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Starting Soon: ITRC Panel Event

Poll Question

- Based on ITRC Guidance: Stormwater Best Management Practices Performance Evaluation (Stormwater-1) Oct-18
  - Enter your questions about using the ITRC guidance in the Q&A pod
- Pre-event videos - We assume you have watched
- Access panel overview, panelist bios, links
  - CLU-IN panel page: https://clu-in.org/conf/itrc/stormwaterBMP/ Under “Download Training Materials”
- Using Adobe Connect
  - Related Links (on right)
    - Select name of link
    - Click “Browse To”
  - Full Screen button near top of page
- Follow ITRC

Poll Question:

What do you hope to get out of this session? (SELECT MULTIPLE)

- General information about post-construction stormwater BMPs.
- Information about how your document can help me.
- How to use the tool.
- Other “insert short answer”

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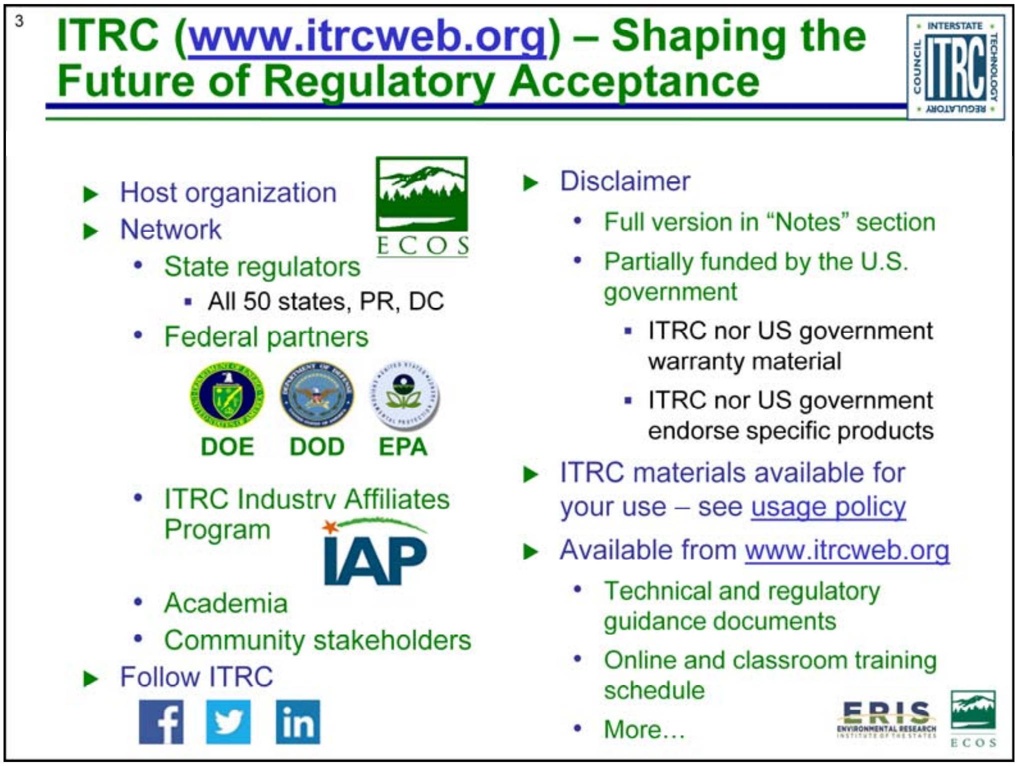
WELCOME - ITRC Panel Event
DRY RUN

Poll Question

ITRC Guidance: Stormwater Best Management Practices Performance Evaluation

Enter your questions about using the ITRC guidance in the Q&A pod

Sponsored by: Interstate Technology and Regulatory Council (www.itrcweb.org)
Hosted by: US EPA Clean Up Information Network (www.cluin.org)



The Interstate Technology and Regulatory Council (ITRC) is a state-led coalition of regulators, industry experts, citizen stakeholders, academia and federal partners that work to achieve regulatory acceptance of environmental technologies and innovative approaches. ITRC consists of all 50 states (and Puerto Rico and the District of Columbia) that work to break down barriers and reduce compliance costs, making it easier to use new technologies and helping states maximize resources. ITRC brings together a diverse mix of environmental experts and stakeholders from both the public and private sectors to broaden and deepen technical knowledge and advance the regulatory acceptance of environmental technologies. Together, we're building the environmental community's ability to expedite quality decision making while protecting human health and the environment. With our network of organizations and individuals throughout the environmental community, ITRC is a unique catalyst for dialogue between regulators and the regulated community.

For a state to be a member of ITRC their environmental agency must designate a State Point of Contact. To find out who your State POC is check out the "contacts" section at www.itrcweb.org. Also, click on "membership" to learn how you can become a member of an ITRC Technical Team.

What is your role in stormwater management?

- I select stormwater BMPs (Best Management Practices) at sites
- I install or maintain stormwater BMPs at sites
- I review, approve, and/or inspect stormwater BMPs
- I regulate stormwater BMPs, but I am not involved in the selection of stormwater BMPs
- I advise others on stormwater program requirements
- I am a provider of stormwater BMP technologies and/or approaches
- I have no role in stormwater management
- Other “insert short answer”

Rebecca Higgins is a Senior Hydrogeologist in the East Metro Unit of the Minnesota Pollution Control Agency (MPCA) in St. Paul. In her roll at the MPCA, she is a member of the team assigned to evaluate releases of hazardous substances and PFAS compounds that pose a risk to human and ecological receptors. Rebecca also serves as liaison between the stormwater program and remediation divisions of the MPCA. In that role she seeks to find innovative technical solutions for sites where contamination poses a risk to human health and the environment from infiltrated stormwater. Rebecca is an ITRC Point-of-Contact for the State of Minnesota and a Co-Team Leader the Stormwater BMP Performance Evaluation Team. She earned a Bachelor's degree in Geology from North Dakota State University in 1998 and spent 9 years in the environmental consulting industry in Colorado and Minnesota until joining the MPCA in 2007. Rebecca is a licensed Professional Geologist in the state of Minnesota.

Poll Question:

Have you or are you currently using the ITRC Stormwater Best Management Practices (BMPs) Performance Evaluation guidance document?

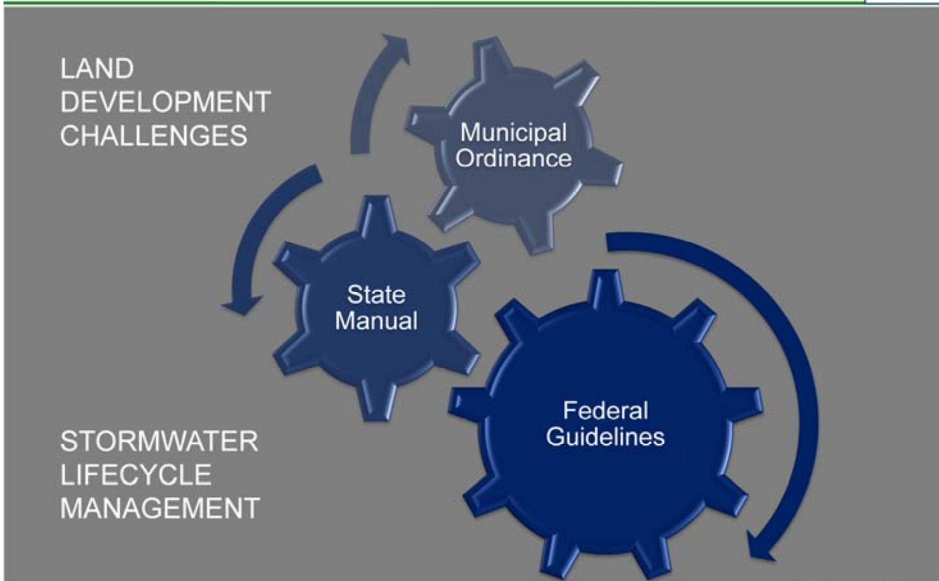
- Yes, I am using the document
- Not yet, but I plan to use the document within the next 6 months
- No, I am not using the document
- I was not aware of this document until this panel session

Poll Question:

What is your level of expertise in post-construction stormwater?

- I am an expert
- I have a few years experience and work with post-construction stormwater issues on a regular basis
- I have a little knowledge, but don't work with post-construction stormwater issues the field very often
- I know nothing about post-construction stormwater, and am looking to expand my overall knowledge base

BMP Performance Evaluation Regs



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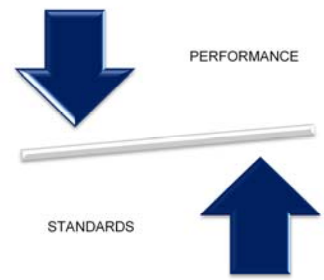
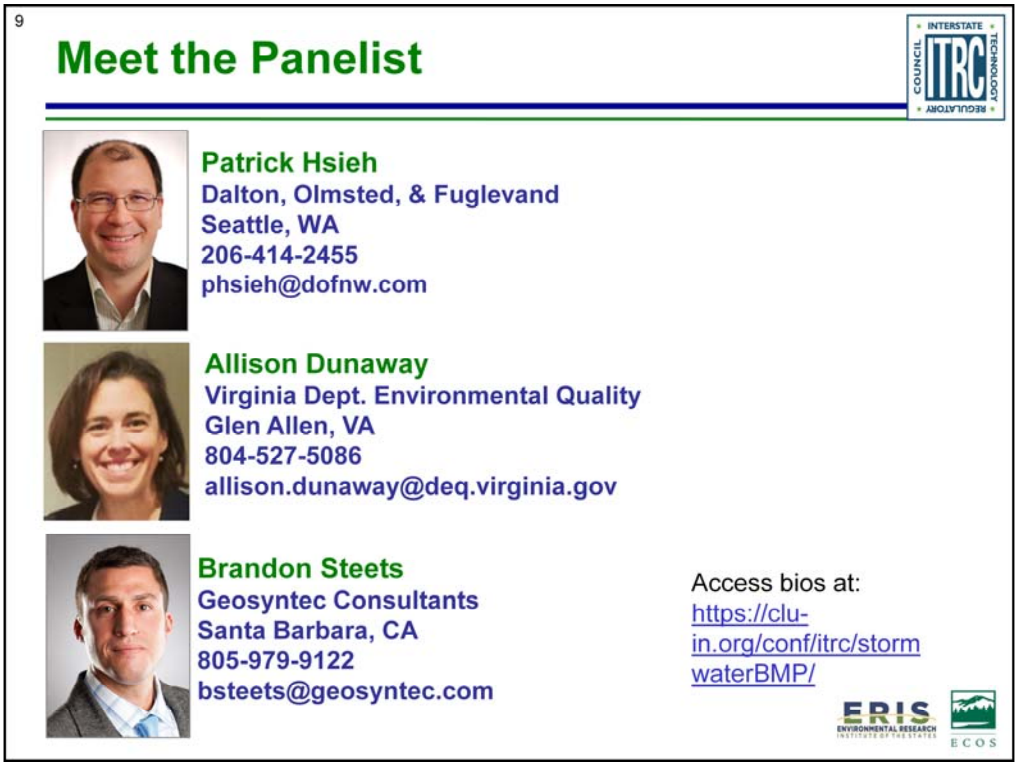
A Resource for YOU – Centralized Information Source

- Lifecycle Basis
  - screening, selection, installation, operation, and monitoring and maintenance
- Limitations and benefits of specific BMPs
- Starting point in the absence of established numeric standards
- Helps you in avoiding or resolving regulatory conflicts



This guidance document does NOT:

- Address sediment and erosion BMPs during construction
- Replace policy or regulatory standards
- Provide detailed design criteria for individual site-specific use
- Provide an exhaustive BMP selection tool
- Verify or certify BMPs



Patrick Hsieh is a Senior Engineer with Dalton, Olmsted, & Fuglevand (DOF) based out of their Seattle, Washington office. Since 2016, Patrick has worked at DOF specializing in managing environmental concerns at complex sites (upland and sediment remediation as well as environmental compliance) with a focus on stormwater management for industrial clients in the Pacific Northwest. He is responsible for the completion of feasibility studies, corrective action plans, and engineering design for cleanups at superfund sites as well as for supporting environmental compliance engineering design at active industrial manufacturing facilities.

He has led the design and operation and maintenance (O&M) of air sparging, soil vapor extraction, groundwater extraction and treatment, stormwater treatment, dredge return water treatment, and in situ bioremediation systems for environmental remediation projects throughout the country. He has directed clients in improving industrial stormwater treatment to reach benchmarks, designed stormwater facilities to meet low impact development goals and aided clients in negotiations with regulators and third party groups. Patrick has evaluated the efficacy of hundreds of water treatment devices or best management practices to treat for metals, polychlorinated biphenyls, suspended solids, pH, volatile organic compounds, 1,4-dioxane, turbidity, chemical and biological oxygen demand in stormwater and wastewater.

Prior to DOF, he worked for 11 years in the environmental consulting field with AMEC Earth and Environmental (previously Geomatrix). Since 2016, Patrick has contributed to ITRC as a team member and trainer for ITRC's Stormwater BMP Evaluation team. Patrick earned a bachelor's (2001) and master's (2003) degree in chemical engineering from University of Rochester in Rochester, New York Patrick is certified as a Professional Engineer in Washington, Oregon, Alaska, and Nevada.

Allison Dunaway manages the Wetland and Stream Protection Program and the Construction Stormwater Program at the Virginia Department of Environmental Quality, Piedmont Regional Office. Over the last 20 years, Allison has worked in the public and private sectors performing water quality monitoring, water and wetlands permitting and inspections, and air, water and waste program enforcement and policy development. She currently supervises a staff of 14 environmental specialists who evaluate permit applications, review plans and conduct compliance inspections related to the wetland and stream protection program and the construction stormwater program. Allison has been active in ITRC since 2011, serving on the Biochemical Reactors for Mining Influenced Waters team from 2011 to 2013 and as a sub-group leader on the Long Term Contaminant Management Using Institutional Controls team from 2014-2015. Since 2016, she has served as the co-team leader on the Stormwater BMP Performance Evaluation team. Allison earned a bachelor's degree with distinction in environmental science from the University of Virginia in 2000, and a master's in environmental science and engineering from Virginia Tech in 2003.

Brandon Steets is a Senior Principal at Geosyntec Consultants in Santa Barbara, California. He has served as a consultant since 2000 and specializes in National Pollutant Discharge Elimination System (NPDES) and Total Maximum Daily Load (TMDL) regulations, water quality modelling and monitoring, pollutant source investigation, and stormwater Best Management Practices (BMP) planning and design. Brandon has led watershed modeling to plan over $6 billion in new green infrastructure and demonstrate compliance with TMDL limits. He has led numerous award winning projects, including biofilter design for the Boeing Santa Susana Field Laboratory (2013 CASQA award) and microbial and nutrient source tracking for the Boston Water and Sewer Commission (2018 NACWA award).He has performed training for the American Society of Civil Engineers (ASCE) and for numerous municipalities across the United States Brandon recently advised the National Academy of Sciences industrial stormwater committee regarding recommendations for U.S. EPA's 2020 Multi-Sector General Permit renewal. He received his BS in environmental engineering from Rensselaer Polytechnic Institute in 1998 and his MS in environmental engineering from the University of California at Santa Barbara in 2000.Â He is a licensed professional chemical engineer (CA), and California Stormwater Quality Association (CASQA) certified Qualified Industrial Stormwater Practitioner and Trainer of Record.

Toni McCrory is a Director in U.S. Environmental, Health, and Safety Compliance for Walmart, Inc in Bentonville, AR. Toni has worked within the water compliance field since 2008. She oversees all water-related compliance programs (stormwater, wastewater, pre-treatment, drinking water, groundwater, wetlands, and water reuse) for over 5200 U.S. facilities. In her role, Toni has developed, implemented, and refined national stormwater programs by generating innovative compliance solutions for performance-based contract management, predictive analytics for asset management, and digital transformation. Toni has been an active member of ITRC since the inception of the Stormwater BMP Performance Evaluation team in 2016 and is currently a trainer for the team. Toni earned her bachelor's degree in biological and agricultural engineering from the University of Arkansas in Fayetteville, Arkansas in 2007 and a master's in business administration from John Brown University in Siloam Springs, Arkansas in 2010.

Chris Nickell is the Director of Environmental Health and Safety at Drake University in Des Moines, Iowa, since 2015. He oversees the Universities environmental compliance. Before joining Drake, he worked in the private sector in Environmental Health and Safety, and as an environmental compliance consultant. Prior to working in the public sector Chris served in the United States Air Force, where he was an Emergency and Disaster Manager. He also holds both the Certified Safety Professional (CSP) and Certified Hazardous Materials Manager (CHMM) designations. Chris is a member of the ITRC Stormwater BMP Performance Evaluation Team. He joined the team in 2017 and served as the operations and maintenance sub team lead. He graduated with a bachelor's degree in Emergency and Disaster Management from Upper Iowa University in 2009.

Kevin Michael Lienau, PE is a Corporate Engineering Manager / Principle with Groundwater and Environmental Services, Inc. (GES) located in GES' Eagan, Minnesota office. Since 1992, Kevin has worked at GES specializing in investigation, remediation, and site progression of a wide variety of industrial and petroleum projects. Contaminants of concern include both chlorinated and non-chlorinated hydrocarbon sites. With his knowledge of varied contaminants and remedial techniques, Kevin also provides third-party review services to clients.

Other areas of expertise include industrial facility auditing, spill prevention, control, and countermeasure (SPCC) plan preparation, stormwater pollution prevention (SWPP) plan preparation, National Pollutant Discharge Elimination System (NPDES) and underground injection control permit acquisition and compliance, analysis and implementation of feasibility tests, control system design, electrical code classification/interpretation, and PLC programming. Additionally, Kevin has extensive experience in landfill leachate and gas system operations, maintenance, design, and control.

Since 2015, Kevin has contributed to ITRC as a team member and now trainer for ITRC's Stormwater Best Management Practices Performance Evaluation team. Kevin earned a bachelor's degree in Chemical Engineering and a bachelor's degree in Material Science and Engineering from the University of Minnesota - Twin Cities in Minneapolis, Minnesota in 1992. Kevin is a licensed professional engineer in 21 states.

Patrick Hsieh is a Senior Engineer with Dalton, Olmsted, & Fuglevand (DOF) based out of their Seattle, Washington office. Since 2016, Patrick has worked at DOF specializing in managing environmental concerns at complex sites (upland and sediment remediation as well as environmental compliance) with a focus on stormwater management for industrial clients in the Pacific Northwest. He is responsible for the completion of feasibility studies, corrective action plans, and engineering design for cleanups at superfund sites as well as for supporting environmental compliance engineering design at active industrial manufacturing facilities.

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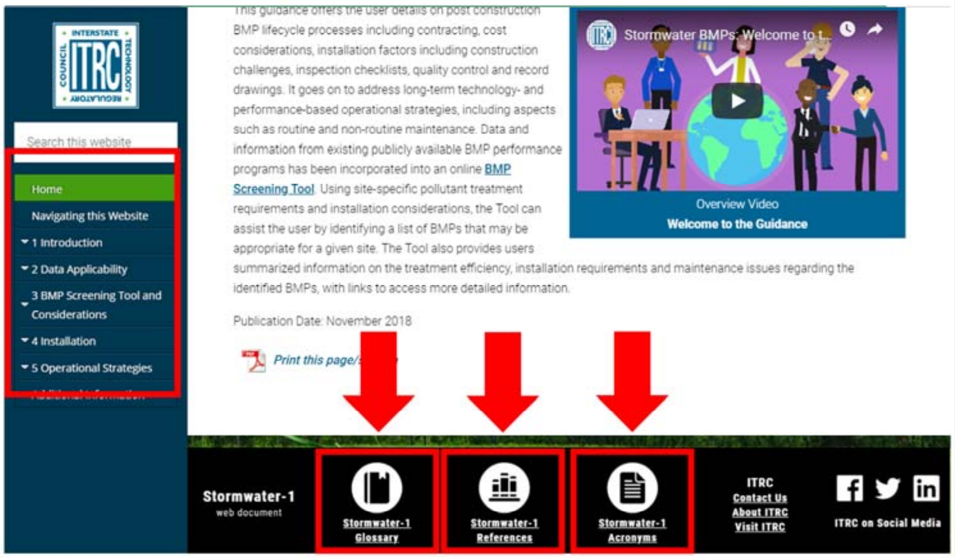
ITRC's Online Stormwater BMP Guidance Document

Centralized resource for information on stormwater BMP effectiveness and how to use and implement that information



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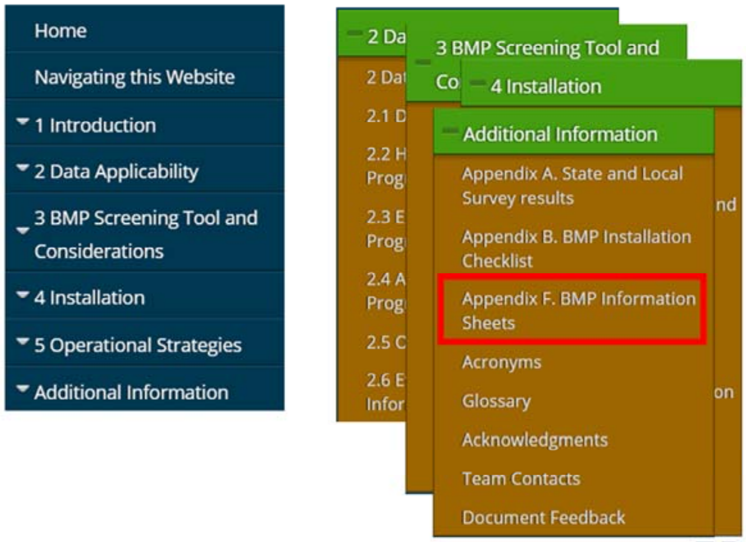
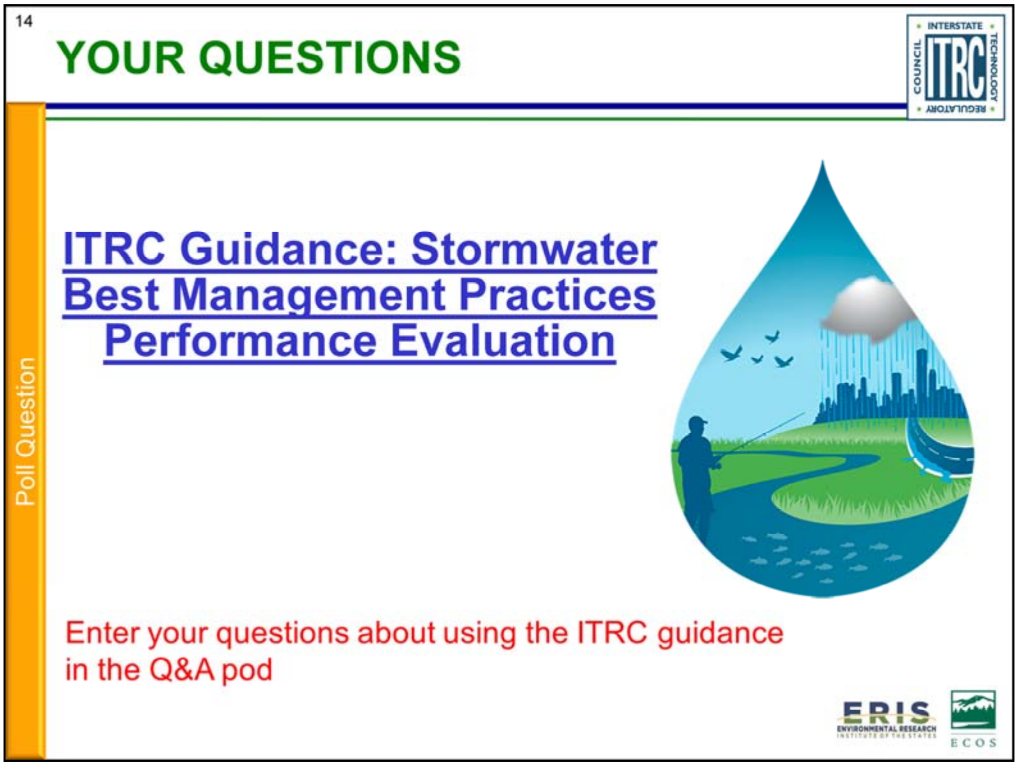
ITRC's Online Stormwater BMP Guidance Document





Poll Question:

What type of organization do you represent?

- City/local government
- State government
- Federal government
- Technology vendor
- Consultant
- Community stakeholder
- Other

Poll Question:

What are challenges that you've experienced when evaluating a BMP for use on a site? (Note: The challenges could be experienced from a site design, approving-authority or owner perspective.) [select all that apply]

- It's difficult to find data to determine if the BMP will be effective.
- There's no standard, national protocol to certify or prove a BMP will be effective.
- I'm unsure if the maintenance requirements of the BMPs will be acceptable to the client and/or the approving authority.
- I don't have reliable information on short- and long-term costs.
- Other

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Panelist

Allison Dunaway
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- Stormwater Best Management Practices Screening Tool

Enter your questions about using the ITRC guidance in the Q&A pod

Access bios at: https://clu-in.org/conf/itrc/stormwaterBMP/

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The Stormwater Tool Can Help





Photo credit: University of Virginia

17 Stormwater Best Management Practices Performance Evaluation (Stormwater-1) Oct-18

Welcome!

ITRC Stormwater Post-Construction BMP Evaluation Tool

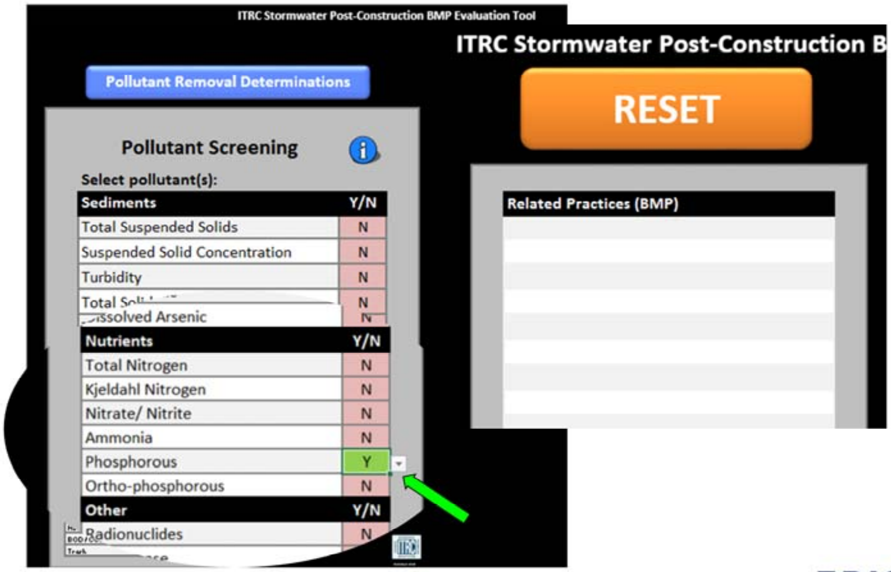
This tool is not an exhaustive list of potential pollutants treated by post-construction BMPs. The pollutants included here are explicity regulated by state or local permit requirements. These pollutants are not exclusive to the presence of an industrial activity or pollutants for which TMDLs impairments exist.

These information sheets are not intended to be guidance and are not independent of the text of this guidance. These information sheets are intended as information that will inform the user on BMP components and help them access additional information.

Additonal information and references can be found in each BMP information sheet, as well as, the Stormwater BMP Evaluation documentation located at the ITRC website (https://www.itrcweb.org/).

OK

Step 1: Choose Pollutants



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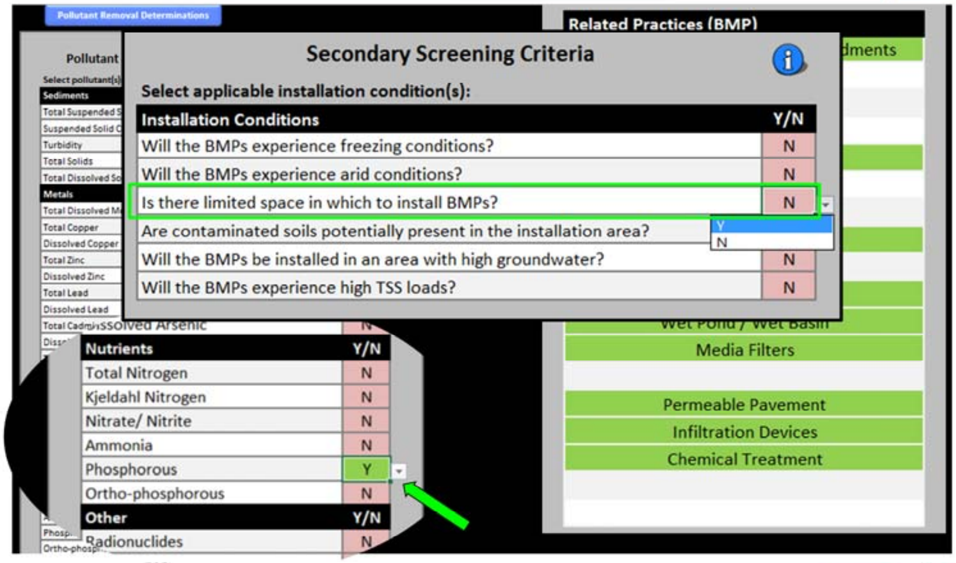
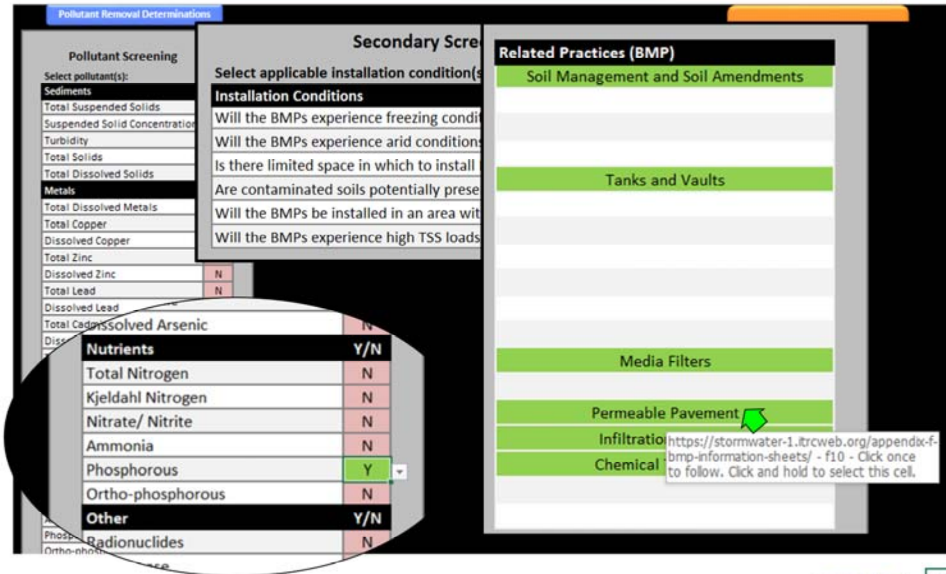
Step 2: Secondary Screening



Step 3: Review Related Practices



BMP Information Sheet
Description & Pollutant Summary

F.10 Permeable Pavement

December 2018

Description

Permeable or porous pavement has a higher than normal percentage of air voids to allow water to pass through it and infiltrate into the subsoil or collect in an underdrain system. Massachusetts Stormwater Handbook and Stormwater Standards

Pollutants of Concern Treated by Permeable Pavement

Permeable Pavement										
Solids	**Solid Metals**	**Dissolved Metals**	**Hydro Carbons**	**Nutrients**	**Ammonia**	**PH**	**Bacteria Pathogens**	**Organics**	**Trash**	**Pesticides Herbicides**
TSS	Cu		O/G	Phosphorus				PCB		
SSC	Zn	Zn	TPH					PAH		
Turbidity	Pb									
Total Solids	Ni	Ni								

BMP Information Sheet
Data Summary

International Stormwater BMP Database Performance Summary, 2016 – Porous Pavement International Stormwater BMP Database. Prepared for City and County of Denver and Urban Drainage and Flood Control District, February 2017. Prepared by Wright Water Engineers and Geosyntec Consultants (Consultants 2016)

	BMPs		EMCs		25th		Median			75th	
	In	Out	In	Out	In	Out	In	Out	Difference	In	Out
Nitrogen, NO_x as N (mg/L)	7	7	388	220	0.34	0.85	0.59 (0.53, 0.62)	1.36 (1.22, 1.51)	◆◆◆	0.88	2.06
Nitrogen, Nitrite (NO_2) + Nitrate (NO_3) as N (mg/L)	7	7	388	220	0.34	0.85	0.59 (0.53, 0.62)	1.36 (1.22, 1.51)	◆◆◆	0.88	2.06
Phosphorus as P, Dissolved (mg/L)	4	4	244	119	0.03	0.04	0.05 (0.04, 0.05)	0.05 (0.05, 0.07)	◇◆◆	0.08	0.10
Phosphorus as P, Total (mg/L)	8	8	373	219	0.12	0.07	0.19 (0.16, 0.21)	0.11 (0.10, 0.11)	◆◆◆	0.36	0.20
Phosphorus, orthophosphate as P (mg/L)	6	6	174	114	0.03	0.03	0.05 (0.04, 0.06)	0.07 (0.05, 0.08)	◇◆◆	0.08	0.12
Phosphorus as P, Total (mg/L)	55	55	891	873	0.09	0.04	0.20 (0.18, 0.22)	0.09 (0.08, 0.10)	◆◆◆	0.42	0.20
Chromium, Dissolved (µg/L)	4	4	292	133	0.50	1.70	0.50 (0.50, 0.50)	2.70 (2.30, 2.80)	◆◆◆	0.50	3.80
Chromium, Total (µg/L)	4	4	300	143	2.04	2.50	3.62 (3.40, 4.10)	4.28 (3.51, 5.06)	◇◇◇	6.60	7.23
Copper, Dissolved (µg/L)	7	7	381	216	2.80	3.00	5.00 (4.70, 5.50)	5.10 (4.40, 5.60)	◇◇◆	7.80	7.12
Copper, Total (µg/L)	11	11	439	262	7.50	4.00	12.00 (10.80, 12.50)	7.70 (6.70, 8.00)	◆◆◆	23.30	13.76

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BMP Information Sheet

Design

[28] Certifications more commonly apply to products, or proprietary BMPs, which generally follow the demonstrative approach and must demonstrate they are effective. Most practices, or public domain BMPs such as permeable pavement, follow the presumptive approach and are presumed to be effective as long as they are built following the design criteria of the regulatory agency. Users should refer to their local regulatory agency for information on approved permeable pavement BMPs.

Structural Design

- The subgrade is the layer below the paving and the subbase. Where traditional pavement tries to reduce water from entering the subgrade, permeable pavement allows for water to enter the subgrade.
- The subbase is below the paving and provides vertical support, storage capacity and filtering ability.
- Pavement strength (i.e., concrete, paver, asphalt, etc.) is based on the material used and the design specifications for the area.
- Structural thickness can vary based on the local conditions, experience of using permeable pavements, and pavement mixture design.

Stormwater Management Design

- Determine permeable pavement type (i.e., porous concrete, pervious pavers, non-pervious interlocking pavers, etc.).
- Consider three specific design features: 1) reduced runoff volume, 2) reduced treatment volume, and 3) reduced impervious area.
- Determine if there is a stormwater treatment option considered and its effectiveness for the design considerations.

BMP Information Sheet
Additional Information

Example Submittals Checklist

- American Concrete Institute (ACI) Specification for Pervious Concrete Pavement, ACI 522.1-13

Timeframe

- Hold pre-construction meeting and construct test sections to address construction issues.
- Assemble materials on-site and ensure they meet design specifications.
- Follow erosion control measures according to an approved site plan (e.g., silt fence).
- Follow general pervious concrete construction guidelines such as subgrade preparation and layout.
- Place paving material as per site specifications and industry standards:
  - Porous Asphalt – see Jackson (2007)
  - Pervious Concrete – see American Concrete Institute (2008)
  - Interlocking Pavers – see Smith (2006)
- Consolidation
- Jointing
- Curing protection
  - Cold weather protection
  - Hot weather protection
- Protect permeable pavement from adjacent stormwater runoff areas to avoid introduction of sediment

Example Inspection Checklist

- Virginia Department of Environmental Quality (DEQ) Design Specification No 7: Permeable Pavers, Version 2.0

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BMP Information Sheet
Sample Inspection Checklists

- ☐ **Filter Layer and Underdrain Placement**
  - ☐ All aggregates, including, as required, the filter layer (choker stone & sand), the reservoir layer, and bedding layer are clean and washed and otherwise conform to specifications as certified by quarry.
  - ☐ Underdrain size and perforations meet the specifications.
  - ☐ Placement of filter layer and initial layer of reservoir layer aggregates (approximately 2 inches) spread (not dumped) to avoid aggregate segregation; or
  - ☐ Impermeable liner meets project specifications and is placed in accordance with manufacturers specifications.
  - ☐ Placement of underdrain, observation wells, and underdrain fittings (45 degree wyes, cap at upstream end, etc.) in accordance with the approved plans.
  - ☐ Invert elevations of underdrain and outlet structure and surface gradient in accordance with approved plans.
  - ☐ **Certification of Filter Layer and Underdrain Placement Inspection:** Inspector certifies the successful completion of the filter layer and underdrain placement steps listed above.
- ☐ **Stone Reservoir Aggregate Placement**
  - ☐ Sides of excavation covered with geotextile, when required, prior to placing stone reservoir aggregate; no tears or holes, or excessive wrinkles are present.
  - ☐ Thickness, placement, compaction and surface tolerances meet specifications and approved plans.
  - ☐ **Certification of Stone Reservoir Aggregate Placement Inspection**: Inspector certifies the successful stone reservoir layer placement steps listed above.
- ☐ **Bedding Layer and Pavement Installation**

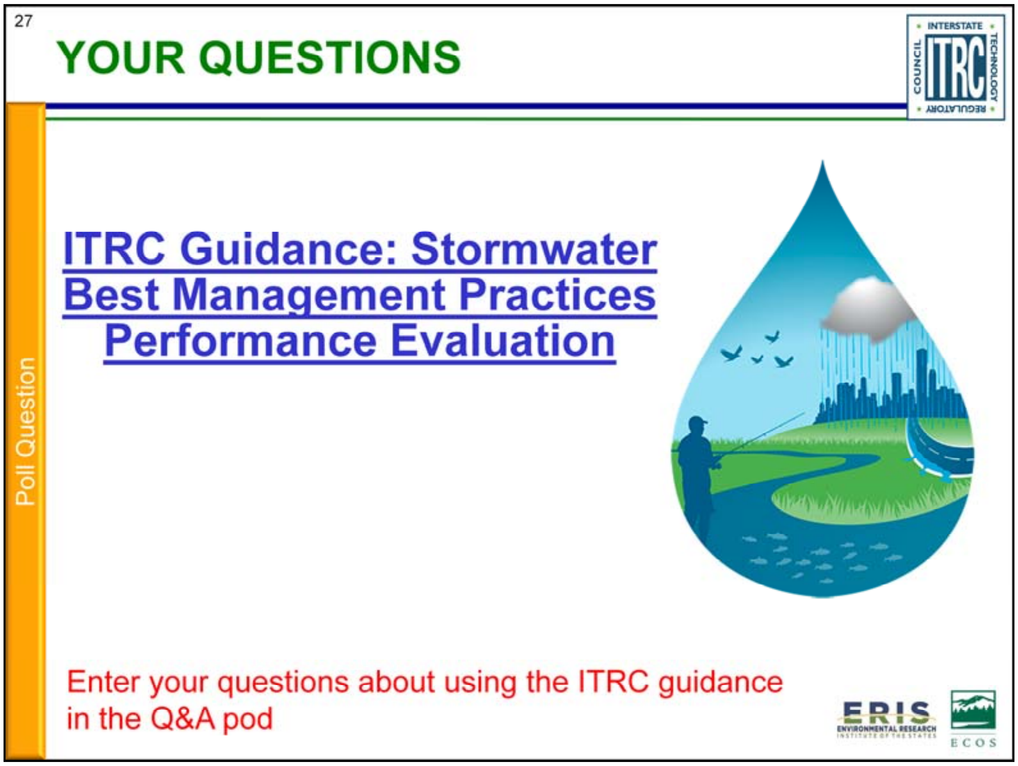
BMP Information Sheet
O&M and More Information Sources

Operation and Maintenance Considerations

- Post signage to identify the porous pavement areas. Avoid typical measures for maintaining standard pavements including application of sand, salt and snow melting chemicals, seal coating and power washing.
- In winter, do not pile plowed snow on pavement to prevent concentrations of grit and nutrients from being deposited on pavement.
- Maintain stabilizing ground cover around pavement to prevent erosion and washing of sediment onto the permeable pavement surface.

References and Links

- American Concrete Institute (ACI) Pervious Concrete, ACI 522R-06
- American Concrete Institute (ACI) Report on Pervious Concrete, ACI 522R-10
- American Concrete Institute (ACI) Specification for Pervious Concrete Pavement, ACI 522.1-08
- American Concrete Institute (ACI) Specification for Pervious Concrete Pavement, ACI 522.1-13
- California Department of Transportation – Pervious Pavement Guidance
- Jackson, N. 2007. *Design, Construction and Maintenance Guide for Porous Asphalt Pavements.* National Asphalt Pavement Association. Information Series 131. Lanham, MD. (Jackson 2007)
- Minnesota Pollution Control Agency Stormwater Manual: Permeable Pavement
- New York State Stormwater Management Design Manual
- North Carolina Department of Environmental Quality Stormwater Design Manual Minimum Design Criteria and Recommendations for Stormwater Control Measures C-5: Permeable Pavement
- S. Department of Transportation Federal Highway Administration, Permeable Interlocking Concrete Pavement, TechBrief Publication Number FHWA-HIF-15-007



Poll Question:

What road blocks have you or others encountered when using the ITRC Stormwater BMP document? [short answer]

Panelist

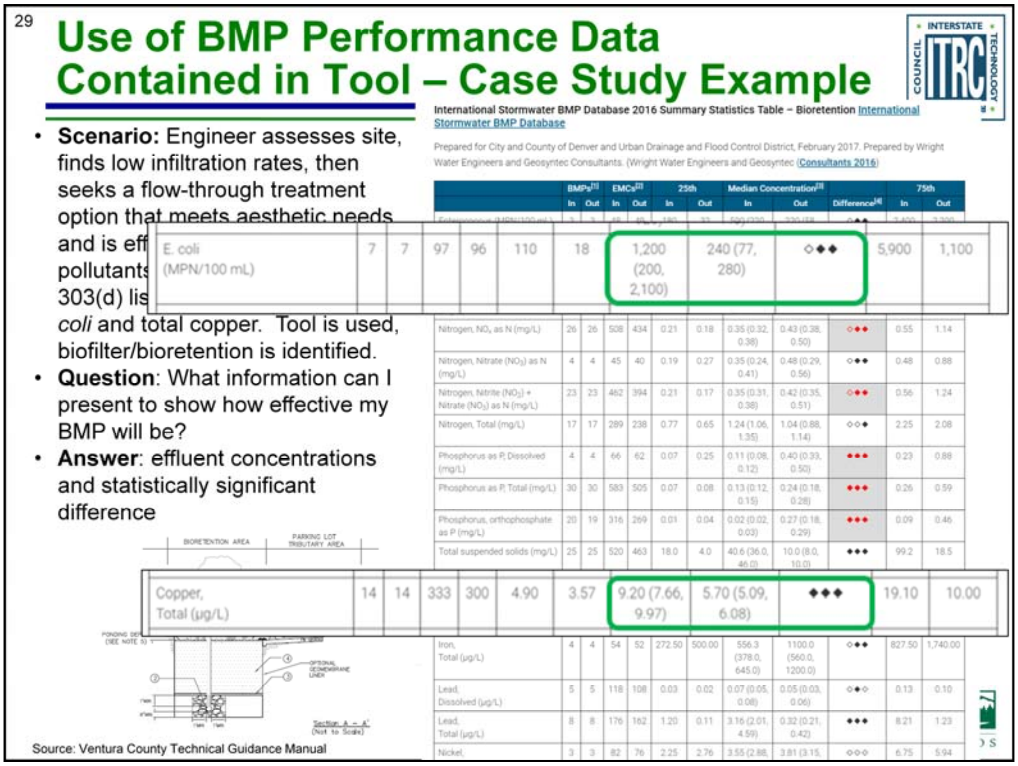
Brandon Steets
Geosyntec Consultants
Santa Barbara, CA
805-979-9122
bsteets@geosyntec.com

- Use of BMP performance data contained in the tool

Enter your questions about using the ITRC guidance in the Q&A pod

Access bios at: https://clu-in.org/conf/itrc/stormwaterBMP/

Brandon Steets is a Senior Principal at Geosyntec Consultants in Santa Barbara, California. He has served as a consultant since 2000 and specializes in National Pollutant Discharge Elimination System (NPDES) and Total Maximum Daily Load (TMDL) regulations, water quality modelling and monitoring, pollutant source investigation, and stormwater Best Management Practices (BMP) planning and design. Brandon has led watershed modeling to plan over $6 billion in new green infrastructure and demonstrate compliance with TMDL limits. He has led numerous award winning projects, including biofilter design for the Boeing Santa Susana Field Laboratory (2013 CASQA award) and microbial and nutrient source tracking for the Boston Water and Sewer Commission (2018 NACWA award).He has performed training for the American Society of Civil Engineers (ASCE) and for numerous municipalities across the United States.Â Brandon recently advised the National Academy of Sciences industrial stormwater committee regarding recommendations for U.S. EPA's 2020 Multi-Sector General Permit renewal. He received his BS in environmental engineering from Rensselaer Polytechnic Institute in 1998 and his MS in environmental engineering from the University of California at Santa Barbara in 2000.Â He is a licensed professional chemical engineer (CA), and California Stormwater Quality Association (CASQA) certified Qualified Industrial Stormwater Practitioner and Trainer of Record.



	BMPs[1] In	BMPs[1] Out	EMCs[2] In	EMCs[2] Out	25th In	25th Out	Median Concentration[3] In	Median Concentration[3] Out	Difference[4]	75th In	75th Out
Enterococcus (MPN/100 mL)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	◇◆◆	[illegible]	[illegible]
E. coli (MPN/100 mL)	7	7	97	96	110	18	1,200 (200, 2,100)	240 (77, 280)	◇◆◆	5,900	1,100
Nitrogen, NO_x as N (mg/L)	26	26	508	434	0.21	0.18	0.35 (0.32, 0.38)	0.43 (0.38, 0.50)	◇◆◆	0.55	1.14
Nitrogen, Nitrate (NO_3) as N (mg/L)	4	4	45	40	0.19	0.27	0.35 (0.24, 0.41)	0.48 (0.29, 0.56)	◇◆◆	0.48	0.88
Nitrogen, Nitrite (NO_2) + Nitrate (NO_3) as N (mg/L)	23	23	462	394	0.21	0.17	0.35 (0.31, 0.38)	0.42 (0.35, 0.51)	◇◆◆	0.56	1.24
Nitrogen, Total (mg/L)	17	17	289	238	0.77	0.65	1.24 (1.06, 1.35)	1.04 (0.88, 1.14)	◇◇◆	2.25	2.08
Phosphorus as P, Dissolved (mg/L)	4	4	66	62	0.07	0.25	0.11 (0.08, 0.12)	0.40 (0.33, 0.50)	◆◆◆	0.23	0.88
Phosphorus as P, Total (mg/L)	30	30	583	505	0.07	0.08	0.13 (0.12, 0.15)	0.24 (0.18, 0.28)	◆◆◆	0.26	0.59
Phosphorus, orthophosphate as P (mg/L)	20	19	316	269	0.01	0.04	0.02 (0.02, 0.03)	0.27 (0.18, 0.29)	◆◆◆	0.09	0.46
Total suspended solids (mg/L)	25	25	520	463	18.0	4.0	40.6 (36.0, 46.0)	10.0 (8.0, 10.0)	◆◆◆	99.2	18.5
Copper, Total (µg/L)	14	14	333	300	4.90	3.57	9.20 (7.66, 9.97)	5.70 (5.09, 6.08)	◆◆◆	19.10	10.00
Iron, Total (µg/L)	4	4	54	52	272.50	500.00	556.3 (378.0, 645.0)	1100.0 (560.0, 1200.0)	◇◆◆	827.50	1,740.00
Lead, Dissolved (µg/L)	5	5	118	108	0.03	0.02	0.07 (0.05, 0.08)	0.05 (0.03, 0.06)	◇◆◇	0.13	0.10
Lead, Total (µg/L)	8	8	176	162	1.20	0.11	3.16 (2.01, 4.59)	0.32 (0.21, 0.42)	◆◆◆	8.21	1.23
Nickel,	3	3	82	76	2.25	2.76	3.55 (2.88,	3.81 (3.15,	◇◇◇	6.75	5.94

Difference diamonds:

Left diamond: overlap of 95% confidence intervals (strongest)

Middle: whether medians are statistically different from each other, mann whitney test (least strong)

Right: wilcoxen rank sum test on paired influent-effluent, very useful for flow-through BMPs with short residence times (so not wet ponds)

Case Study Example – What Else Should You Look For?

- Robustness of dataset (note data counts)
- Pollutant concentration increases (e.g., phosphorus and iron)
- How the BMP achieves this removal (e.g., removing particulate copper only, so don't expect less copper-based toxicity)

International Stormwater BMP Database 2016 Summary Statistics Table – Bioretention International Stormwater BMP Database

Prepared for City and County of Denver and Urban Drainage and Flood Control District, February 2017. Prepared by Wright Water Engineers and Geosyntec Consultants. (Wright Water Engineers and Geosyntec (Consultants 2016)

	BMPs[1]		EMCs[2]		25th		Median Concentration[3]			75th	
	In	Out	In	Out	In	Out	In	Out	Difference[4]	In	Out
Enterococcus (MPN/100 mL)	3	3	48	49	180	32	590 (220, 920)	220 (58, 440)	◇◆◆	2,400	2,200
E. coli (MPN/100 mL)	7	7	97	96	110	18	1,200 (200, 2,100)	240 (77, 280)	◇◆◆	5,900	1,100
Kjeldahl nitrogen (TKN) (mg/L)	23	23	451	390	0.62	0.64	1.10 (1.07, 1.24)	1.39 (1.14, 1.40)	◇◇◇	2.20	2.39
Nitrogen, NO_x as N (mg/L)	26	26	508	434	0.21	0.18	0.35 (0.32, 0.38)	0.43 (0.38, 0.50)	◇◆◆	0.55	1.14
Nitrogen, Nitrate (NO_3) as N (mg/L)	4	4	45	40	0.19	0.27	0.35 (0.24, 0.41)	0.48 (0.29, 0.56)	◇◆◆	0.48	0.88
Nitrogen, Nitrite (NO_2) + Nitrate (NO_3) as N (mg/L)	23	23	462	394	0.21	0.17	0.35 (0.31, 0.38)	0.42 (0.35, 0.51)	◇◆◆	0.56	1.24
Nitrogen, Total (mg/L)	17	17	289	238	0.77	0.65	1.24 (1.06,	1.04 (0.88,	◇◇◆	2.25	2.08
E. coli (MPN/100 mL)	7	7	97	96	110	18	1,200 (200, 2,100)	240 (77, 280)	◇◆◆	5,900	1,100
Phosphorus as P, Total (mg/L)	30	30	583	505	0.07	0.08	0.13 (0.12, 0.15)	0.24 (0.18, 0.28)	◆◆◆	0.26	0.59
Iron, Total (µg/L)	4	4	54	52	272.50	500.00	556.3 (378.0, 645.0)	1100.0 (560.0, 1200.0)	◇◆◆	827.50	1,740.00
Copper, Dissolved (µg/L)	7	7	143	127	3.21	3.28	5.11 (4.41, 5.80)	6.50 (4.70, 7.10)	◇◇◆	8.13	12.60
Total (µg/L)							4.59)	0.42)			
Nickel,	3	3	82	76	2.25	2.76	3.55 (2.88,	3.81 (3.15,	◇◇◇	6.75	5.94

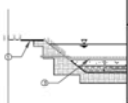
Case Study Example – Exploring Options

- **Question:** Media filter is another option for the site, though [illegible] would it [illegible] for my p[illegible]
- **Answer:** similar (using Fecal Coliform as surrogate for *E. coli*), and without the increases in phosphorus and iron
  - But greater confidence in nitrate increase (likely converted from organic nitrogen)

International Stormwater BMP Database Performance Summary, 2016 – Media Filters

Prepared for City and County of Denver and Urban Drainage and Flood Control District, February 2017. Prepared by Wright Water Engineers and Geosyntec Consultants. (Wright Water Engineers and Geosyntec (Consultants 2016))

	BMPs[17]		EMCs[18]		25th		Median Concentration[19]			75th	
Fecal Coliform (MPN/100 mL)	15	15	184	169	120	33	900 (400, 1,500)	400 (200, 800)	◇◆◆	10,000	5,600
Copper, Total (µg/L)	20	20	345	330	4.97	2.46	9.98 (8.60, 10.00)	5.53 (4.58, 6.30)	◆◆◆	16.87	10.00
Nitrogen, Nitrate (NO_3) as N (mg/L)	12	12	178	174	0.20	0.30	0.32 (0.28, 0.35)	0.56 (0.46, 0.63)	◆◆◆	0.59	0.94
Nitrogen, Nitrite (NO_2) + Nitrate (NO_3) as N (mg/L)	10	9	168	154	0.24	0.38	0.35 (0.31, 0.40)	0.57 (0.48, 0.68)	◆◆◆	0.58	0.94
Nitrogen, Total (mg/L)	10	9	160	151	0.79	0.73	1.22 (1.03, 1.33)	1.05 (0.90, 1.16)	◇◇◆	2.10	1.72
Phosphorus as P, Dissolved (mg/L)	11	10	118	100	0.01	0.02	0.05 (0.03, 0.06)	0.04 (0.03, 0.06)	◇◇◆	0.09	0.10
Phosphorus as P, Total (mg/L)	23	22	372	349	0.07	0.04	0.15 (0.13, 0.15)	0.09 (0.07, 0.10)	◆◆◆	0.28	0.16
Phosphorus, orthophosphate as P (mg/L)	7	7	116	115	0.02	0.02	0.04 (0.03, 0.05)	0.03 (0.02, 0.04)	◇◇◆	0.09	0.07
Total suspended solids (mg/L)	25	25	400	377	22.0	3.9	56.4 (46.0, 61.9)	9.0 (6.4, 10.0)	◆◆◆	120.0	22.8
Copper, Dissolved (µg/L)	11	11	189	176	1.63	1.50	3.75 (2.70, [illegible]	3.25 (2.53, [illegible]	◇◇◆	7.60	6.90
Iron, Total (µg/L)	8	7	153	132	267.76	113.23	642.3 (452.2, 755.0)	209.7 (162.8, 256.9)	◆◆◆	1,460.00	420.69



Other Uses - Evaluating BMP's Reliability For Meeting Permit Limits

- **Question**: Existing site runoff at 50 ug/L copper, limit is 10 ug/L, how consistently will media filter meet this limit?
- **Answer**: 75% of effluent samples <=10 ug/L, but at 17 ug/L influent (takeaway: select pretreatment BMP to meet ~17 [i.e., treatment train concept])
- **For more info**: Look at paired influent-effluent in BMP Database to match 50 ug/L influent, and review design info (e.g., media type, contact time)

International Stormwater BMP Database Performance Summary, 2016 – Media Filters

Prepared for City and County of Denver and Urban Drainage and Flood Control District, February 2017. Prepared by Wright Water Engineers and Geosyntec Consultants. (Wright Water Engineers and Geosyntec (Consultants 2016))

	BMPs[17]		EMCs[18]		25th		Median Concentration[19]			75th	
	In	Out	In	Out	In	Out	In	Out	Difference[20]	In	Out
Fecal Coliform (MPN/100 mL)	15	15	184	169	120	33	900 (400, 1,500)	400 (200, 800)	◇◆◆	10,000	5,600
Kjeldahl nitrogen (TKN) (mg/L)	21	20	323	312	0.56	0.29	0.94 (0.83, 1.02)	0.50 (0.43, 0.55)	◆◆◆	1.78	1.00
Nitrogen, NO_x as N (mg/L)	22	21	346	328	0.21	0.34	0.34 (0.31, 0.37)	0.57 (0.49, 0.63)	◆◆◆	0.58	0.94
Nitrogen, Nitrate (NO_3) as N (mg/L)	12	12	178	174	0.20	0.30	0.32 (0.28, 0.35)	0.56 (0.46, 0.63)	◆◆◆	0.59	0.94
Nitrogen, Nitrite (NO_2) + Nitrate (NO_3) as N (mg/L)	10	9	168	154	0.24	0.38	0.35 (0.31, 0.40)	0.57 (0.48, 0.68)	◆◆◆	0.58	0.94
Nitrogen, Total (mg/L)	10	9	160	151	0.79	0.73	1.22 (1.03, 1.33)	1.05 (0.90, 1.16)	◇◇◆	2.10	1.72
Phosphorus as P, Dissolved (mg/L)	11	10	118	100	0.01	0.02	0.05 (0.03, 0.06)	0.04 (0.03, 0.06)	◇◇◆	0.09	0.10
Phosphorus as P, Total (mg/L)	23	22	372	349	0.07	0.04	0.15 (0.13, 0.15)	0.09 (0.07, 0.10)	◆◆◆	0.28	0.16
Phosphorus, orthophosphate as P (mg/L)	7	7	116	115	0.02	0.02	0.04 (0.03, 0.05)	0.03 (0.02, 0.04)	◇◇◆	0.09	0.07
Total suspended solids (mg/L)	25	25	400	377	22.0	3.9	56.4 (46.0, 61.9)	9.0 (6.4, 10.0)	◆◆◆	120.0	22.8
Copper, Dissolved (µg/L)	11	11	189	176	1.63	1.50	3.75 (2.70, 4.10)	3.25 (2.53, 3.90)	◇◇◆	7.60	6.90
Copper, Total (µg/L)	20	20	345	330	4.97	2.46	9.98 (8.60, 10.00)	5.53 (4.58, 6.30)	◆◆◆	16.87	10.00

Copper, Total (µg/L)	20	20	345	330	4.97	2.46	9.98 (8.60, 10.00)	5.53 (4.58, 6.30)	◆◆◆	16.87	10.00

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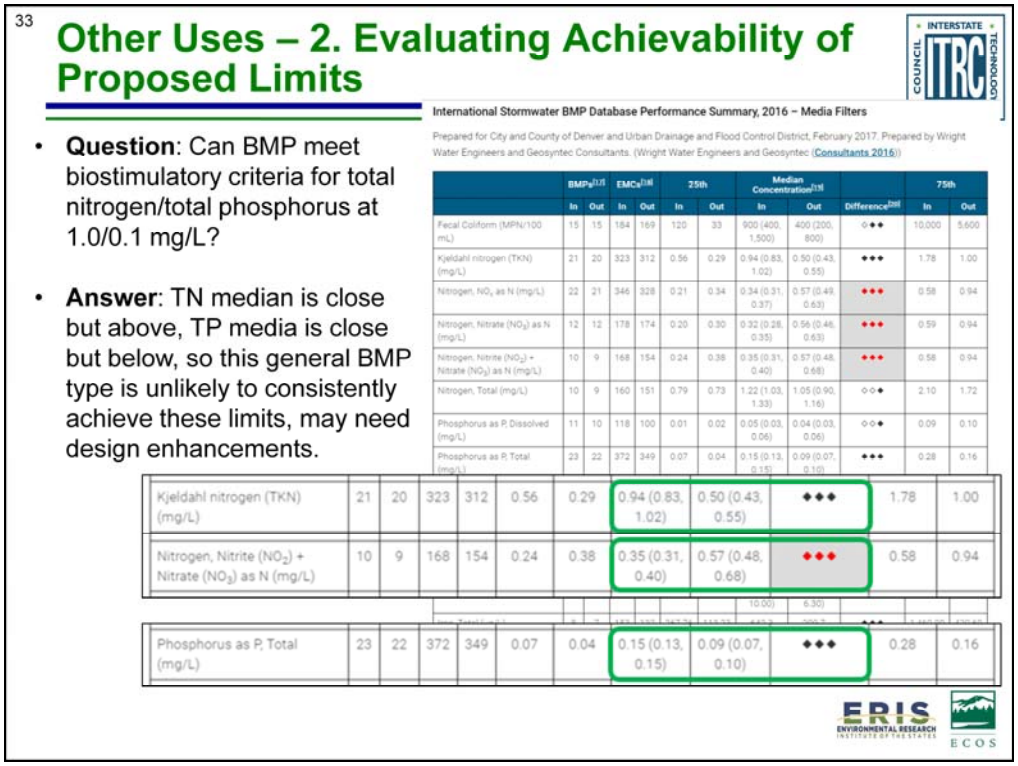
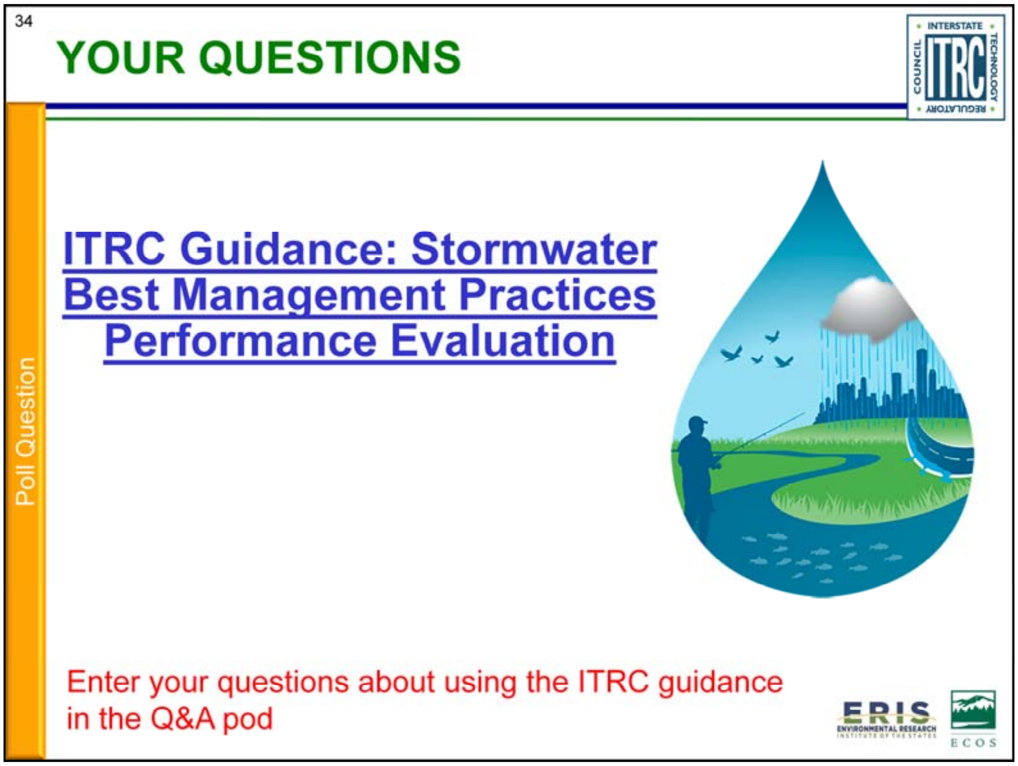


For TN, consider saturated zone that will go anoxic to allow nitrate reduction, for TP consider iron-based media enhancements to sequester TP. Also outlet controls to increase contact time.

Two last things:

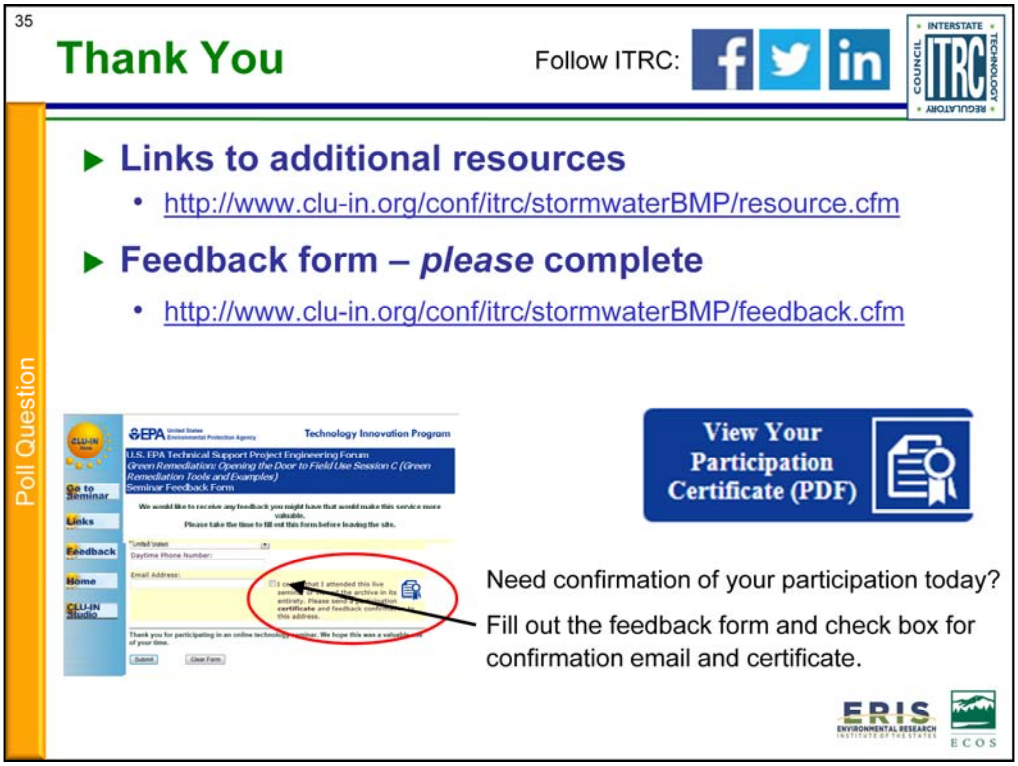
1. Data tables are also useful to support modeling to estimate load reductions achieved through BMP implementation scenarios.
2. Remember this concentration info is just one side of the load story. For loads to be reduced, also consider the volume reduction differences between sites (perc rates are site specific) and BMPs (eg, sizing, volume storage, etc.). There's also data on this in the BMP database, particularly for bioretention.



Poll Question:

What is your interest in the development of a national program to certify BMP effectiveness?

- 1 - no interest
- 2 - some interest
- 3 - significant interest



Poll Question:
Do you feel more confident in applying the ITRC Stormwater BMP document?

- Yes
- No
- Unsure – need to learn more

Think about projects that you are working on. In the next 6 months, how could you use this ITRC guidance? [short answer]

Links to additional resources:
http://www.clu-in.org/conf/itrc/xxxx/resource.cfm

Your feedback is important – please fill out the form at:
http://www.clu-in.org/conf/itrc/xxxx/feedback.cfm

The benefits that ITRC offers to state regulators and technology developers, vendors, and consultants include:
✓Helping regulators build their knowledge base and raise their confidence about new environmental technologies
✓Helping regulators save time and money when evaluating environmental technologies
✓Guiding technology developers in the collection of performance data to satisfy the requirements of multiple states
✓Helping technology vendors avoid the time and expense of conducting duplicative and costly demonstrations
✓Providing a reliable network among members of the environmental community to focus on innovative environmental technologies

How you can get involved with ITRC:
✓Join an ITRC Team – with just 10% of your time you can have a positive impact on the regulatory process and acceptance of innovative technologies and approaches
✓Sponsor ITRC's technical team and other activities
✓Use ITRC products and attend training courses
✓Submit proposals for new technical teams and projects