U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of Transportation
Federal Highway Administration

Stochastic Empirical Loading and Dilution Model (SELDM) –

A New Water Quality Model for Evaluating Stormwater Discharges from Transportation Projects

A joint presentation by the
NC Department of Transportation (Hydraulics Unit)
http://connect.ncdot.gov/resources/hydro
and
USGS South Atlantic Water Science Center (Raleigh)
http://nc.water.usgs.gov

Presented to:
2017 Water Resources Research Institute annual conference
Jane S. McKimmon Center, Raleigh, NC
March 15, 2017

Stormwater collection system on U.S. 64 bridge over the Hiwassee River in Cherokee County, North Carolina

Project Goal #1

- Compile 15 years of NCDOT stormwater research into a single database:

71 sites monitored across NC
2,751 storm events
33,579 event mean concentrations
162 different analytes

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Project Goal #2

- Enhance the national SELDM model with more NC specific data
- Release the enhanced model for the public's free use

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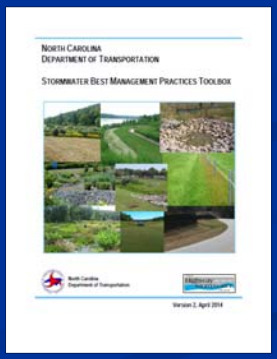
Project Goal #3

- Integrate SELDM into NCDOT's Post-Construction Stormwater Program



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Brief His

1) Developed by USGS in c
Administration
2) Replaced the FHWA runc
and published in 1990
3) Concerns of previous mo
on the 1980's standards,
concentrations (assumed
newer operating software

Source: htt

4) Developed by Greg Gran
office within the USGS N
5) Documented in 2013 in U


Stochastic Empirical Loading and Dilution Model (SELDM) Version 1.0.0

By Gregory E. Granato

Chapter 3
Section C, Water Quality,
Book 4, Hydrologic Analysis and Interpretation

Prepared in cooperation with the
U.S. Department of Transportation, Federal Highway Administration,
Office of Project Development and Environmental Review

Techniques and Methods 4–C3

U.S. Department of the Interior
U.S. Geological Survey

USGS

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SELDM is based on methods in 3 FHWA reports, 5 USGS reports, and 5 case studies that were reviewed and/or approved by FHWA, USEPA, USGS, and others.

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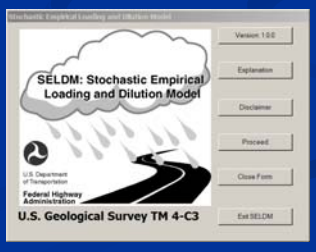
Slide source: G.E.Granato, written commun., May 2016

SELDM was tested and/or reviewed by 43 professionals from USGS, USEPA, USFWS, and 16 state agencies

Slide source: G.E.Granato, written commun., May 2016

Stochastic Empirical Loading and Dilution Model

- Easily create and run highway-runoff simulations
- Simulate storm flows, concentrations, and loads
- Calculate the risk of exceeding water-quality criteria with and without user-defined BMPs
- Calculate annual runoff loads (can a simple annual lake-loading analysis



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"Planning-level estimates…"

1) SELDM is designed to help develop planning-level estimates of event mean concentrations, flows, and loads in stormwater from a site of interest and from an upstream basin.

2) Planning-level estimates are:

   (A) Defined as the results of analyses used to evaluate alternative management measures

   (B) Recognized to include substantial uncertainties (commonly orders of magnitude).

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Reference: Techniques and Methods, book 4, chap C3, (Granato, 2013) 9

So what do you mean by the term "stochastic model"?

1) SELDM is a stochastic model because it uses Monte Carlo methods to produce the random combinations of input variable values needed to generate the stochastic population of values for each component variable.

2) *Which in turn*…quantifies the effects of a wide range of precipitation characteristics, streamflow, estimated runoff quantity and quality, and best management practices on the probability distribution of receiving-water concentrations

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SELDM uses a simple mass balance approach to calculate flows, concentrations, and loads by storm and by year

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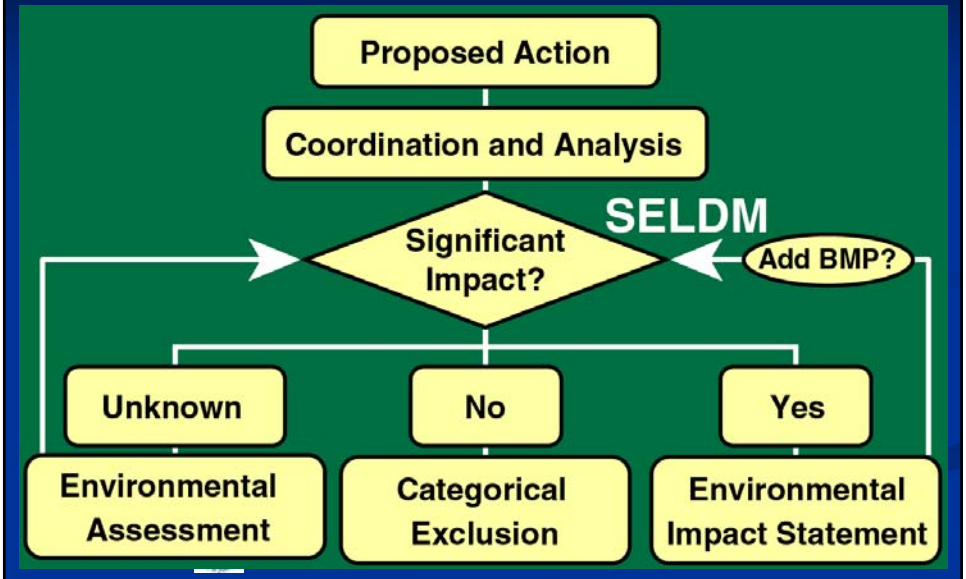
Slide source: G.E.Granato, written commun., May 2016

SELDM is designed to facilitate the National Environmental Policy Act (NEPA) process



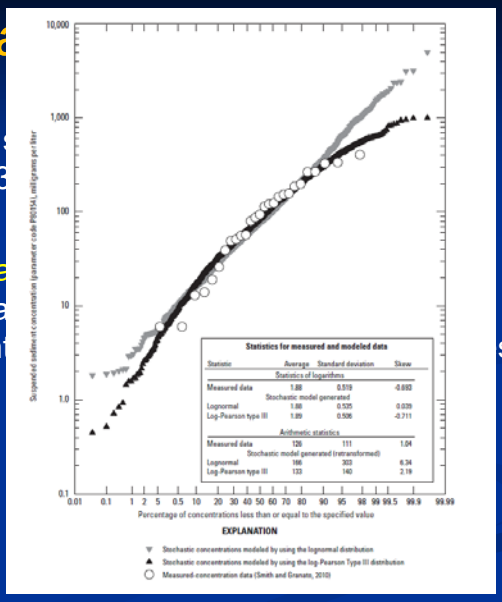
Slide source: G.E.Granato, written commun., May 2016

Water-qua

SELDM can predict a s
concentrations using 3

(1) Random water-qua
statistics (average, sta
from available concent

st.

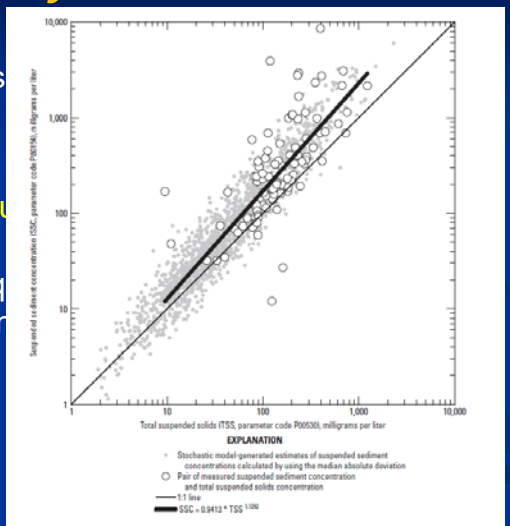


Reference: Granato, 2013, USGS TM, book 4, chapter C3

Water-quality concentrations

SELDM can predict a s
concentrations using 3

(2) Dependent water-qu
statistics calculated on
data and regression eq
between two constituer

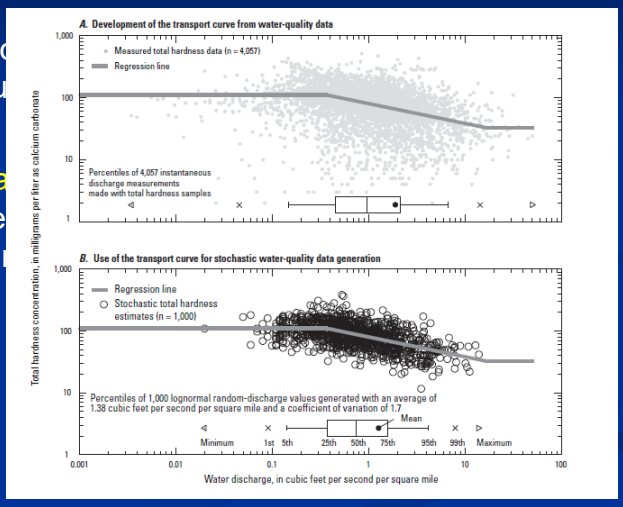


Reference: Granato, 2013, USGS TM, book 4, chapter C3

Water-quality concentrations

SELDM can pred
concentrations u

(3) Upstream wa
modeling…gene
water-quality tra
interest.



Reference: Granato, 2013, USGS TM, book 4, chapter C3

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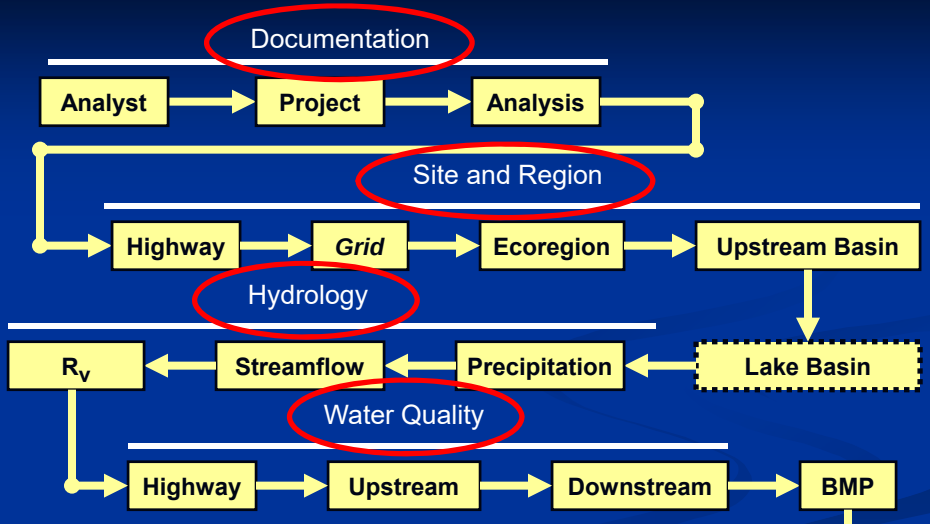
SELDM has a GUI with a series of forms



Slide source: G.E.Granato, written commun., September 2016

Overall NC project objectives

1) Refine SELDM statistics using local data to improve the estimations of how highway runoff is affecting the water quality of receiving streams in North Carolina
2) Provide guidance on appropriate uses of SELDM to support North Carolina's implementation of the National Environmental Policy Act (NEPA)
3) Project end scheduled for March 2018

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Incorporate North Carolina highway-runoff water-quality and quantity data into the FHWA Highway-Runoff Database (HRDB)

1) HRDB is the data warehouse and preprocessor of QW concentration data for SELDM
2) Largest task in the study
3) AECOM compiled QW data from highway runoff studies in NC (8 non-USGS and one USGS)
4) Primary requirement is that data must be event mean concentration (EMC)…that is, single grab sample data not eligible
5) Overview of compilation from 9 studies:
   - 71 edge-of-pavement or BMP effluent sites
   - 2,751 storm events
   - 33,579 event mean concentrations
   - 162 different analytes

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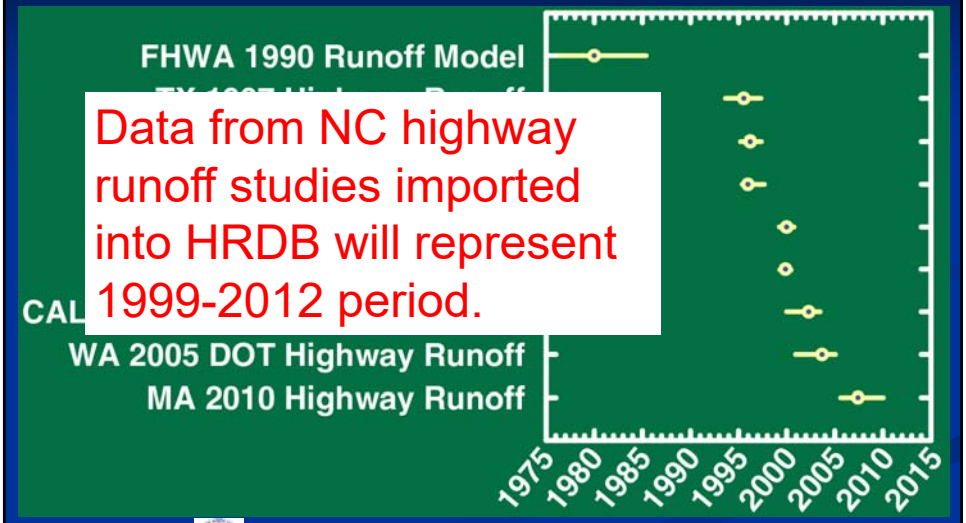
Data in Version 1.0.0a of the HRDB span the period from 1975 to 2009



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Source: G.E.Granato, written commun., June 2016

Develop and refine precipitation, hydrologic data (i.e. streamflow statistics), water-quality transport curves needed for SELDM applications in North Carolina

1) 2nd largest analysis task in study…consists of 4 elements
2) Pertains to bulk of input variables that users can put into SELDM usage
   - Task 2a – streamflow statistics
   - Task 2b – precipitation statistics
   - Task 2c – recession ratios used to develop hydrographs during SELDM runs
   - Task 2d – water-quality transport curves (concentrations)

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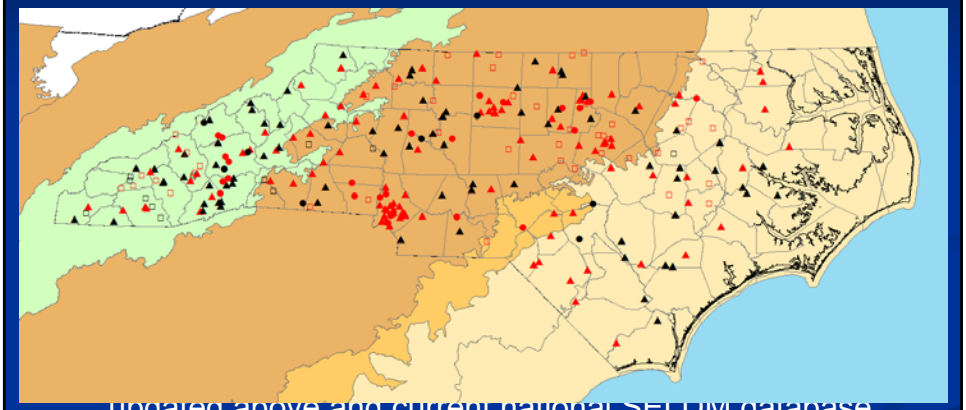
Pre-storm streamflow statistics



updated above and current national SELDM database are very favorable, save for a few sites

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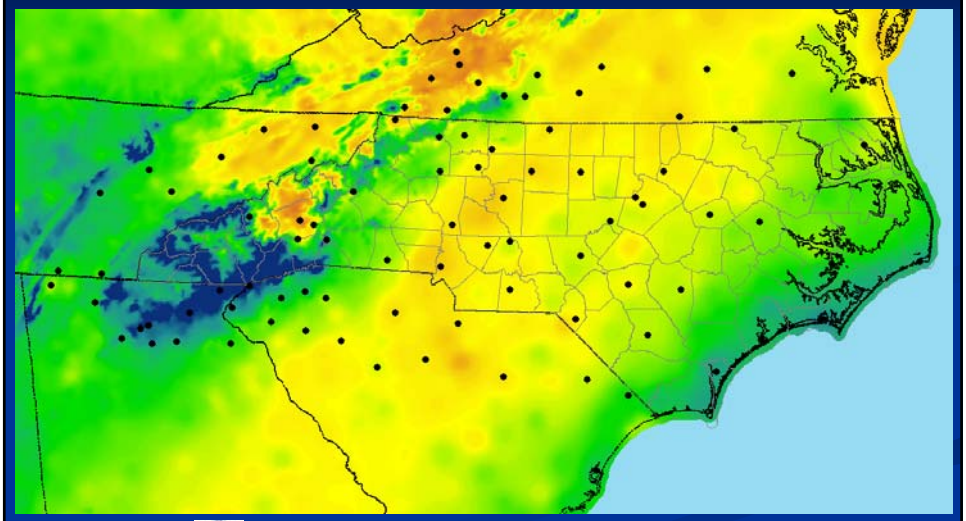
Overlay of PRISM precipitation map for NC on selected NOAA sites with data from 1965-2009 (Granato, 2010)



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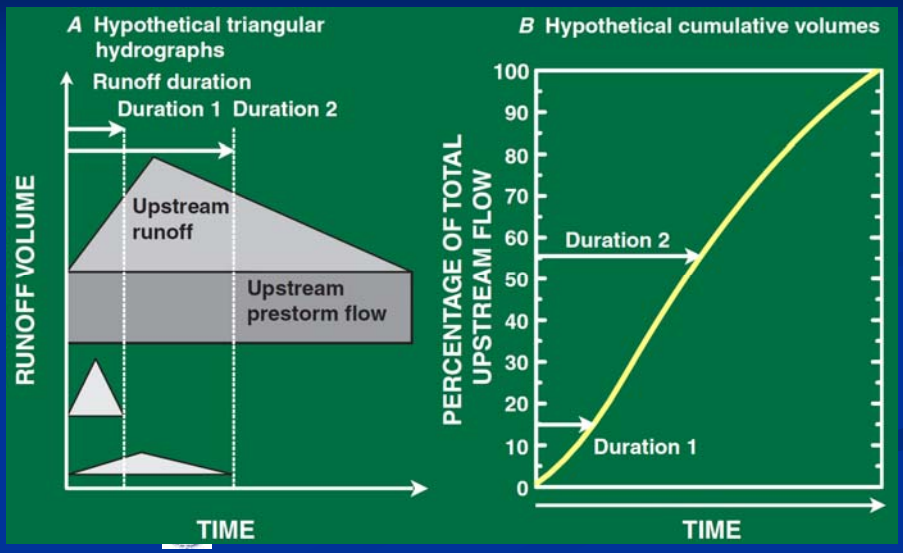
Use triangular hydrograph durations to determine the proportion of upstream stormflow available for mixing



Slide source: G.E.Granato, written commun., June 2016

30 selected USGS streamgages across NC used for recession ratio development

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Other tasks to attain NC objectives

- Integrate all necessary SELDM input hydrologic and land-use variables into NC StreamStats;
- Evaluate the impacts of stormwater runoff on downstream water quality at six to eight NCDOT highway sites of interest using SELDM as a demonstration for future implementation of the model by NCDOT;
- Incorporate NCDOT Best Management Practice performance data into SELDM;

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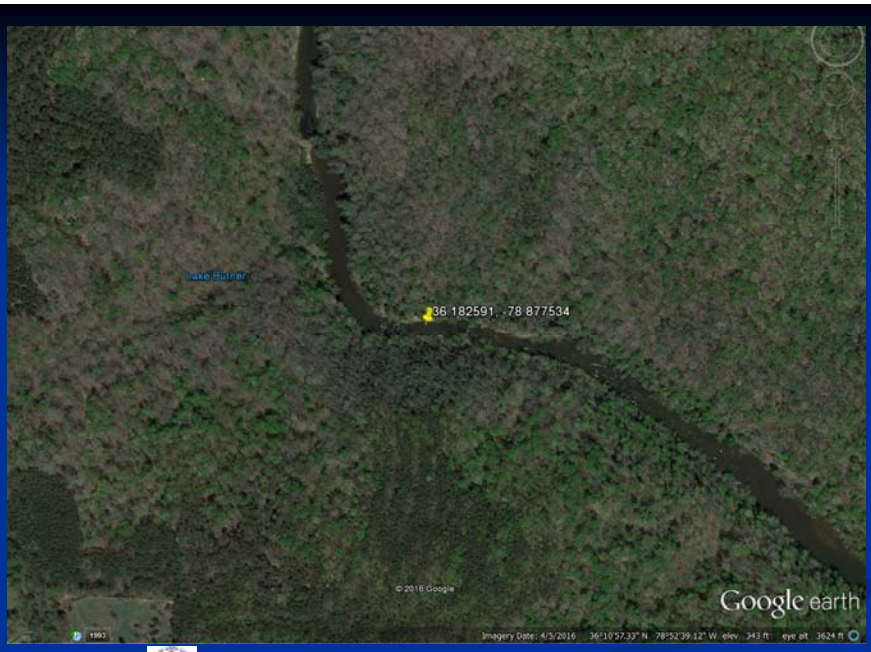

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Flat River example

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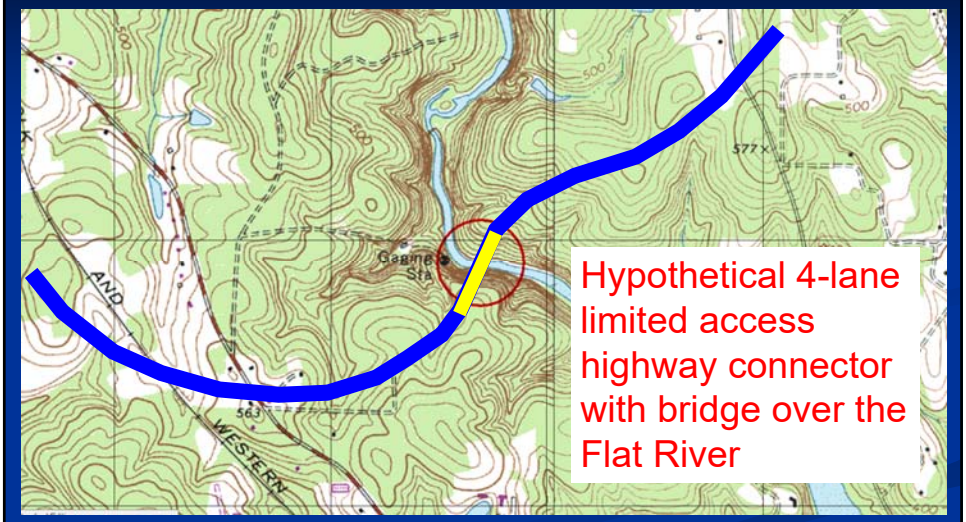

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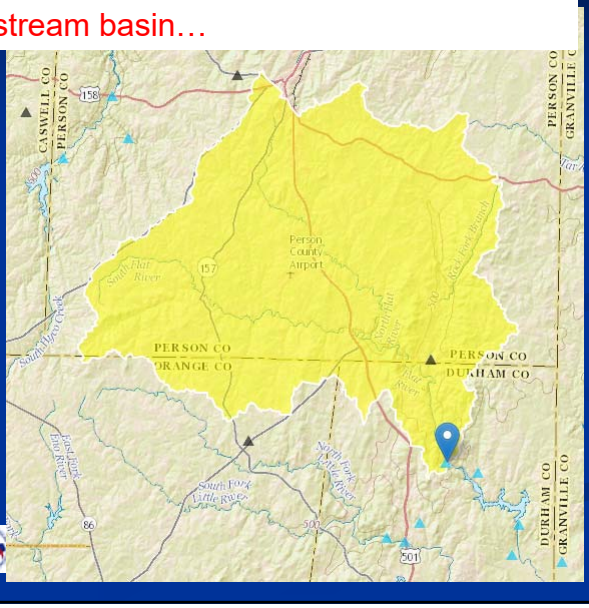
SELDM allows the user to compute a potential range of stormflows and event-mean concentrations from the upstream basin…



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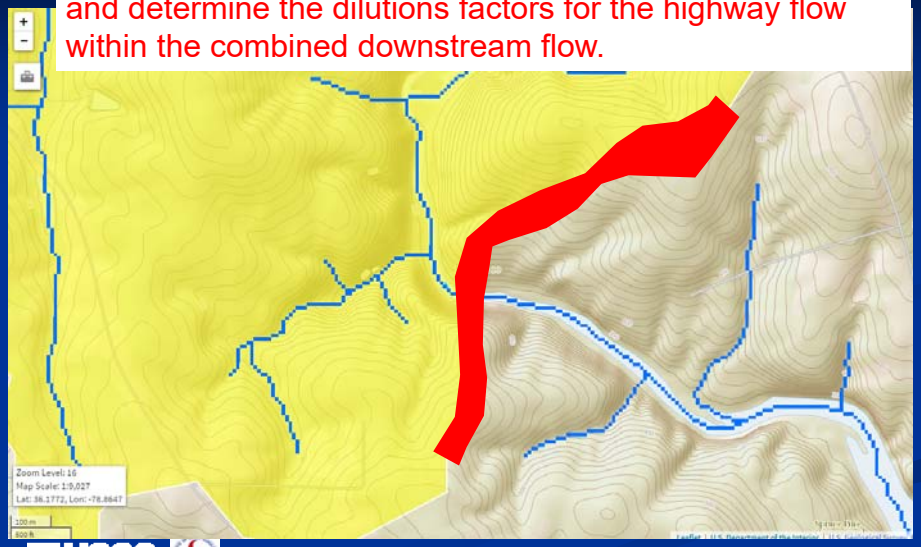
…plus a potential range of stormflows and event-mean concentrations from a highway basin…
and determine the dilutions factors for the highway flow within the combined downstream flow.



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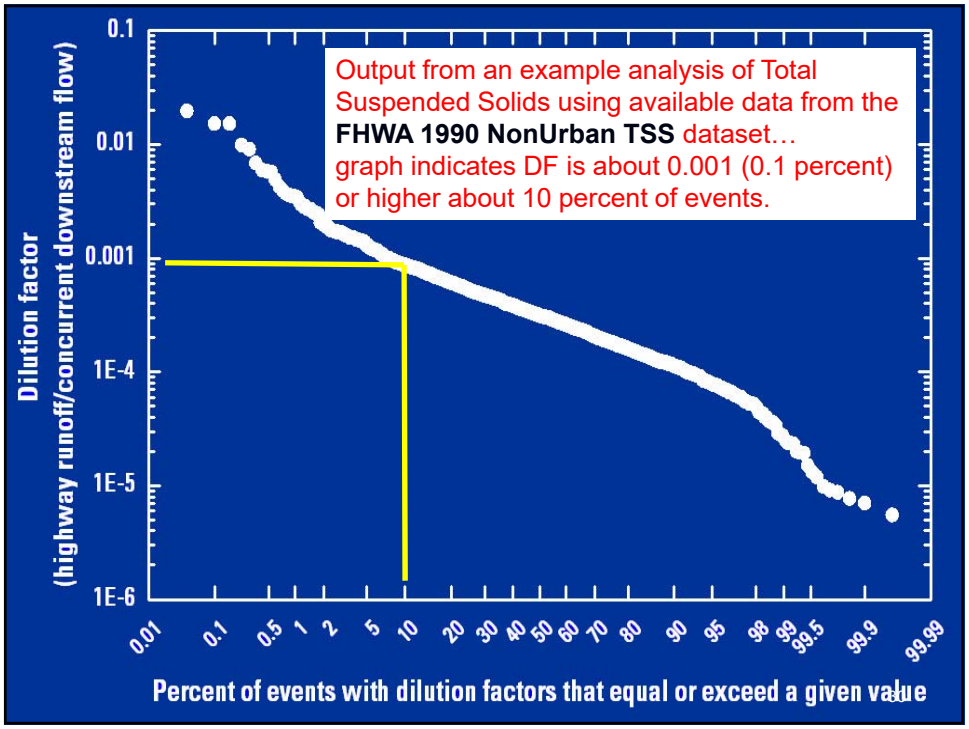

Frequently asked questions…

- Is the SELDM model available for use today?
- Is training available?

(2) Training can be made available with the SELDM developer (Granato)…classes for both public and targeted audiences have been provided from time to time.

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In closing…questions…comments

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Traffic on I-40 Business bridge crossing Salem Creek in Forsyth County, North Carolina, during a precipitation event, January 6, 2009

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