responsibilities, and folder archival considerations.

DR-105.10 OTHER KYTC PROJECTS REQUIRING REVIEW

Projects such as design-build, highway safety improvement projects (HSIP), construction manager/general contractor (CMGC), as well as maintenance projects, may require modifications to KYTC drainage facilities. While these projects may offer a more streamlined approach to design, it is still the responsibility of the Central Office Drainage Branch to review the drainage design of **ALL** projects.

To allow the Drainage Branch to fulfill its primary purpose without delaying the timeline of these projects, KYTC recommends the following guidance for alternative delivery projects:

- Include the Drainage Branch in all drainage-related meetings, including predesign and scoping meetings, so the Drainage Branch engineer and the project's drainage designer can discuss review requirements and schedule.

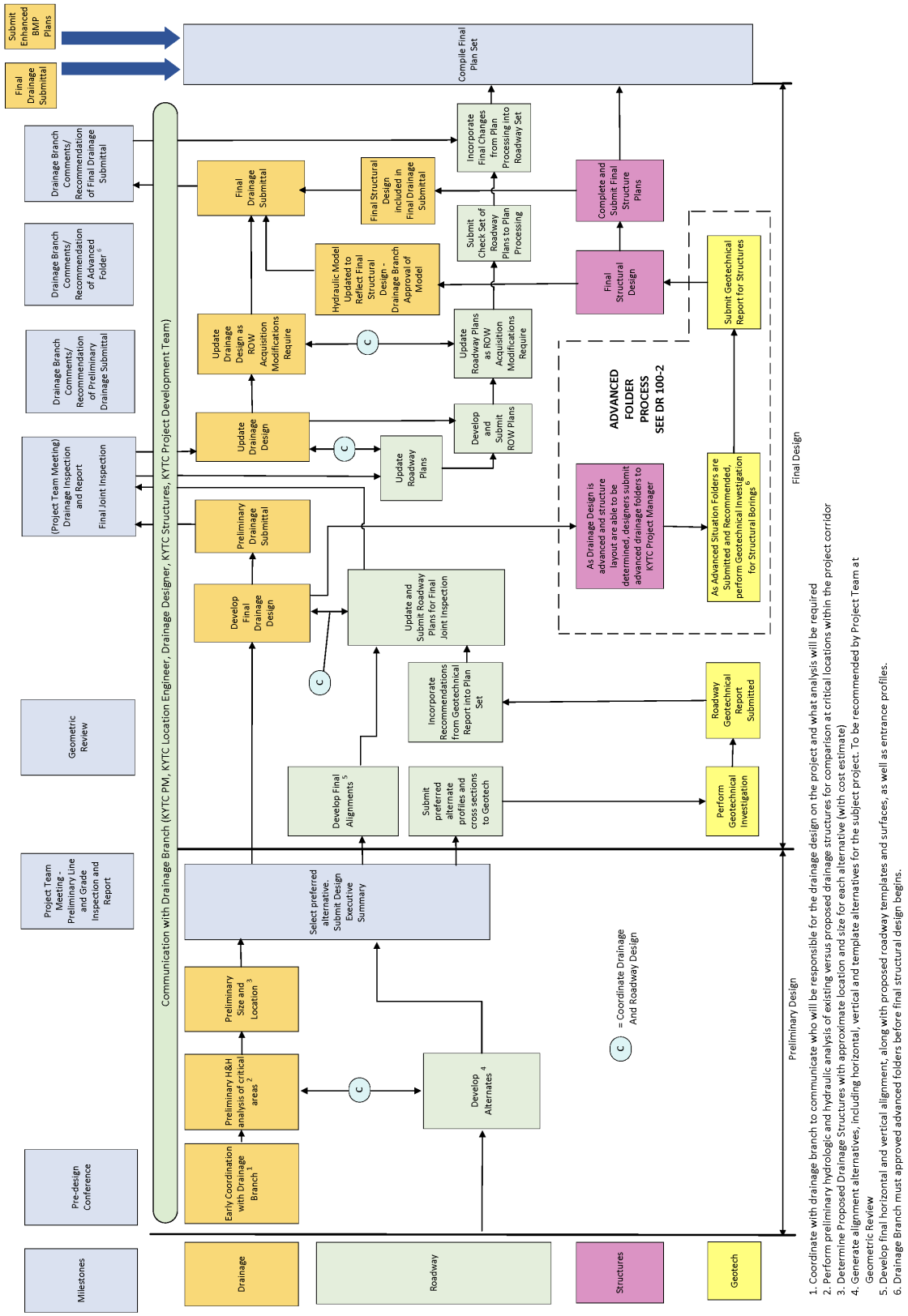
- The drainage designer shall submit all drainage plans and calculations to the Drainage Branch engineer. At minimum, summary tables of all applicable hydrologic and hydraulic facilities, as well as applicable source data, shall be included in this submittal.

- The Drainage Branch engineer shall make all efforts to help maintain the schedule for project deliverables. The KYTC project manager shall ensure the Drainage Branch engineer is aware of this schedule at the time of submittal. A reasonable amount of time will be provided to the Drainage Branch engineer for review.

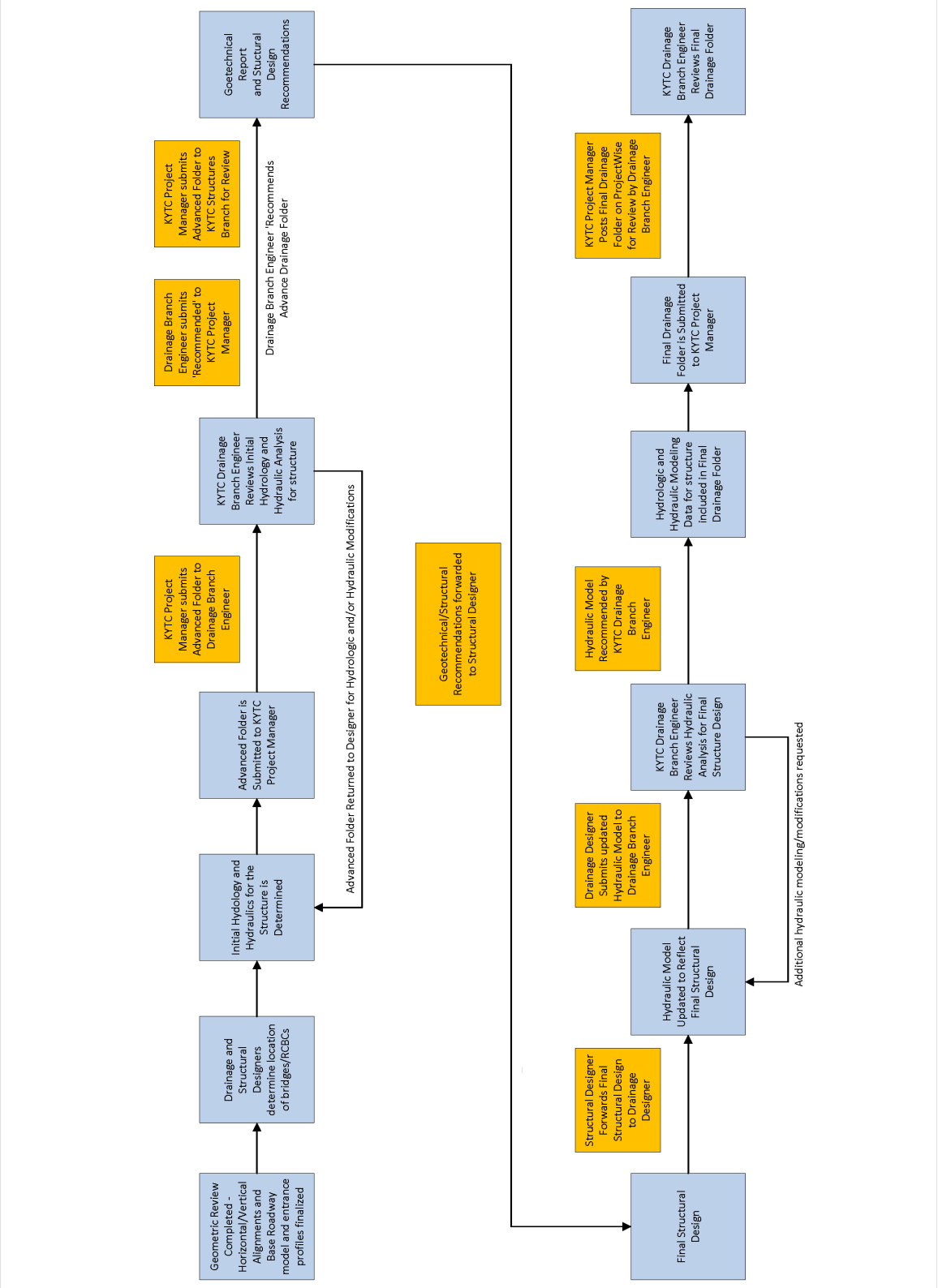
- The Drainage Branch engineer shall provide immediate electronic notification to the drainage designer of any issues requiring attention.

- Final drainage plans, calculations, and source data used in project construction shall be submitted to the project manager, who will then notify the Drainage Branch engineer. The Drainage Branch engineer shall archive this information in the appropriate KYTC database.

Exhibit 100-01



1. Coordinate with drainage branch to communicate who will be responsible for the drainage design on the project and what analysis will be required
2. Perform preliminary hydrologic and hydraulic analysis of existing versus proposed drainage structures for comparison at critical locations within the project corridor
3. Determine Proposed Drainage Structures with approximate location and size for each alternative (with cost estimate)
4. Generate alignment alternatives, including horizontal, vertical and template alternatives for the subject project. To be recommended by Project Team at Geometric Review
5. Develop final horizontal and vertical alignment, along with proposed roadway templates and surfaces, as well as entrance profiles.
6. Drainage Branch must approved advanced folders before final structural design begins.


Geometric Review Completed - Horizontal/Vertical Alignments and Base Roadway model and entrance profiles finalized
Drainage and Structural Designers determine location of bridges/RCBCs
Initial Hydrology and Hydraulics for the Structure is Determined
Advanced Folder is Submitted to KYTC Project Manager
KYTC Project Manager submits Advanced Folder to Drainage Branch Engineer
KYTC Drainage Branch Engineer Reviews Initial Hydrology and Hydraulic Analysis for structure
Drainage Branch Engineer submits 'Recommended' to KYTC Project Manager
KYTC Project Manager submits Advanced Folder to KYTC Structures Branch for Review
Goetechnical Report and Stuctural Design Recommendations
Advanced Folder Returned to Designer for Hydrologic and/or Hydraulic Modifications
Drainage Branch Engineer 'Recommends Advance Drainage Folder
Geotechnical/Structural Recommendations forwarded to Structural Designer
Final Structural Design
Structural Designer Forwards Final Structural Design to Drainage Designer
Hydraulic Model Updated to Reflect Final Structural Design
Drainage Designer Submits updated Hydraulic Model to Drainage Branch Engineer
KYTC Drainage Branch Engineer Reviews Hydraulic Analysis for Final Structure Design
Hydraulic Model Recommended by KYTC Drainage Branch Engineer
Hydrologic and Hydraulic Modeling Data for structure included in Final Drainage Folder
Additional hydraulic modeling/modifications requested
Final Drainage Folder is Submitted to KYTC Project Manager
KYTC Project Manager Posts Final Drainage Folder on ProjectWise for Review by Drainage Branch Engineer
KYTC Drainage Branch Engineer Reviews Final Drainage Folder