2.0 DRAINAGE POLICIES

In drainage design, policy considerations play an important role. Policies should reflect current design criteria and guidelines in conjunction with existing law. However, policy is not a substitute for specific review and, therefore, where unusual circumstances arise legal advice should be sought.

This section provides general guidance for the preparation of highway drainage designs that are compatible with the goals and practices of KDOT. For more information on legal aspects of highway drainage, see the *Highway Drainage Guidelines* and *Drainage Manual* of the American Association of State Highway and Transportation Officials (AASHTO).

2.1 CHANGES TO DRAINAGE CONDITIONS

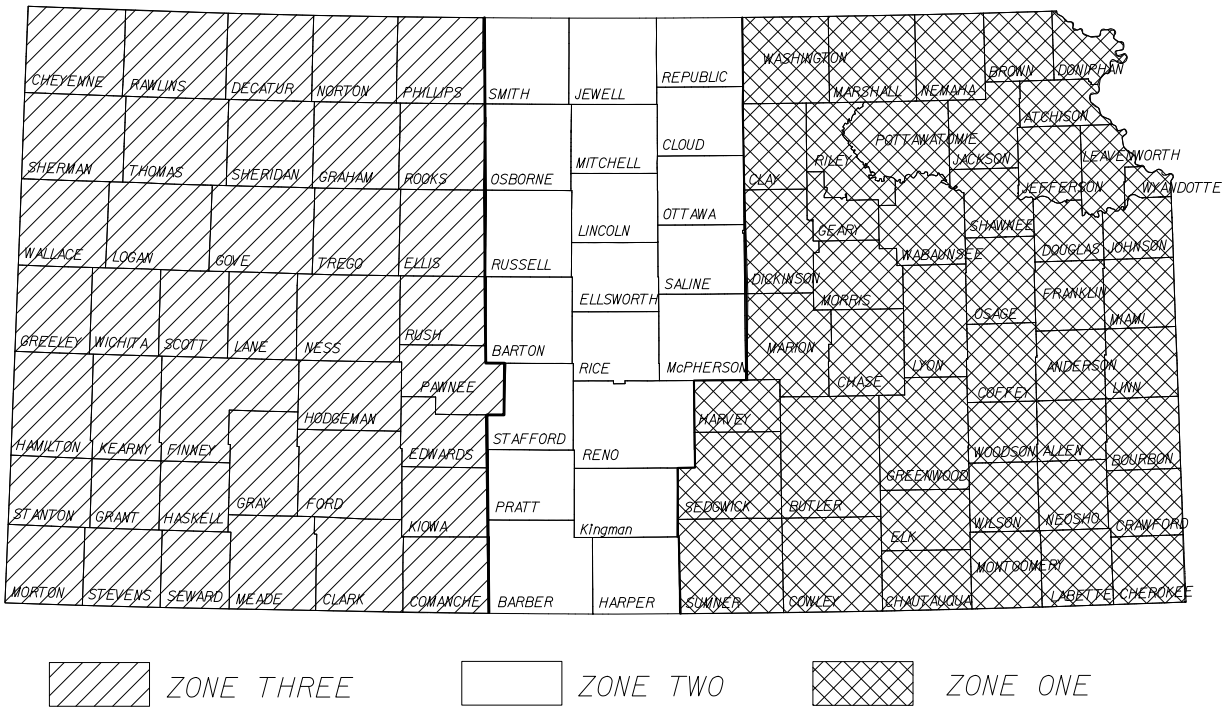
Highway construction or reconstruction may impact surface drainage patterns. Surface drainage within the corporate limits of a city may be regulated by local ordinances while that outside of the corporate limits of a city may be subject to State regulation.

Although the laws pertaining to surface drainage may vary depending on the location, it is the practice of KDOT that the construction or reconstruction of state highways to achieve one of the following:

- Make no substantial change, perpetuating existing drainage patterns insofar as practicable.
- Improve the existing drainage with consideration given to downstream effects.
- Provide reasonable measures to offset impacts of substantial changes (purchase of easement, payment of damage, construction of drainage structures, etc.)

Streams are subject to State regulation through the Division of Water Resources (DWR) of the Kansas Department of Agriculture. A regular or general permit is required for the construction of a dam or other water obstruction, or for a change in the course, current or cross section of a stream in Kansas. According to the Rules and Regulations of DWR, a stream under DWR jurisdiction is a watercourse that has a well-defined bed and banks, and that has a watershed above the geographic point in question that exceeds the following number of acres: (1) Zone three: 1,920 ac for all geographic points within any county west of a line formed by the adjoining eastern boundaries of Phillips, Rooks, Ellis, Rush, Pawnee, Edwards, Kiowa, and Comanche counties; (2) zone two: 1,280 ac for all geographic points within any county located east of zone three and west of a line formed by the adjoining eastern boundaries of Republic, Cloud, Ottawa, Saline, McPherson, Reno, Kingman, and Harper counties; and (3) zone one: 640 ac for all geographic points within any county located east of zone two. Figure 2.1-1, "Map of Kansas DWR Zones" shows a map of the DWR zones.

Figure 2.1-1 Map of Kansas DWR Zones



Certain other regulations and ordinances such as FEMA restrictions or a Drainage District may apply and should also be carefully considered. See Section 2.2, "COORDINATION WITH OTHER GOVERNMENTAL AGENCIES".

2.1.1 Changes in Drainage Areas

It is desirable that highway construction not cause a substantial change in the size of a drainage area at a stream crossing. If the highway configuration results in a substantial change in the drainage area, the effects of this change should be evaluated and appropriate measures should be taken to alleviate apparent impacts.

2.1.2 Changes in Permeability of Surfaces

An increase in impervious surface area from highway construction causes an increase in runoff. The effects of an increase in impervious surface area can be similar to the effects of an increase in drainage area. If the highway construction will cause a substantial increase in impervious surface area, the effects of this change should be evaluated and appropriate measures should be taken to alleviate apparent impacts.

2.1.3 Changes in Channels

It may be necessary to modify a channel in order to make it more compatible with the highway facility and the physical constraints imposed by local terrain or land use. Alterations to channels may result in changed velocities in the altered section and changes to the potential for erosion.

Substantial changes should be evaluated to assess the short term and long term effects on the channel. Changes in channels should be avoided if feasible.

2.1.4 Changes to Drainage Structures

Highway improvement projects often include the extension of existing drainage structures. In many cases the extension of a drainage structure will not change its hydraulic performance. However, in cases where changes to an existing drainage structure are made, the upstream and downstream effects should be considered. In general, existing drainage structures should be altered to the minimum extent practical.

2.2 COORDINATION WITH OTHER GOVERNMENTAL AGENCIES

Where local public authorities have adopted floodplain ordinances pursuant to the 1968 National Flood Insurance Act, under the authority of FEMA, the FHWA has directed that all federal-aid highway projects will comply with the authorized regulations. It is the practice of KDOT to follow that directive. See FHWA's "Procedures for Coordinating Highway Encroachments on Floodplains with FEMA" in the Bridge Design Manual.

In areas where a detailed engineering study has established the 100-year flood elevation and the 100-year floodway boundaries under the direction of FEMA, the design should not increase the 100-year water-surface elevation (WSE) by more than an amount specified by FEMA and KDOT.

In areas where the floodplain is defined by a FEMA Flood Hazard Boundary Map but does not have a firm WSE established by a detailed engineering study, it is the practice of KDOT to provide a design that meets the applicable criteria in this manual.

When a proposed structure is located within a flood control project under the direction of the U.S. Army Corps of Engineers (USACE) or a local public authority, it is the practice of KDOT to cooperate with the flood control agency and provide a design that does not violate or modify either the assumptions of the design or the operation of the flood control works.

KDOT projects that may impact a USACE constructed project requires review and approval from the Corps under 33 USC 408 (Section 408). Section 408 applies to Civil Works projects constructed by the Corps, including dams, levees, channels, and other flood risk management projects. The National Levee Database can be useful in determining locations of many of these USACE projects. Proposed temporary or permanent alterations on, or nearby, a Corps Civil Works project, needs to be submitted to the Corps for review.

The Corps may require additional project information, including detailed geotechnical, hydraulic, or other analysis during the review process. The request for approval should be submitted as early in the project as practical to allow time for the review process and possible adjustments to the highway project, if needed. The designer should contact the USACE Tulsa District office for projects in southern Kansas, or the USACE Kansas City District office for projects in northern Kansas. KDOT ESS can assist in identifying which office has jurisdiction.

The Section 408 review and approval is not an environmental review itself but permits for the USACE Section 404 of the Clean Water Act cannot be issued by the USACE Regulatory Branch until the Section 408 approval is received. The USACE Engineering Circular (EC) 1165-2-220, "Policy and Procedural Guidance for Processing Requests to alter US Army Corps of Engineers

Civil Works projects Pursuant to 33 USC 408" provides guidance in processing requests to alter or modify Civil Works projects that were constructed by the Corps.

Application for Section 408 approval is the responsibility of the designer, and not the KDOT Environmental Services Section.

See Section 2.1 for coordination with DWR.

2.3 ALLOWABLE WATER SURFACE ELEVATION

The allowable water surface (AWS) elevation should be determined for each improvement or land use upstream of a drainage structure or adjacent to a road ditch. The calculated allowable headwater elevation (AHW) for a drainage structure accommodating the design flow should not exceed the AWS for the upstream improvement or land use. If the backwater from the drainage structure is shown to affect multiple improvements or land uses that require different degrees of protection, the designer should determine an AWS elevation and a corresponding recurrence interval from Table 2.4-1 "Guidelines for Design Recurrence Interval" for each type of improvement or land use.

Table 2.3-1 provides guidelines for determining the AWS elevations. The AWS elevation should also comply with backwater restrictions imposed by a jurisdictional regulatory agency, such as FEMA or DWR.

Table 2.3-1 Guidelines for Allowable Water Surface

Improvement or Land Use	Allowable Water Surface Elevation
Buildings*	Floor Elevation (Slab Floor) Basement Window, Basement Drain,
Bridges	See Bridge Design Manual
Roads	Top of subgrade at outside edge of shoulder
Road Ditches	Top of low bank, or top of subgrade at outside edge of shoulder in a cut section
Culverts	May be submerged without damage
Levees	Top of levee, less freeboard
Cemeteries	Low point on property line

*Insurable buildings such as residences, commercial buildings, offices, schools, and churches; also includes building sites in subdivisions with plats approved by local government. Providing additional freeboard may be considered on a case by case basis.

2.4 RECURRENCE INTERVAL

An appropriate recurrence interval should be selected for design considering the improvement and/or land use. For highway bridge crossings, see the Bridge Design Manual. Table 2.4-1 provides guidelines for selection of the recurrence interval.

Table 2.4-1 Guidelines for Design Recurrence Interval

Design Recurrence Interval	Improvement or Land Use
100 year	Buildings*, cemeteries
50 year	Freeways; highways designed to interstate standards
25 year	Primary routes, secondary routes, major side roads, interstate ramps; facilities for storage of low-value, non-hazardous goods or materials
10 year	Local routes, minor side roads, entrances, road ditches; detours and temporary roadways to be used for more than two construction seasons
5 year	Detours and temporary roadways to be used for two construction seasons
2 year	Detours and temporary roadways to be used for one construction season

*Insurable buildings such as residences, commercial buildings, offices, schools, and churches; also includes building sites in subdivisions with plats approved by local government

These guidelines should be applied to the extent practicable for new and existing highway drainage structures. On highway reconstruction or replacement projects, where existing facilities and right-of-way often dictate highway profiles, it may not be feasible to meet these guidelines. In such cases, the designer should endeavor to provide the highest degree of protection that is cost-effective under the existing circumstances. Federal, state, or local floodplain ordinances requiring a greater degree of protection may take precedence over these guidelines.

It is reasonable to expect that an improvement located near a stream could be flooded more frequently than these guidelines indicate even if the highway were not present. Most streams overtop their banks naturally with an average recurrence interval of approximately two years. Improvements located in flood-prone areas are likely to be flooded occasionally. KDOT is not responsible for mitigation of flooding that is unrelated to the highway.

If a drainage structure is located a short distance upstream of a confluence with a much larger stream, the tailwater level at the structure may be substantially affected by backwater from the larger stream. In this case, the water level in the larger stream should be determined before the

tailwater level at the structure can be computed. If the drainage area of the larger stream is more than ten times the drainage area of the smaller stream, the recurrence interval used to compute the water level in the larger stream should be shorter than the recurrence interval used to design the structure. Guidelines for this situation, which is termed frequency mixing, are presented in the Bridge Design Manual.

2.5 DETENTION STORAGE DESIGN FOR CULVERTS

Many highway crossings temporarily impound some water during floods. At some locations, it may be practical and beneficial to consider the hydraulic effects of the natural storage in the design of the structure. Structures designed for detention storage effects may be smaller and more economical than structures designed for peak flow. The feasibility of detention storage design is determined by weighing the savings in the structure cost against the costs of additional surveys and additional right-of-way (R/W). A structure designed for detention storage should be capable of fully draining the detained runoff for the design event within 24 hours of the peak stage.

A structure may be designated as a detention storage structure only where sufficient storage volume is provided by purchase of easement or R/W. KDOT generally prefers that land needed for detention storage be acquired by purchase of R/W. However, where continued private use of the land is mutually beneficial to KDOT and the landowner, a flowage easement may be purchased. The purpose of a flowage easement is for managing or preserving the flow and/or storage of water within the easement. The flowage easement also permits access for clearing and dredging as needed to maintain the storage capacity. When the purchase of R/W or flowage easement is determined to be appropriate, it should include the land within an elevation contour 1.0 ft above the 100-year WSE, although the legal description need not follow this contour. Two examples of flowage easements are provided in the Bridge Design Manual.

Detention storage areas are not limited to locations immediately adjacent to the R/W. Detention structures may be constructed at locations remote from the highway. If the adjacent landowner desires a permanent impoundment for agriculture or conservation purposes and such impoundment would qualify for National Resource Conservation Service (NRCS) assistance, it is the practice of KDOT to cooperate with the NRCS and contribute to the extent that benefits accrue to KDOT.

2.6 ALTERNATE TYPES AND MATERIALS FOR DRAINAGE STRUCTURES

2.6.1 Alternate Structure Types

The designer should determine the type and size of structure to meet the hydraulic and structural requirements set forth in this manual. Economics should be considered in selecting the type of structure. Alternate structure types should not be included in the highway plans.

2.6.2 Corrugated Metal Pipe

The designer should refer to KDOT's current policy on the use of corrugated metal pipe (CMP). Generally, the designer should allow the use of CMP for conditions consistent with those stated in the policy.

2.6.3 Thermoplastic Pipe

The designer should refer to KDOT's current policy on the use of thermoplastic pipe including high density polyethylene (HDPE) and polyvinyl chloride (PVC). Generally, the designer should allow the use of HDPE and/or PVC for conditions consistent with those stated in the policy.

2.6.4 Precast Structures

Many drainage structures such as inlets, manholes, and reinforced concrete boxes are available as prefabricated units. A precast structure should be allowed, but not specified, as an alternate on the plans unless circumstances require a cast-in-place structure. As a general rule, precast reinforced concrete boxes are not permitted in the following situations:

1. Fill height over RCB is less than 2.0 ft, unless conditions favor the precast option.
2. Multiple-cell installations with more than two cells, unless significant economic justification is shown.
3. Where substantial settlement or erosion is expected due to foundation soils or conditions.
4. When a structure is within a MSE wall.
5. Extension of an existing structure.

2.6.5 Proprietary Items

Proprietary items should not be specified unless their use would constitute a clear cost reduction. The designer should refer to Volume I, Bureau of Road Design, Section 2.6.17 of the KDOT Road Design Manual, "Proprietary Items on Plans" if "approved equal" products are not available for a specific item.

2.7 MINIMUM SIZES FOR DRAINAGE STRUCTURES

The minimum size for culverts and storm sewers depends on the potential for sedimentation within the pipe and the resultant need for periodic cleaning. Pipes that will carry clean water, such as from paved areas and grassed medians, may be as small as 12 in. in diameter. Pipes that need to be entered for cleaning should be 30 in. in diameter or larger. Pipes that can be cleaned from either end should be 24 in. in diameter or larger. Each District should be contacted concerning its preference and experience regarding minimum pipe size. The minimum height for a new RCB culvert that does not require embedment is 3 ft. In addition, constructibility should be considered in the process to determine the culvert size and type.

For minimum sizes and other information regarding culverts that require embedment, the designer should review Road Memorandum No.16-02, "Embedment of Culverts on Jurisdictional Streams". In addition, the designer should contact the Environmental Services Section.

2.8 END TREATMENTS FOR DRAINAGE STRUCTURES

The inlets and outlets of permanent drainage structures should be provided with an appropriate end treatment. This requirement applies to extensions of existing structures as well as new structures. The end treatment is typically a manufactured end section or a concrete headwall and wingwalls. The inlet and outlet locations and end treatments should comply with the KDOT Roadside Design Guidelines.

2.9 REFERENCES

AASHTO (2007). *The Legal Aspects of Highway Drainage,* Highway Drainage Guidelines, Chapter 5.

AASHTO (2014). Drainage Manual.

AASHTO (2011). *Roadside Design Guide.*

FHWA (1999). *Procedures for Coordinating Highway Encroachment of Floodplains with FEMA*, KDOT Bridge Design Manual.