Monitoring 101:
Collecting data for urban watersheds in a post-construction environment

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Water Quality Priorities for Stormwater Management:

Active Construction
- B & C horizon soils
- Event-based runoff
- 20 Acres or fewer in size
- Finite time frame

Post-Construction/MS4
- All Soil Types
- Wet and dry season concerns
- City/Watershed scale
- Ongoing troubleshooting

Effluent

- **Effluent:** Discharge water or gas from a natural body of water, or from a human-made structure.

- **Effluent Limitation Guidelines (ELGs):** The maximum amount of a pollutant that an entity is permitted to release into a water body over a given period of time – usually 24 hours.

So what are we to do?

- Advanced monitoring techniques & programs
  - Mostly research-based
  - Very costly
  - Highly credible data
- Stormwater triage
  - Event-based monitoring
  - ELGs will be driven by this

Key Parameters

- Sediment
- Metals (Pb, Cu, Zn, Cd)
- Nutrients (N, P)
- Bacteria
- (Nutrients)

Davis, 2003; Pitt, 1995, et.al., EPA

Turbidity (water cloudiness)

- Usually measured in the laboratory.
- True NTUs are derived from taking a measurement of defracted light at a right angle to a known quantity of light.
- Often uncritically taken to be equivalent to visual clarity.

Turbidity Concentration Over Time = Degradation

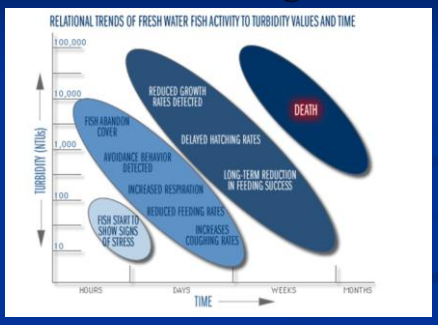


Image source: oftimeandtheriver.com

Visual Clarity as a Measurement

- Considered a "true" scientific measurement
- Has immediate environmental relevance
- Is readily understood
- Is not particularly subjective
- Can be measured with better precision than SSC and turbidity
- Is more relevant than SSC and turbidity

"In many cases, the resources being spent for outfall monitoring could be more effectively spent to better understand many other aspects of an effective stormwater management program."

Robert Pitt, et.al. (2004)

Monitoring from the Macro-Level

- Questions to be Asked
- What is a Watershed?
- Basic Monitoring Concepts
- Sampling Methods

Questions to be asked:

- ***What do you already know?***
  - Gather as much existing data and reference material for the project site. If this is a construction site, include your geotechnical information, any existing site or design plans, etc.
- ***What do you <u>want</u> to know?***
  - This question will depend on the purpose for gathering data. In Sections 6 and 7 we will go into more detail on these topics.
- ***What's the area you want to assess?***
  - The size of the project site or location of your monitoring will affect the overall scope of your plan.
- ***How will the data be used?***
  - Will you be submitting data to others, or is the data for your own records only?

What is a Watershed?

Watershed Address

- The region or area of land that drains into a body of water such as a lake, river, or stream.
- Water quality is a direct reflection of the surrounding watershed – our actions on the land shape our streams, rivers, and lakes.

Hydrologic Unit Code

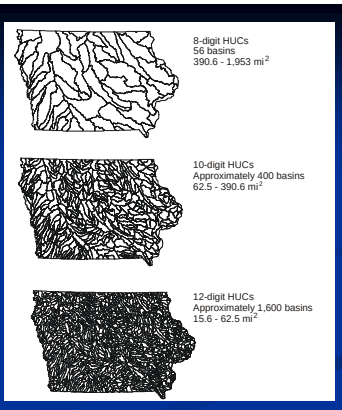
- HUCs describe the different scales of watersheds and identify specific watersheds.
- As the watersheds get smaller, the descriptive and unique HUC number gets larger.

Hydrologic Unit Codes (HUCs) vary in scale

The larger the HUC, the smaller the watershed.

Each digit represents a characteristic describing the scale of the watershed.

Smaller watersheds are more detailed descriptions, making their HUC have more digits than a larger watershed.



Basic Monitoring Concepts

- **Baseline Assessment**
  - Initial investigation.
  - No other data exists, or conducted prior to a change in the landscape.
  - Can serve as a "control" when comparing data after land disturbance, changes in management, or other impacts on a water body occur.

Basic Monitoring Concepts

- **Compliance Monitoring**
  - Recorded in order to remain in compliance with local, state or federal regulations.
  - ***Always follow the guidelines provided by the regulatory agency first.***
  - Any additional monitoring may be considered "above and beyond" the basic monitoring required by the regulatory agency.

Basic Monitoring Concepts

- **Snapshot Sampling**
  - Gather initial, discrete data on a number of locations at a given time.
  - Community Involvement: engage and energize citizens in other watershed protection activities.
    - Citizens
    - Local organizations
    - Youth
    - Other stakeholders

Basic Monitoring Concepts

- **Performance Monitoring**
  - Determine water quality impacts of specific structural or non-structural practices.
  - May require pre and post data, as well as interval samples over time.
  - May be used to validate models.
  - Both short and long-term impacts may be assessed..

Basic Monitoring Concepts

- **Receiving Water Assessments**
  - May link to watershed improvement plan or Total Maximum Daily Load (TMDL)
  - May be done in cooperation with state or federal agencies
    - More broadly understand local water quality problems
    - Identify sources of impairment
    - Work to establish watershed-wide management plans.

Basic Monitoring Concepts

- **Source Area Monitoring**
  - May help identify or detect critical sources of stormwater pollutants.
    - Illicit discharge detection
    - Identification of "hot spots"
  - Solutions oriented – not problem seeking!

Basic Sampling Methods

Discrete Sampling

Composite Sampling

Sampling Alternatives

- Bucket/pole method may be used.
  - Pour samples into cells as quickly as possible.
  - Stir or swirl the sample bucket as needed to keep the solids suspended before pouring.
- Take cell only to sampling site, leave meter behind.

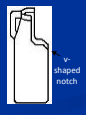


Image source: IOWATER Manual, thestamfordtimes.com

Monitoring Methodology

- Micro-Site Approach to Data Collection
  - <40 acres preferred
- Land Use Types
  - Residential/Commercial/Industrial
- Land Forms
  - Rooftops/Roads/Parking Lots/Turf/Crops/Native
- Fixed Sites/Structures
  - Location based on access
  - Ability/Ease of use for sample collectors
- Stream Sampling
  - Wet & Dry weather sampling
  - Above& Below sampling
  - Flow

Evaluation & Reporting Results

- Increase Data Set Over Time
  - Local Data Collection
  - Other Areas
- Statistical Analysis
  - Predictive Modeling tools
  - Aid in "prescribing" practices
- Are we generating measurable results?

Data Collection Considerations

- **Time of year**
- **Location**
- **Frequency**
- **Time of day**
- **Weather conditions**
- **Who should do the monitoring**

Initial Monitoring Data Set

- Begin with what you already have.
- Incorporate data within design plans.
  - GIS Data
    - Storm drains (as sinks)
    - Slope
    - FEMA Floodplain
    - Existing Greenspace
    - Hydric Soils
  - Planning & Zoning Maps
  - Digitizing Impervious Surface*
  - Existing DNR Data
    - Biological Assessment?
    - 303(d) Status?
    - IOWATER Volunteers?

What Data Do We Need?

- Current/ambient conditions
- Event-based change
- Track trends over time

Two People, Two Tests

- Turbidity
  - 3 readings at each site.
  - Average also entered.
- Transparency
  - 3 readings at each site.
  - Average also entered.

Monitoring Basics (for the MS4):

Data for the 6 Minimum NPDES Measures through locally-led monitoring efforts

Phase II Minimum Measures

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post Construction Runoff Control
- Pollution Prevention/Good Housekeeping

Water quality monitoring can bring it all together.

Ways to Incorporate Monitoring

	Public Outreach & Education	Public Participation & Involvement	IDDE	Construction Runoff	Post-Con	Good Housekeeping
Snapshots	✓	✓				✓
IOWATER	✓	✓	✓	✓	✓	✓
Modeling & Assessment	✓		✓		✓	✓
Targeted Composite Sampling			✓		✓	✓
BMP Monitoring	✓				✓	✓

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Robert Pitt, et.al. (2004)

Volunteer Monitoring as a Community Resource

- Citizen engagement
- "Regular" activity is possible
- (more) Cost effective
- Gather baseline data to troubleshoot for further investigation

Uses of an IOWATER Kit

- Construction Site Inspections
  - Transparency Tube
  - DO Kit
  - pH strips
- Public Events
  - Snapshots
  - Partnering Activities
- Random/Scheduled Monitoring
  - Connecting/Engaging with Local Volunteers

Public Education and Outreach

- IOWATER Volunteer Water Monitoring Network
  - Snapshot monitoring events
  - Forming IOWATER "teams"
- Gathering & Sharing Data from Existing Sources
  - Watershed Atlas
  - IOWATER Database
  - Storet Database

IOWATER Equipment	Price per Item
Aquatic Dip Net	$24.81
Dissolved Oxygen Test Kit	$30.63
Phosphate Test Kit	$35.79
Thermometer	$5.10
Tape Measure	$32.00
pH Test Strips	$8.38
N/Ni Test Strips	$11.90
Transparency Tube	$26.50
Plastic Tub	$0.77
Tennis Ball on 1-Meter String	$1.63
3-Ring Binder	$1.45
IOWATER bag	$6.20
Magnifying Cube	$0.89
Meter Stick	$0.90
Waste container	$0.30
Chloride Titrators	$23.65
Secchi Disc	$32.00
Total for Level 1	$242.90

IOWATER
Volunteer Water Quality Monitoring

Other State Volunteer Programs

MISSOURI STREAM TEAM

Nebraska Wildlife Federation

The Kansas Department of Health and Environment
Mark Parkinson, Governor - John W. Mitchell, Acting Secretary
Curtis State Office Building 1000 SW Jackson Topeka, KS. 66612
(785) 296-1500 FAX:(785)368-6368 Email:info@kdheks.gov

Public Participation/Involvement

- Monitoring & Awareness Events
  - Snapshot Sampling
  - Stream/Lake/Pond Cleanup Days
- Partnering with Local Groups
  - SWCD
  - Local Nonprofit Groups
  - County Naturalist Programs & Events

IDDE

- Create opportunities for partnering versus "targeting."
  - Engage with local IOWATER volunteers
  - School groups
- Regular activities in the watershed increase awareness of ongoing impacts to water quality.
- Run "baseline" assessments to determine what's "normal."

IDDE Monitoring Baseline

- Identify your "usual suspects"
  - Ammonia (wastewater)
  - Phosphorus (car wash runoff, etc.)
  - Hydrocarbons (vehicle drippings, etc.)
  - Others
- Run lab tests to determine what may indicate a presence
- Reference checklist for future use.

IDDE - Hotline

- IOWATER volunteers instructed to take action if illicit discharge is/may be detected:
  - IOWATER first – we'll ask more questions.
  (or other state volunteer monitoring program)
  - MS4 hotline (if available)
  - DNR/PCA Field Office
  - County Sanitarian

Construction Site Runoff Control

- Primary concern is sediment.
  - EGS regulations pending.
- Other parameters of concern:
  - pH
  - Dissolved Oxygen
  - Temperature
  - Hydrocarbons & Organic Compounds

Post Construction Runoff Control

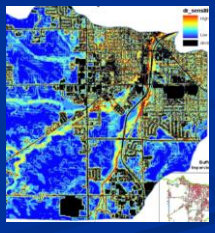
- Observational monitoring!
- Planned developments and retrofits
- Often least noticeable, yet most potential for impact.
- Two major factors:
  - A: Inability to infiltrate
  - B: Introduction of potential contaminants

Post Construction Runoff Control

- Planning for pollutant load reduction: modeling
- Both retrofits and new construction
- Take volume and pollutant load into account
  - Sediment
  - Nutrients
  - Metals
  - Bacteria (advancing)

Impervious Surface is the Key!

Cannot be detected by this model



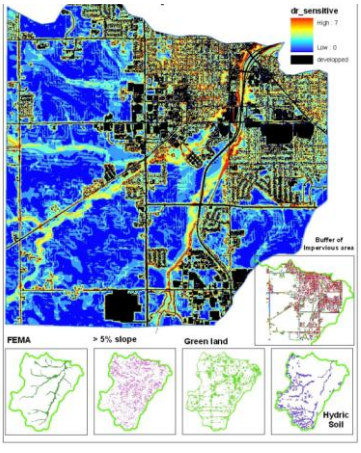
Indicates potential impact

Micro-Watershed Approach

->40 Acres

-Combine USLE data with GIS, Remote Sensing

-Combine DNR & UNI Technologies



Post Construction Runoff Control

- Assess – Model – Monitor
  - Identify parameters and source data (inputs).
  - Run your model.
  - Monitor to determine actual results.

"New" MS4 Program Design

- Specific monitoring beyond basic characterization:
  - **Receiving water assessment:** understand local problems or concerns (impairment)
  - **Source area monitoring:** identify critical sources of stormwater pollutants (may include IDDE)
  - **Treatability test:** verify performance of stormwater controls for local conditions (BMPs)
  - **Assessment monitoring:** verify success of the local stormwater management approach (including model calibration and verification).

Receiving water assessments **to understand local problems**

- Watershed approach
- Align with USEPA Section 319 Nonpoint Source Program
- Targeting impaired water bodies identified by Iowa's 303(d) list.
- Also WINOFI

Source area monitoring to identify stormwater pollutants

- "Source" = "hot spots"
- Can include IDDE
- Targeting specific land use for BMP implementation
  - Identify/define a concern
  - Assess risk
  - Respond accordingly
  - Measure impact

Treatability tests **to verify performance of stormwater controls for local conditions**

- **Performance measurement**
- **Short/long-term impact assessment; prediction**
- **Target specific pollutants/practices**
- **Generate a quantifiable benchmark**
- ***Can prove costly!***
- **Growing research body**

Assessment monitoring to measure success

- Listed last, although most important
- Can/should include model calibration and verification to determine actual impact on local water quality
- Must align with initial assessment work in order to measure accurately

Garbage in, garbage out: don't just monitor at the end of a project and expect good data!

Current Emphasis

- Use existing resource whenever possible
- Understand the scope of available tools
- Plan with tomorrow in mind

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Meaningful data is valuable data.

- Monitor with a goal – answer a question.
- Partnerships can help make data collection easier.
- Existing resources can increase efficiency.
- Data can be a great communications/educational tool.
- Many MS4 requirements can be met through monitoring.

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We're all in this together.

- Compliance isn't easy.
- All entities are facing challenges.
- "Ducking" could result in consequences!

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