Kentucky Statewide TMDL for Bacteria Impaired Waters

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TMDL Section
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Why Pathogen TMDLs?

- Protect recreational uses…

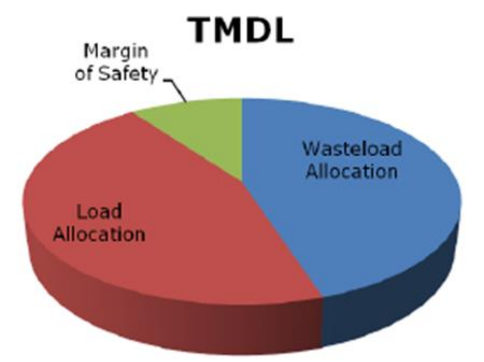
- Promote awareness

TMDL Requirements

- Clean Water Act regulations require states to calculate a **T**otal **M**aximum **D**aily **L**oad for each surface water impaired by a pollutant

- TMDL must be expressed as a **load** (amount of pollutant per day)
  - **Bacteria: colonies/day** of *E. coli* or fecal coliform

- Total load is allocated among sources of the pollutant



A TMDL Calculation Represents…

- Maximum amount of a pollutant a water body can receive in a day and still meet water quality standards
- Receiving water’s capacity to assimilate the pollutant of concern
- ***Allowable loading*** of the pollutant

Watershed-based TMDL Process…

- 2-3 year data collection effort
- Sample multiple streams in watershed for bacteria levels
- Assess previously unassessed streams
- Collect flow data from multiple streams
- Identify all KPDES-permitted sources, obtain design flows

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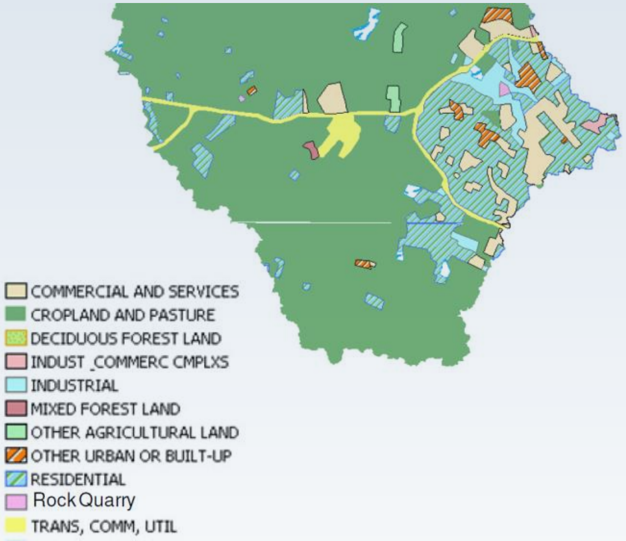
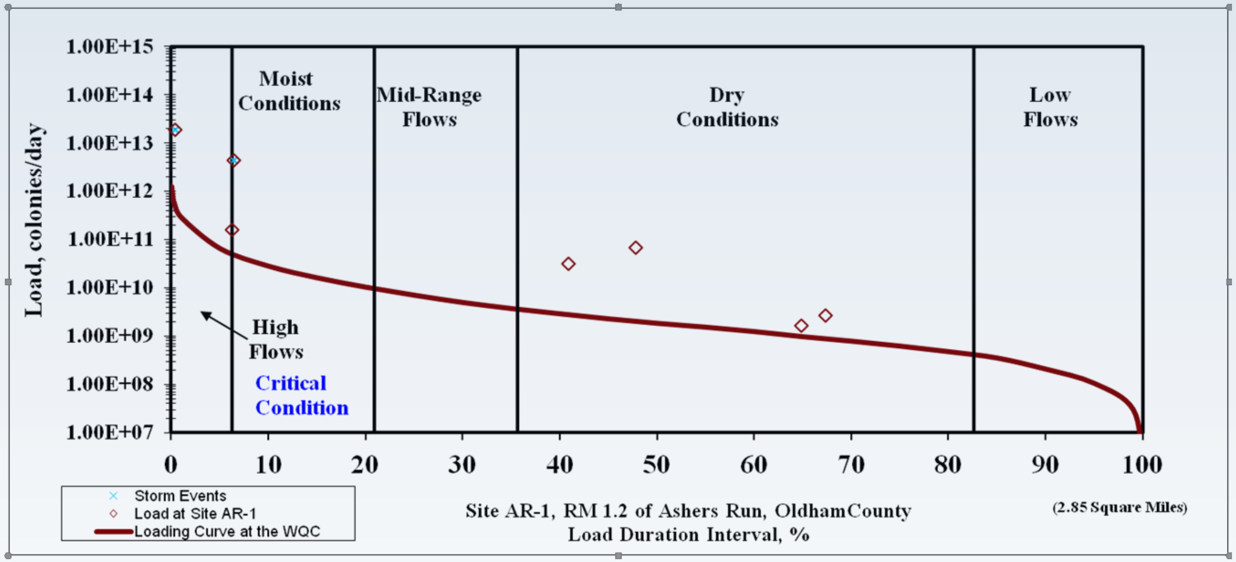
…Watershed TMDL Process

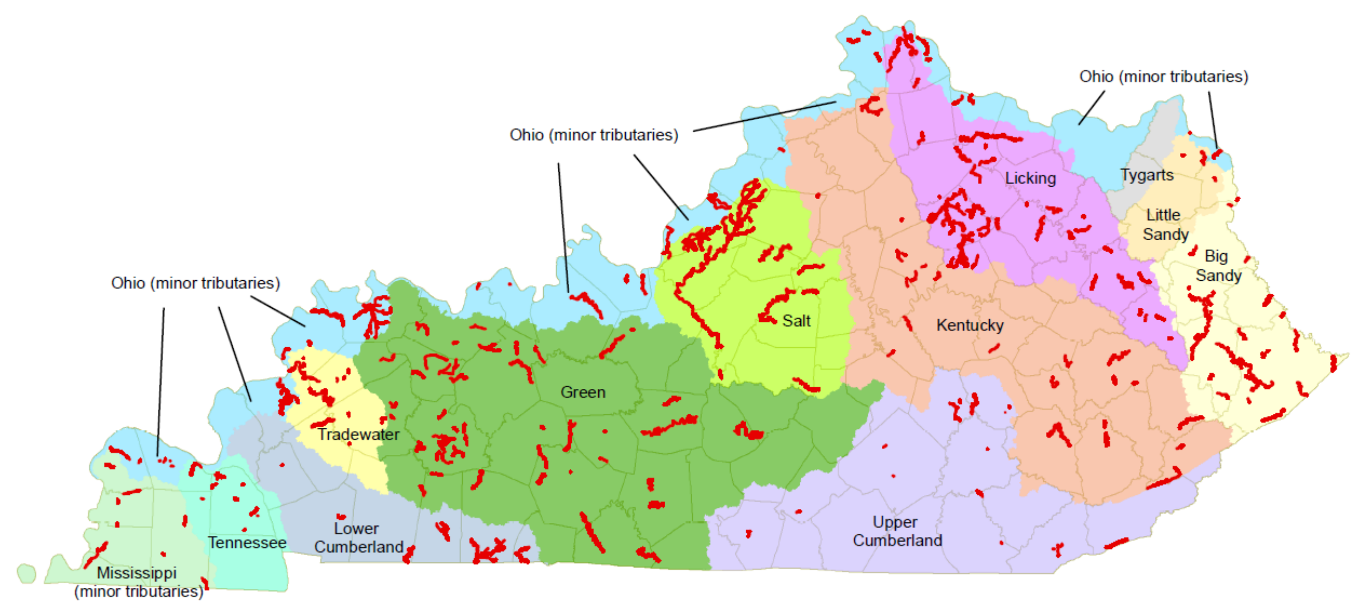
- Use data to develop flow & load duration curves
- Determine critical flow – when conditions at their worst
- Use critical flow to calculate numeric TMDL
- Use GIS to analyze land use within MS4 boundaries
- Identify & evaluate relative impact of nonpoint sources





Current KY Pathogen TMDL Reality

- 2016 draft 303(d) list: 422 bacteria listings
- Decades to complete TMDLs for all current bacteria listings using watershed method – & new waters get added each listing cycle
- KPDES facility permits: require year-round disinfection; bacteria limits based on most protective criterion
- MS4, CSO, and NPS programs have frameworks tailored to addressing bacteria from these sources



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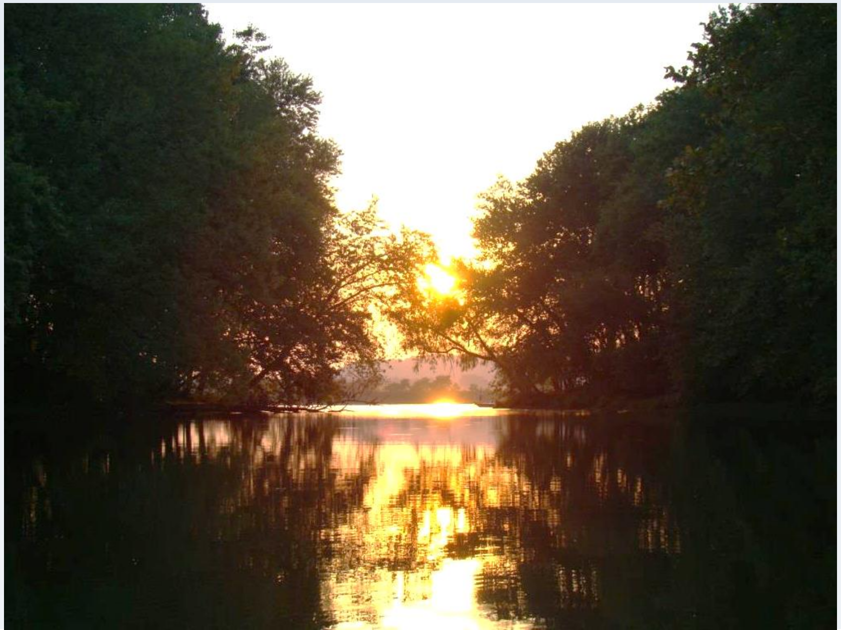
Pathogen TMDL Method Goals

- Efficient/simple method allowing many TMDLs to be produced within a few years
- Applicable to all bacterial indicators and recreational uses, even if indicator changes
- Applicable to all sizes of stream systems
- Does not require additional data collection



- Minimizes or eliminates the need to work with other state TMDL programs
- Meets CWA requirements and EPA TMDL guidance

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Streamlined Method Overview

- **Produce Segment TMDLs instead of Watershed TMDLs.**

  Upstream and tributary loadings are noted separately from the segment loadings

- **Leave TMDLs & allocations in equation form**

  as opposed to solving equations for one critical condition using one bacteria criterion

The Equation Driving the Process

- Total load for a water is divided among pollutant sources, with a margin of safety (MOS) factored in to address uncertainties
- KPDES-permitted dischargers (point sources) each receive individual **Wasteload Allocation** (WLA)
- Nonpoint sources receive a **Load Allocation** (LA)


hu.wikipedia.org

$$TMDL = \underbrace{\sum WLA}_{\text{point sources}} + \underbrace{\sum LA}_{\text{nonpoint sources}} + MOS$$

Deriving the Segment Method

$$\mathrm{TMDL} = \underset{\text{Point sources}}{\sum \mathrm{WLA}} + \underset{\text{Nonpoint sources}}{\sum \mathrm{LA}} + \mathrm{MOS}$$

$$\sum \mathrm{WLA} = \sum \mathrm{WLA}_{\mathrm{segment}} + \sum \mathrm{WLA}_{\mathrm{upstream}} + \sum \mathrm{WLA}_{\mathrm{tributary}}$$

$$\sum \mathrm{LA} = \sum \mathrm{LA}_{\mathrm{segment}} + \sum \mathrm{LA}_{\mathrm{upstream}} + \sum \mathrm{LA}_{\mathrm{tributary}}$$

Regroup and “lump”:

$$\mathrm{TMDL} =$$

$$\left(\sum \mathrm{WLA} + \sum \mathrm{LA}\right)_{\mathrm{Segment}} + \underbrace{\left(\sum \mathrm{WLA} + \sum \mathrm{LA}\right)_{\mathrm{Upstream}}}_{\text{Lumped allowable upstream load}} + \underbrace{\left(\sum \mathrm{WLA} + \sum \mathrm{LA}\right)_{\mathrm{Tributary}}}_{\text{Lumped allowable tributary load}}$$

$$\ldots + \mathrm{MOS}$$

In Other Words…

Allowable loads for direct sources
+ Allowable upstream load
+ Allowable tributary load
+ MOS
= TMDL

How to Determine Allowable Loads?

- Start with the water quality criteria (WQC) – the standards to meet

Recreational Use Protected →	**Primary Contact (swimming)**	**Secondary Contact (wading, boating)**
Instantaneous Criterion →	240 colonies E. coli/100 ml 400 colonies fecal coliform/100 ml	2,000 colonies fecal coliform/100 ml
Geometric Mean Criterion →	130 colonies E. coli/100 ml 200 colonies fecal coliform/100 ml	1,000 colonies fecal coliform/100 ml
Season Applied →	May 1 - Oct. 31	year-round

- Instantaneous criteria shall not be exceeded in 20 percent or more of all samples taken during a 30-day period.
- Geometric mean based on not less than 5 samples taken during a 30-day period.

- 401 KAR 10:031

Calculating Loads

$$\textbf{Allowable Load} = Q \times WQC \times CF$$

Where:
Q is the flow
WQC is the applicable criterion
CF is the conversion factor to obtain a load (colonies/day)

$$\textbf{Segment TMDL} = Q_S \times WQC \times CF$$

Where
Q_S : instantaneous flow in the segment
MOS is implicit based on conservative assumptions

Next, substitute flow-based equation into allowable load terms for upstream, tributary, and direct sources to obtain allocations…

Segment TMDL Allocations

Source allocation/allowable load:

$$= Q_{source} \text{ x } WQC \text{ x } CF$$

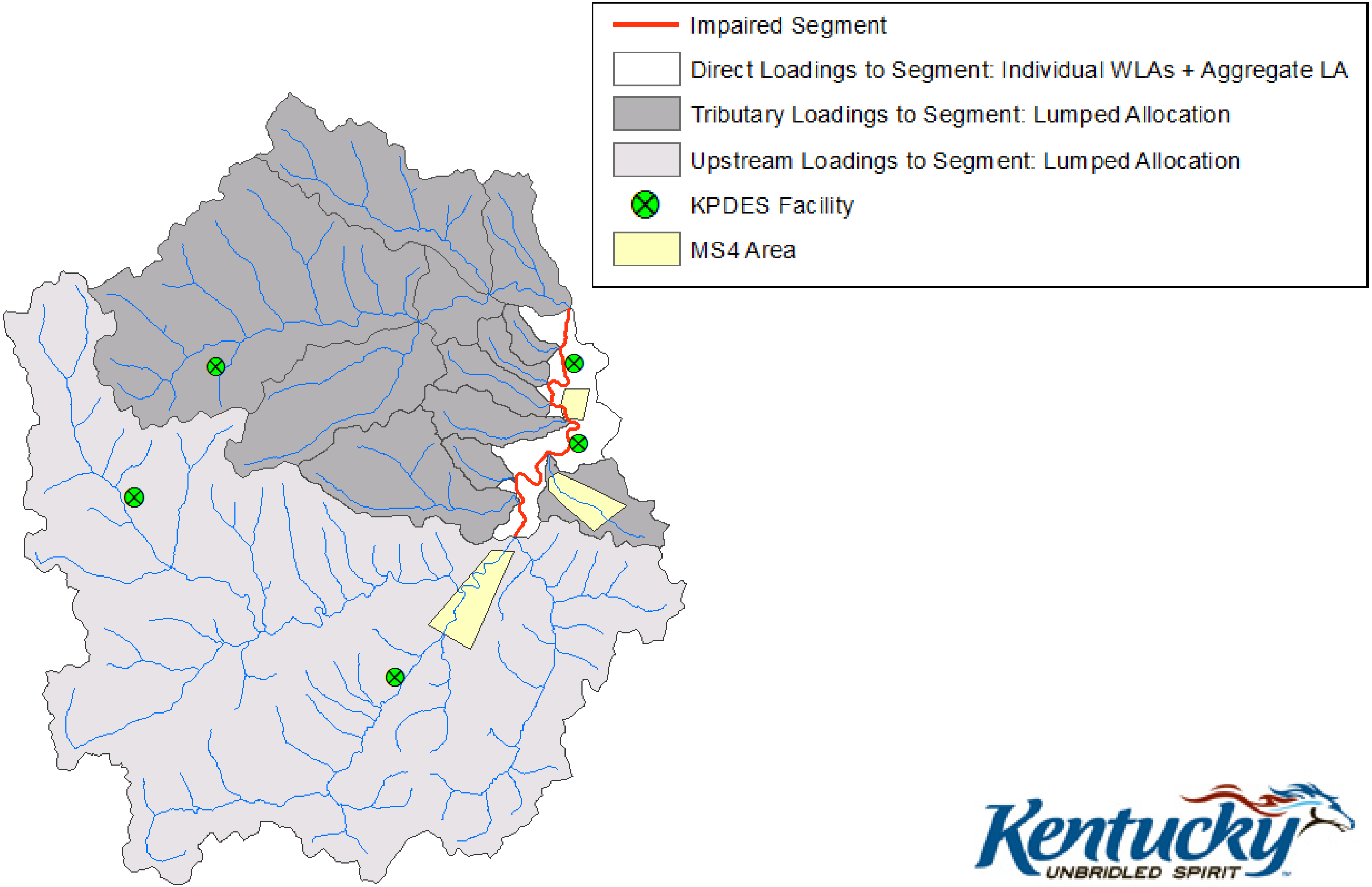
Where sources include:

- upstream areas
- tributary areas
- direct discharges from…
    - KPDES sanitary wastewater systems
    - MS4 entities
    - CSO entities
    - nonpoint/runoff

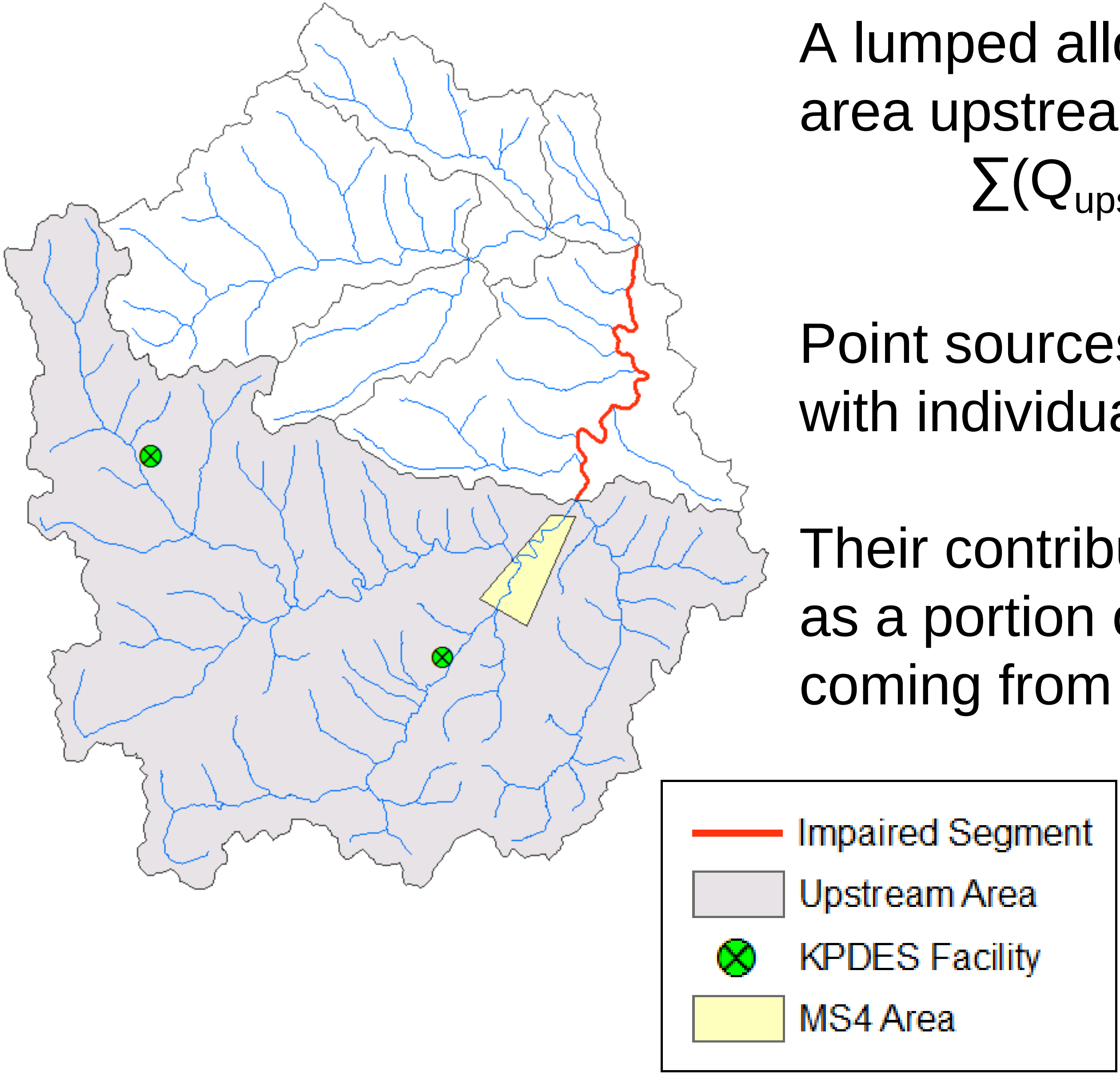
- All flows (Q) are instantaneous
- All allowable loads remain in equation form

Allowable load for each entity depends on the flow contributed by that entity.

Example Impaired Segment



Upstream Loadings



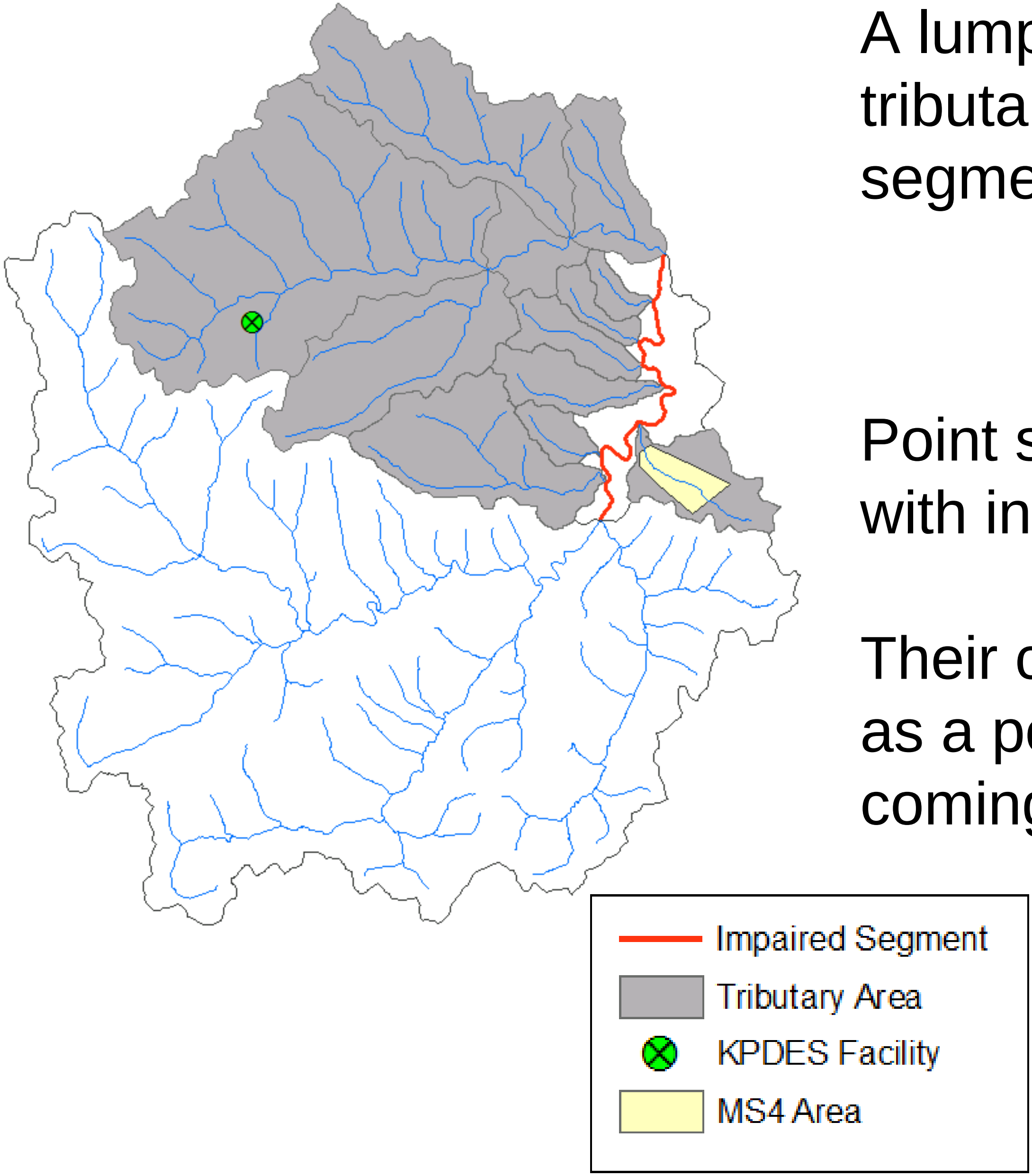
A lumped allocation is given to the area upstream of the segment.

$$\sum(Q_{upstream} \times WQC \times CF)$$

Point sources are not identified with individual WLAs.

Their contribution is accounted for as a portion of total flow & load coming from upstream.

Tributary Loadings



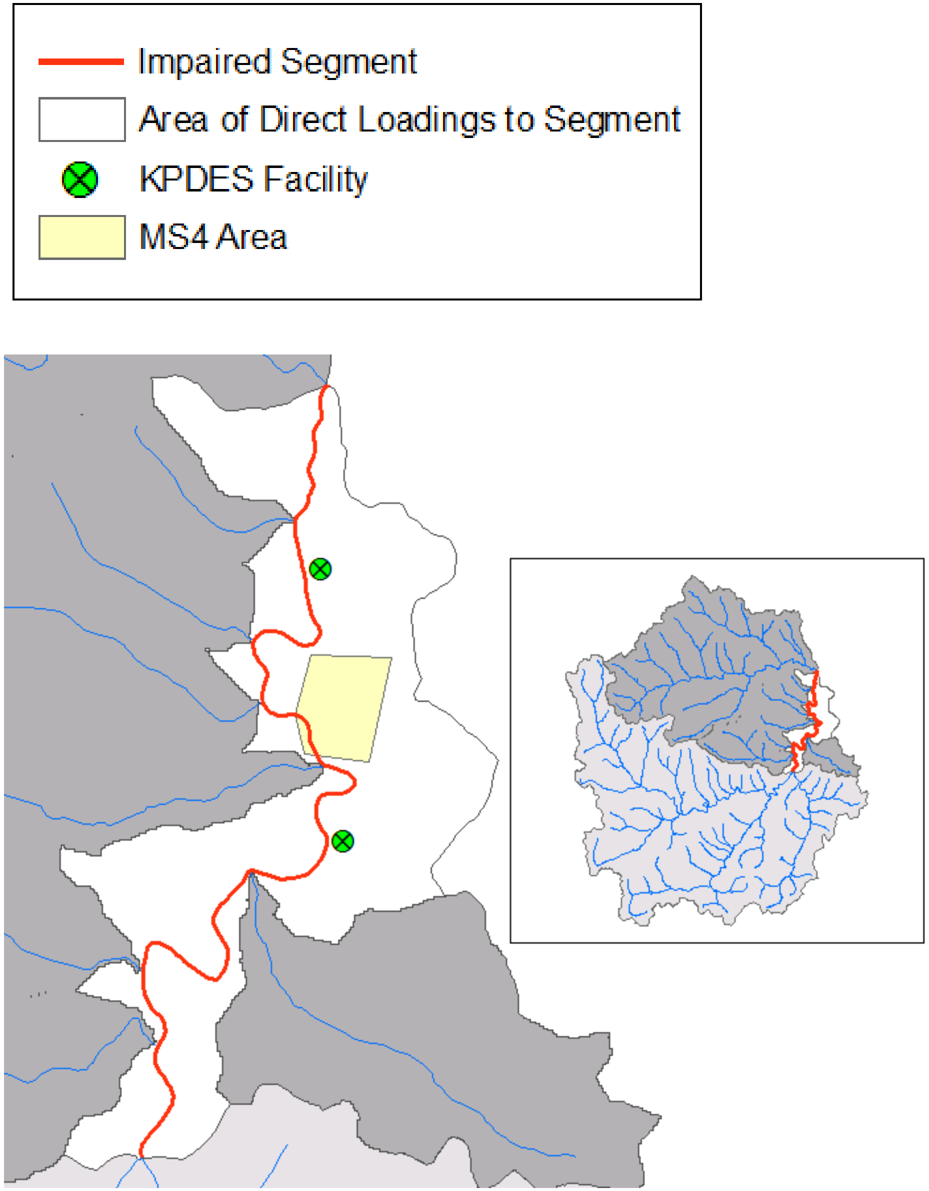
A lumped allocation is given to tributary contributions to the segment.

$$\sum(Q_{tributary} \text{ x } WQC \text{ x } CF)$$

Point sources are not identified with individual WLAs.

Their contribution is accounted for as a portion of total flow & load coming from tributaries.

Direct Loadings



KPDES sanitary dischargers and CSOs get individual WLAs.

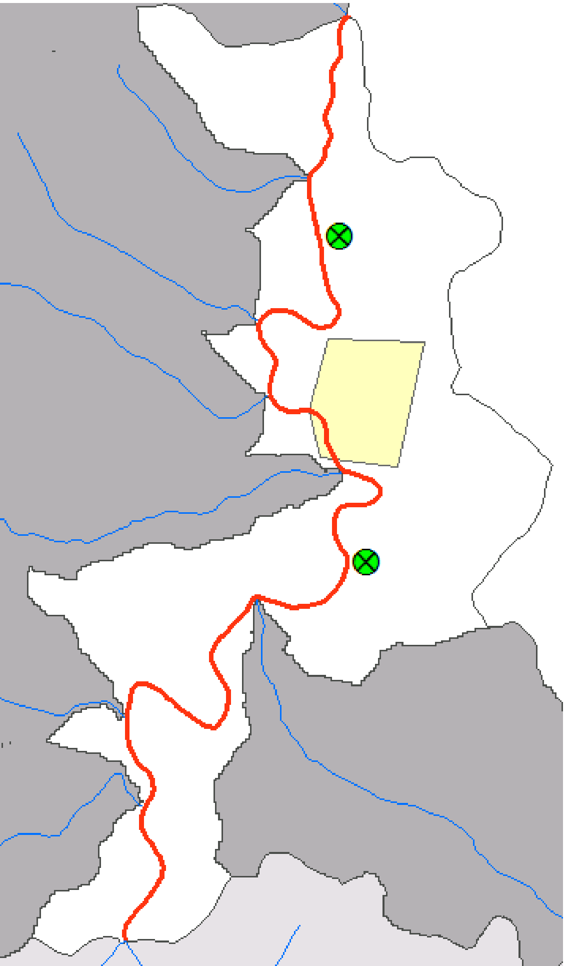
MS4 areas get an in-stream allocation proportional to their flow contribution.

Nonpoint sources receive a load allocation.

Direct Loading Allocations

Allocations for direct loads to the segment:

$\sum(Q_{SWS} \times WQC \times CF)$ = WLA for KPDES sanitary system discharges



$\sum(Q_{MS4} \times WQC \times CF)$ = WLA for MS4s

$\sum(Q_{CSO} \times WQC \times CF)$ = WLA for CSOs

$\sum(Q_{LA} \times WQC \times CF)$ = Load Allocation for nonpoint sources

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What about Storm Water?

- “During wet weather events, a CSO entity is considered to be compliant with its CSO-WLA if it is compliant with its KPDES permit.”

- “Dry weather CSO flows are prohibited.”

MS4s

- Only MS4s with land directly adjacent to the impaired segment would be identified in the segment MS4-WLA.

- Any other MS4s in the watershed would be included in a “lumped allocation” under the tributary or upstream category.

MS4s

- The MS4-WLA is an in-stream allocation, not an end-of-pipe limit.

  “The MS4-WLA is an aggregate of the in-stream contribution of all MS4 outfalls within the MS4 jurisdiction, not the storm water contribution from individual MS4 outfalls.

  The MS4-WLA will be addressed through the MS4 permit and implemented through the Storm Water Quality Management Plan (SWQMP) to the Maximum Extent Practicable (MEP).”

Method Effect

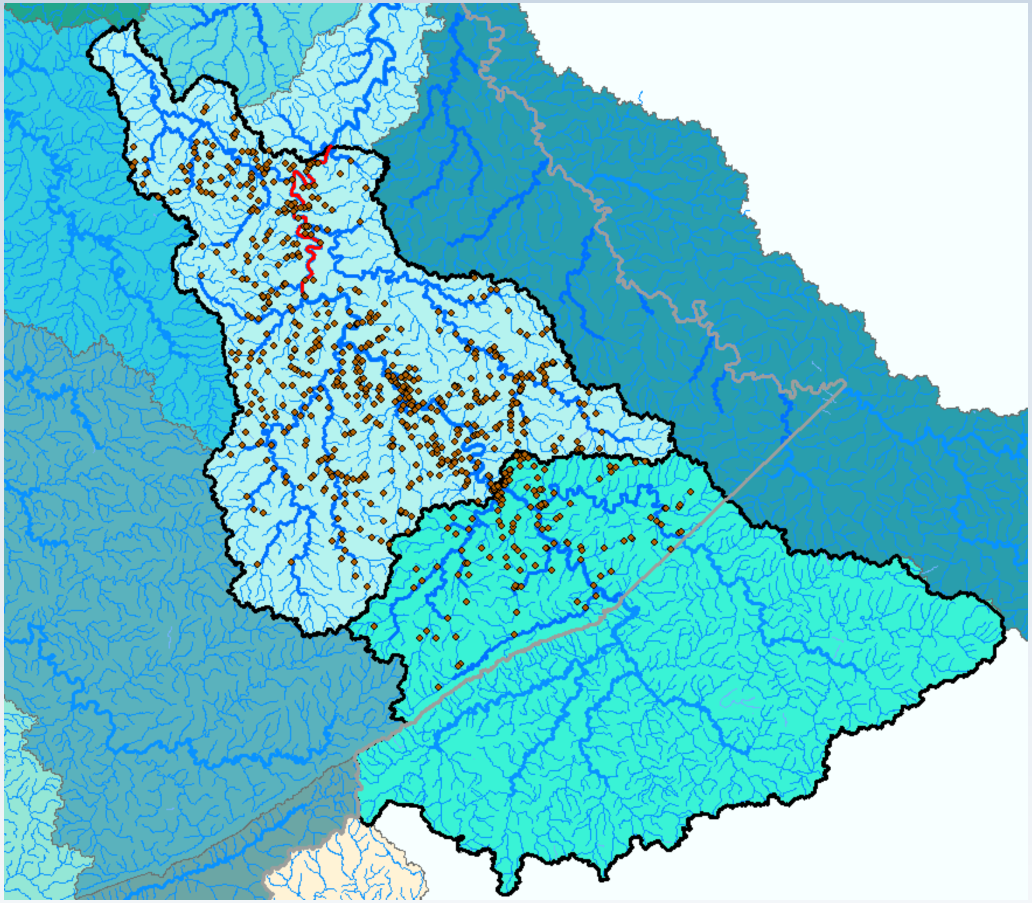


- No numeric WLA or LA calculations
- No existing load calculations
- No percent reduction calculations




Impact on Example Watershed TMDL

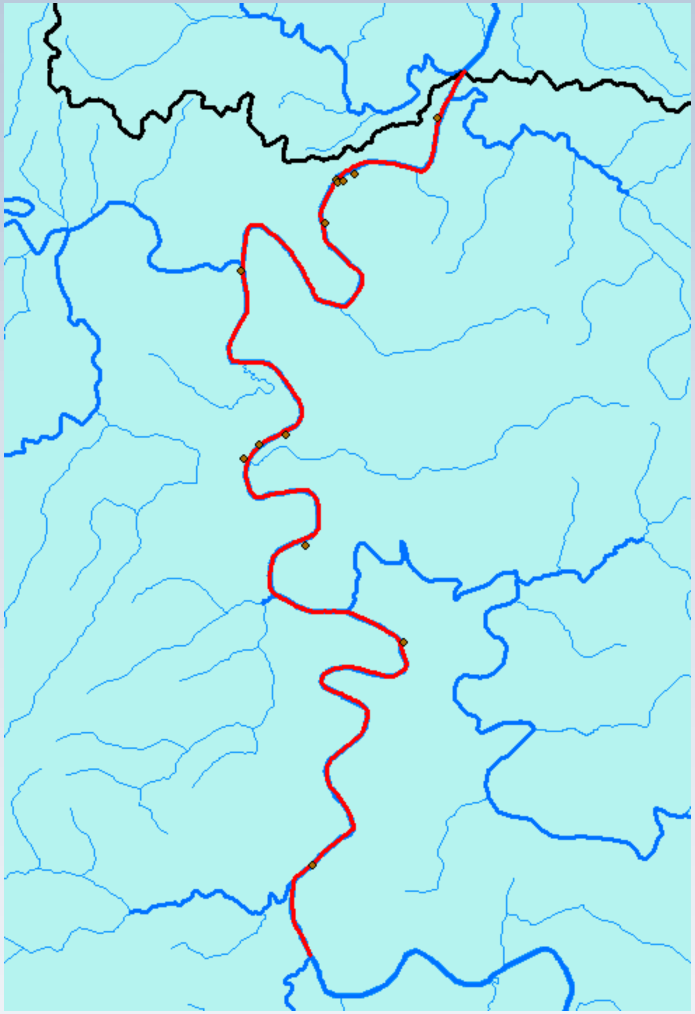
- Levisa Fork 34.1 to 54.7 (3130 mi^2):
  - – 791 KPDES sanitary discharges in KY plus unknown number in VA



Segment TMDL Method

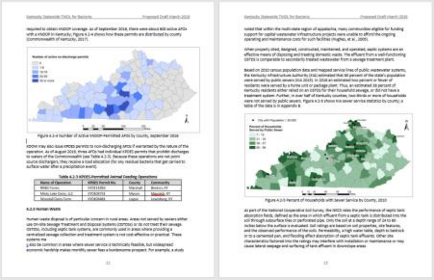
Levisa Fork 34.1 to 54.7:

  - 12 KPDES sanitary discharges directly into segment (tributaries at 1:24K)



Report Organization

- **Core document**



  - Problem statement
  - WQCs
  - Physical setting (physiographic regions, karst considerations)
  - Source types discussion
  - Explanation of equation-based TMDL method
  - Implementation options

- **Basin appendices**
  - 1 appendix for each major basin (total of 13)
  - Overview of basin characteristics (hydrology, land use)
  - TMDL and allocations for each impaired segment within the basin

Example Basin Appendix

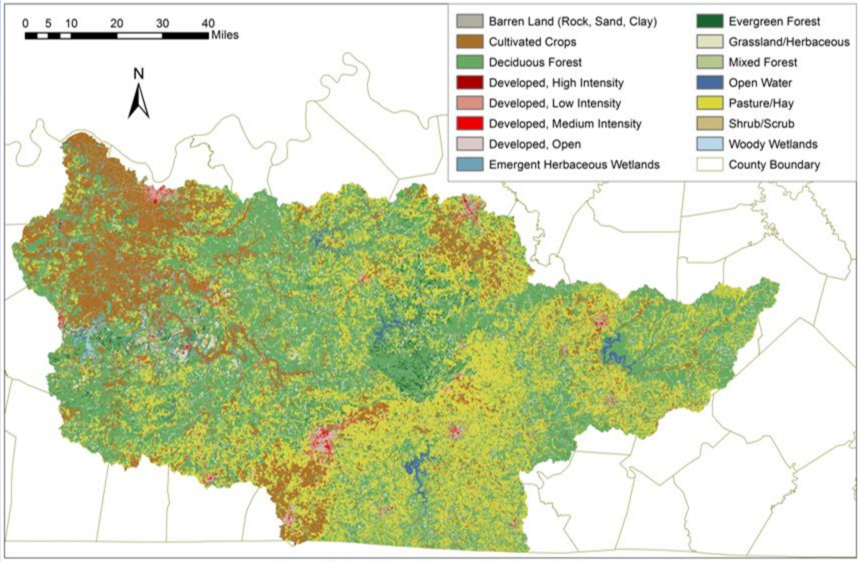
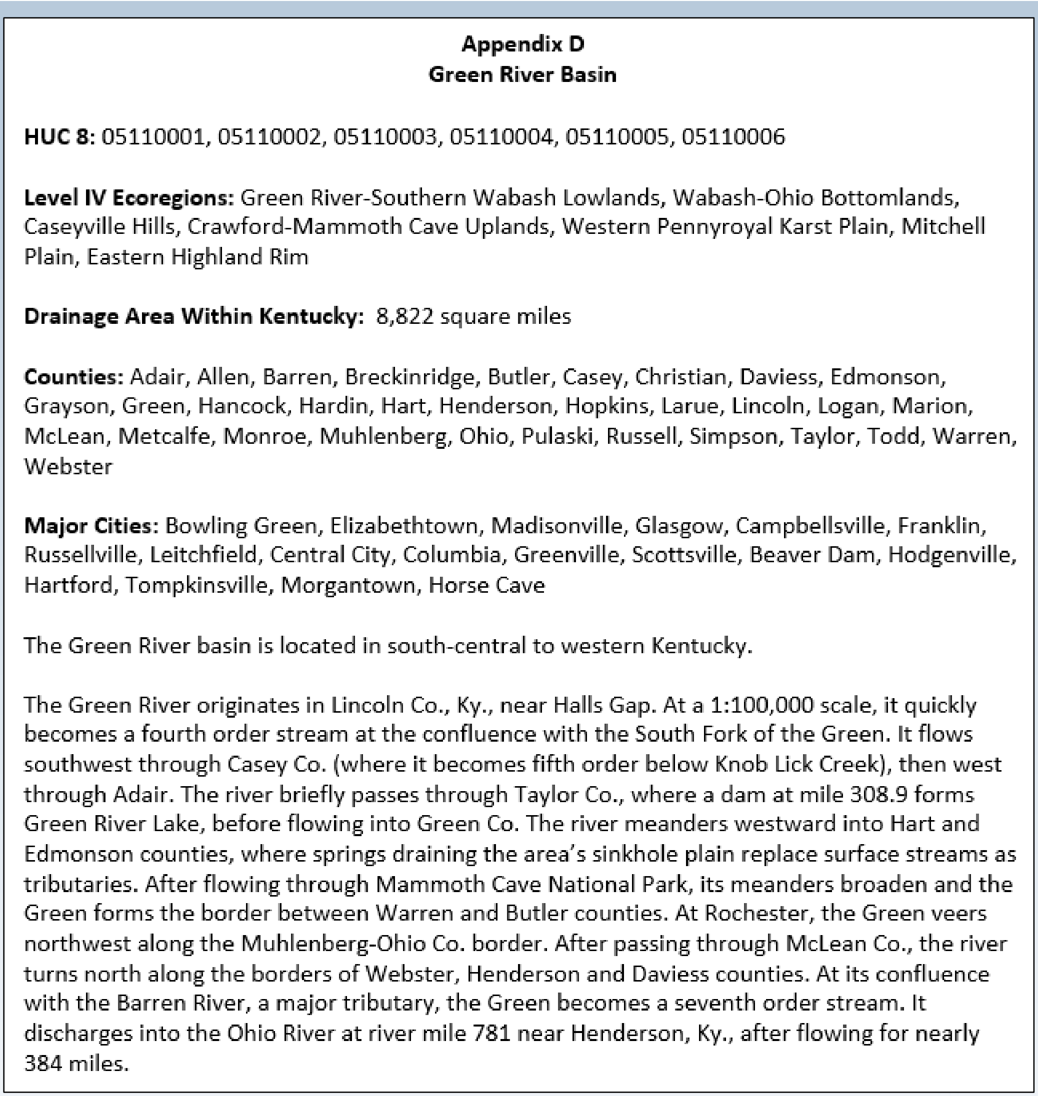


Figure D.2 Land Cover Classes in the Green Basin



Appendix D
Green River Basin

HUC 8: 05110001, 05110002, 05110003, 05110004, 05110005, 05110006

Level IV Ecoregions: Green River-Southern Wabash Lowlands, Wabash-Ohio Bottomlands, Caseyville Hills, Crawford-Mammoth Cave Uplands, Western Pennyroyal Karst Plain, Mitchell Plain, Eastern Highland Rim

Drainage Area Within Kentucky: 8,822 square miles

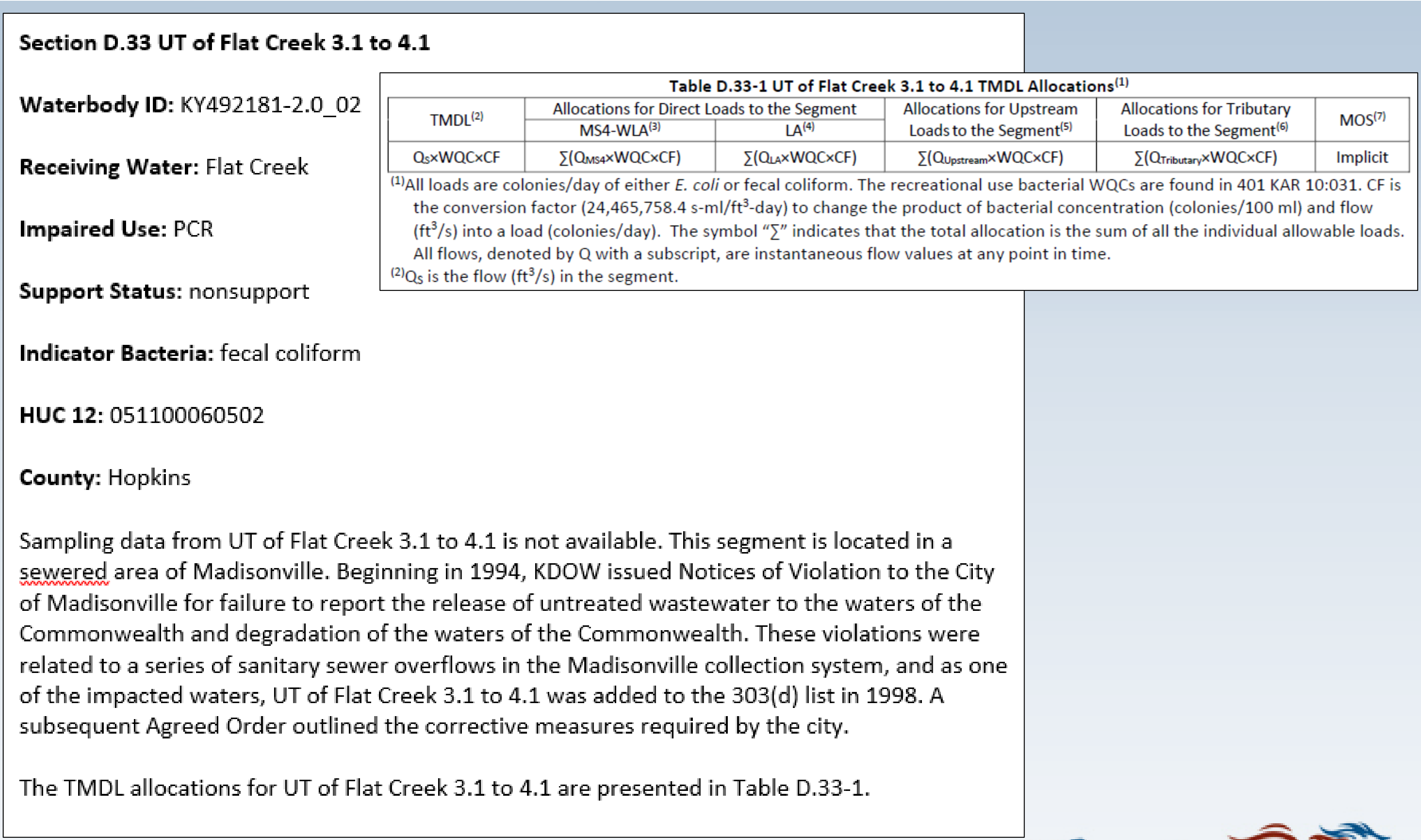
Counties: Adair, Allen, Barren, Breckinridge, Butler, Casey, Christian, Daviess, Edmonson, Grayson, Green, Hancock, Hardin, Hart, Henderson, Hopkins, Larue, Lincoln, Logan, Marion, McLean, Metcalfe, Monroe, Muhlenberg, Ohio, Pulaski, Russell, Simpson, Taylor, Todd, Warren, Webster

Major Cities: Bowling Green, Elizabethtown, Madisonville, Glasgow, Campbellsville, Franklin, Russellville, Leitchfield, Central City, Columbia, Greenville, Scottsville, Beaver Dam, Hodgenville, Hartford, Tompkinsville, Morgantown, Horse Cave

The Green River basin is located in south-central to western Kentucky.

The Green River originates in Lincoln Co., Ky., near Halls Gap. At a 1:100,000 scale, it quickly becomes a fourth order stream at the confluence with the South Fork of the Green. It flows southwest through Casey Co. (where it becomes fifth order below Knob Lick Creek), then west through Adair. The river briefly passes through Taylor Co., where a dam at mile 308.9 forms Green River Lake, before flowing into Green Co. The river meanders westward into Hart and Edmonson counties, where springs draining the area's sinkhole plain replace surface streams as tributaries. After flowing through Mammoth Cave National Park, its meanders broaden and the Green forms the border between Warren and Butler counties. At Rochester, the Green veers northwest along the Muhlenberg-Ohio Co. border. After passing through McLean Co., the river turns north along the borders of Webster, Henderson and Daviess counties. At its confluence with the Barren River, a major tributary, the Green becomes a seventh order stream. It discharges into the Ohio River at river mile 781 near Henderson, Ky., after flowing for nearly 384 miles.

Example Segment



Section D.33 UT of Flat Creek 3.1 to 4.1

Waterbody ID: KY492181-2.0_02

Receiving Water: Flat Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100060502

County: Hopkins

Table D.33-1 UT of Flat Creek 3.1 to 4.1 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment		Allocations for Upstream Loads to the Segment[5]	Allocations for Tributary Loads to the Segment[6]	MOS[7]
	MS4-WLA[3]	LA[4]			
$Q_S \times WQC \times CF$	$\sum(Q_{MS4} \times WQC \times CF)$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

[1] All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads. All flows, denoted by Q with a subscript, are instantaneous flow values at any point in time.

[2] Q_S is the flow (ft^3/s) in the segment.

Sampling data from UT of Flat Creek 3.1 to 4.1 is not available. This segment is located in a sewered area of Madisonville. Beginning in 1994, KDOW issued Notices of Violation to the City of Madisonville for failure to report the release of untreated wastewater to the waters of the Commonwealth and degradation of the waters of the Commonwealth. These violations were related to a series of sanitary sewer overflows in the Madisonville collection system, and as one of the impacted waters, UT of Flat Creek 3.1 to 4.1 was added to the 303(d) list in 1998. A subsequent Agreed Order outlined the corrective measures required by the city.

The TMDL allocations for UT of Flat Creek 3.1 to 4.1 are presented in Table D.33-1.

Example Segment, Cont.

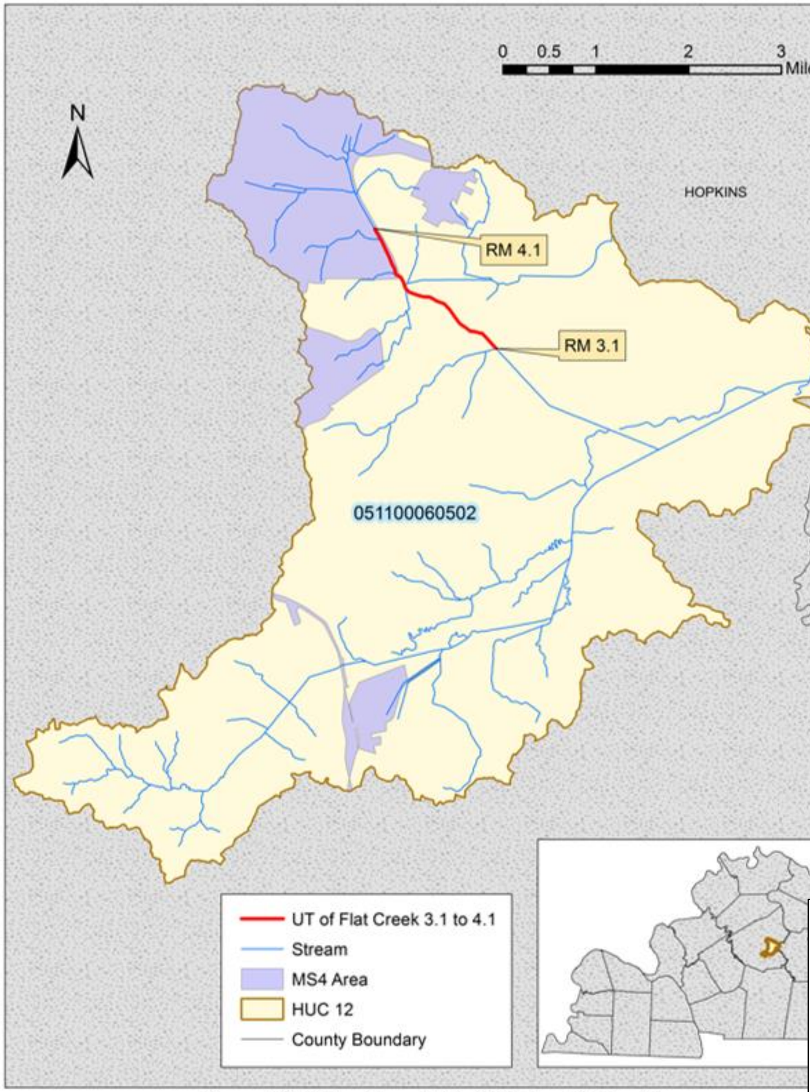


Figure D.33-1 Location of UT of Flat Creek 3.1 to 4.1

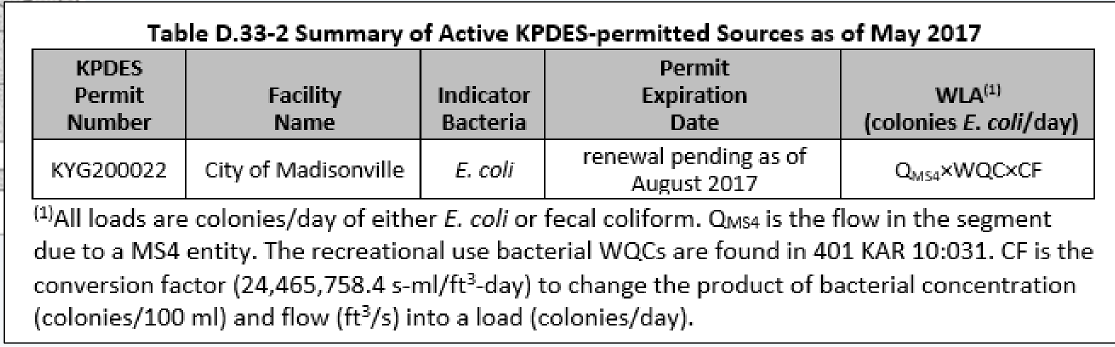


Table D.33-2 Summary of Active KPDES-permitted Sources as of May 2017

KPDES Permit Number	Facility Name	Indicator Bacteria	Permit Expiration Date	WLA[1] (colonies *E. coli*/day)
KYG200022	City of Madisonville	*E. coli*	renewal pending as of August 2017	Q_{MS4}×WQC×CF

[1] All loads are colonies/day of either *E. coli* or fecal coliform. Q_{MS4} is the flow in the segment due to a MS4 entity. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day).

When is my watershed’s turn?

- **Estimated** dates for public notice

- 2018: Green/Tradewater
- 2019: Big Sandy/Little Sandy/Tygarts Creek
- 2020: Kentucky River
  Salt/Licking
- 2021: Upper Cumberland/Four Rivers
- 2022: Ohio River minor tributaries

Benefits of Segment Method

- ✓ Flexible
  - Applicable to PCR/SCR uses, *E*. *coli*/fecal coliform, large river/small stream
  - Accommodates changes to standards
- ✓ Efficient
  - Does not require collection of new data
  - 5-6 years to complete TMDLs for currently listed segments
- ✓ TMDL applies to all flow conditions
  - Allocations are a continuum based on flow from each source
- ✓ Aligns with permitting programs

<u>Drawback:</u> loss of watershed information at beginning of restoration process

Final Thoughts

- Segments/watersheds recommended for TMDL alternative or watershed-based TMDL can be withheld from statewide document

- The streamlined approach allows KDOW to allocate resources for water quality projects more strategically

Comment Period Ends June 11, 2018

Public Hearings

☐	Hearing Date	Subject	Comments Due	Location	Documents

There are no items to show in this view of the "Public Hearings" list.

TMDL

Documents	Public Notice Begin Date	Public Notice End Date	Contact for Comments/Questions
Public Notice Statewide Bacteria TMDL Statewide Bacteria TMDL Proposed Draft	3/14/2018	6/11/2018	Lauren McDonald Division of Water 300 Sower Blvd., 3rd Floor Frankfort, KY 40601 lauren.mcdonald@ky.gov

water.ky.gov

Questions?