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TRANSPORTATION RESEARCH BOARD

Complying with TMDL Requirements Related to Roadway Stormwater Runoff

Thursday, October 31, 2019
2:00-3:30 PM ET

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.

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Purpose

To discuss NCHRP's Research Report 918: Approaches for Determining and Complying with TMDL Requirements Related to Roadway Stormwater Runoff.

Learning Objectives

At the end of this webinar, you will be able to:

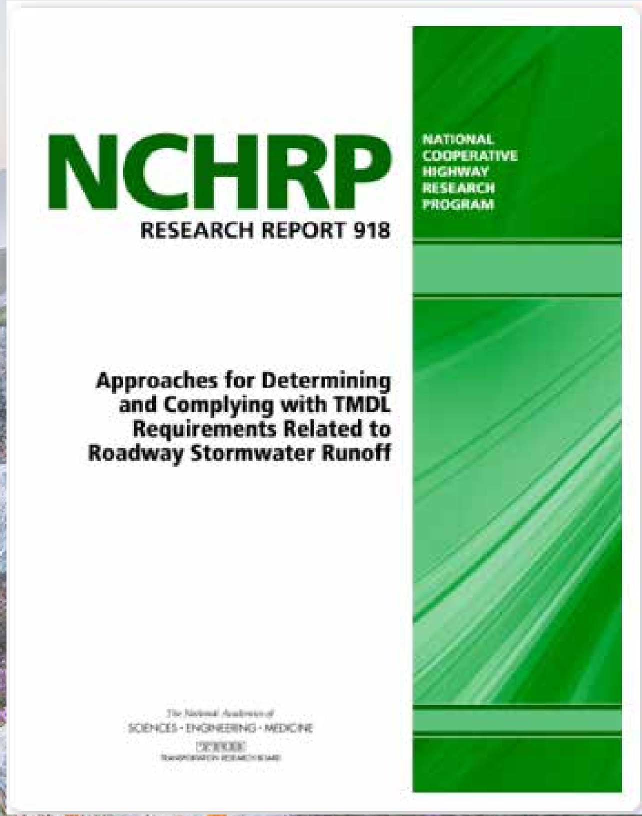
- Discuss how to develop a DOT TMDL program
- Identify appropriate tools and strategies available to DOT practitioners
- Define how to stay in compliance

PDH Certificate Information

- This webinar is valued at 1.5 Professional Development Hours (PDH)
- Instructions on retrieving your certificate will be found in your webinar reminder and follow-up emails
- You must register and attend as an individual to receive a PDH certificate
- Certificates of Completion will be issued only to individuals who register for and attend the entire webinar session – this includes Q&A
- TRB will report your hours within one week
- Questions? Contact Reggie Gillum at RGillum@nas.edu

NCHRP 25-53 Report 918

Approaches for Determining and Complying with TMDL Requirements Related to Roadway Stormwater Runoff



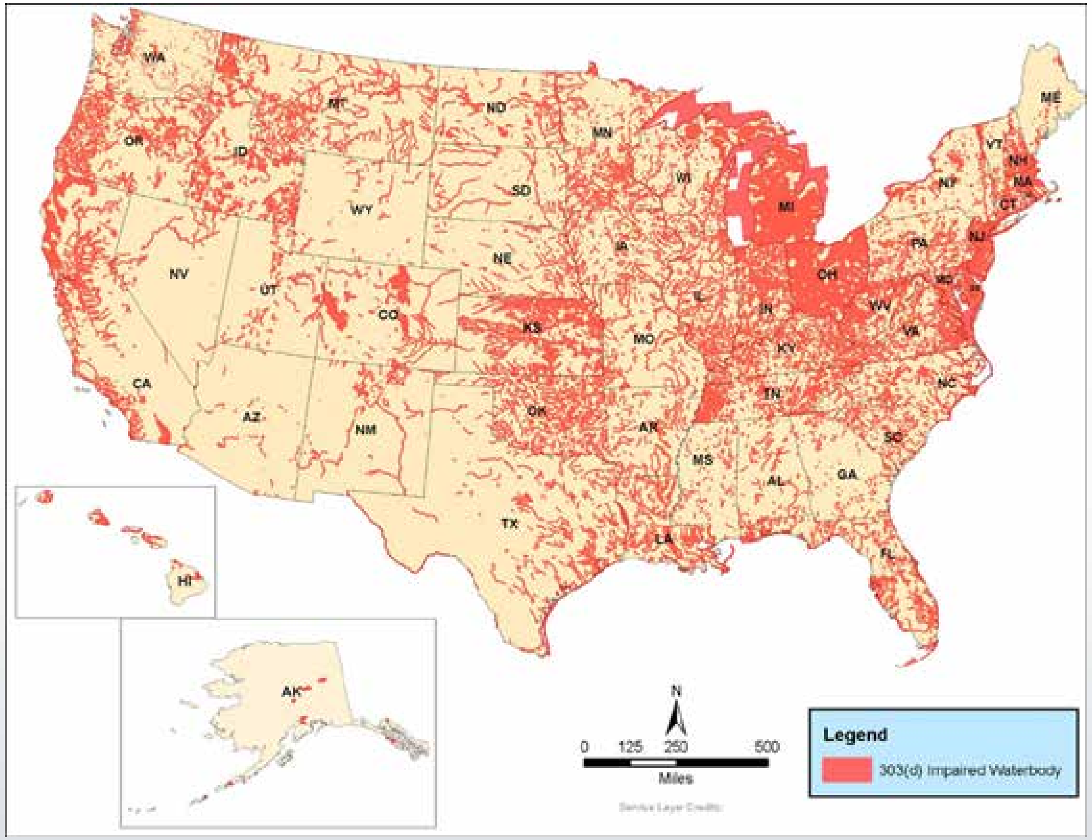
Webinar Presenters

- William Fletcher, Oregon DOT (ret.)
  - Chair of the NCHRP Research Study
- Anna Lantin, PE, Michael Baker International
  - Principal Investigator for NCHRP 918
- Greg Granato, USGS
  - Panel member, NCHRP 918
- Fred Noble, PE, Florida DOT
  - Panel member, NCHRP 918




Clean Water Act and TMDLs (TMDL - Total Maximum Daily Load)

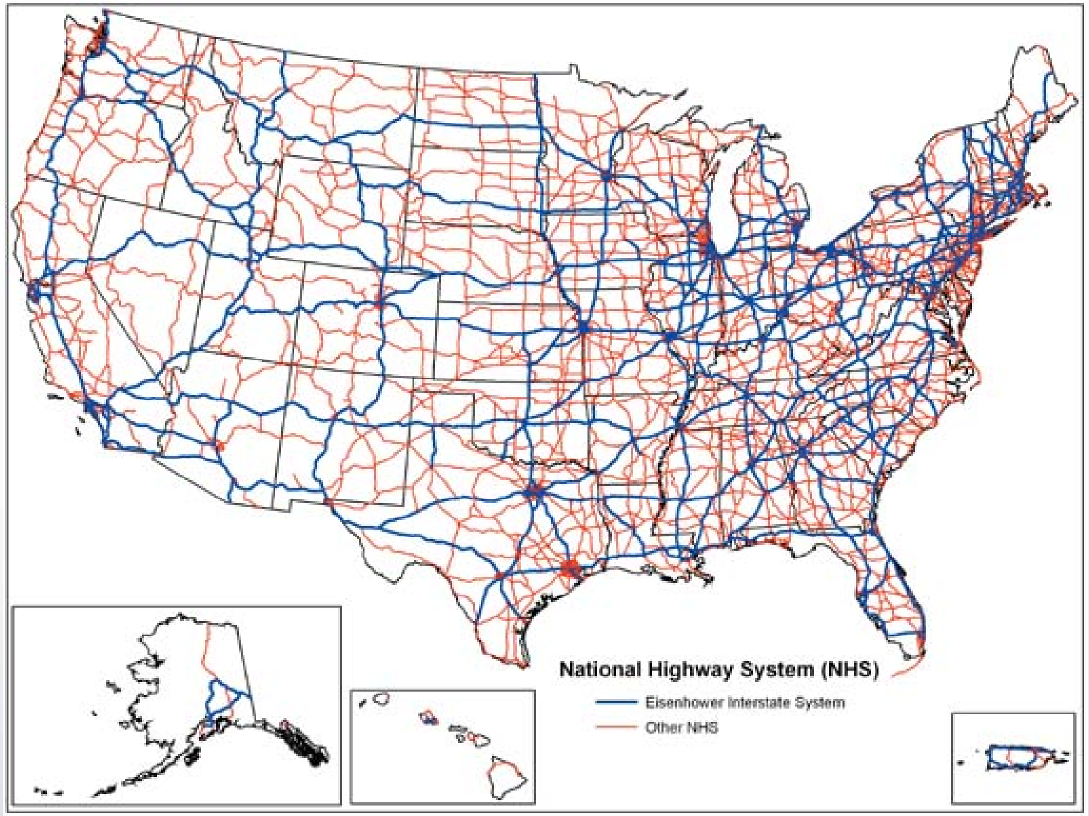
- States identify impaired water bodies and the pollutants that cause the impairment
- The Total Maximum Daily Load the water body can handle is calculated, and then allocated among the various sources
- Stakeholders/Designated Management Agencies (including DOTs) must develop and implement programs to achieve the load allocations



Impaired Waters (303(d) listed)

TMDLs pose unique Challenges for DOTs

- Highways are ubiquitous. DOTs discharges in multiple TMDL watersheds
- Highway runoff carries different pollutants, so DOTs may be named in multiple TMDLs
- Highways can have large numbers of outfalls to a stream, making consolidated treatment facilities infeasible
- DOTs have little authority to control many of the highway runoff pollutant sources



National Highway System
Wikipedia

Research Objectives Addressed by NCHRP 918

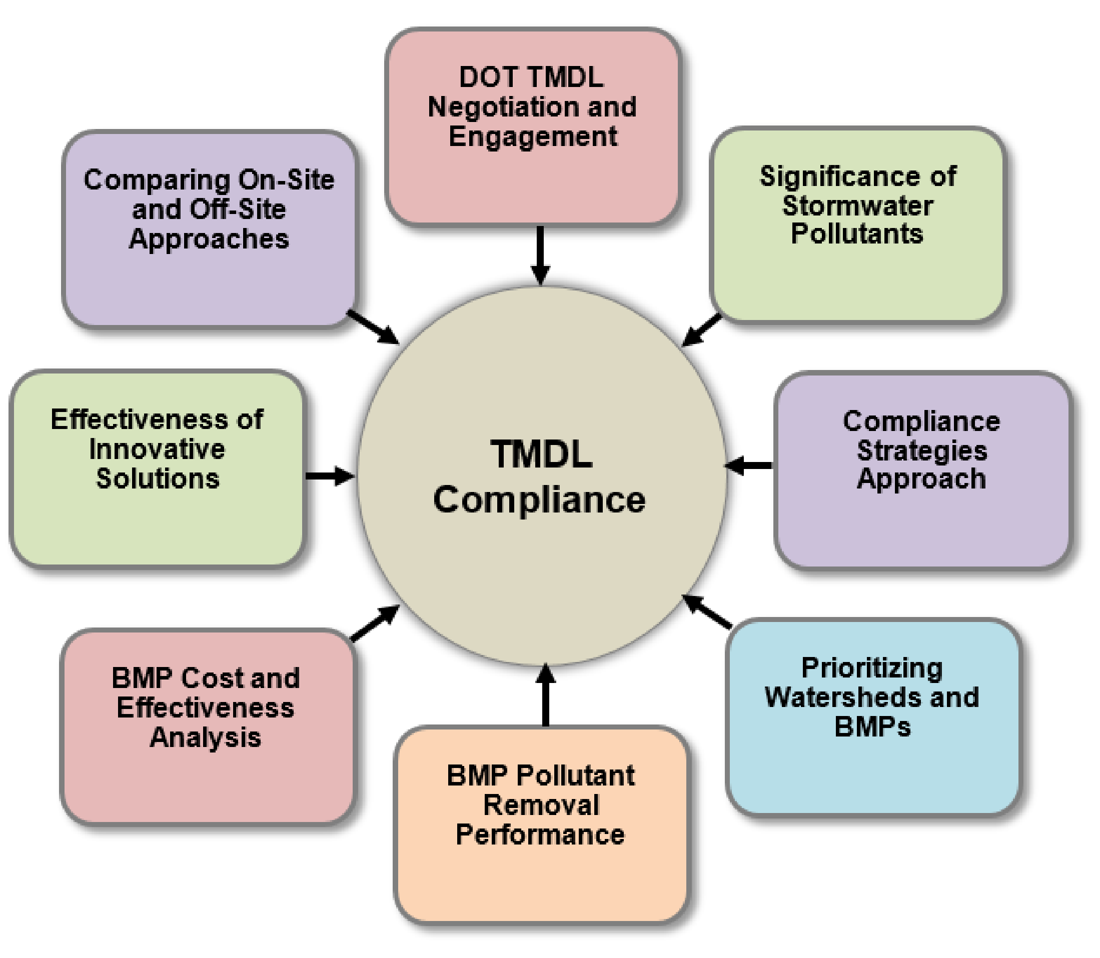
Provide foundation of approaches for DOT compliance with TMDLs by addressing the following objectives:

- Analyze data, statistics, and information about stormwater runoff from roadways
- Identify strategies and approaches for:
  - Determining the significance of roadways
  - Determining the feasibility of implementing traditional structural and nonstructural BMPs
  - Determining the relationship between performance and cost effectiveness.
  - Determining the efficiency and effectiveness of innovative solutions

Hosmer Lake, Oregon

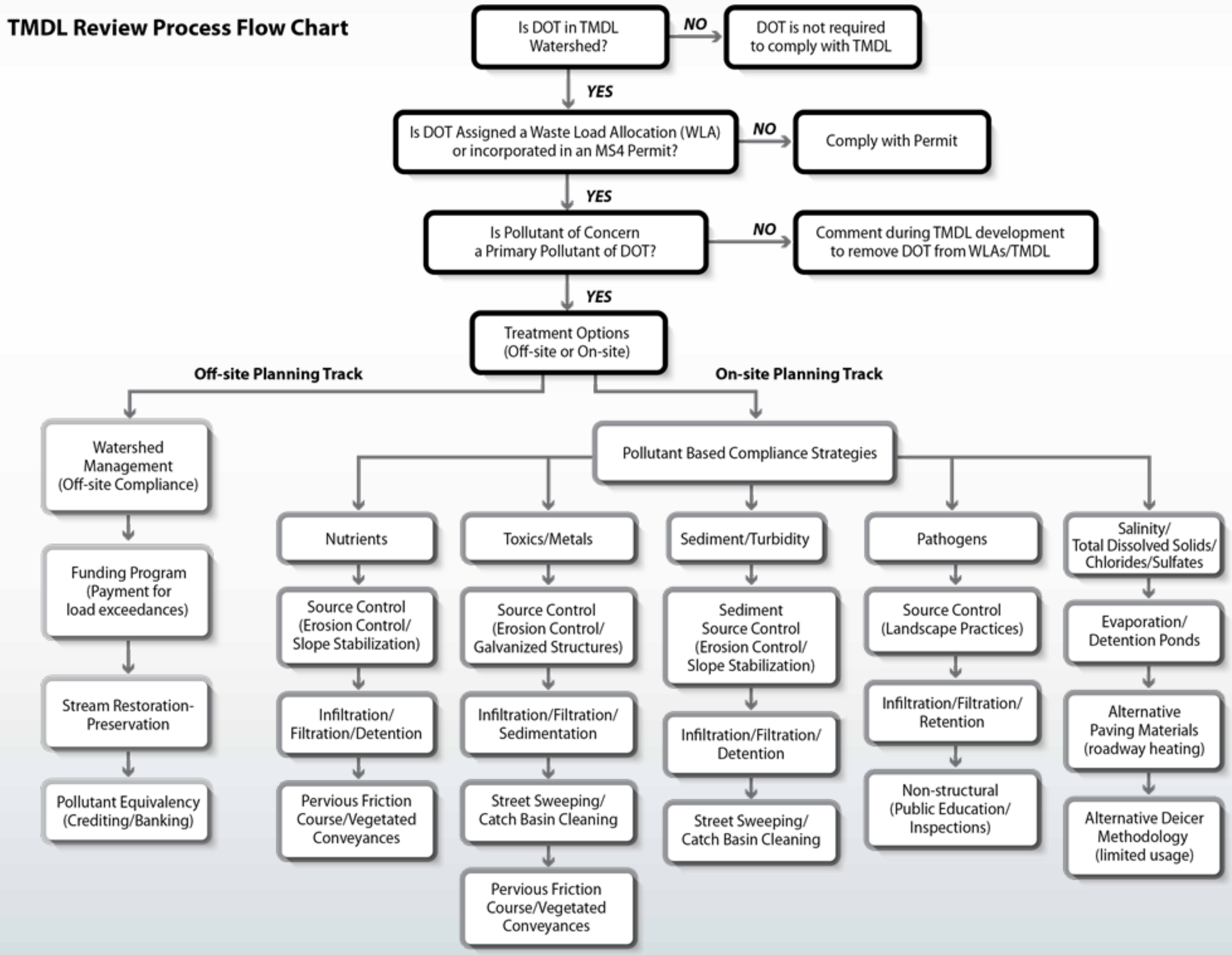
NCHRP Report 918 - Overview of Content

- DOTs TMDL Negotiation and Engagement
- Pollutants of Concern: Significance and Source Analysis
  - Atmospheric Deposition
  - Background Sources
  - Varying Sources by Land Uses
- Compliance Strategies
  - Structural vs. Non-Structural BMPs
  - TMDL Alternative Compliance
- DOT Watershed Significance
- BMP Performance and Feasibility
- Cost Analysis and Effectiveness
- Innovative Solutions



Importance of TMDL Negotiation and Engagement

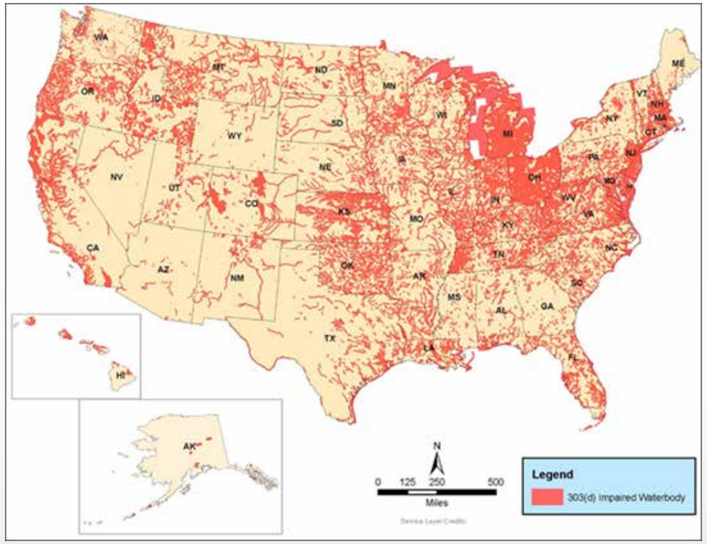
- Does DOT have drainage area in watershed/TMDL?
  - Yes: identify primary POC and participate to develop TMDL/WLAs
  - No: track status and comply with DOT permit
- Is POC a primary pollutant for a DOT?
  - Yes: participate to develop TMDL/WLAs
  - No: track status and comply with DOT permit
- On-site and Off-site compliance alternatives
  - Pollutant Based Strategies
  - Watershed Management (Banking/Crediting System)
  - Municipality collaboration
- Typically when DOTs are <1% of watershed
  - Recommend collaborative compliance



DOT's interest to Participate in TMDL Development Process

- Early Engagement with state agencies (US EPA/State Regulator)
  - 303(d) listing and TMDL development
  - Use the targeted pollutants list (POC for DOTs)
  - Determine DOT drainage areas in watershed/TMDL
  - Validate accuracy of TMDL WLAs
- Implement Feasibility Study
  - For removal from TMDL (provide data results)
  - Waterbody specific compliance measures
- Reopen and Renegotiate a TMDL with State Regulator/US EPA

Is my DOT subject to TMDLs?



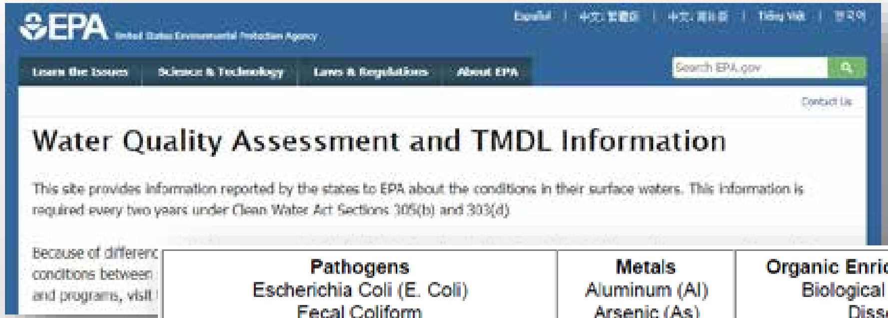
State[1]	Nutrients	Toxics/ Metals	Sediment/ Turbidity	Pathogens	Organic Enrichment Oxygen Depletion	Ammonia	pH/ Alkalinity	Temperature	Salinity/ TDS/ Chlorides/ Sulfates	Pesticides	Algal Growth	PCBs	Toxic Organics	Impaired Biota	Trash	Uranium	Other
AK		X	X	X	X												X
AL					X												
AR			X	X													
AZ	X	X	X	X													
CA	X	X	X	X	X	X		X		X		X	X		X		X
CO	X			X													
CT				X									X				
DE	X				X												
FL	X	X	X	X	X	X						X					X
GA			X	X													
HI	X		X	X													
ID	X		X	X	X			X		X							
IL	X	X	X	X	X	X			X								
KS	X				X						X						
KY				X													
LA	X	X	X	X	X	X			X								
MA	X			X													
MD	X				X												
ME	X	X		X													
MI	X		X	X								X					
MN	X		X	X	X			X	X								
MO			X	X													
MS	X	X	X		X												
MT	X	X	X	X				X	X								
NC	X	X	X	X			X										X
NH				X					X								
NJ	X																
NM	X	X	X	X	X		X	X	X							X	
NV	X		X														
NY	X			X													
OH	X	X	X	X	X	X	X			X			X				X
OK	X		X	X	X												
OR	X	X	X	X	X	X	X	X		X	X	X					
PA	X	X	X	X						X		X					X
RI	X	X		X													
SC				X	X	X											
SD	X		X	X			X										
TN		X	X	X	X	X			X	X		X					X
TX				X													
UT	X				X												
VA	X	X	X	X			X					X					X
WA	X	X	X	X	X	X	X	X		X		X	X				X
WI	X		X														
WV		X	X	X			X		X								X
WY		X	X	X		X			X								

State DOTs are facing TMDLS for many different Constituents

How to identify POCs for DOT TMDLs?

Two quantification queries using US EPA Database:

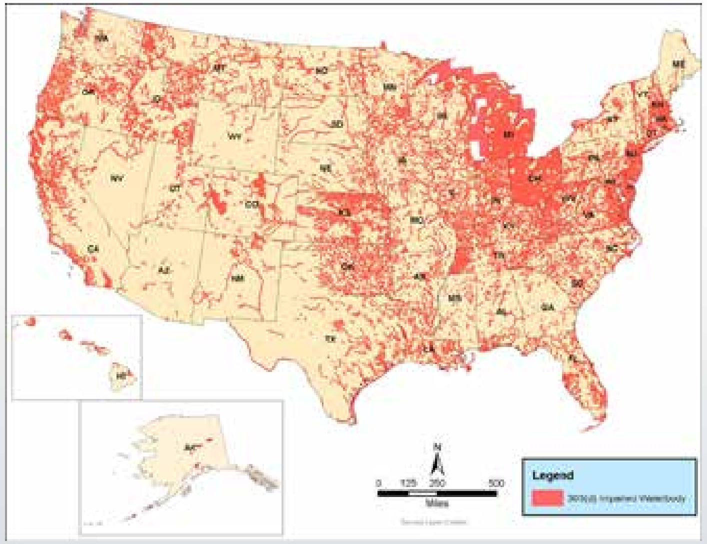
1. TMDLs with Transportation Agencies Listed
2. Urban Runoff Impaired Waterbodies



Pathogens	Metals	Organic Enrichment / Oxygen Depletion
Escherichia Coli (E. Coli) Fecal Coliform	Aluminum (Al) Arsenic (As) Cadmium (Cd) Copper (Cu) Iron (Fe) Lead (Pb) Manganese (Mn) Mercury (Hg) Zinc (Zn)	Biological Oxygen Demand (BOD) Dissolved Oxygen (DO)
Nutrients		**Salinity / Dissolved Constituents**
Nitrogen, Total (TN) Nitrogen, Nitrate/Nitrite ($NO_{2,3}$ as N) Nitrogen, Total Kjeldahl Nitrogen (TKN) Phosphorus, Total (TP) Phosphorus, Dissolved (DP)		Chloride (Cl^-) Total Dissolved Solids (TDS)
		Sediment
		Total Suspended Sediment (TSS)

Results:

- *20%* of developed TMDLs list state agencies
- *21* primary pollutants of concern within *6* pollutant categories targeted for analysis
- Growing number of TMDLs nationally



TMDL pollutant categories and pollutants targeted for analysis

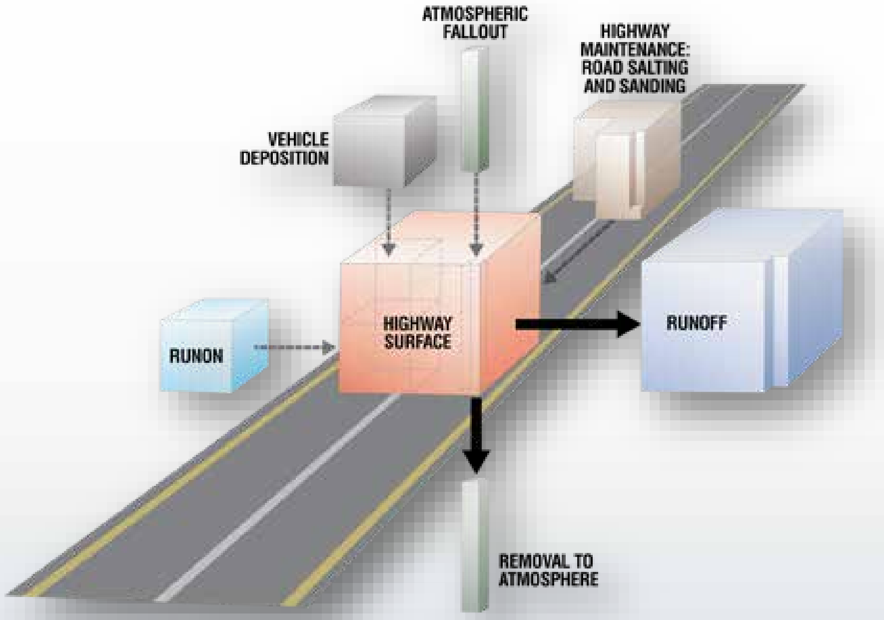
Highway Runoff Loads Have Many Sources

Factors that contribute to the relative contribution of roadways on downstream water quality?

- Highway Maintenance (Salt/Sanding)
- Run-on
- Atmospheric Fallout
- Vehicle Deposition
- Roadway degradation (not shown)

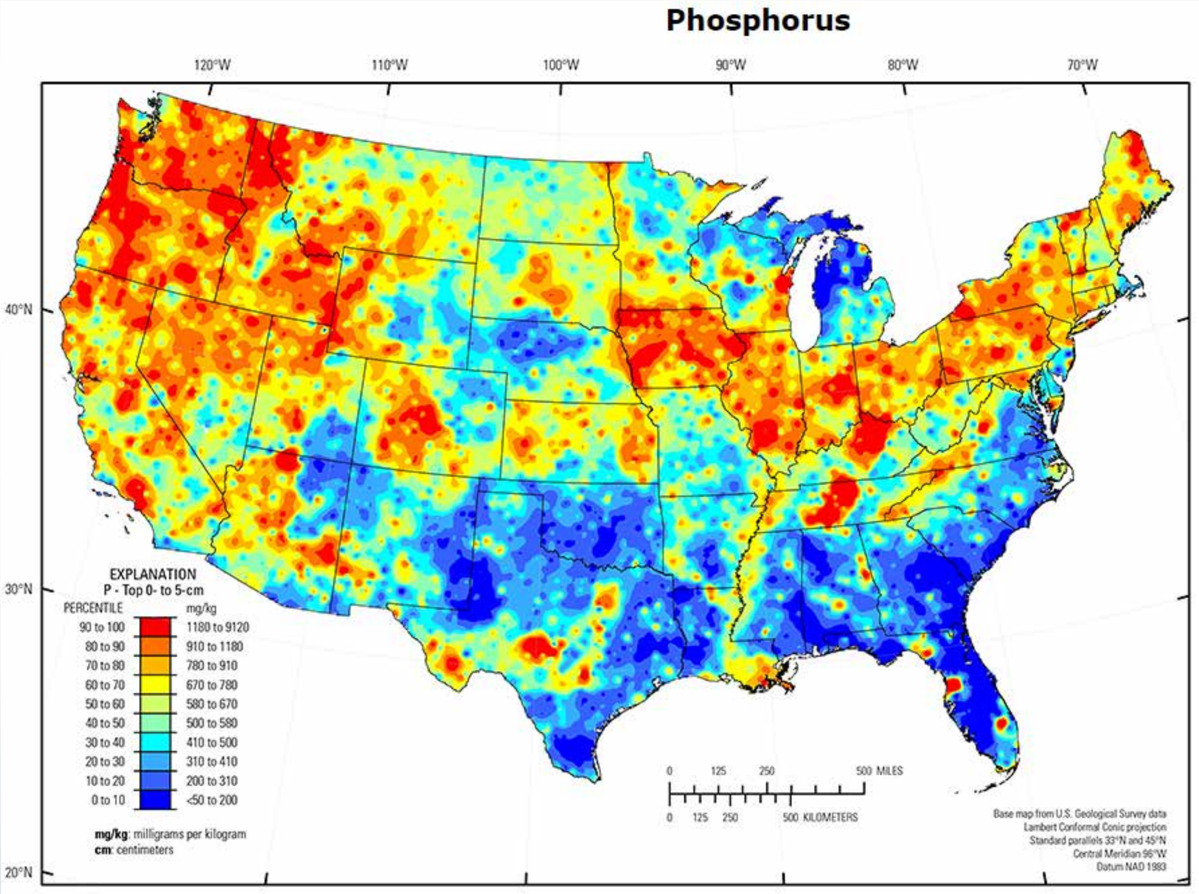
Project Objectives:

Create analysis protocols that allow DOT practitioners to investigate these factors for local conditions.



Conceptual roadway pollutant load mass balance, adapted from Harned (1988)

Local Soils Contribute to Runoff Loads



Phosphorus soil concentrations in top 5 cm Smith et al. (2014)

Phosphorus Roadway Runoff Attributed to Soil Wash-off

Soil Percentile	Proportion of Median Roadway TP Concentration Attributed to Soil Wash-Off
5%	0.05
25%	0.14
50%	0.22
75%	0.32
95%	0.52

Phosphorus concentrations from top 5 cm.

Assumes 70 mg/L TSS roadway runoff concentration.

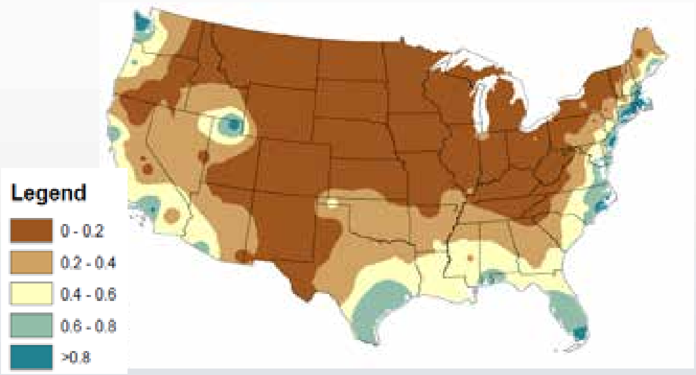
Dry and Wet Atmospheric Deposition Contribute to Runoff Loads

Atmospheric Deposition

- Spatial heat maps showing proportion of highway runoff concentrations potentially attributed to atmospheric deposition.
- Results:
  - Ammonia and Nitrate: Potentially significant contributors
  - Chloride: Minor except in areas of salt spray
  - Mercury and Sulfate: Data limitations, may be significant in certain areas

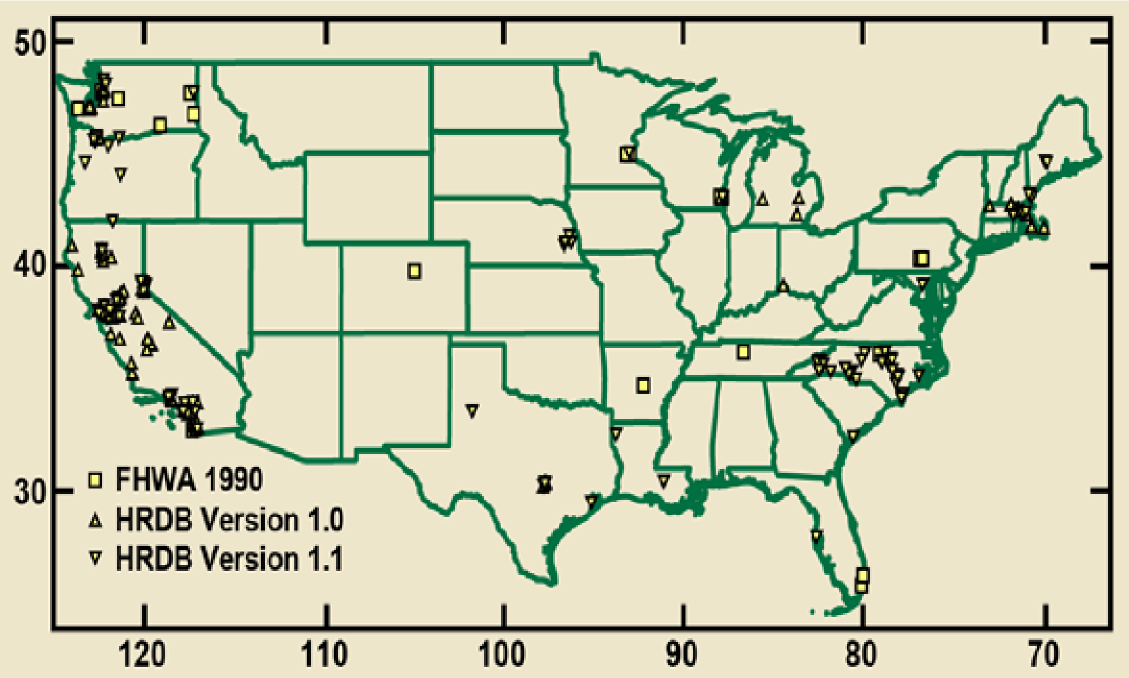
Ammonia

Chloride



Proportion of 25th percentile concentration attributed to deposition

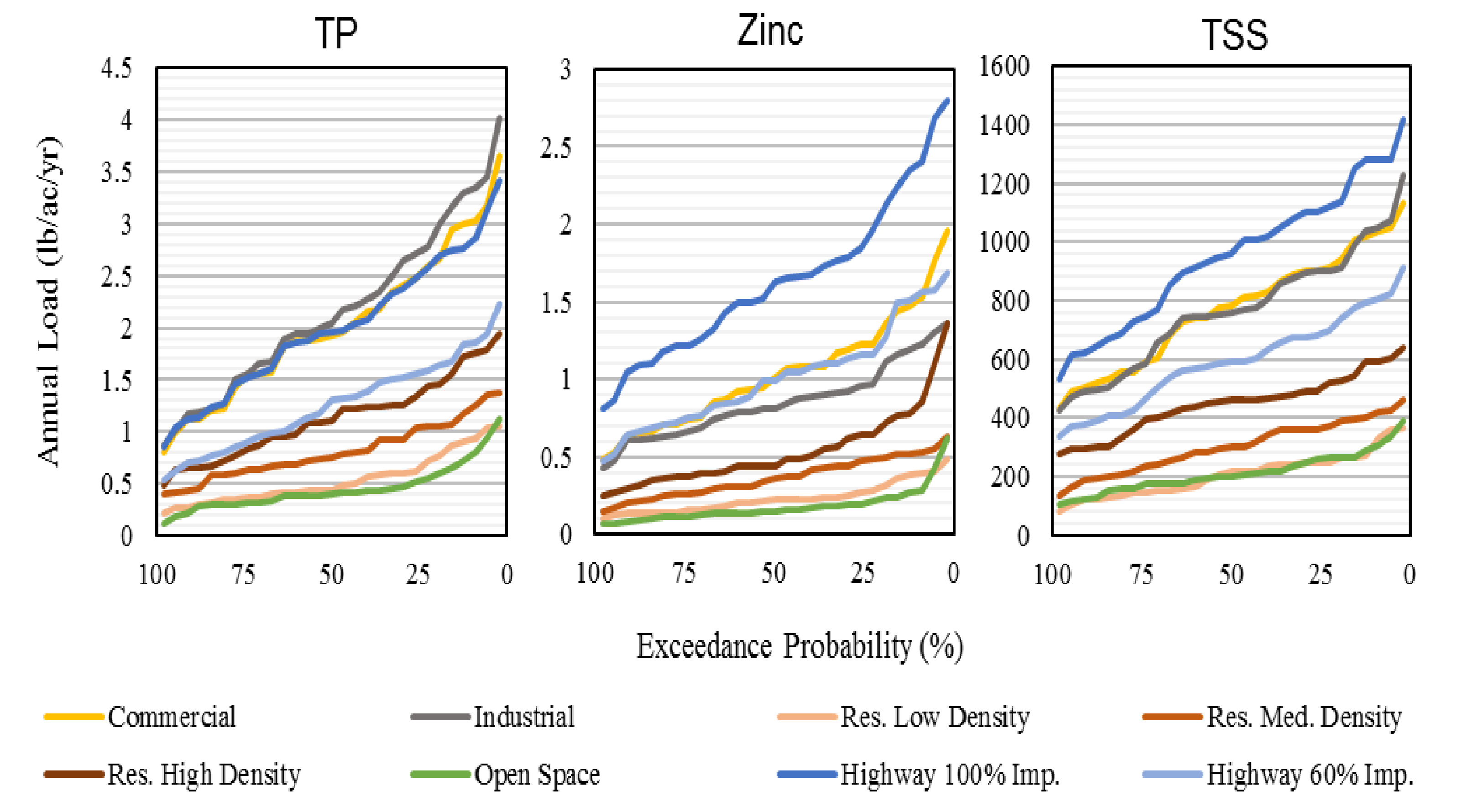
Runoff Concentrations come from National Datasets (HRDB, NSQD, BMPDB, & AgBMPDB)



HRDB map

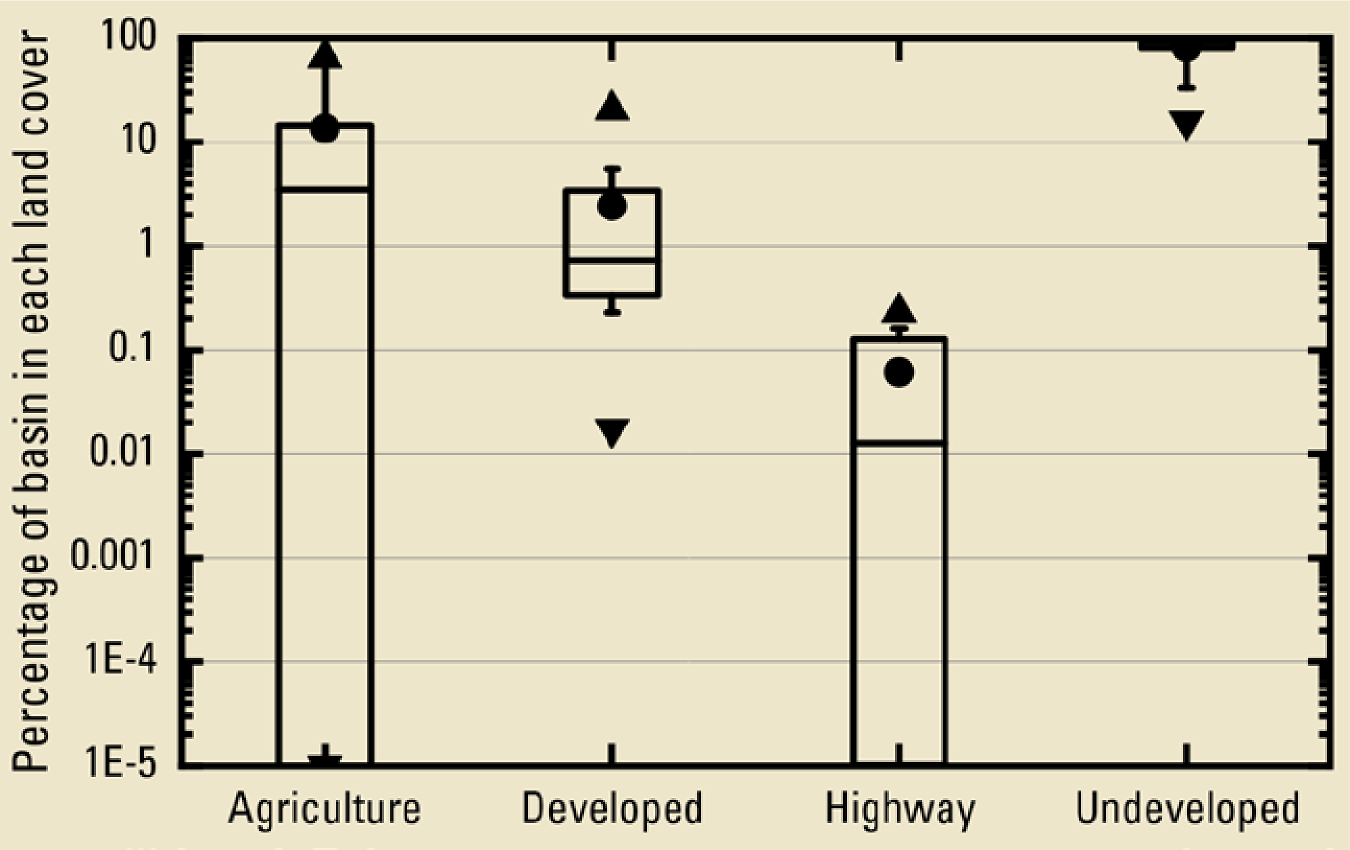
BMPDB map

Annual yields for different land uses were calculated with SELDM to assess different contributions



Annual unit area loading rate exceedance for Pacific Northwest

Important to note that Total Loads are the Product of Yield times Area



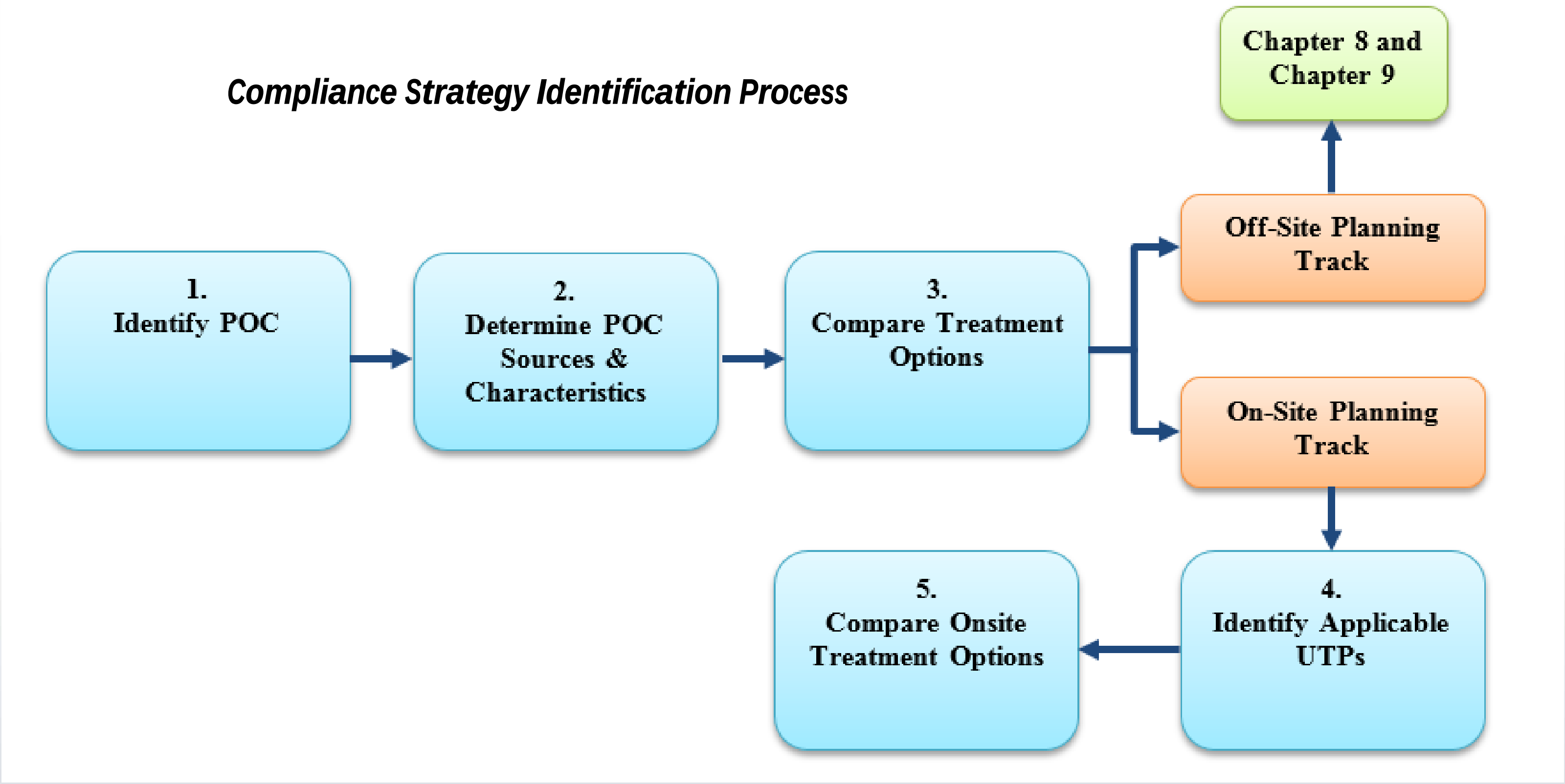
Adam Stonewall, USGS, written communication, 2018

Sample Unit Area Load Result (from SELDM)

Annual unit area loading for highways (all AADT) within various states

Constituent	Unit	CA	WA	FL	MA
TSS	lbs/ac/yr	346.55	863.09	991.07	919.48
TN	lbs/ac/yr	6.53	16.87	22.33	17.17
TKN	lbs/ac/yr	5.38	12.57	15.24	13.72
NO_x as N	lbs/ac/yr	2.22	5.37	6.22	5.9
TP	lbs/ac/yr	0.65	1.92	2.13	2.02
DP	lbs/ac/yr	0.29	0.73	0.92	0.83
Aluminum	lbs/ac/yr	14.53	41.18	46.79	41.26
Arsenic	lbs/ac/yr	0.0082	0.017	0.02	0.02
Cadmium	lbs/ac/yr	0.0018	0.0048	0.0058	0.005
Copper	lbs/ac/yr	0.098	0.26	0.30	0.26
Iron	lbs/ac/yr	4.83	13.61	14.55	12.61
Lead	lbs/ac/yr	0.55	2.09	2.48	2.21
Mercury	lbs/ac/yr	0.00045	0.0015	0.0017	0.0014
Zinc	lbs/ac/yr	0.62	1.47	1.82	1.66
E. Coli	MPN	12,586,206	365,727,272	464,966,666	419,689,655
Fecal Coliform	MPN	950,000,000	2,093,272,727	2,392,366,667	2,508,103,448
BOD	lbs/ac/yr	38.103	87.21	103.61	101.6
Cl^-	lbs/ac/yr	188.10	514.33	503.87	439.55
TDS	lbs/ac/yr	239.31	582.03	681.37	580.62

Process starts with Identifying the Pollutant of Concern (POC) then formulate the Implementation Strategies



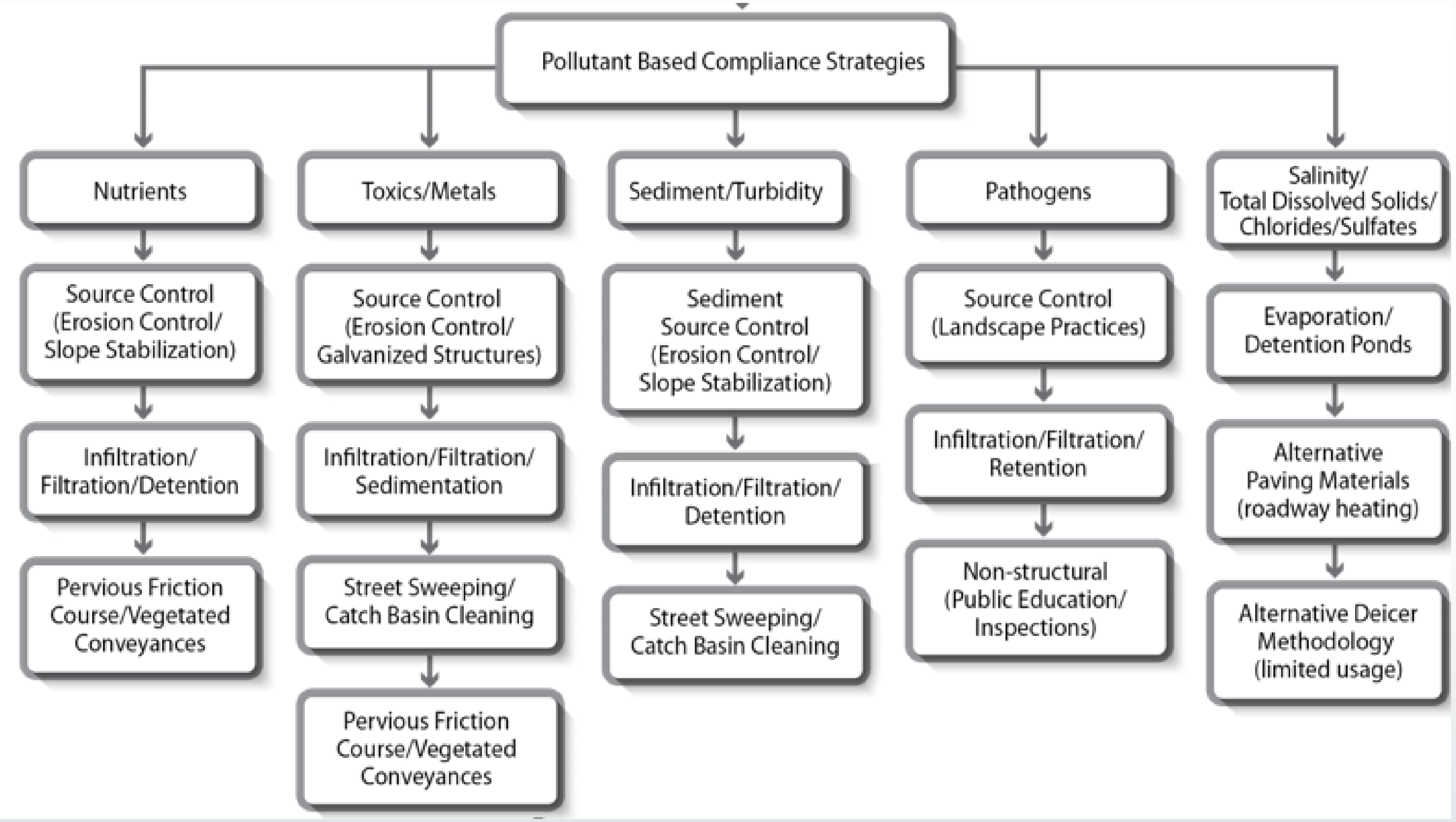
Plan for On-site, Off-site Solutions, or combination of Approaches

- Treatment options for a specific POC
- On-Site Planning Track
  - Identify Applicable unit treatment processes (UTPs)
  - Structural and Source Control BMPs
- Off-Site Planning Track
  - Watershed-based compliance strategies (Banking/Crediting/Trading Credits, Restoration/Preservation).
  - Identify a metric equivalence for cooperative efforts to quantify loads reduced.
  - Structural and Source Control BMPs

Treatment processes by POC

Particle Size Gradation	Pollutant of Concern: Sediment	Nutrients	Metals	Bacteria	Chloride	Example Effective Treatment Process
Gross Solids (>5000 µm)						Screening
Coarse to Medium (125 to 5000 µm)						Sedimentation
Fine Particulates (10 to 125 µm)						Filtration
Very Fine/Colloidal (0.25 to 10 µm)						Sorption
Dissolved (<0.45 µm)						Source Control, Sorption, Biological Uptake

TMDL Compliance Strategies by Pollutant Category



Media Filter, Redding CA

Treatment BMPs (Stormwater Devices) installed in Highway Application


Detention basins or Infiltration basins


Permeable Friction Course


Bioretention


Biofilter Strip/Infiltration Trench


Media Filter – Earthen

TMDL Compliance Strategies for Sediment

- Sediment Compliance Strategy
- Sources: deposition, washoff of adjacent soils, vehicular traffic and urban activities

Sonoma Creek Sediment TMDL

Compliance Strategy	Method	Components	Applicability	Critical Considerations	Critical Constraints
Traction Control Plan	Source control	Reduce sand application rate or switch to alternative material	Cold weather climate in which road sanding has been identified as a contributor to sediment loading.	Identify methodology and consequences of implementing change to traction material application.	• Public safety • Institutional coordination • Equipment availability • Maintenance • Accessibility • Cost
Erosion Control	Source control	Vegetation or material coverage of exposed soil, channel banks, or outfalls	Construction sites or bare areas in DOT jurisdiction. Erodible landscapes or flow paths identified in the watershed.	Identify applicable erosion control practices and areas for implementation.	• Longevity • Maintenance • Accessibility • Cost
Street Sweeping/ Catch Basin Cleaning	Source control	Routine removal of solids from road surface or catch basin sumps using a Vactor® truck.	Solids size fraction of concern has been identified and are removable using prescribed methods.	Identify anticipated frequency and removal method to achieve pollutant load reduction.	• Institutional coordination • Equipment availability • Operational costs • Material disposal • Maintenance • Accessibility • Cost
Infiltration	Volume reduction	Basins, vaults, trenches, Underground Injection Controls, or dispersion	Applicable to all situations if constraints met.	Identify available space and moderate to high permeability soils.	• Soil infiltration capacity • Groundwater contamination • Space • Clogging • Maintenance • Accessibility • Cost
Detention	Flow attenuation, separation	Detention ponds, wet ponds, or wetlands	Solids size fraction of concern is settable (≥20 µm) Inclined plate settlers or coagulation/flocculation enhancements for fine solids size fractions (<20 µm)	Identify available space and settable fraction based on particle settling theory.	• Space • Maintenance • Accessibility • Cost
Filtration	Filtration/ sorption	Bioretention, media filters, or permeable friction course (PFC)	Solids size fraction of concern is fine (<20 µm), or settleable (≥20 µm)	Identify available space and filter media parameters, construction schedule for replacement of road surfaces with PFC	• Space • Clogging • Maintenance • Accessibility • Cost

TMDL Compliance Strategies for Nutrients

- Nutrients Compliance Strategy
- Sources: Soils, vegetation and agricultural practices

Compliance Strategy	Method	Components	Applicability	Critical Considerations	Critical Constraints
Vegetation Management	Source control	Removal of leaves and mowing of overgrown vegetation to prevent decay and nutrient release.	Areas with high concentrations of trees, vegetated medians, or shoulders.	Identify locations of concern, frequency, and timing of maintenance.	• Equipment availability • Institutional coordination • Maintenance • Accessibility • Cost
Erosion Control	Source control	Vegetation or material coverage of exposed soil, channel banks, or outfalls.	Erodible landscapes or flow paths have been identified in the watershed.	Identify applicable erosion control practices and areas for implementation.	• Longevity • Plant establishment • Maintenance • Accessibility • Cost
Infiltration	Volume reduction	Basins, vaults, trenches, or dispersion.	Applicable to all situations if constraints are met.	Identify available space and soils with moderate to high permeability	• Soil infiltration capacity • Groundwater contamination • Space • Clogging • Geotechnical stability • Maintenance • Accessibility • Cost
Detention	Flow attenuation, separation	Detention ponds, wet ponds, or wetlands.	Particulate nutrients are associated with settleable solids (>20 μm).	Identify available space and determine if settable fraction is large enough to be useful in reducing nutrient loads.	• Space • Maintenance • Accessibility • Cost
Filtration	Filtration/ sorption	Bioretention filters, filter amendments.	Particulate nutrients, and possibly dissolved phosphorus or TKN are of concern.	Identify available space and filter media parameters.	• Space • Clogging • Maintenance • Accessibility • Cost
Multi-stage filtration, with anaerobic zone	Microbially-mediated transformation	Bioretention filters with saturated zone, electron donor material.	Particular concern for dissolved nitrogen, especially nitrate and nitrite.	Identify available space, filter media parameters, potential for anoxic zone.	• Space • Clogging • Maintenance • Accessibility • Cost
Vegetated Conveyance	Uptake and storage	Vegetated swale or filter strip, with or without amended soils.	Dissolved nutrients; areas where plants are not dormant during wet season.	Identify available space and maintenance plan for vegetation harvesting.	• Space • Clogging • Maintenance • Accessibility • Cost
PFC	Filtration/ sorption	PFC-paved roadways	TKN, nitrate	Identify feasibility of pavement replacement, maintenance plan, and life span needs.	• Clogging • Maintenance • Longevity • Timing • Maintenance • Accessibility • Cost

TMDL Compliance Strategies for Metals

- Metals Compliance Strategy
- Sources: Vehicular traffic, litter, spills, and roadway maintenance operations

Compliance Strategy	Method	Components	Applicability	Critical Considerations	Critical Constraints
Street Sweeping/ Catch Basin Cleaning	Source control	Routine solids removal from road surface or catch basin sumps using a Vactor® truck.	Total suspended solids are a concern for metals and are removable using prescribed methods.	Identify anticipated frequency and removal method to achieve pollutant load reduction.	• Institutional coordination • Equipment availability • Operational costs • Material disposal • Maintenance • Accessibility • Cost
Pre-treatment Structure (Sedimentation Basin)	Source Control	Basins or vaults	Applicable to all situations if constraints are met.	Identify available space.	• Soil infiltration capacity • Groundwater contamination • Space • Longevity • Capacity • Maintenance • Accessibility • Cost
Infiltration	Volume reduction	Basins, vaults, trenches, Underground Injection Controls, or dispersion.	Applicable to all situations if constraints are met.	Identify available space and moderate to high permeability soils.	• Soil infiltration capacity • Groundwater contamination • Space • Clogging • Maintenance • Accessibility • Cost
Filtration	Filtration/ sorption	Bioretention filters, filter amendments.	Particulate metals, and dissolved metals are of concern.	Identify available space and filter media parameters.	• Space • Clogging • Maintenance • Accessibility • Media replacement • Maintenance • Accessibility • Cost
Vegetated Conveyance (Biofiltration Strips and Swales)	Uptake and storage	Vegetated swale or filter strip, with or without amended soils.	Dissolved metals and total metals are of concern.	Identify available space and maintenance plan for vegetation harvesting.	• Space • Clogging • Maintenance • Accessibility • Cost
Reducing Galvanized Structures	Source Control	Guardrails, fences, sign posts, or pipes	Particulate Zinc, Particulate Cadmium, Dissolved Zinc, and Dissolved Cadmium are of concern.	Identify locations with galvanized downspouts and paint/coat (containing no zinc) these structures.	• Longevity • Maintenance • Accessibility • Cost
PFC	Filtration/ sorption	PFC-paved roadways	Particulate metals, and dissolved metals	Identify feasibility of pavement replacement, maintenance plan, and life span needs.	• Clogging • Maintenance • Longevity • Timing • Maintenance • Accessibility • Cost

TMDL Compliance Strategies for Chlorides

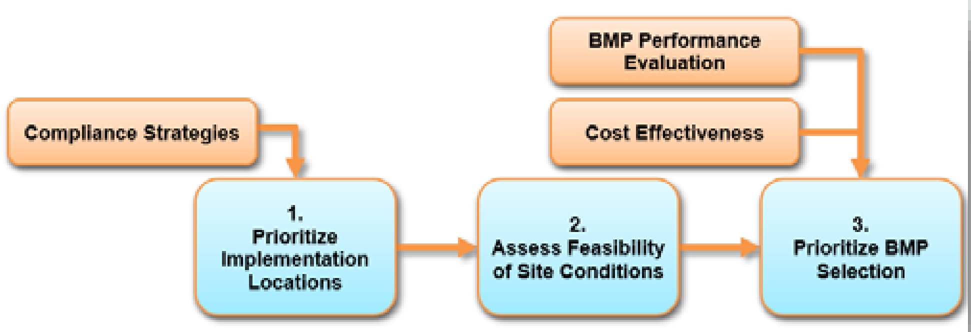
- Chloride Compliance Strategy
- Sources: Deicing chemicals and atmospheric deposition

Compliance Strategy	Method	Components	Applicability	Critical Considerations	Critical Constraints
Traction Control Plan	Source control	Reduce salt application rate, method, or locations of salt application, use of alternative materials, educational programs for operators	Cold weather climate in which road salting has been identified as a contributor to chloride loading.	Identify methodology and consequences of implementing change to traction chemical application.	• Public safety • Institutional coordination • Equipment availability
Alternative Paving Materials	Source control	Construction of alternative road surfaces or roadway heating mechanisms	Cold weather climates with access to sufficient power or natural sources of heat; key areas such as bridges, corners, or areas near affected waterways	Identify key locations and economic feasibility	• Maintenance • Coordination of construction • Cost
Evaporation Ponds	Separation, evapotranspiration	Retention basin	Low runoff volumes	Identify available space	• Space • Maintenance • Cost • Accessibility
Detention Ponds	Flow attenuation, evapotranspiration	Detention ponds, bioretention basins	Large peak flows, appropriate dilution factor in receiving water	Identify available space	• Space • Dilution ratio in receiving water • Availability of salt-tolerant species • Cost • Maintenance • Accessibility

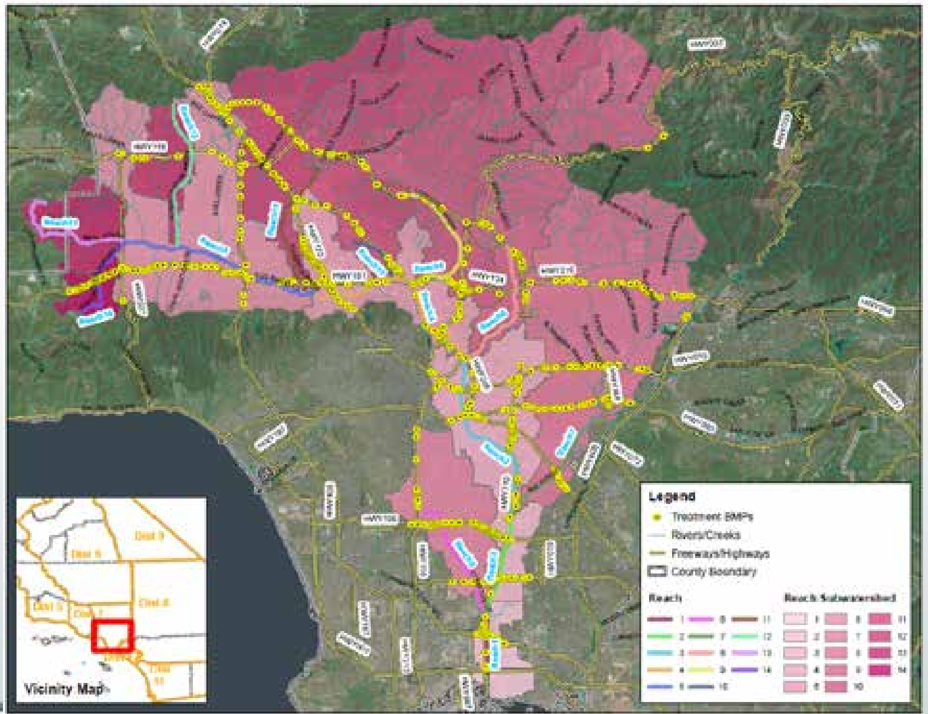
I-15, Utah

Factors to consider for Prioritizing BMP Implementation

- Overall BMP Selection Framework
  - Prioritize Implementing Locations
  - Assess Feasibility of Site Conditions
  - Prioritize BMP Selection
- Multi-Benefit Criteria
  - BMP Performance
  - Maintenance and Safety Access
  - Space and Geometry Requirements
  - Aesthetics
  - Social and Ecological Benefit
  - Climate Adaptability
  - Groundwater Constraints
  - Soil Impacts



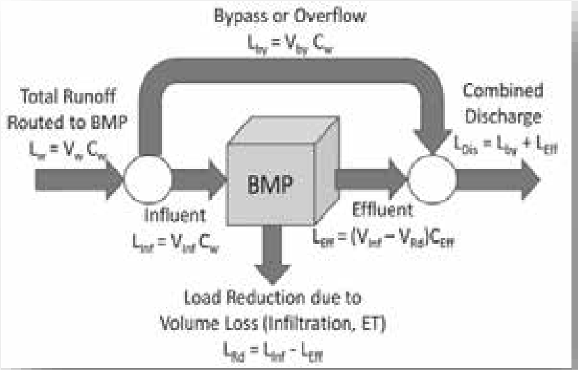
Prioritization and feasibility framework process



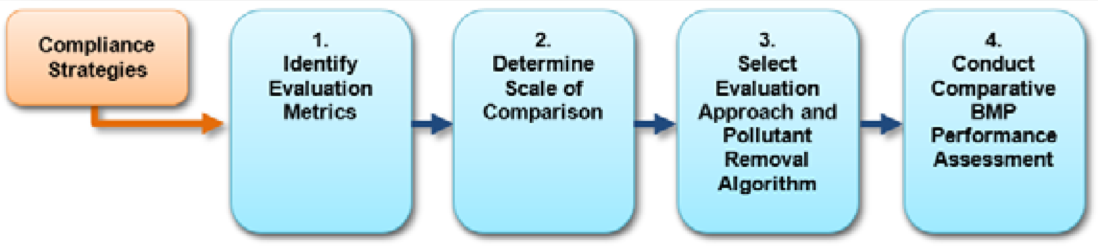
LA River Watershed

BMP Performance and Meeting TMDL Objectives

- Performance Evaluation Methodology
  - § Identify Evaluation Metrics
  - § Determine Scale of Comparison
  - § Select Evaluation Approach and Pollutant Removal Algorithm
    - Size BMP based on locally prescribed methods
    - Determine BMP capture efficiency
    - Segregate captured runoff into retention and treatment flow paths
    - Assign performance metrics to bypass, retention, and treatment flow paths
    - Compare performance
  - § Conduct Comparative BMP Performance Assessment



Conceptual model for calculation of load reduction based on flow pathways (Taylor et al., 2014)



BMP performance comparison methodology flowchart

There are BMP Performance Tools Available

- Tools for Structural BMP Performance
  - International Stormwater BMP Database
  - EPA SWMM
  - EPA Stormwater Calculator
  - SELDM
  - NCHRP 792: Long-Term Performance and Life-Cycle Costs of Stormwater Best Management Practices Tools
- Limited performance data on Non-Structural BMPs

Tool	EPA Stormwater Calculator	NCHRP 792	SELDM
Included BMPs	• Bioretention (rain garden and street planter) • Cisterns (rain harvesting) • Green roof • Impervious area disconnection • Infiltration basin • Permeable pavement	• Bioretention • Dry detention • Filter strip • Permeable friction course (PFC) • Sand filter • Swale • Wet pond	BMPs and associated hydrologic and water quality statistic distributions are user defined. Input statistics for the following BMP types using BMPDB designations are defined in Granato (2014): • Bioretention • Composite • Detention basin • Biofilter (swale) • Infiltration basin • Manufactured device • Media filter • Retention pond • Wetland basin Wetland channel
Hydrologic Calculation Methodology	Long term simulations are embedded in the program using EPA SWMM as the computational engine.	Runoff volumes and volume bypassed, treated, and lost are estimated from hydrologic performance curves developed using EPA SWMM long-term simulation and defined in the spreadsheets using performance nomographs.	Runoff volumes are determined based on statistical distributions of input variables for a selected location. The impact of a BMP is determined by paired statistical distributions irrespective of BMP sizing.
Pollutant Removal Algorithm	Volume reduction only; pollutant loads are not estimated.	Influent-effluent regressions developed from the BMPDB are embedded in the model for each BMP and the following constituents: • Bacteria: *E. Coli, F. Coliform* • Metals: Cu, Pb, Zn • Nutrients: NO_3, TKN, TN, TP, DP • Sediment: TSS Export of pollutants is excluded such that effluent concentrations can never exceed influent concentrations.	Statistical distributions of the ratio of influent to effluent concentrations from the BMPDB are used to define BMP performance. Input statistics for 11 BMP types are defined in Granato (2014).
Key Features	• Soils, slope, land cover, and meteorological data are dynamically linked to national data sets for the user selected location. • Cost module allows for comparison of BMP construction costs using dynamically updated regional cost factors.	• Influent runoff quality is defined based on highway runoff monitoring data. • BMP sizing parameters can be adjusted to investigate impact on performance • Whole life cycle costing tool allows for calculation of cost of annual load removal ($/lb).	Dilution factors and defined waterbody flow and water quality parameters can be used to assess the effects of BMPs on storm event hydrographs and downstream waterbody concentrations.

Comparison of BMP performance evaluation tools

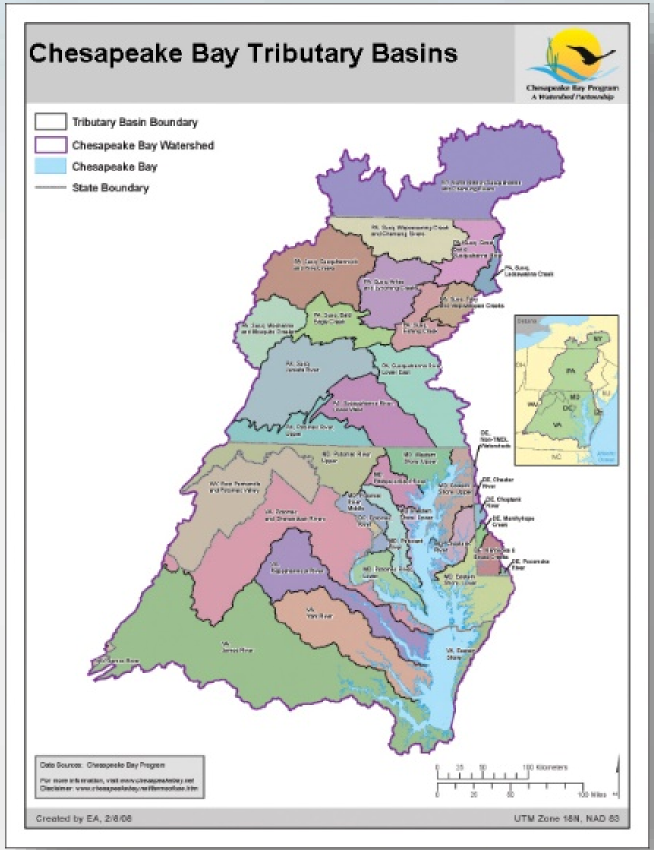
BMP Cost and Effectiveness Analysis

- NCHRP developed BMP Evaluation Tools
  - Long-Term Performance and Life-Cycle Costs of BMPs (NCHRP Report 792)
  - Bridge Stormwater Runoff Analysis and Treatment Options (NCHRP Report 778)
- Quantity of BMPs
  - Number of outfalls in TMDL watersheds to identify potential BMP locations
  - Guide in determining the total TMDL compliance cost
- Incremental costs for increasing BMP footprint
- Cost effectiveness through off-site Compliance strategies
  - Collaborative Implementation
  - Pollutant Offset/Crediting

Area-Weighted BMP Costs (after Weinstein et al. 2017)

BMP	Cost per drainage area (BMP serving less than 3 acres) ($/ac)		Cost per drainage area (BMP serving more than 3 acres) ($/ac)	
	New Construction ($)	Retrofit ($)	New Construction ($)	Retrofit ($)
Sand filter	87,953	113,835	48,136	62,301
Cartridge filter	163,884	201,521	153,039	188,186
Swale	19,499	37,460	2,287	4,394
Strip	11,147	30,940	1,890	5,247
Bioretention	24,458	35,380	13,961	20,196
Extended detention	29,184	58,843	9,662	19,482
Wet pond	32,631	52,051	12,109	20,911
Wetland	32,770	52,273	13,713	21,874

Watershed-Based Approaches can be an Innovative Solution



- Watershed approaches for DOT TMDL Compliance
- Feasible Watershed-based Approaches
  - Pollutant Banking, Pollutant-trading, Off-site Mitigation
  - Restoration/Preservation
  - Brake Pad Partnerships
  - Watershed Management/Cooperative implementation
- Limitations for Watershed-based Approaches
  - Framework and agency receptiveness to watershed-based approaches
  - Feasibility of TMDL crediting approach for pollutant of concern
  - Funding Constraints (Right-of-way vs. off-site)
  - Context and limitations for applying watershed-based approaches to TMDL compliance
  - Approaches for defining offset ratio for specific pollutant

Watershed-based Compliance Examples

- Colorado DOT
  - Treat equivalent areas offsite from the project within the same watershed as an option.
  - Funding to be put toward an account for offsite mitigation (Permanent Water Quality Mitigation Pool funds)
- Delaware DOT
  - Constrained right-of-way perspective, offsite treatment may be accommodated in exchange for accepting additional flow in DOT facilities from the development.
  - Benefit from offsite mitigation for a project and, for example, partner with a developer
- Caltrans
  - When on-site treatment for a project is infeasible, a proposal for alternative compliance is submitted.
  - Alternative compliance for placement of BMPs outside of the project limits within the DOT ROW, included within another project.
- North Carolina DOT
  - In-lieu Fee Program allowed as equivalent to treatment BMPs for Projects.
  - Fee is used for watershed water quality projects –statewide stream restoration projects

Toolbox Comparing On-Site and Off-Site Approaches

0
Tool Overview & Applicability
Determines tool applicability

→

1
Project Details
Enter project area characteristics & goals

→

2
Watershed Characteristics
Enter watershed characteristics

→

3
Targets
Enter and compute Load Reduction Targets

→

4
In-Kind On-Site
Enter BMP design parameters for on-site BMP

↓

5
In-Kind Off-Site
Enter tributary area and BMP design parameters for off-site BMP

←

6
Out-of-Kind Options
Enter out-of-kind mitigation options

←

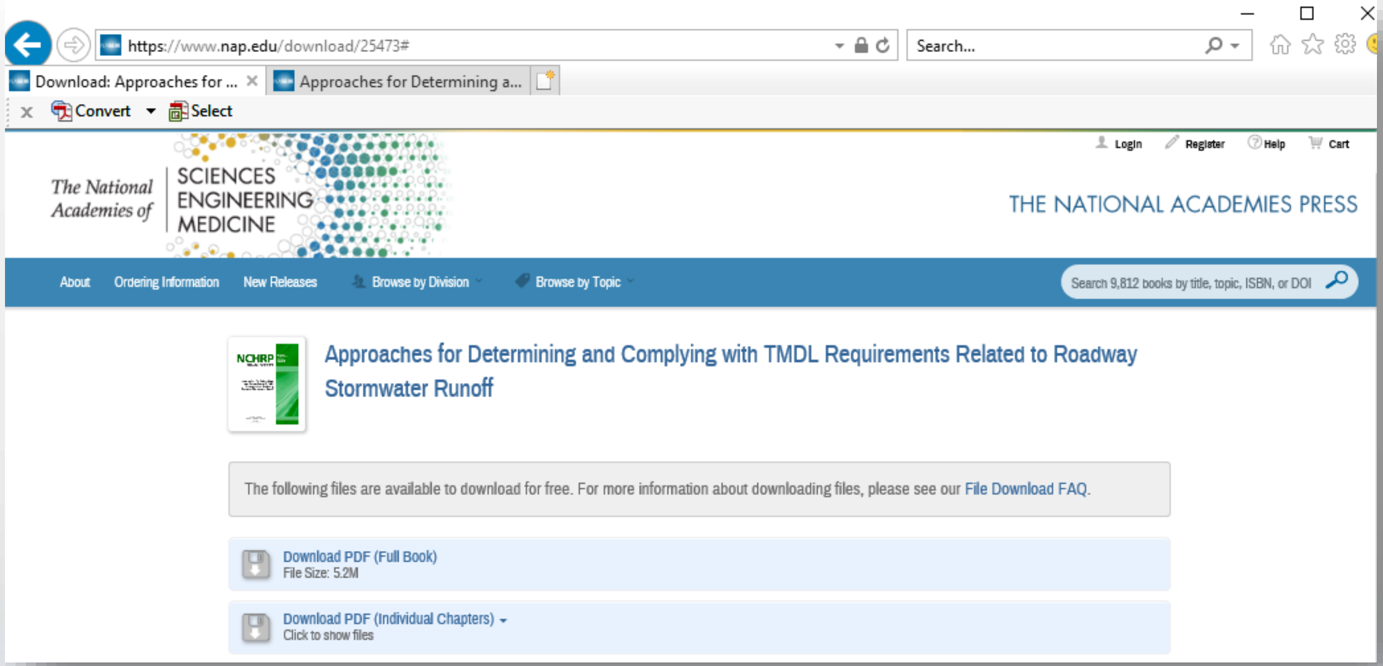
7
Analysis
Enter % implementation & track progress towards load reduction targets

←

8
Report
Summary results of the analysis

Advanced
Enter and modify defaults and lookups

NCHRP 918 Report download http://nap.edu/download/25473# Search “NCHRP TMDL”



A Selection of Associated NCHRP Reports

Available On-Line from the NCHRP

- Report 565: Evaluation fo Best Management Practices for Highway Runoff Control
- Report 728: Guidelines for Evaluating and Selecting Modifications to Existing Roadway Drainage Infrastructure to Improve Water Quality in Ultra-Urban Areas
- Report 767: Measuring and Removing Dissolved Metals from Stormwater in Highway Urbanized Areas
- Report 840: A Watershed Approach to Mitigating Stormwater Impacts
- Synthesis Report 444: Pollutant Load Reductions for Total Maximum Daily Loads for Highways

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