# Outline:

1. Source Water Defined

2. History of US Water Pollution Laws

3. Fundamentals of Pollution Transport Models

4. Compare & Contrast Incident Command – Water (ICWater) and USGS (beta) Time of Travel models

# What is Source Water?

Untreated water from streams, rivers, lakes, and aquifers that is used to supply water that is safe enough for human consumption.

# Evolution of US Water Pollution Laws:

1899 Rivers & Harbors Act | "Can't impede Navigation without a permit"

1924 Oil Pollution Act| "Can't discharge petroleum/petroleum products in navigable coastal waters without a permit"

1948 Water Pollution Control Act | Establish technical and financial assistance to states to protect Water Quality and limit federal authority to enforce water pollution control

# US Water Pollution Laws continued:

1962 R

1965 V
WITH SE
INTERST

1969 C

1970 F





SRBC
SUSQUEHANNA RIVER BASIN COMMISSION
NY ▪ PA ▪ MD ▪ USA

Our Mission:

# US Water Pollution Laws (last slide):

## 1972 Clean Water Act

## 1974 Safe Drinking Water Act

### Safe Drinking Water Act Amendments:

1986 – Wellhead Protection

1996 – Source Water Assessment Program &
Drinking water state revolving loan fund

# Managing Pollutant spills in flowing waters

- 1980s – United States Geological Survey dye studies to better understand how soluble pollutants behave in moving waters; to map dispersion traits; and to develop stream discharge approach for conditions unsuited to standard mechanical methods

- 1990s – USEPA and Ohio River Valley Water Sanitation Commission (ORSANCO) collaborate on core need that water utilities must be alerted to protect human health and their own infrastructure from pollutant spills in their source waters

- Post-9/11/2001 – Homeland Security imperative to protect drinking water sources

# Why is Recharge Potential Important

- Directly influences amount, movement, and filtering of water entering aquifers
- Higher risk of nutrients leaching into groundwater in high recharge potential areas
  - Rapid transport through soil profile, before plants can absorb soluble nutrients
- Higher risk of accumulation in low recharge potential areas
  - Potential for surface runoff and pollution to nearby streams, rather than groundwater

# Power Function Relationship At Core of Transport

Velocity = $a$ * Discharge$^{b}$

$a$ is a scaling factor related to physical traits of the waterway; e.g., channel slope, roughness of bed, shape of channel, etc.

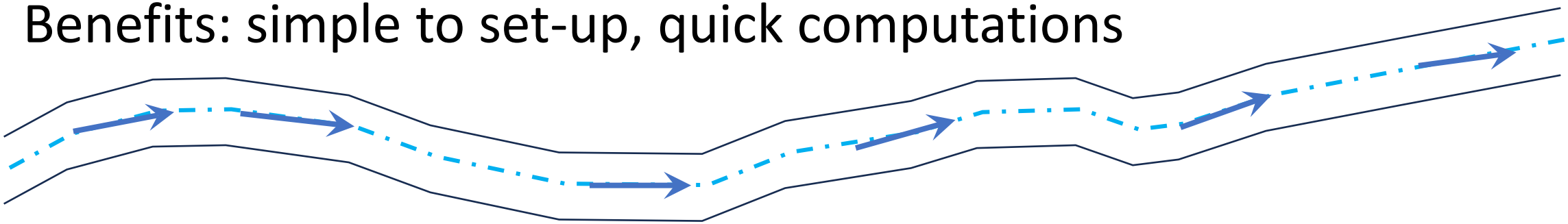
$b$ expresses the rate of change; i.e., how efficiently the channel conveys flow.

- Narrow gorge has high $b$;
- Wide expanse has low $b$.

# One and Two-Dimension Models

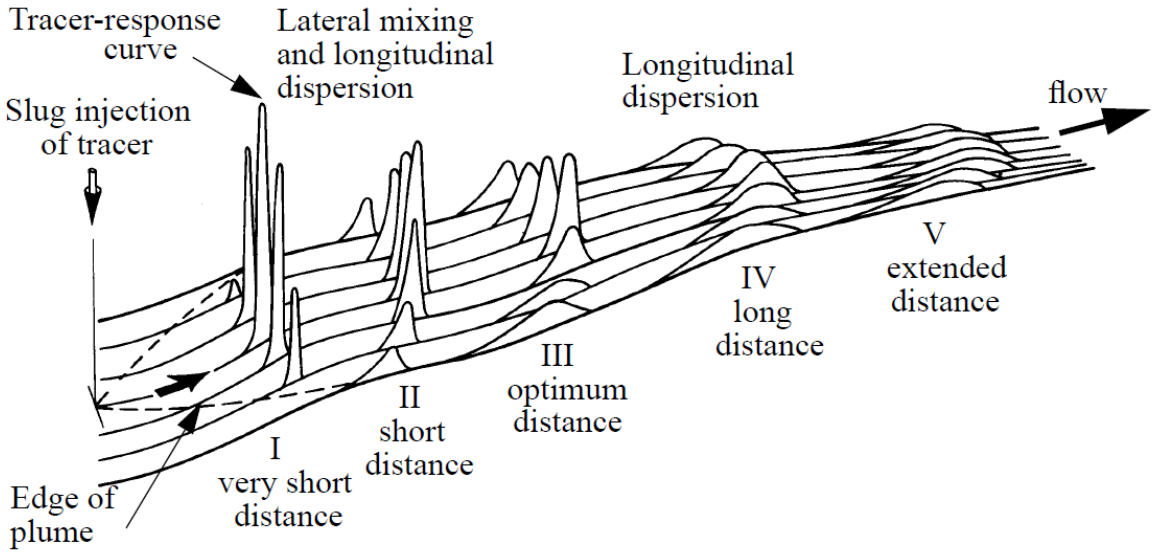
1-D forecasts flow along centerline (longitude) of channel.

Benefits: simple to set-up, quick computations

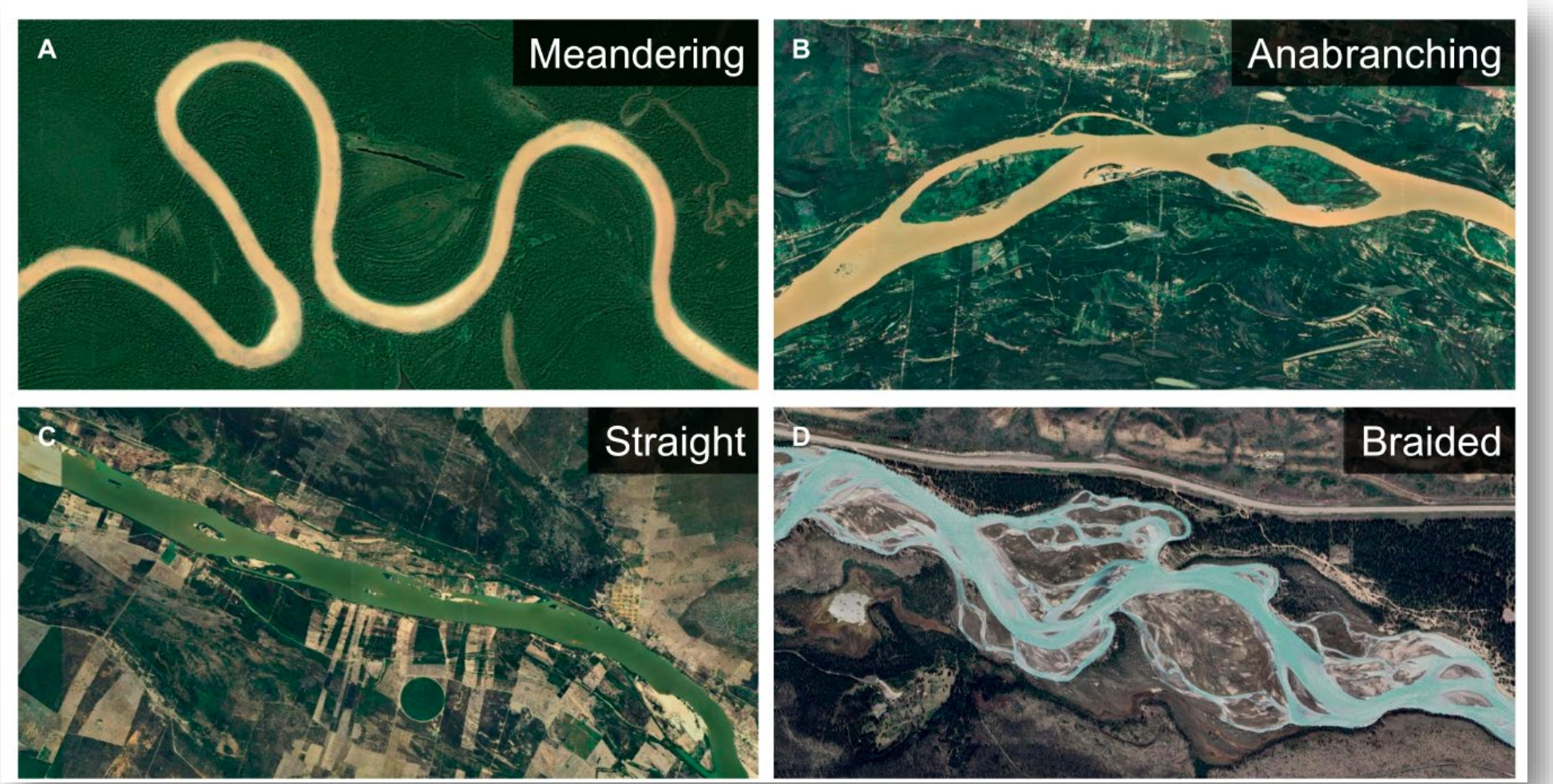


2-D forecasts flow along longitude and lateral coordinates of channel.

Benefits: more realistic

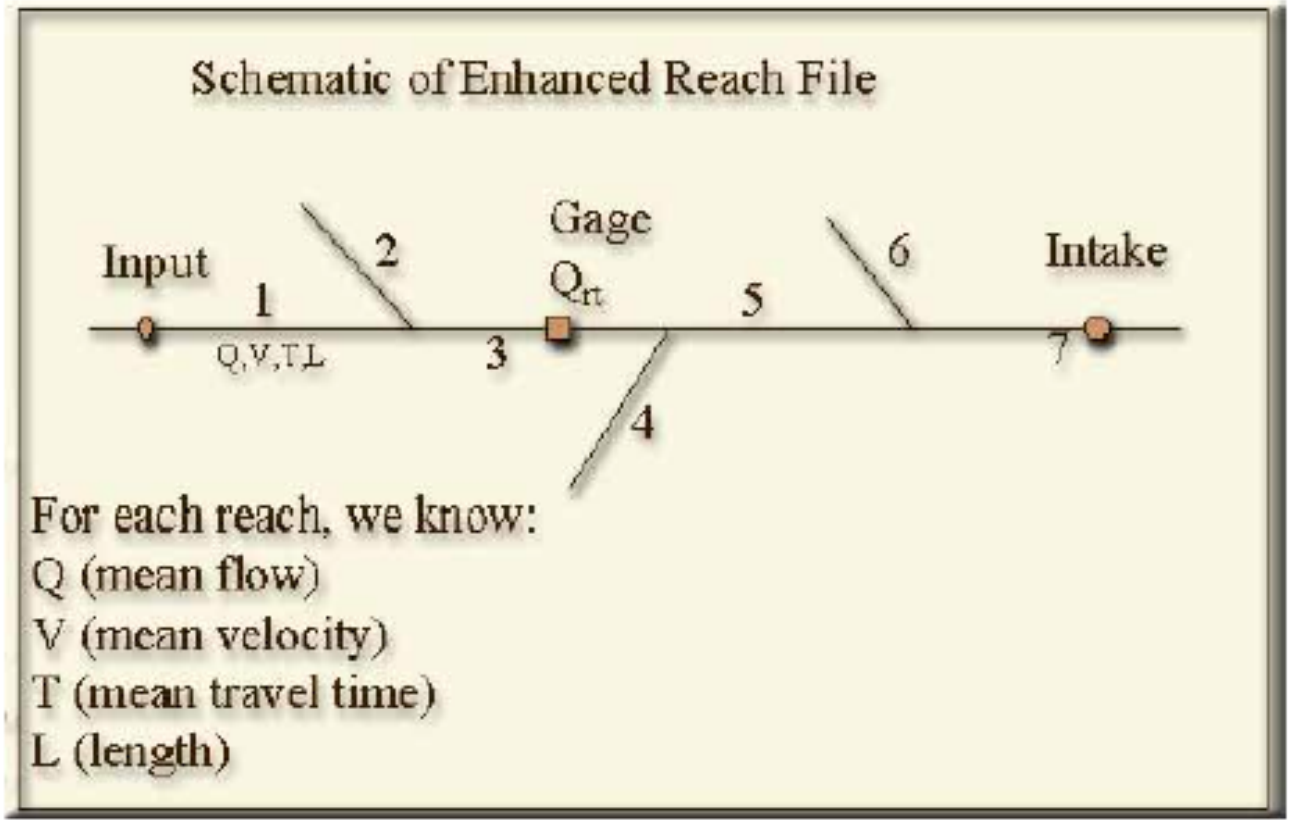


# Actual River Channel Shapes



# Model Schematic

- Input – spill details
- Flow - Look up, Estimate, or Integrate real-time discharge
- Nos. 1 – 7 reach segments (stream network traits)
- Intake – Water utility




W.B. Samuels et al., 2002 RiverSpill: A GIS-Based Real Time Transport Model for Source Water Protection.

# Comparing ICWater and USGS Streamstats Beta T-of-T

| FEATURE | IC Water | USGS Beta Time-of-Travel |
|---|---|---|
| Primary Core Approach | $V = aQ^b$ Power Function:<br><br>V – velocity, Q – discharge, a & b are reach-scale coefficients | Jobson's (1996) Regional regression equations from Time-of-Travel and dispersion studies |
| Transport Physics | 1-Dimension travel time and concentration change over time | Empirical/statistical estimates travel time boundaries |
| Flow Data Incorporation | Integrates USGS real-time gage data | User-defined or estimated baseline discharge values |
| Outputs | Real-time velocity, plume passage times, and downstream concentration curves. | Tabled accumulated travel times for the leading edge, trailing edge, and peak of a spill. |