



U.S. Department of Transportation
Federal Highway Administration

The Stochastic Empirical Loading and Dilution Model (SELDM) provides information needed to assess risks for adverse effects of runoff on receiving waters

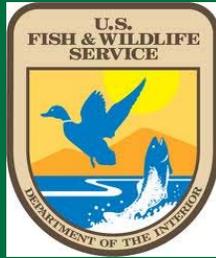
Presented at StormCon in Austin Texas, August 2-6, 2015

By Gregory E. Granato and Susan C. Jones

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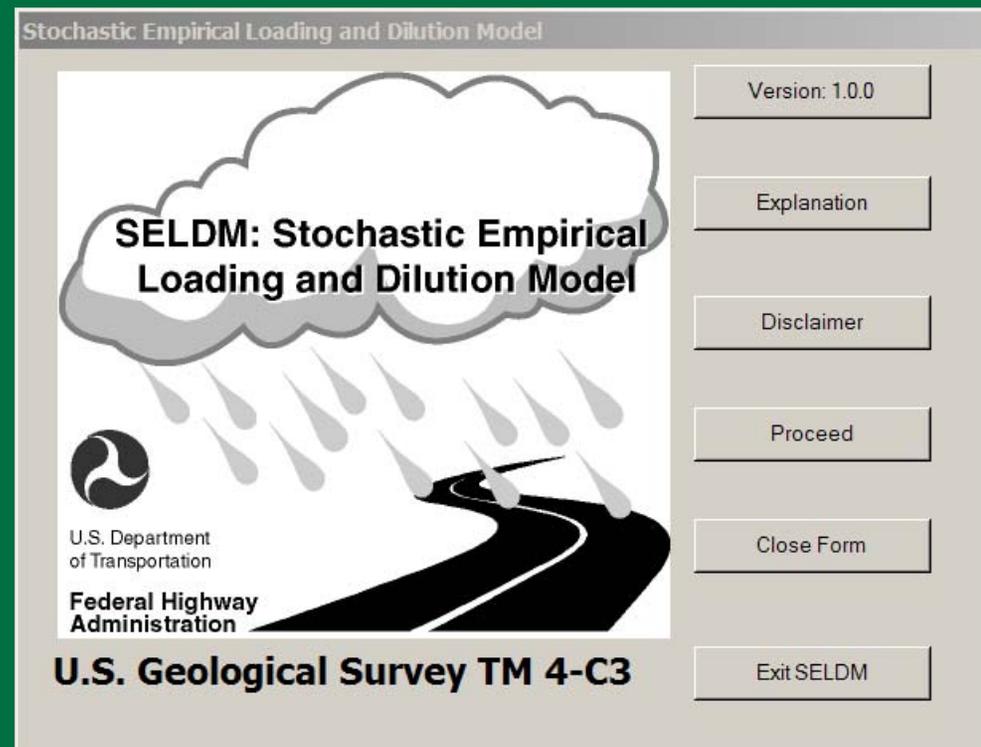
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SELDM was tested and/or reviewed by 43 professionals from USGS, USEPA, USFWS, and 16 state agencies



SELDM is the Stochastic Empirical Loading and Dilution Model

- **Stochastic**—Uses Monte Carlo methods to create a sample of events representing combinations of flows, concentrations, and loads
- **Empirical**—Based on data and statistics rather than pure theory
- **Loading**—Provides storm and annual loads
- **Dilution**—Mixing of upstream and highway indicates chance of exceeding a target value



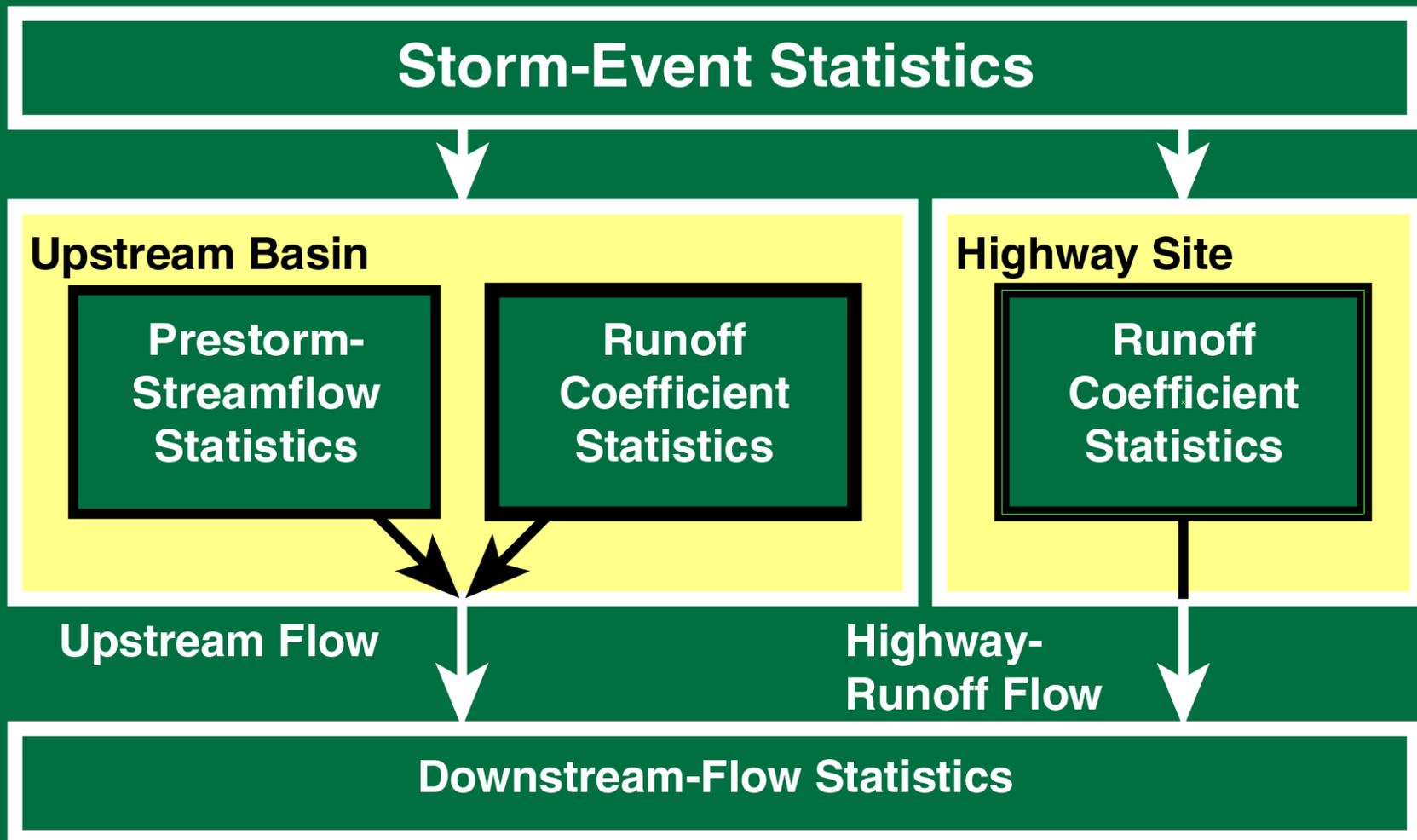
SELDM uses a simple mass balance approach to calculate flows, concentrations, and loads by storm and by year



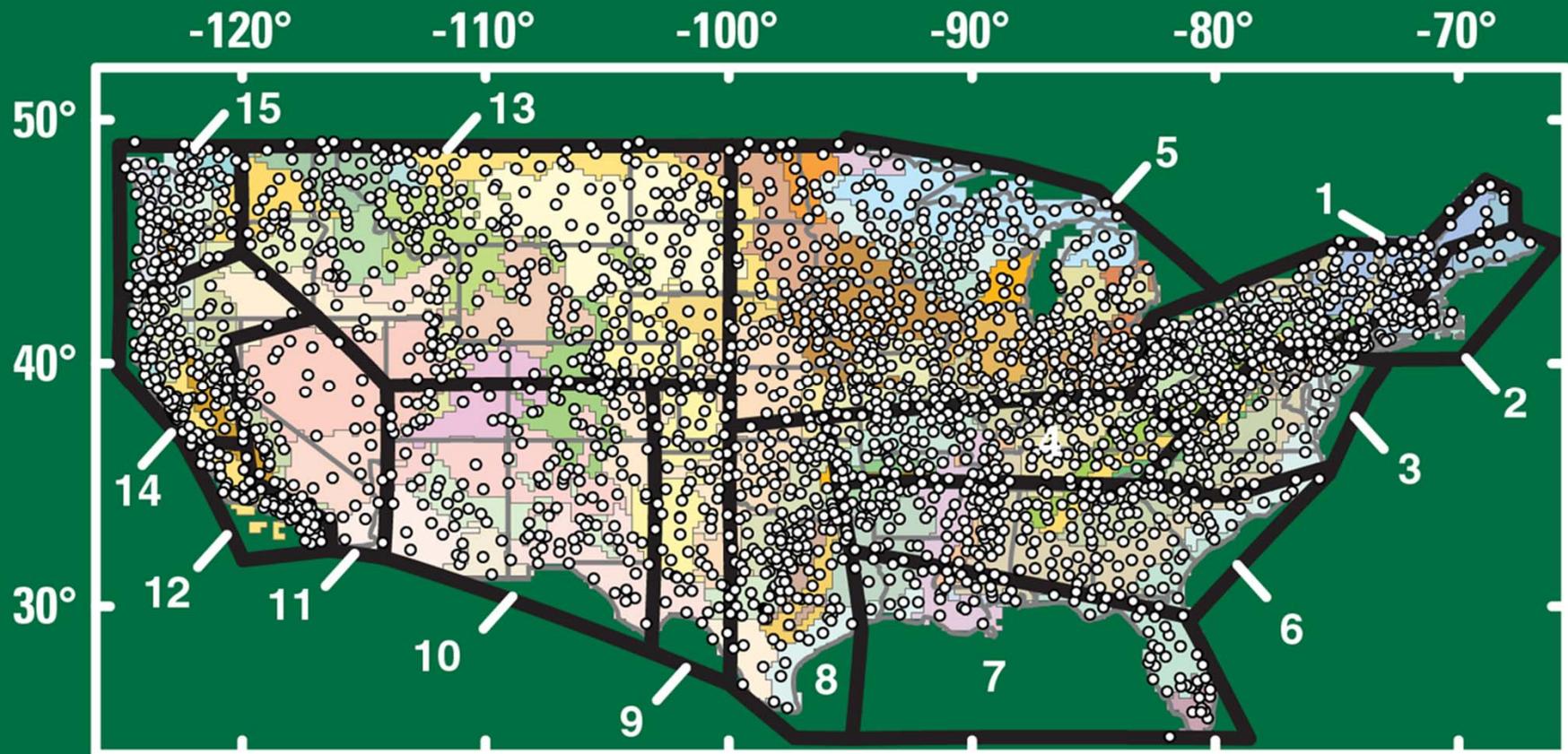
SELDM is a lumped-parameter model that can be run with a few basic input variables

- **Location (latitude and longitude)**
- **Precipitation statistics (from location)**
- **Prestorm streamflow statistics (from location)**
- **Drainage area**
- **Imperviousness**
- **Main-channel length**
- **Main-channel slope**
- **Representative stormwater-quality statistics**
- **BMP performance statistics**

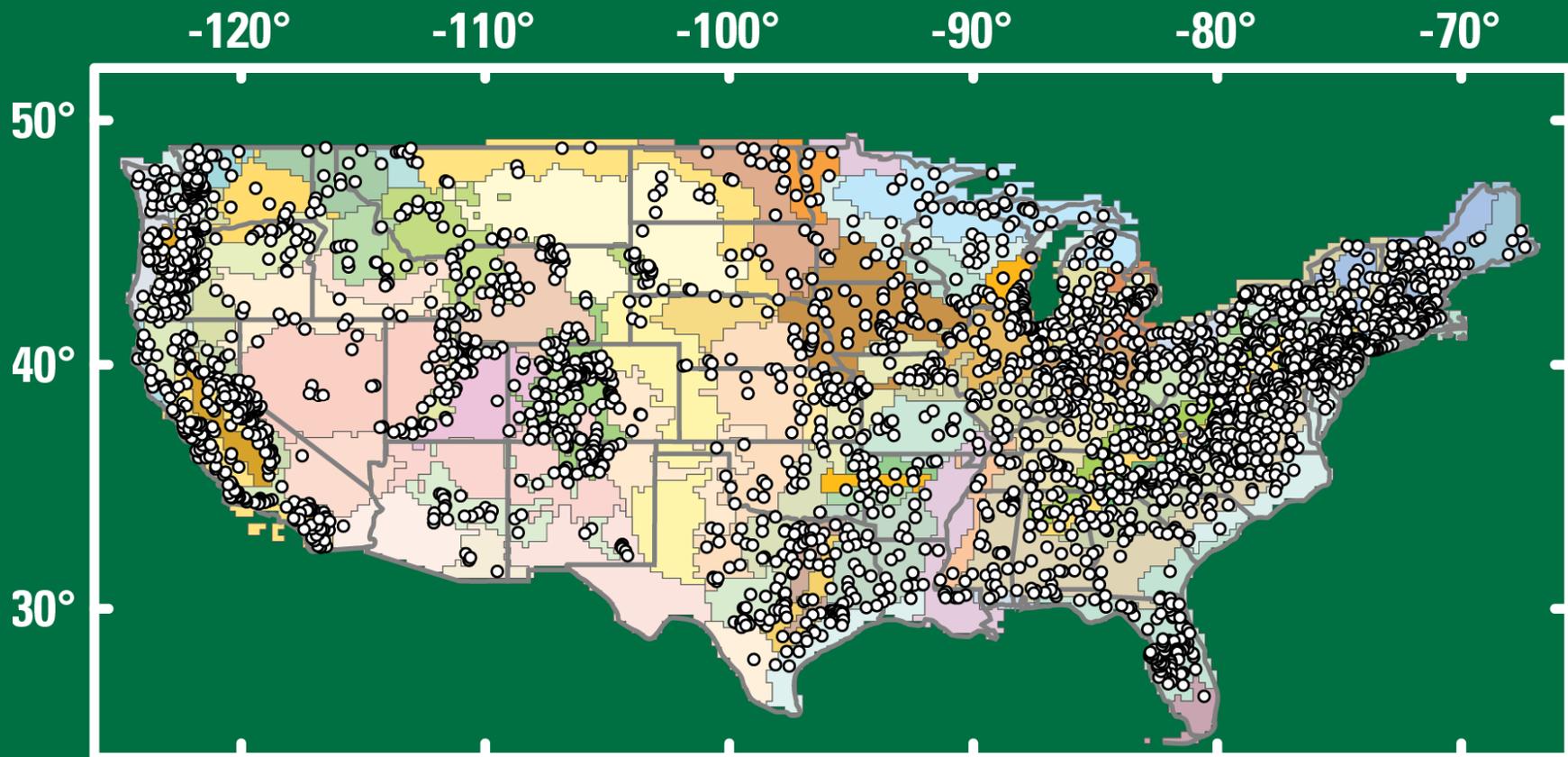
Basin properties determine precipitation events, prestorm flows and runoff coefficients



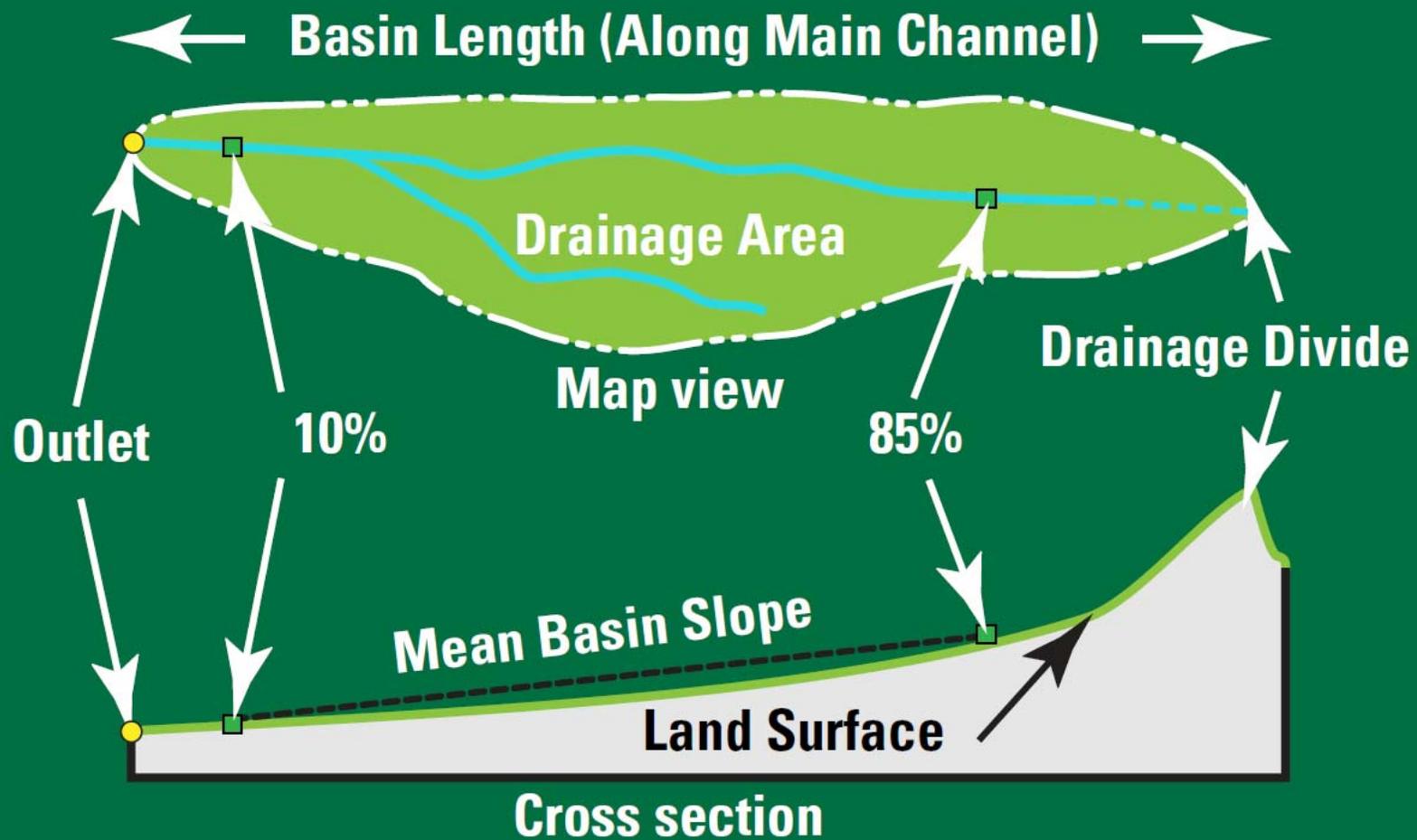
You can select precipitation statistics by region or by using values from one or more of the 2,610 hourly-precipitation data stations that are preloaded into SELDM



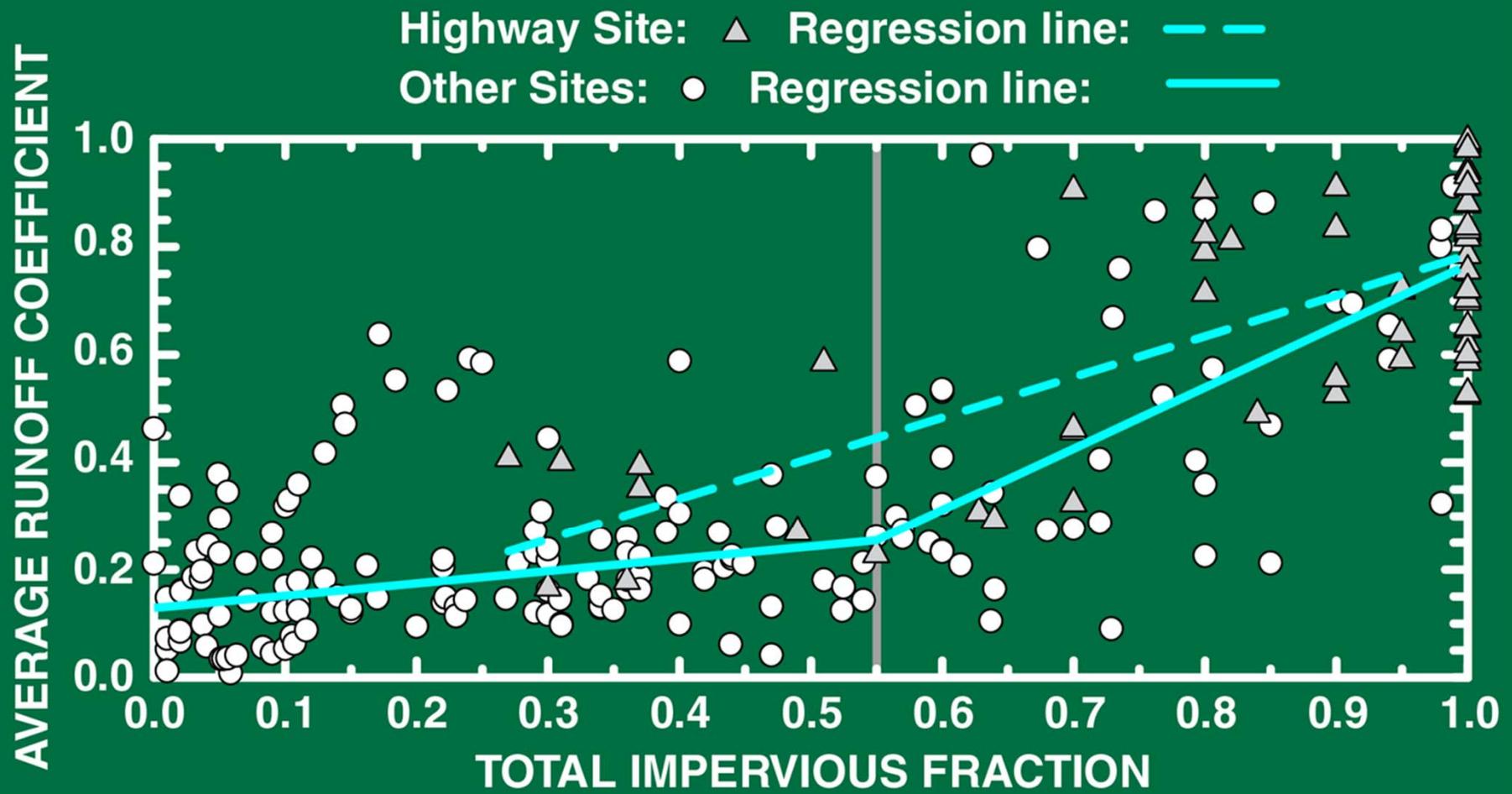
You can select streamflow statistics by region or by using values from one or more of the 2,783 streamgages that are preloaded into SELDM



The drainage area, basin length, and mean basin slope affect the volume and timing of runoff

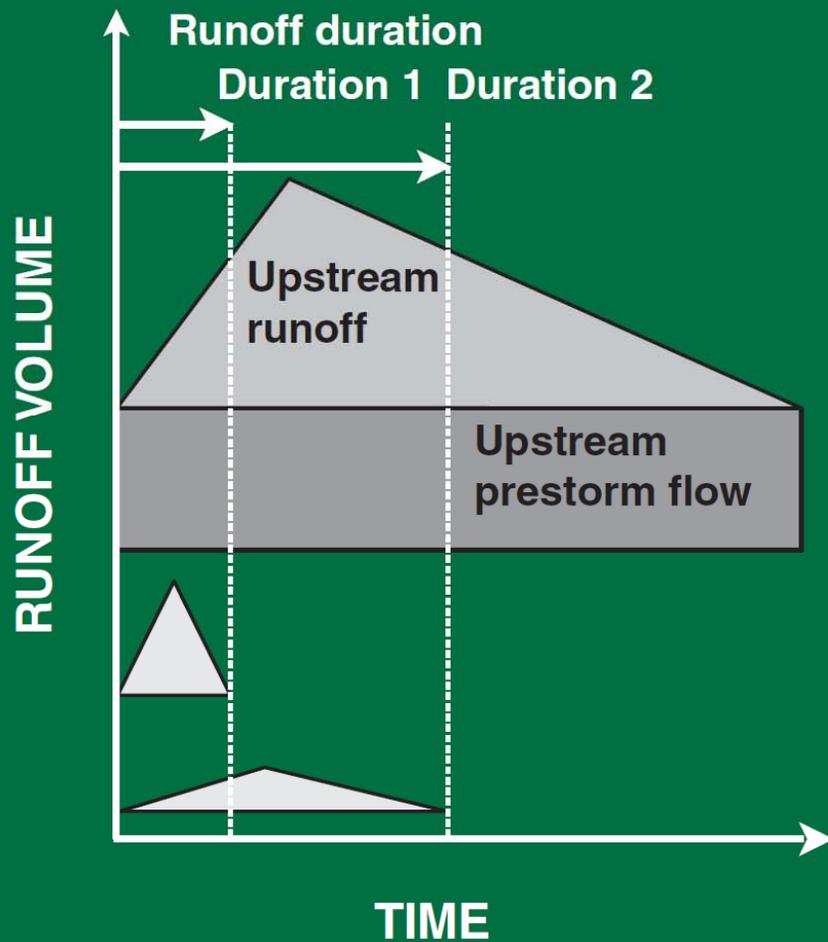


The total impervious fraction affects the volume and timing of runoff

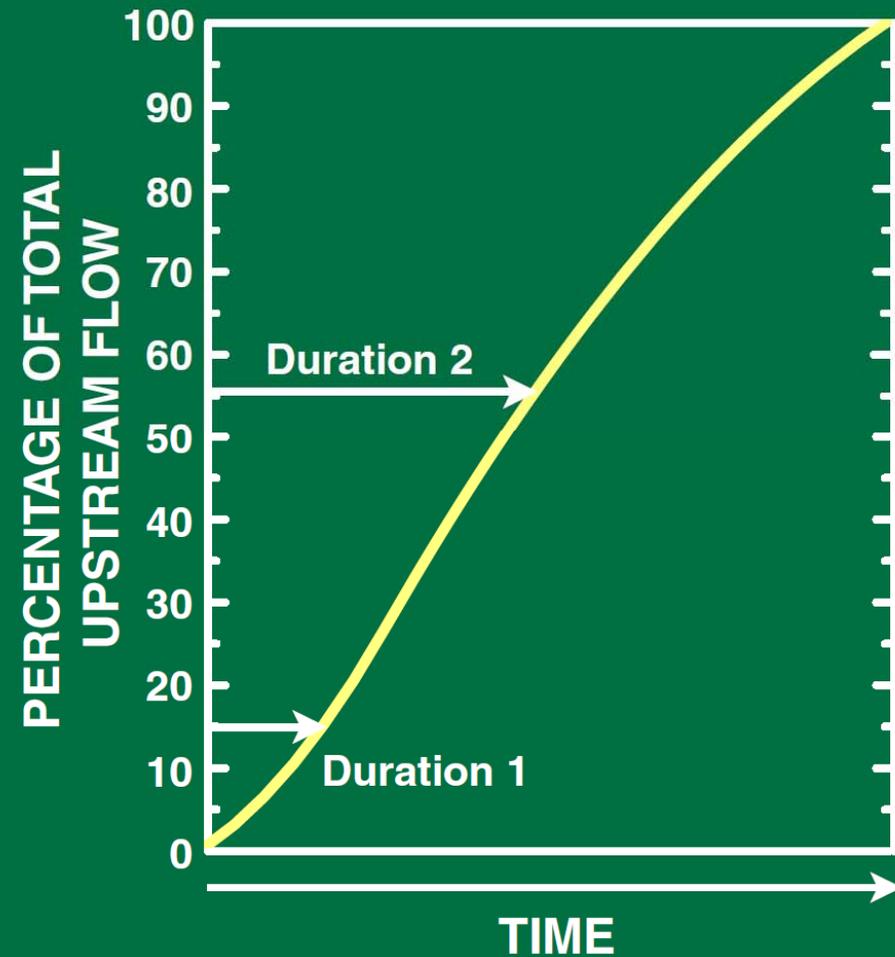


Basin properties also determine the proportion of upstream stormflow available for mixing

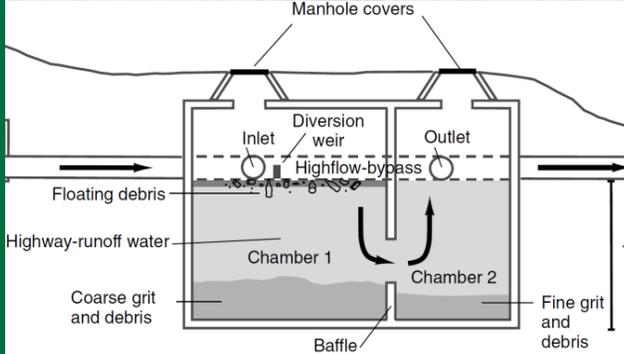
A Hypothetical triangular hydrographs



B Hypothetical cumulative volumes



There are many different treatment processes and BMPs and they can be used in series



SELDM uses a “Black Box” approach to model flow reduction, hydrograph extension and concentration reduction from BMP(s)

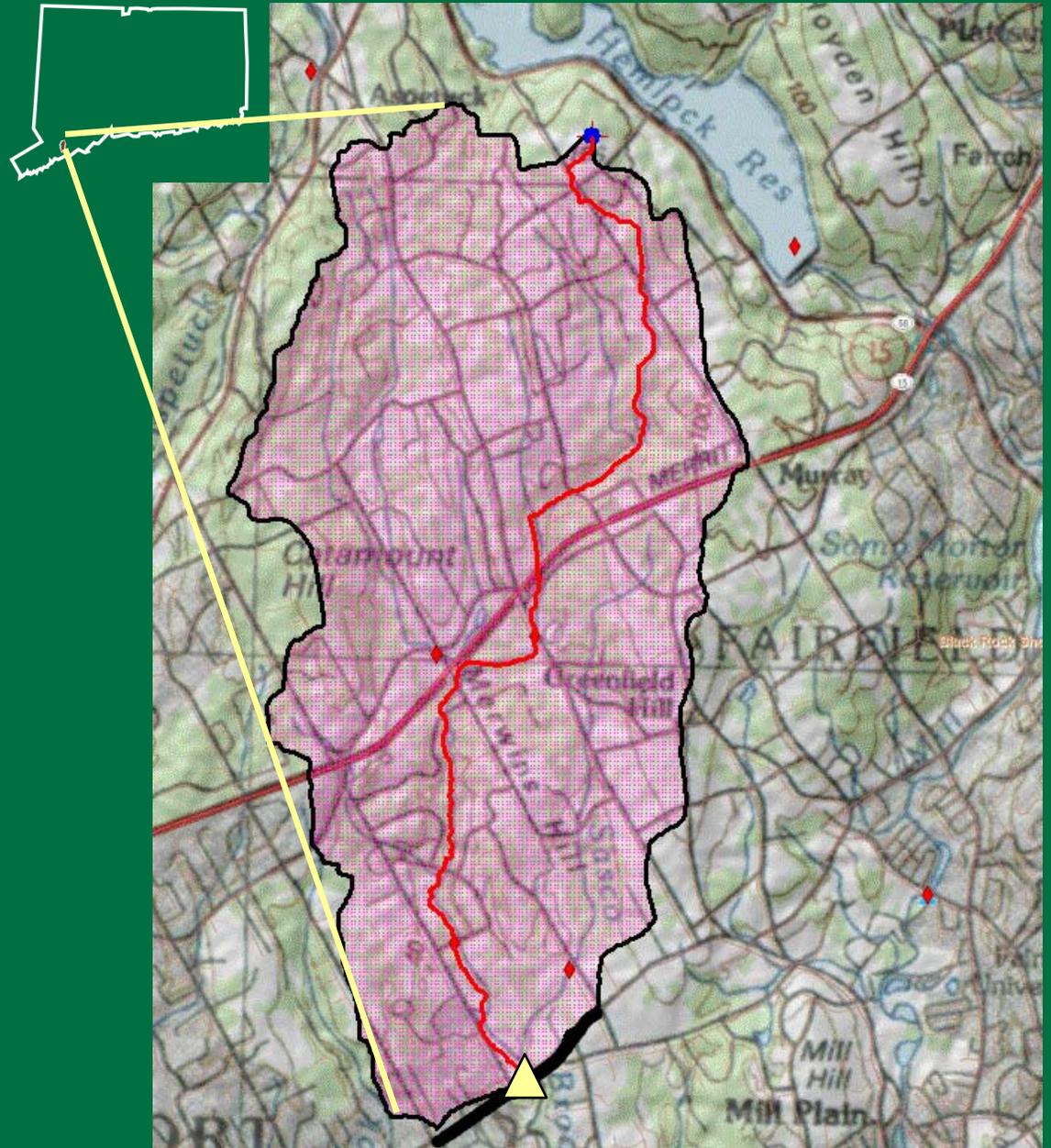


Case Study

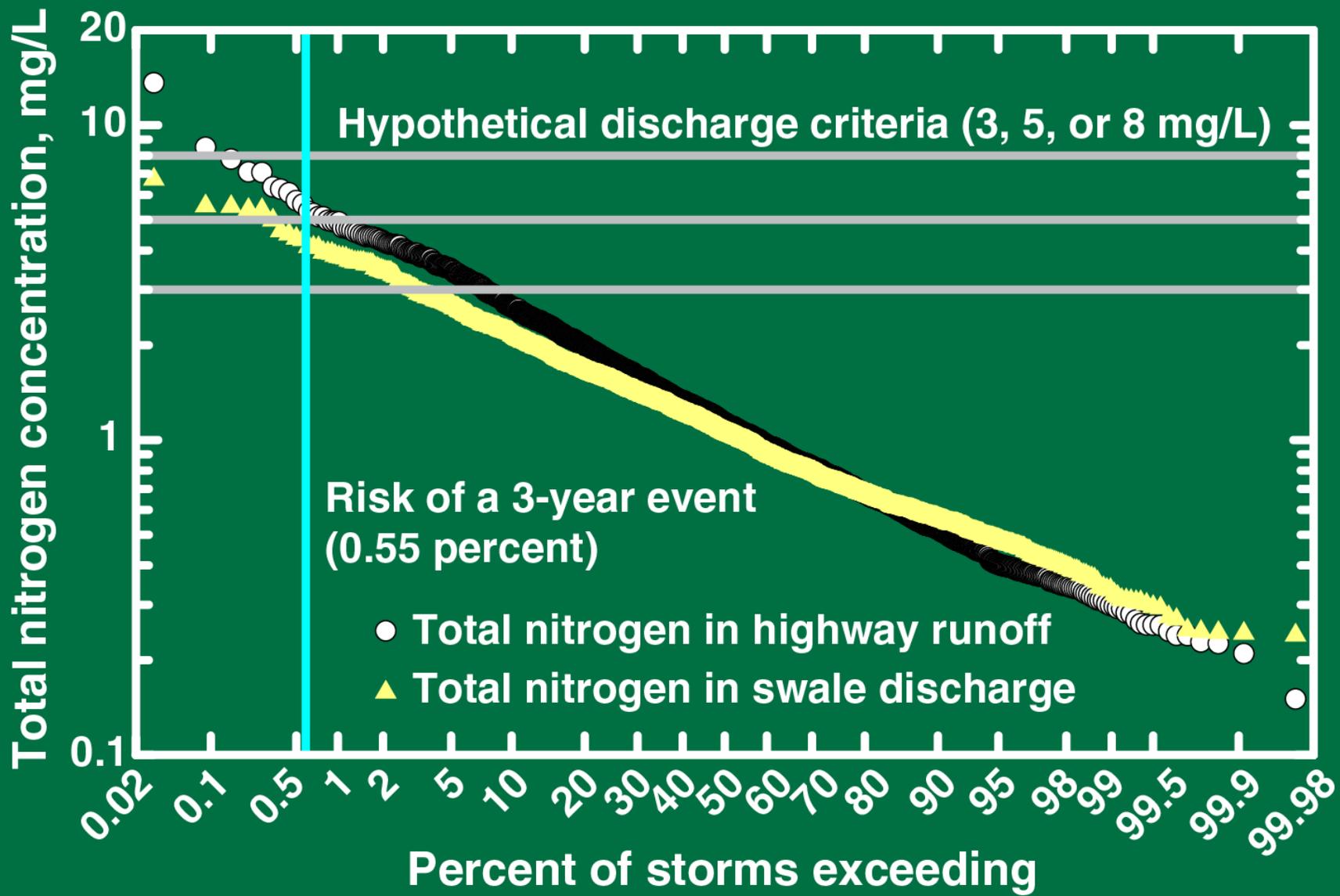
USGS Streamgauge
01208950 Sasco Brook
near Southport, CT:

Latitude: 41.15287
Longitude: -73.30595
Area: 7.38 mi²
Length: 27,984 ft
Slope: 53.3 ft/mi
TIA: 5.5%

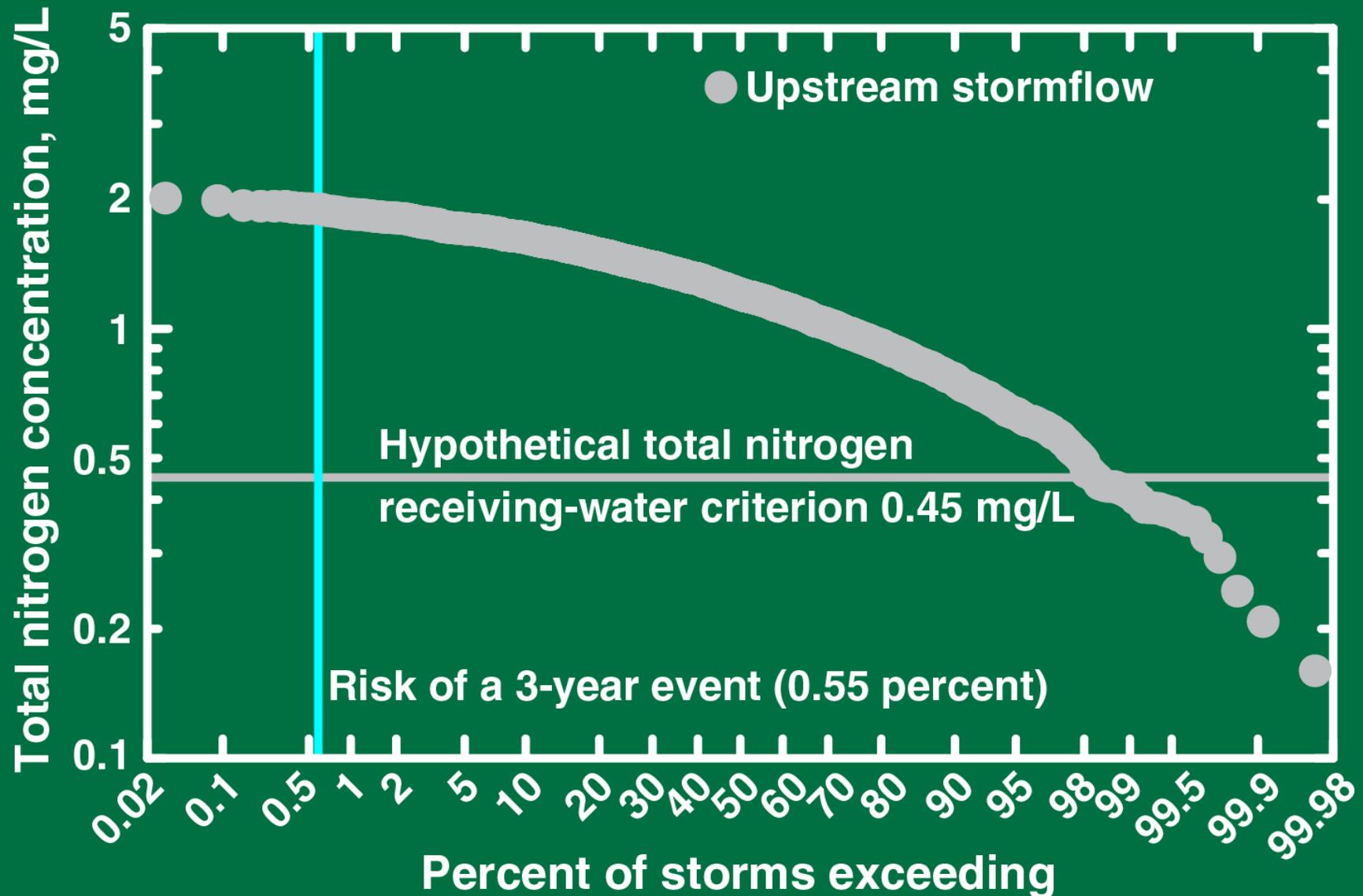
Hypothetical Highway:
Area: 2.26 Ac
Length: 957 ft
Slope: 191 ft/mi
TIA: 100%



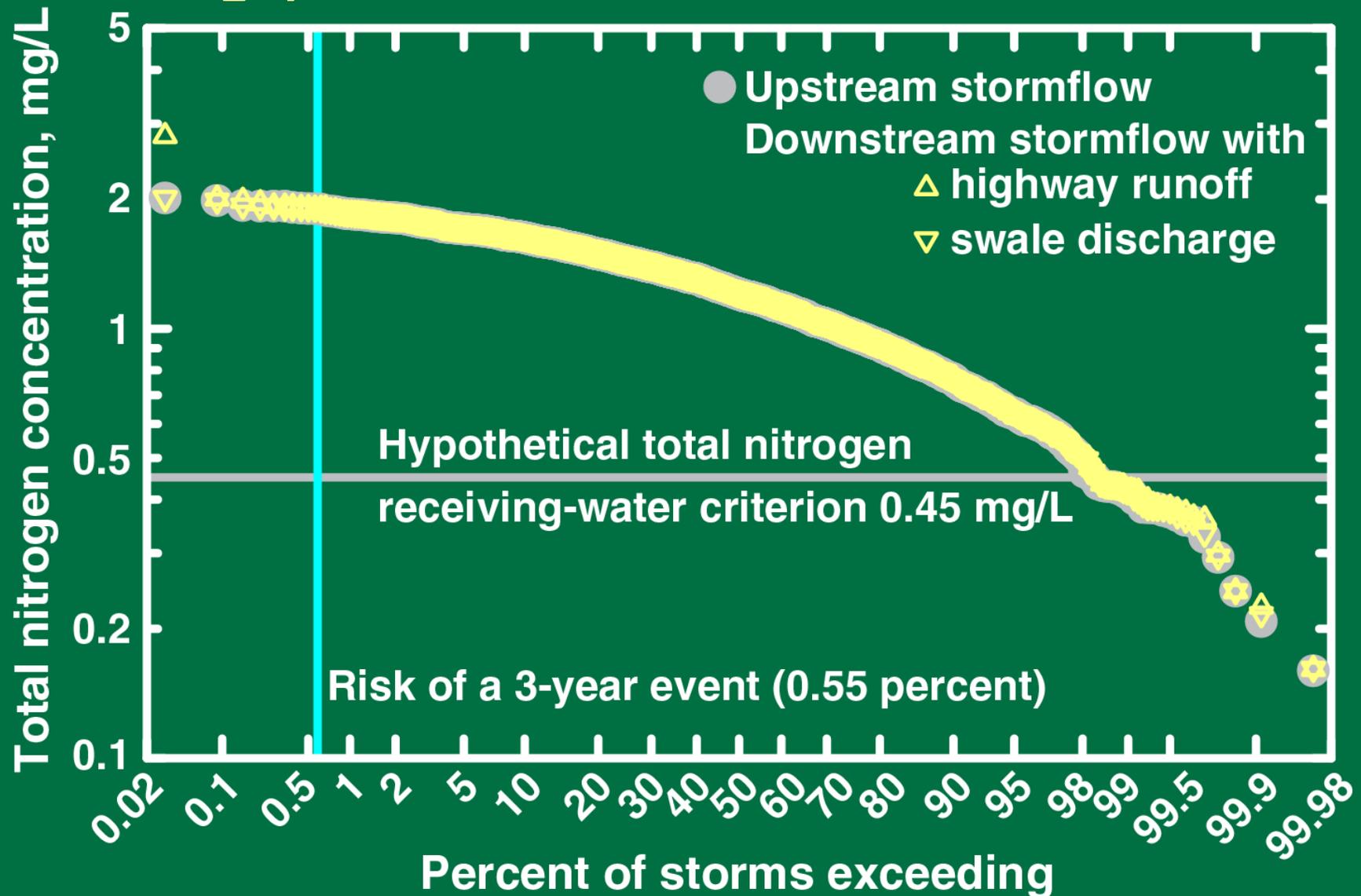
SELDM indicates the risk of exceedance



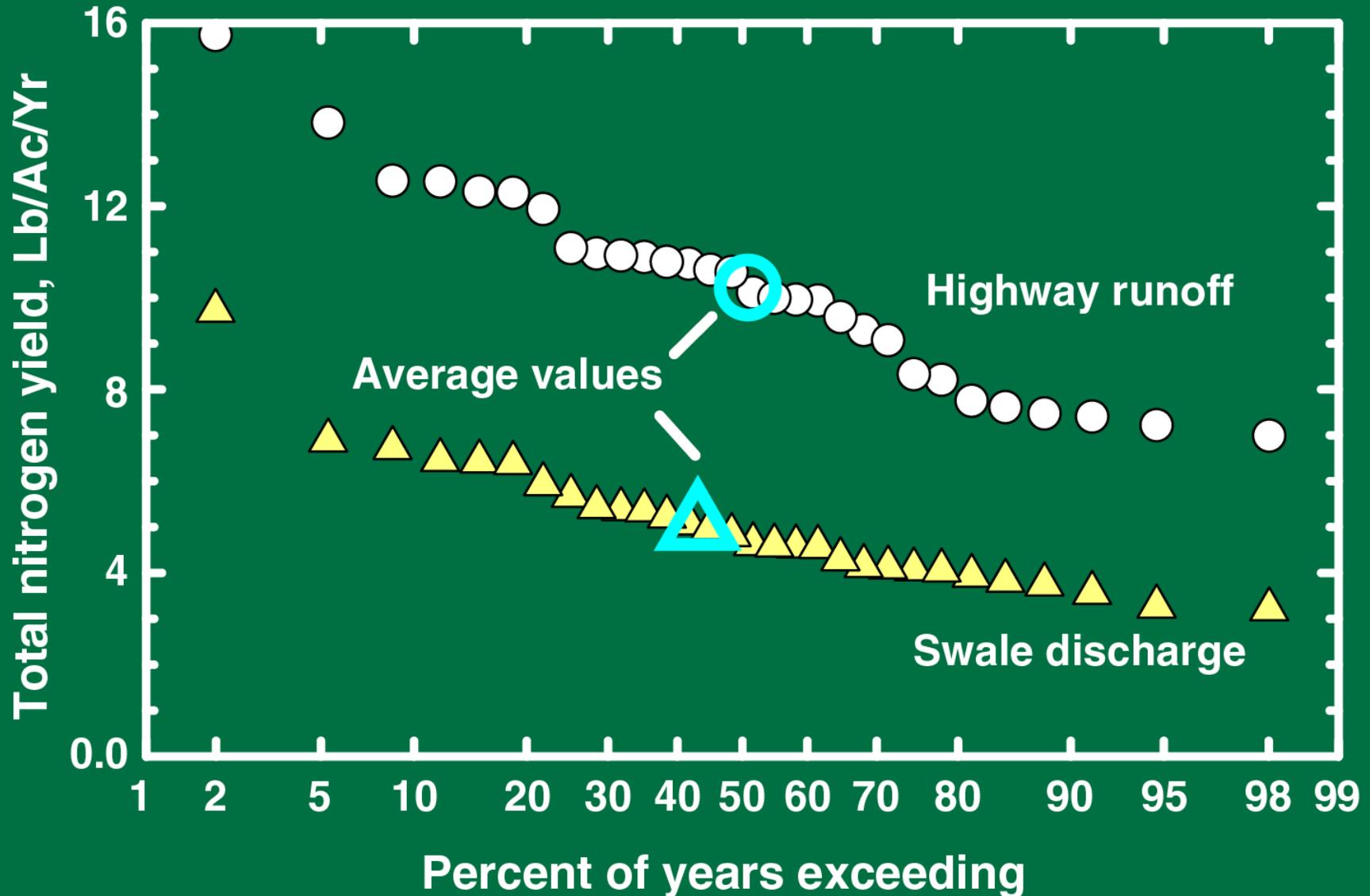
Background water-quality exceeds receiving-water criterion in about 98% of runoff events



The effect of highway runoff (and swale discharge) is small even in a small basin



SELDM can be used to estimate annual loads with and without BMPs for a site or by acre



The web site has links to reports, software, and SELDM version 1.0.1 Google “SELDM highway”



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Publication No. FHWA-HEP-09-004
2009



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Publication No. FHWA-HEP-09-005
2010

Methods for Development of Planning-Level Estimates of Stormflow at Unmonitored Stream Sites in the Conterminous United States



U.S. Department of Transportation
Federal Highway Administration
USGS
U.S. Department of the Interior
U.S. Geological Survey

Publication No. FHWA-HEP-09-003
2009

Methods for Development of Planning-Level Estimates of Water Quality at Unmonitored Stream Sites in the Conterminous United States



Office of Project Development and Environmental Review
1200 New Jersey Avenue, SE
Washington, DC 20590



In cooperation with the
U.S. Department of Transportation
Federal Highway Administration
Office of Natural and Human Environment

Kendall-Theil Robust Line (KTRLine—version 1.0)— A Visual Basic Program for Calculating and Graphing Robust Nonparametric Estimates of Linear-Regression Coefficients Between Two Continuous Variables

Stochastic Empirical Loading and Dilution Model for Analysis of Flows, Concentrations, and Loads of Highway Runoff Constituents

Gregory E. Granato and Susan Cheung Jones

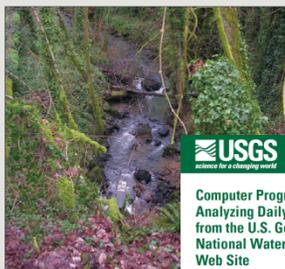
In cooperation with FHWA, the U.S. Geological Survey developed the stochastic empirical loading and dilution model (SELDM) to upgrade the 1994 FHWA runoff quality model. The SELDM tool is designed to transform discrete and complex available data into meaningful information about the adverse risks of runoff on receiving waters, the potential need for mitigation measures, and the potential effectiveness of such measures for reducing such risks. The SELDM tool is easy to use because much of the information and data needed to use are embedded in the model and obtained by defining the site location and the simple hydro properties. Information and data from thousands of other watersheds were compiled to facilitate the use of the SELDM tool. A new model structure has been used in the SELDM tool for modeling the types of variability patterns needed to properly assess water quality risks. For example, the use of deterministic values to model upstream stormflows instead of representing variability by random flow and runoff hydrographs.

(1-4) Managers of water resources are concerned about the frequency, magnitude, and duration of runoff concentrations and loads (i.e., the products of measured streamflow and concentration) to assess the risks of adverse effects on the quality of receiving waters (7-7). FHWA developed a model of highway runoff that uses statistical approaches to estimate the potential impacts of runoff on receiving waters. Publications of the 1994 FHWA runoff quality model was the culmination of FHWA research on runoff quality conducted during the 1970s and 1980s (2, 7). By the mid-1990s, however, the existing data and existing methods were outdated (8,9,10). As a result of the implementation of total maximum daily load regulations, scientific, regulatory, and decision makers have become increasingly aware of the importance of considering random variation in the quantity and quality of highway runoff and secondary upstream receiving waters for estimating the potential effects of

Technique
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Assessing Potential Effects of Highway Runoff on Receiving-Water Quality at Selected Sites in Oregon with the Stochastic Empirical Loading and Dilution Model (SELDM)



Computer Programs for Obtaining and Analyzing Daily Mean Streamflow Data from the U.S. Geological Survey National Water Information System Web Site

by Gregory E. Granato

Scientific Investigations Report 2014-5099

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

Prepared in cooperation with the
U.S. Department of Transportation
Federal Highway Administration
Office of Natural and Human Environment

Open-File Report 2008-1362
U.S. Department of the Interior
U.S. Geological Survey



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

Estimating Basin Lagtime and Hydrograph-Timing Indexes Used to Characterize Stormflows for Runoff-Quality Analysis



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

Statistics for Stochastic Modeling of Volume Reduction, Hydrograph Extension, and Water-Quality Treatment by Structural Stormflow-Runoff Best Management Practices (BMPs)

Scientific Investigation

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



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

Stochastic Empirical Loading and Dilution Model (SELDM) Version 1.0.0

Scientific Invest

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Techniques and Methods Book 4-C3

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