



Evaluation of the Quality and Significance of Stormwater Discharge to Sediment Quality in Urban Waterways

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Evaluation of Urban Stormwater

- **Why is evaluating the impact of stormwater loading on sediment quality important?**
 - Potential source requiring cleanup
 - Potential source of recontamination
 - Often not considered a major source until studied

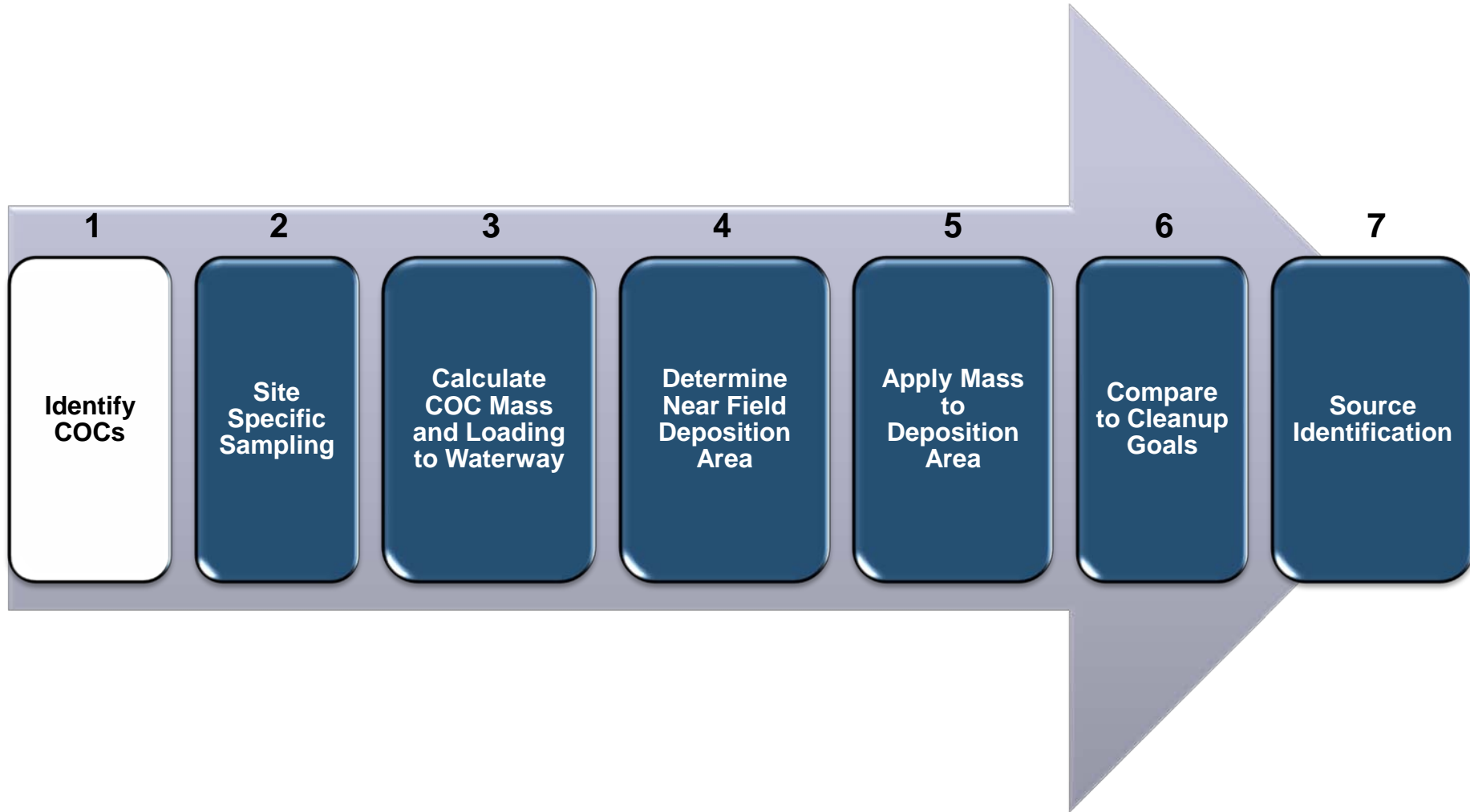


Evaluation of Urban Stormwater



- Urban stormwater runoff can be a **source of COCs** (e.g., roadways, architectural coatings, atmospheric deposition...)
- **Urban stormwater** is associated with specific COCs and typical concentrations
- The **mass of COCs** to the waterway can be used as a model input
- Several models are available to estimate the **mass flux of COCs**
- The **impact and distribution** of COCs adsorbed on sediments from stormwater can be estimated from **sediment transport and water quality modeling**
- Urban stormwater is a bigger issue at sites with more stringent cleanup thresholds

Evaluation of Urban Stormwater



Sources of Pollutants in urban stormwater

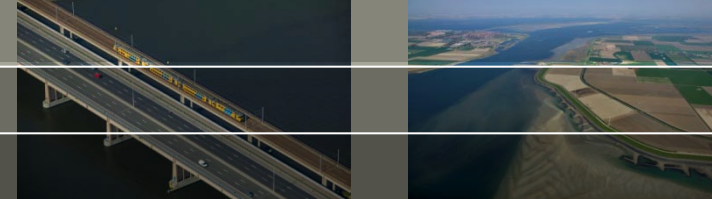
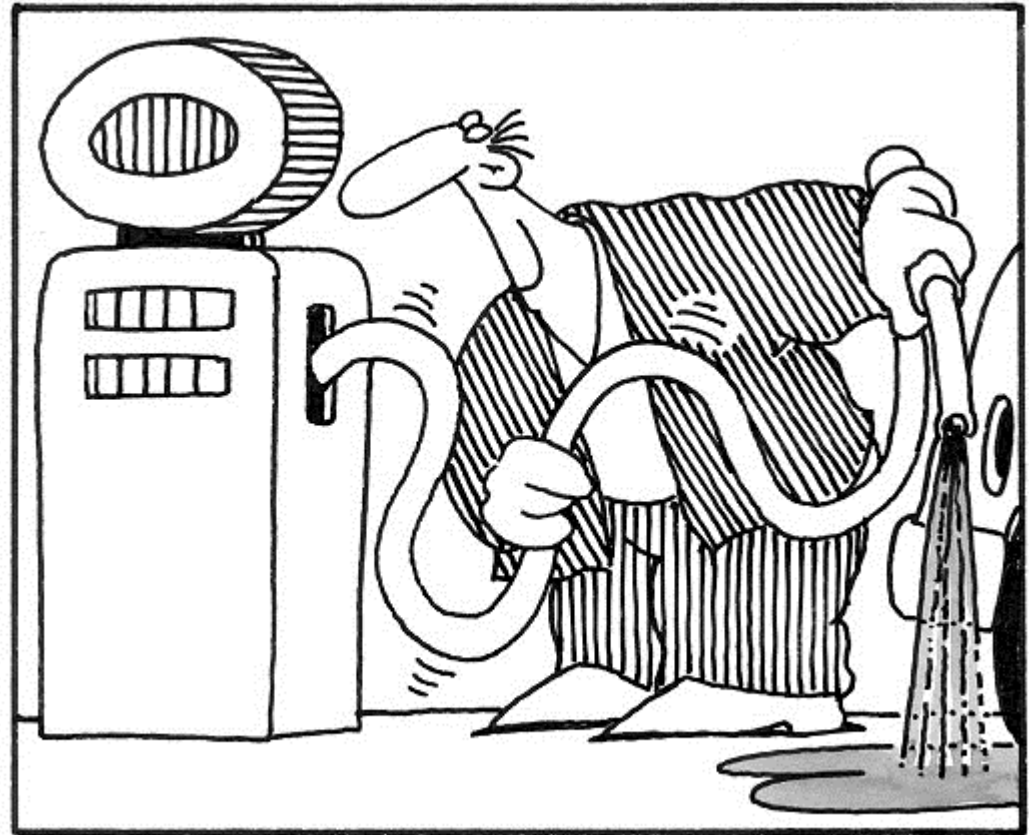
- Atmospheric deposition
- Transportation - Vehicles
- Pavement and construction
- Road maintenance and pavement de-icing
- Landscape management
- Building exteriors
- Industrial businesses
- Commercial businesses
- Residential activities
- Site development
- Public infrastructure



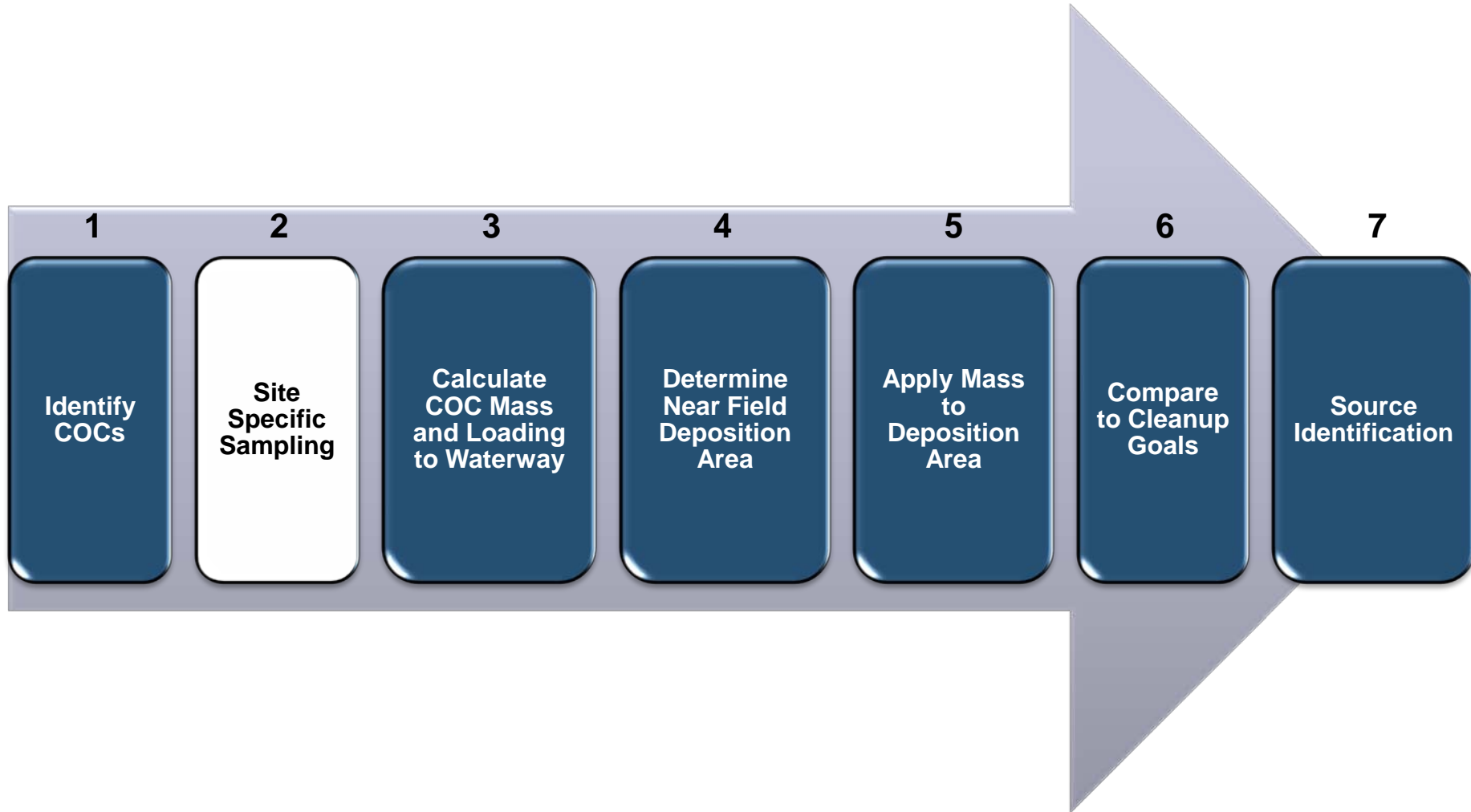
*This presentation does not cover other COCs such as pathogens, conventionals (nitrogen, phosphorus), emerging COCs (pharmaceuticals, plastic micro-particles, etc.)

Major Pollutants Detected

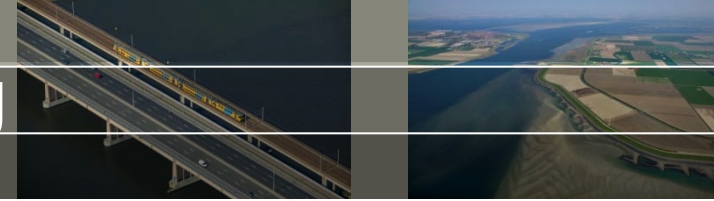
- Metals
- Phthalates
- Oil/grease
- Total Petroleum Hydrocarbons (TPH)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Pesticides and Herbicides
- PCBs
- Dioxins



Evaluation of Urban Stormwater



Step 2 – Site Specific Sampling



Methodology for sampling and types of media sampled are important for evaluating COCs in stormwater

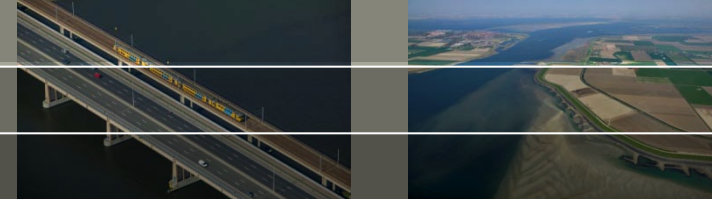
Site-specific sampling (e.g., stormwater, sediment trap, in-line sediment) necessary to characterize stormwater that discharges from roadways under consideration

Stormwater sampling locations can be correlated to traffic volumes and land uses (e.g., low-high traffic volume and rural-urban land use)

Targeted locations allow for development of a more accurate understanding of COC contributions from specific roadways or areas

Results from sampling along with literature review are used to describe typical COCs in stormwater from a specific roadway or facility

Site Specific Sampling



Inline Sediment Sampling

- Grab samples
- Sediment traps

Water Sampling

- Stormwater



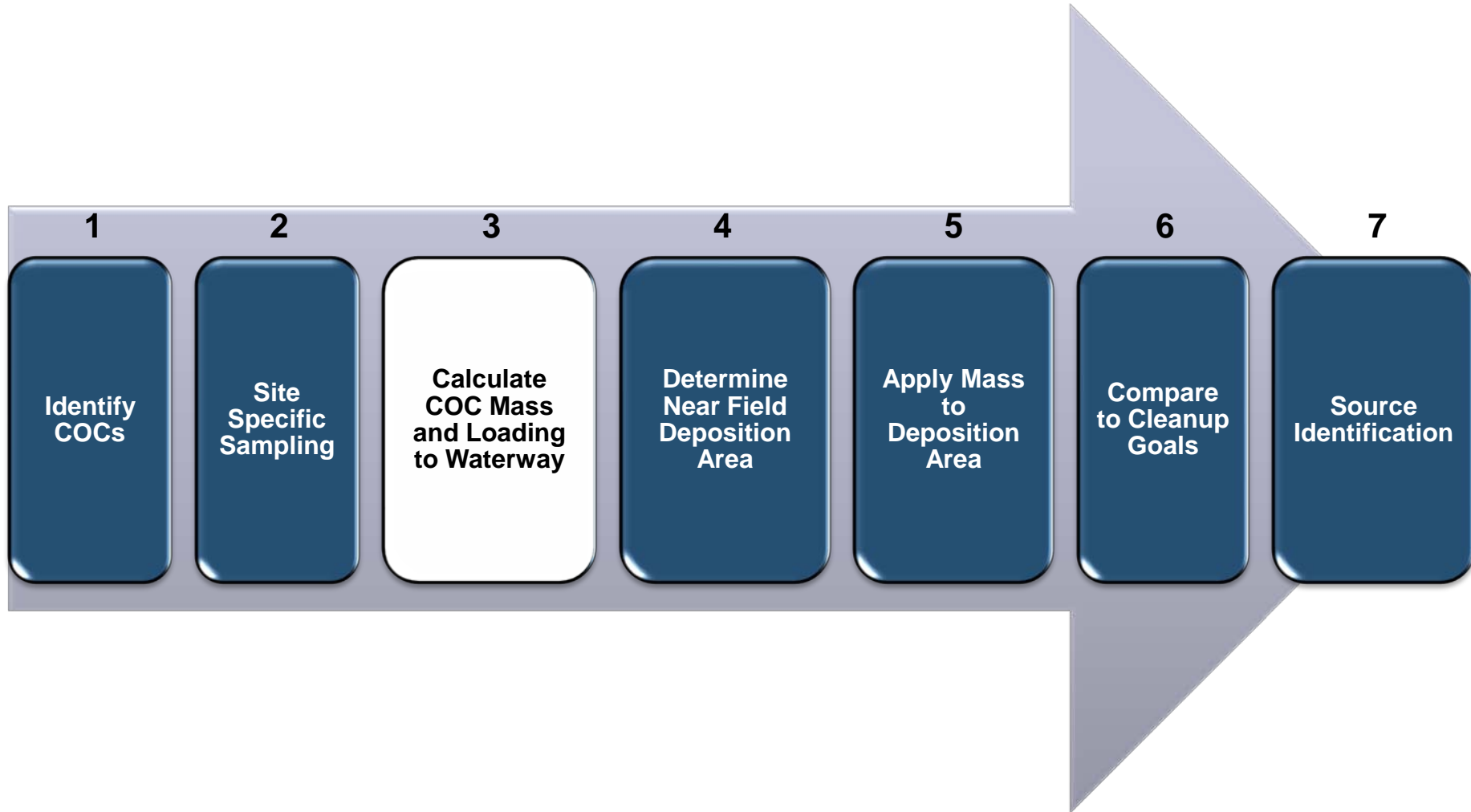
Inline Sediment Sample



Discrete Grab Sample



Evaluation of Urban Stormwater



Estimating Stormwater Loadings from roadways

A number of stormwater pollutant models are available, including: ***STEPL, AVGWLF, WINNSLAMM, SELDM, PLOAD, the P8 Urban Catchment Model, and the Simple Method.***

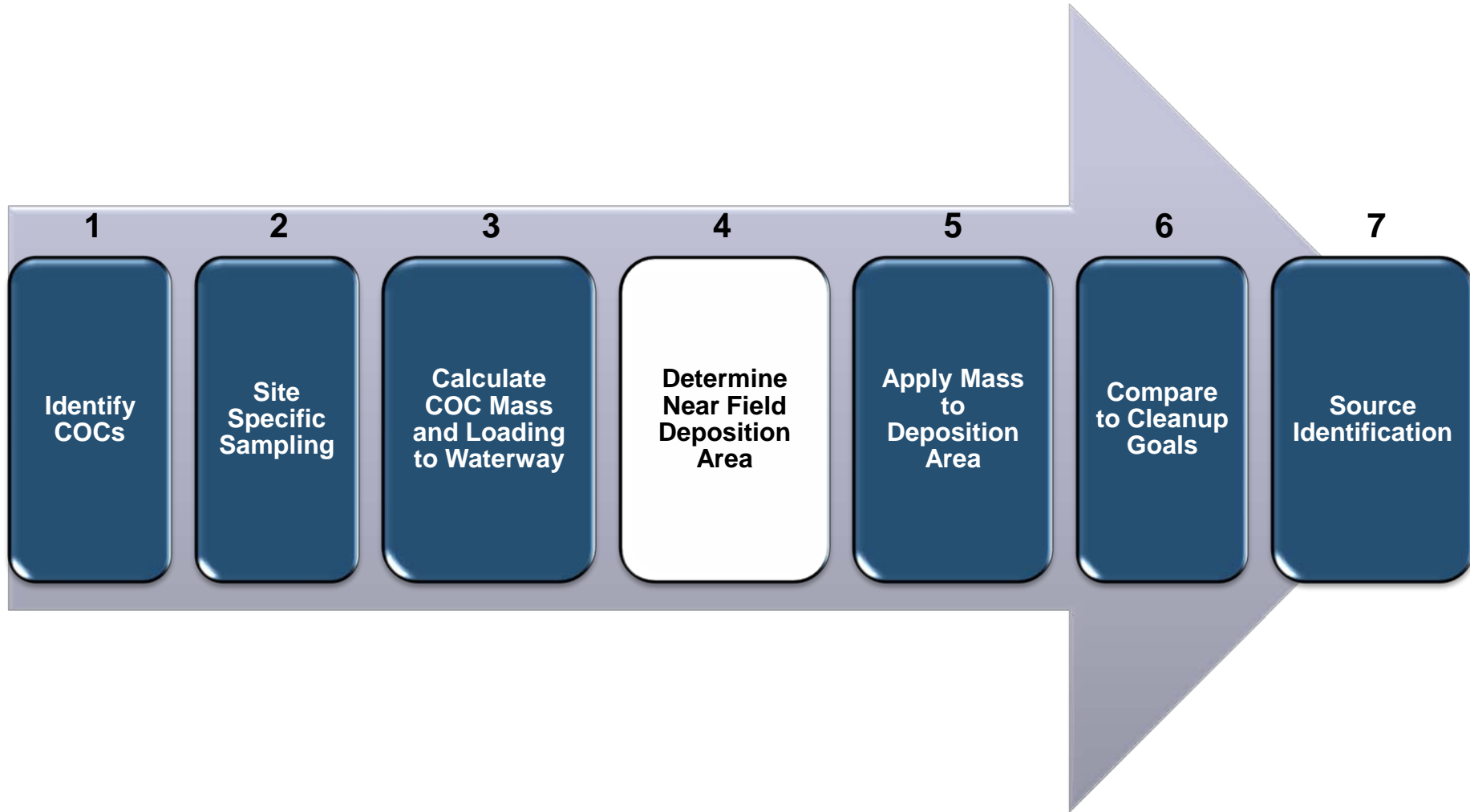
The type of model selected depends on site variables such as scale, types of land use, basin specific source identification, actual measurement of storm events, etc...



Data needed for modeling:

- watershed drainage area
- impervious cover
- concentrations of contaminants in stormwater
- annual precipitation

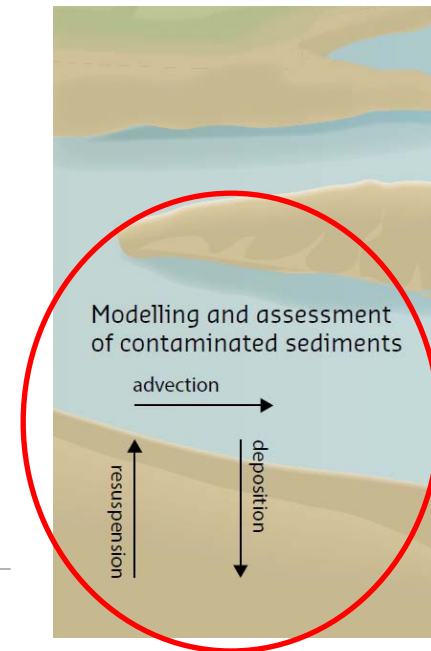
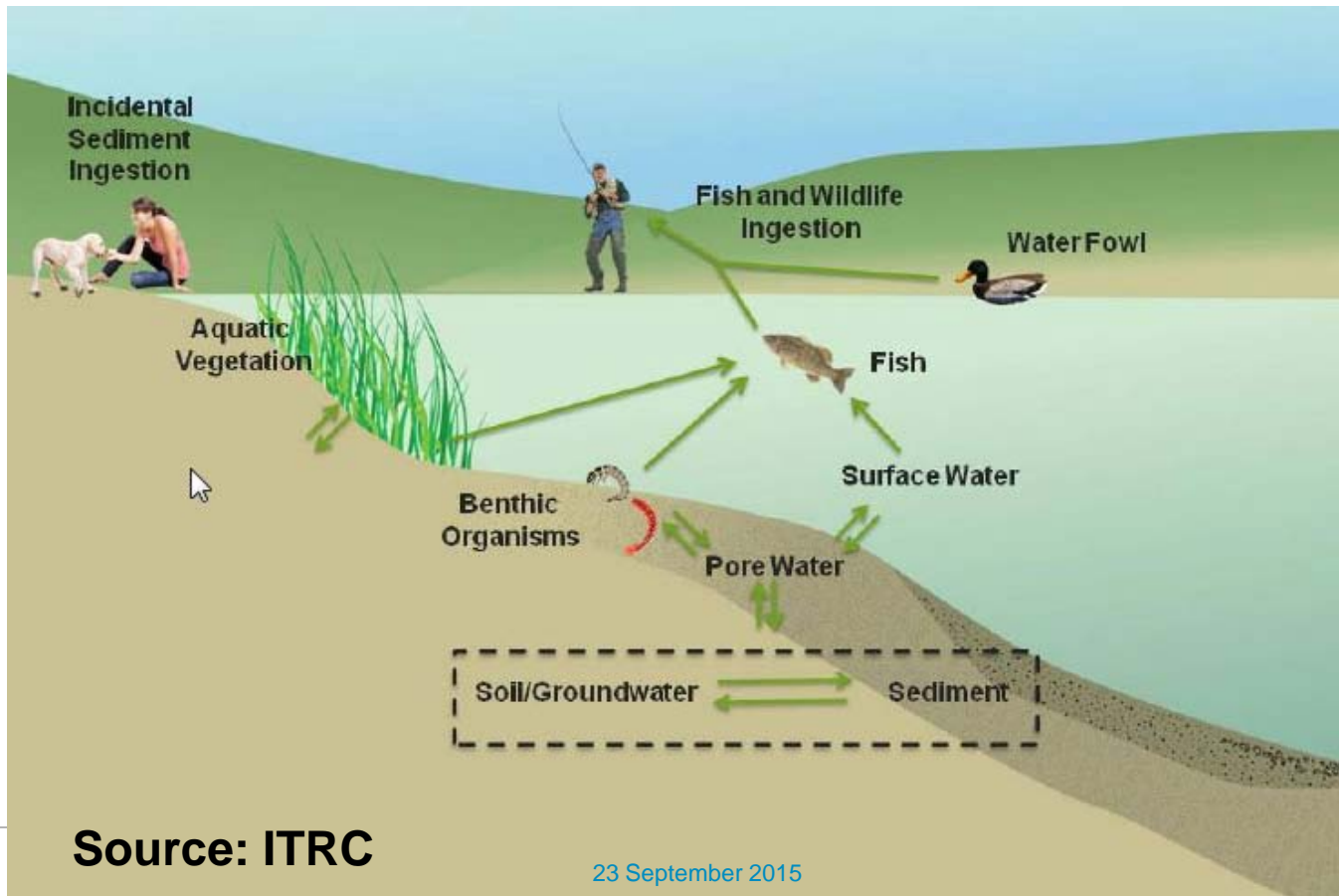
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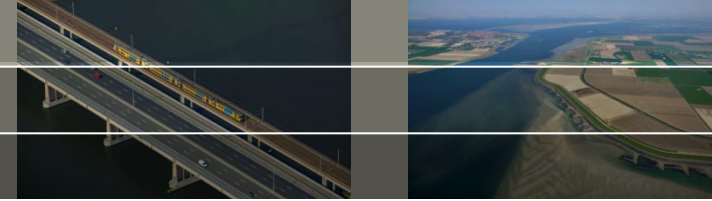
Determine deposition areas

Several aspects influence where contaminants deposit:

- Contaminants → dissolved phase or adsorbed onto a sediment particle
- Exert toxic effects on benthic flora and fauna → propagate through food chain



Why model?



- Empirical observations -> system understanding
- Modelling tools -> build system and process understanding
- Numerical models → very useful tool to examine resuspension, transport and deposition of sediments at different temporal and spatial scales
- However before modelling →
 - Is it necessary?
 - At what level of complexity?
 - What information will it add and how to use the outputs?
 - What about model validation?
 - Predictive modelling or execution support?



- Contaminants adsorb onto finer grained sediments more easily

- Cohesive versus non cohesive

- Hydrodynamics conditions
- Dispersion and diffusion
- Near and far field processes
- Bed shear stresses

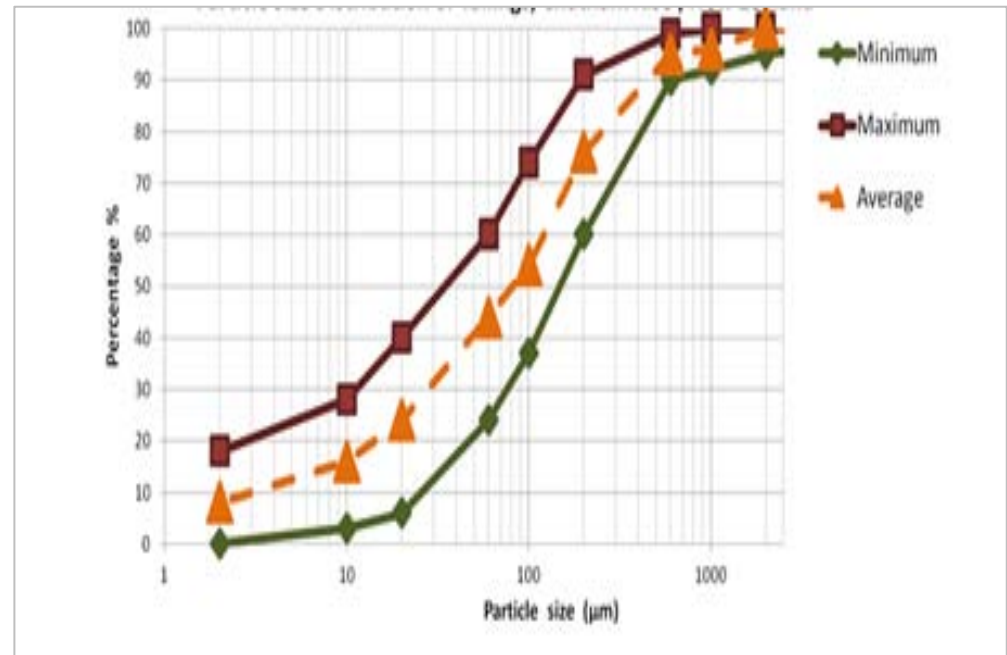
- Settling velocities of particles

- Flocculation and particle characteristics

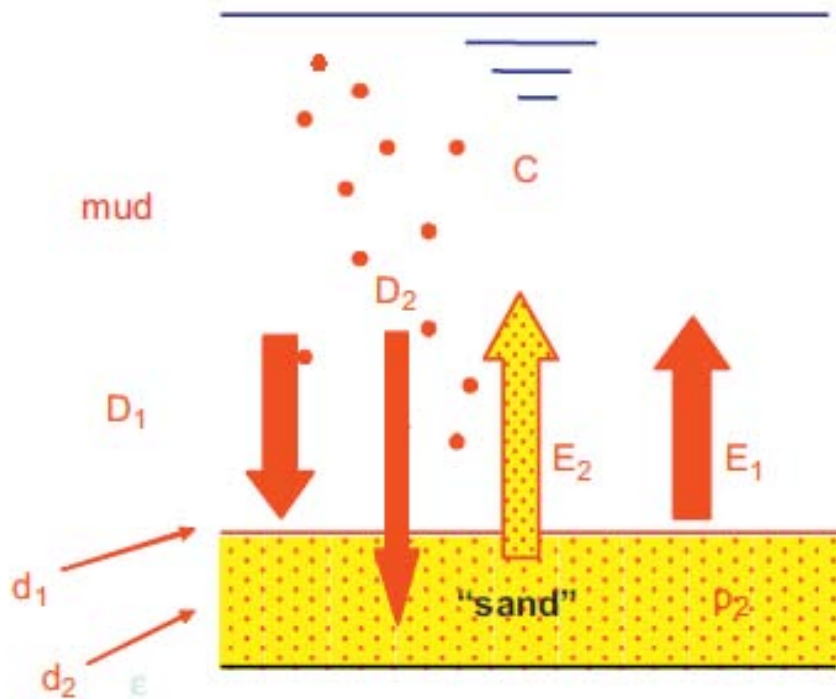
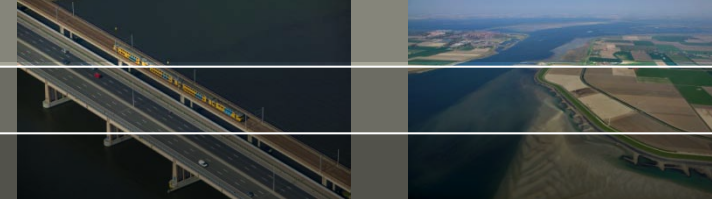


Determine deposition areas

- Outfall sediment load
- Particle size distribution
- Hydrodynamic scenarios and influence of discharge rates
- Scales of interest – near field, mid field – far field ?
- Depositional zone from a particular source
- Longer term transport and mixing
- Delft3D-FLOW and Delft3D-WAQ

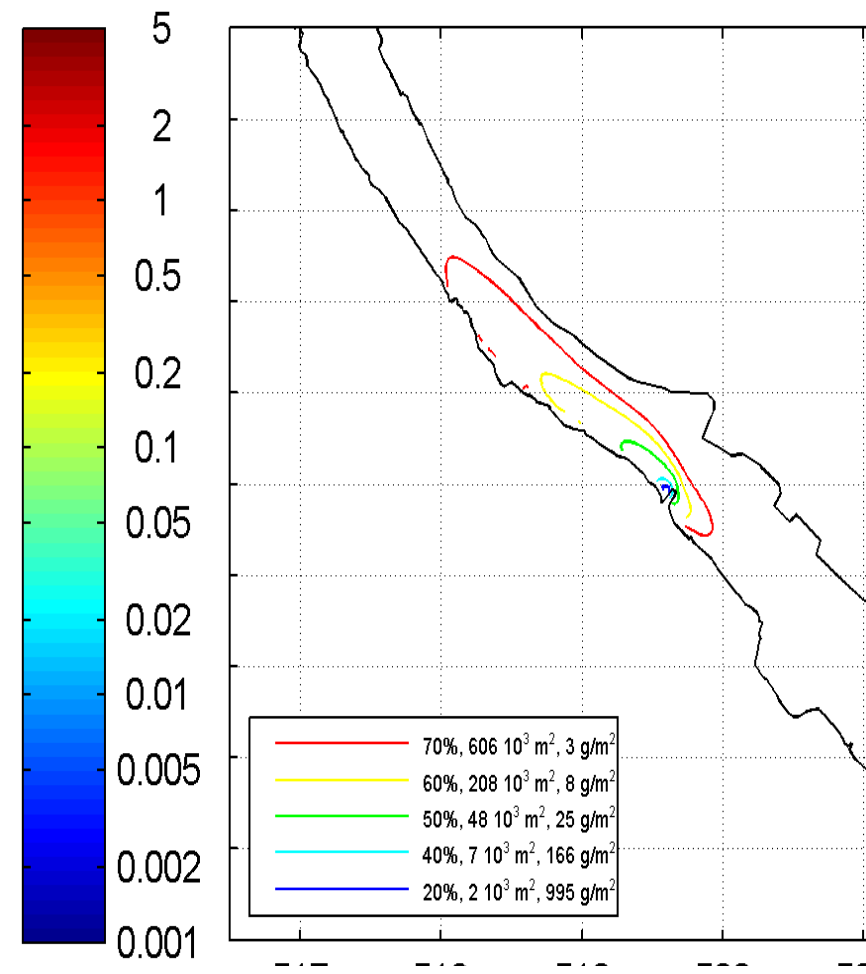
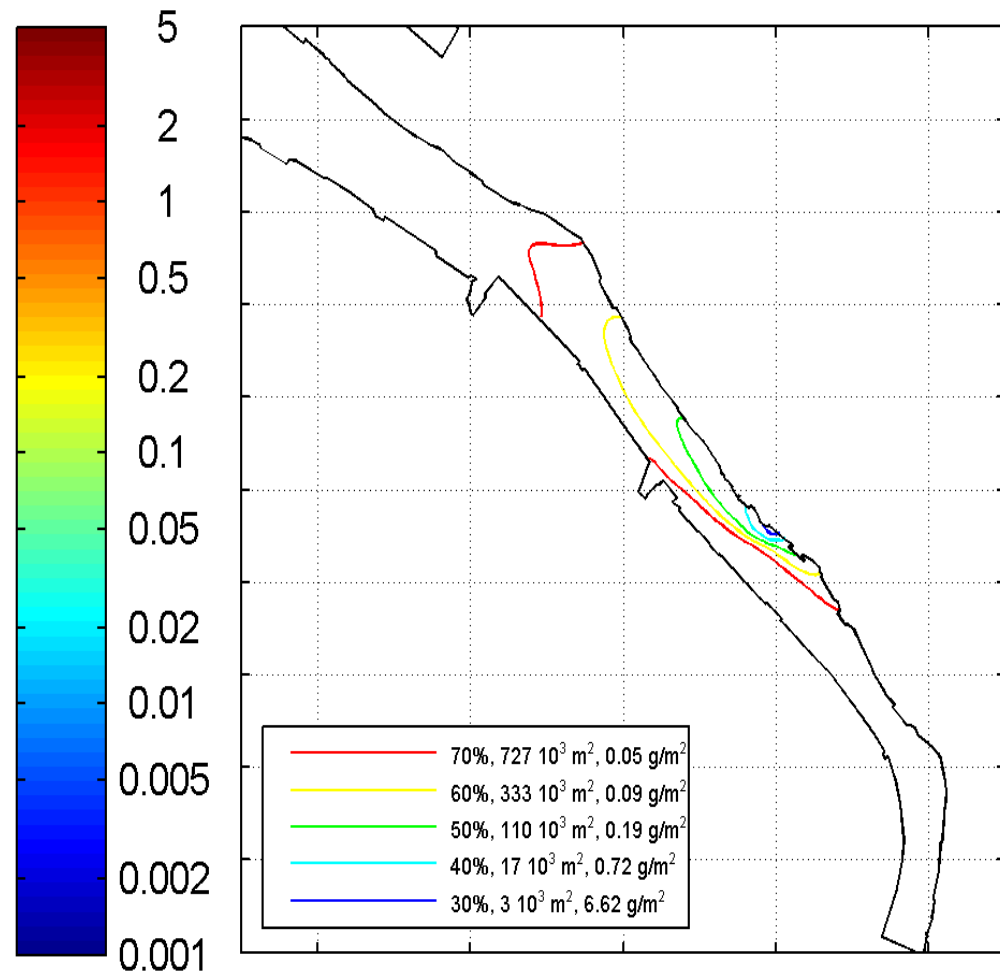
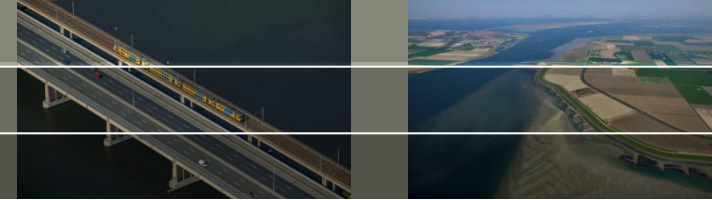


Modelling considerations



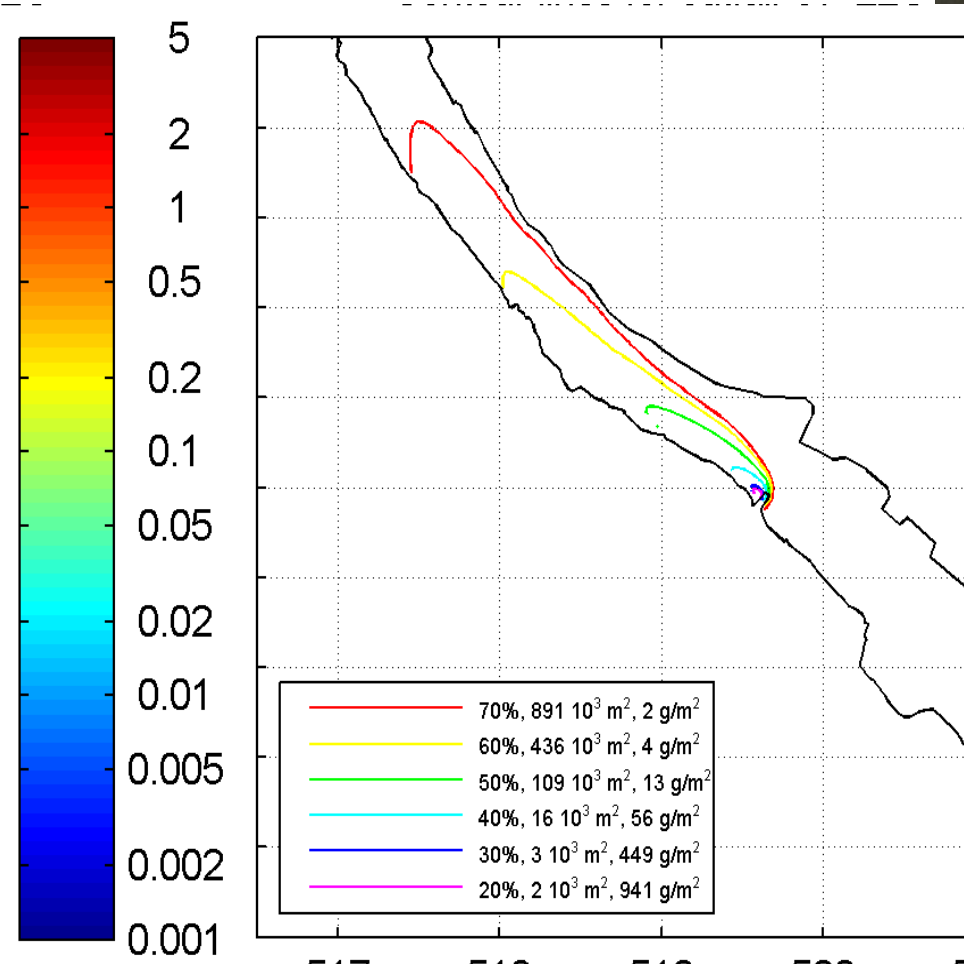
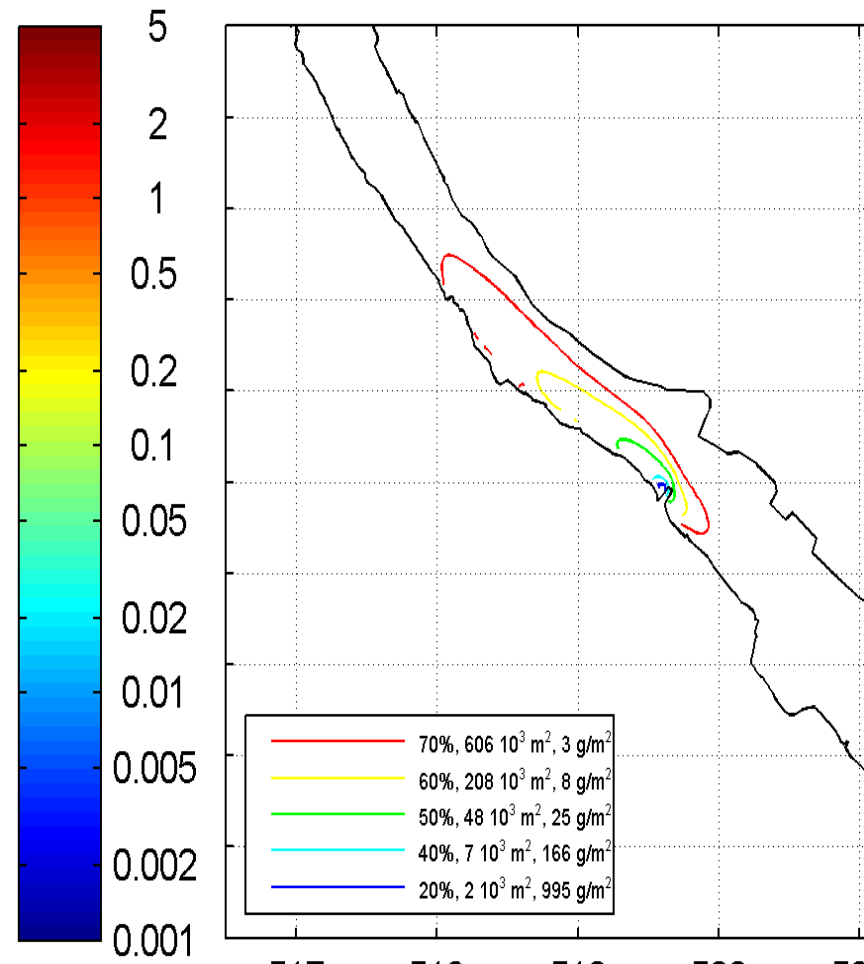
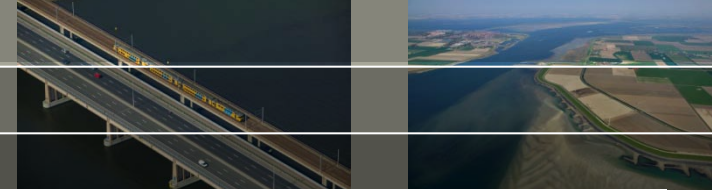
- Grid resolution → dilution
→ enhanced dispersion
- Estuarine circulation
- Tagging of sediment fractions
- Representative scenarios
- Initial deposition zones only
or include resuspension for
longer term estimates

Depositional Zones



Contour lines showing where certain thresholds of sediment has settled

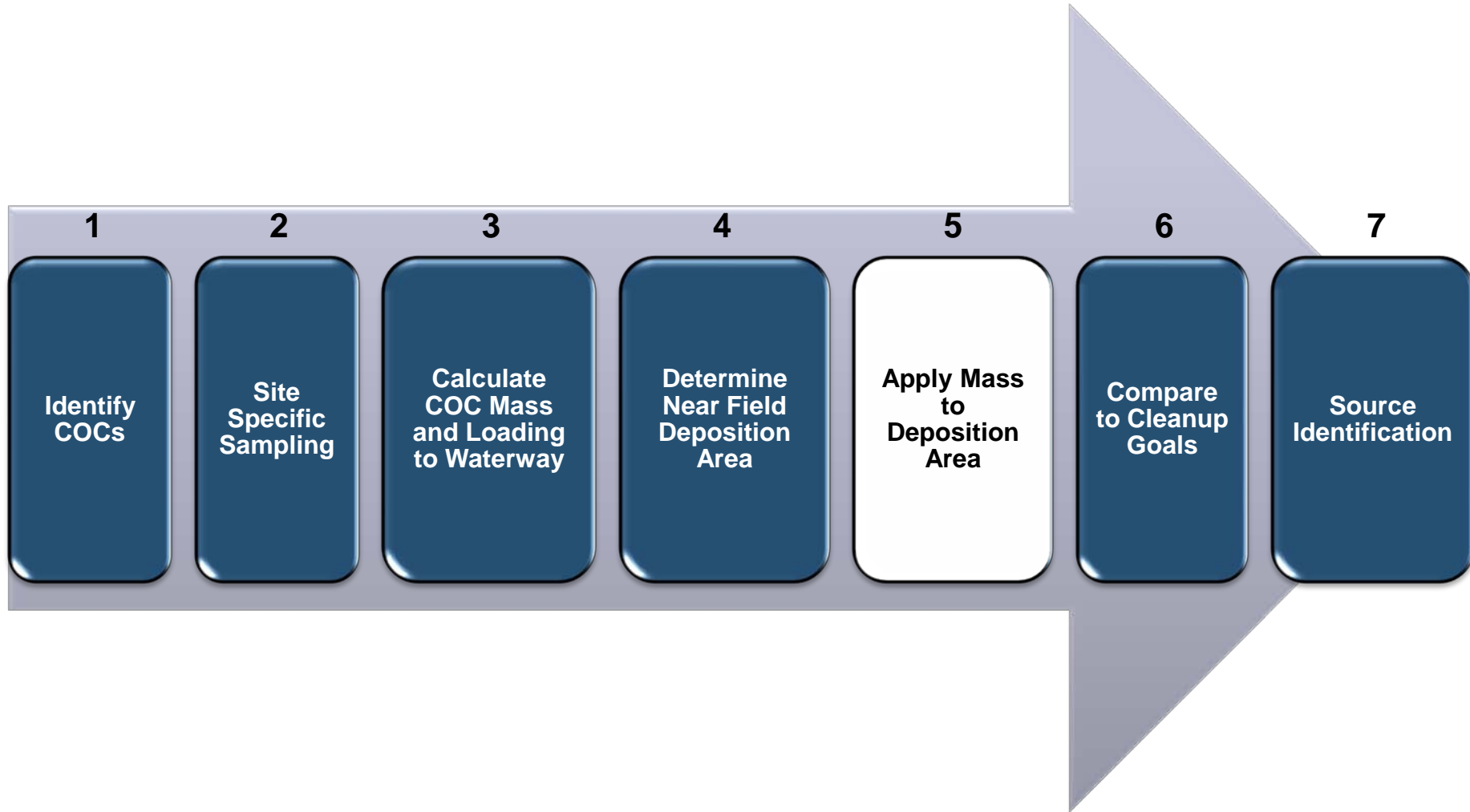
Influence of discharge events



LOW DISCHARGE LARGE RANGE

LOW DISCHARGE SMALL RANGE

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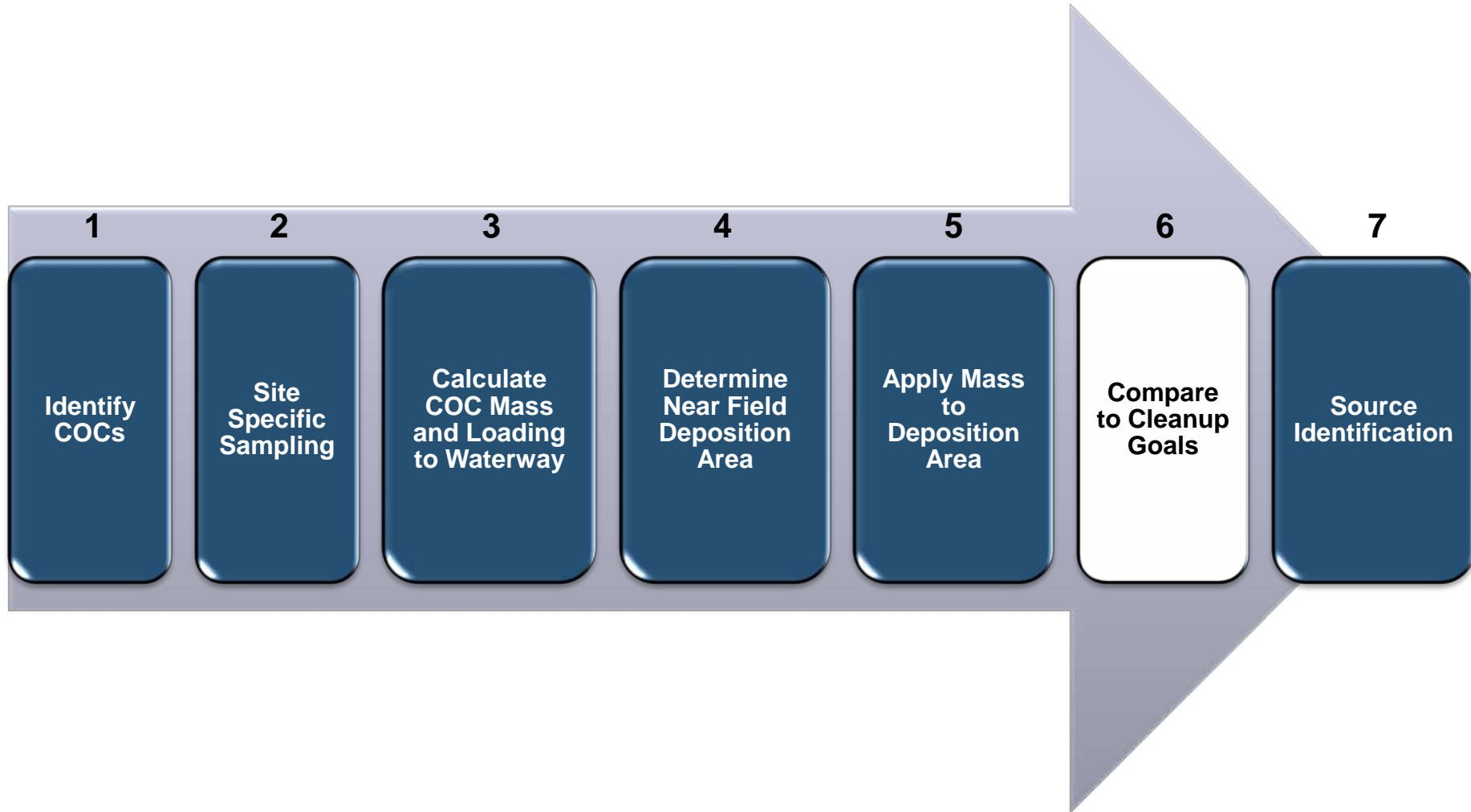
Step 5 – Apply Mass to Deposition Area

SEDCAM Model

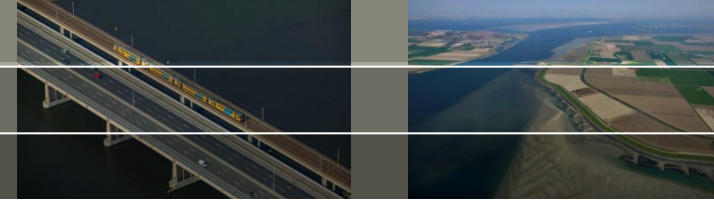
- The SEDCAM model (Jacobs et al. 1988), which is accepted and widely used (in USA) one dimensional mixing model that evaluates source loading, sediment deposition, chemical specific degradation rate, and mixing
- The SEDCAM model considered the following factors to calculate the concentration of the COC in surface sediment over time:
 - > The initial COC concentration in sediment
 - > The rate and total accumulation of sediments deposited in the mixing layer
 - > The concentration of the COC in the deposited sediment

The model contains several simplifying assumptions or limitations, such as a well-mixed surface sediment layer of defined thickness and a single term covering both chemical degradation and diffusion

Evaluation of Urban Stormwater



Step 7 – Source Identification



Why is source identification important?

- Supports divisibility argument
- Helps find and identify sources
- Concentrations of COCs in sediment from stormwater are discernible from other sources of COCs (e.g., PAHs in stormwater have a different PAH signature than PAHs from former manufactured gas plants)

A focused sampling program with defined laboratory methods are necessary for source identification and tracing

Statistical tools (PCA, diagnostic ratios, profiles, and metal techniques) are one approach for source identification and tracing

Summary of Key Points

Sources of COCs in urban runoff (e.g., roadways, architectural coatings, atmospheric deposition...)

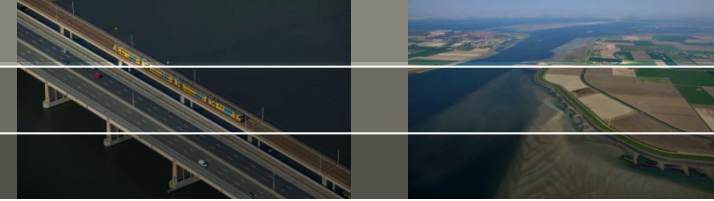
Mass of COCs to the waterway as a model input for flux calculation

Estimate impact of COCs adhered to sediments from stormwater discharge

Impact of different conditions (discharge, particle size etc.) on transport and deposition of contaminated sediments

Urban stormwater is a bigger issue at sites with lower cleanup thresholds

Thanks for listening



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