Integrating Geographic Information Systems (GIS) into NPDES Monitoring

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UNC – Chapel Hill
Environment, Health and Safety

GIS = "Geographic Information Systems"

- GIS is used to **capture**, **manage**, **analyze** and **display** geographic information
- GIS helps reveal **relationships**, **patterns** and **trends**
- Can help with **NPDES permit compliance**:
  - Tracking minimum measures
  - Solving problems
  - Answering questions

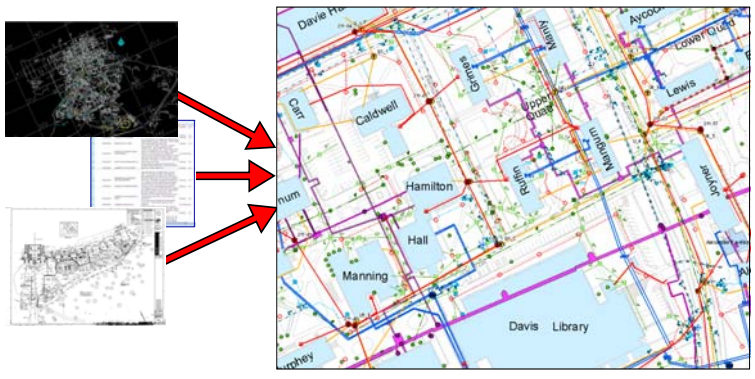
Benefits of GIS

- Cost Savings
- Better Decision Making
- Improved Communications
- Better Record Keeping
- Managing Geographically

from: http://www.esri.com/what-is-gis

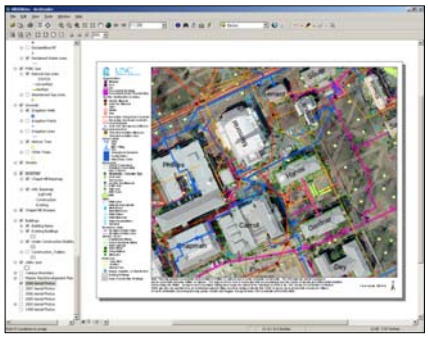
Note: UNC uses Esri ArcMap products

Benefits of GIS



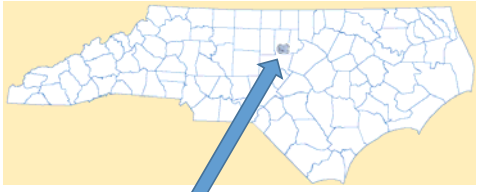
Bring various sources of information together to create a comprehensive, more accurate and useful map

Benefits of GIS



Put maps in the hands of all who need them

UNC –Chapel Hill



- Located in Chapel Hill, Orange County
- About 30,000 students
- Over 800 acres in Central Campus
- More than 400 buildings
- Usually 3 – 6 concurrent projects requiring NDENR ESC Permits

History of GIS at UNC
Stormwater Management

- **Stormwater Master Plan** (2001)
  - Stormwater inventory (2001 – 2003, approx)
- Stormwater inventory **migrated into Enterprise GIS** (2005)
  - Moved data from individual sources into GIS database
  - Allows multiple people to view and edit GIS data
- **NPDES Phase II Permit** (2008)

History of GIS at UNC
Stormwater Management

First, UNC gathered **stormwater infrastructure** data

- **External Data Collection** (Contractors)
  - Rose Group
  - RK&K
- **Internal Data Collection & Maintenance** (UNC Staff)
  - Energy Services
  - Grounds
  - EHS
  - Facilities Services Engineering Information Systems (GIS)

History of GIS at UNC
Stormwater Management

- **Types** of structures inventoried:
  - Pipes
  - Grates
  - Manholes/Junctions
  - Inlets
  - Outlets & Outfalls

- **Information** collected:
  - Size of structure
  - Material
  - Age
  - Condition
  - Connectivity
  - Inverts
  - Location
  - ID Numbers

UNC's NPDES Phase II Permit

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT and NATURAL RESOURCES
DIVISION OF WATER QUALITY
PERMIT NO. NCS000401

TO DISCHARGE STORMWATER UNDER THE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the regulations promulgated and adopted by the North Carolina Environmental Management Commission, and the Federal Water Pollution Control Act, as amended,

The University of North Carolina at Chapel Hill

is hereby authorized to discharge stormwater from property owned by the University of North Carolina at Chapel Hill in accordance with the discharge limitations, monitoring requirements, and other conditions set forth in Parts I through VIII.

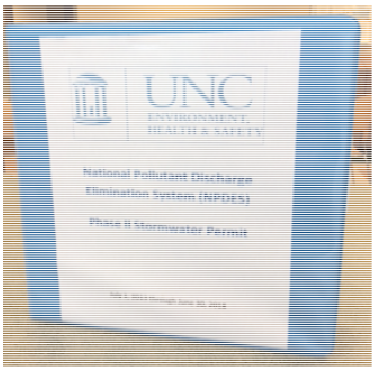
This permit shall become effective July 1, 2013.

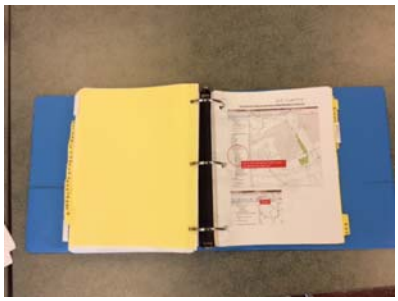
This permit and the authorization to discharge shall expire at midnight on June 30, 2018.

Signed this day July 1, 2013, revised August 7, 2013.

for Tracy E. Davis, Director
Division of Energy, Mineral, and Land Resources

UNC's NPDES Phase II Permit





UNC's NPDES Phase II Permit

UNC's NPDES Phase II Permit

Illicit Discharge Detection & Elimination

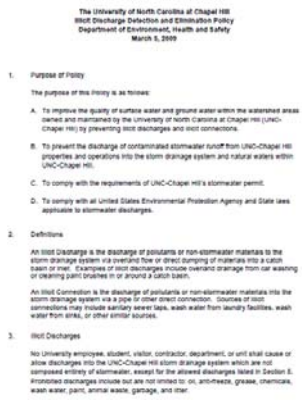
Section D.2.a

- **Outfall inspection**, sampling & maintenance
- Detection & elimination of **illicit discharges**, spills & illegal dumping
- **Reporting** & **Recordkeeping**
- **Training** & **Development**
- Implementation of **BMPs**

Illicit Discharge Detection & Elimination

Section D.2.a

UNC's IDDE Policy



The University of North Carolina at Chapel Hill
Illicit Discharge Detection and Elimination Policy
Department of Environment, Health and Safety
March 5, 2009

1. Purpose of Policy

The purpose of this Policy is as follows:

A. To improve the quality of surface water and ground water within the watersheds areas owned and maintained by the University of North Carolina at Chapel Hill (UNC-Chapel Hill) by preventing illicit discharges and illicit connections.

B. To prevent the discharge of contaminated stormwater runoff from UNC-Chapel Hill properties and operations into the storm drainage system and natural waters within UNC-Chapel Hill.

C. To comply with the requirements of UNC-Chapel Hill's stormwater permit.

D. To comply with all United States Environmental Protection Agency and State laws applicable to stormwater discharges.

2. Definitions

An Illicit Discharge is the discharge of pollutants or non-stormwater materials to the storm drainage system via overland flow or direct dumping of materials into a catch basin or inlet. Examples of illicit discharges include overland drainage from car washing or cleaning paint brushes in or around a catch basin.

An Illicit Connection is the discharge of pollutants or non-stormwater materials into the storm drainage system via a pipe or other direct connection. Sources of illicit connections may include sanitary sewer taps, wash water from laundry facilities, wash water from sinks, or other similar sources.

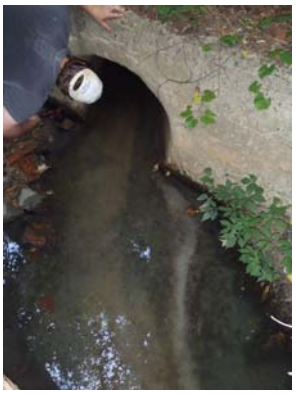
3. Illicit Discharges

No University employee, student, visitor, contractor, department, or unit shall cause or allow discharges into the UNC-Chapel Hill storm drainage system which are not composed entirely of stormwater, except for the allowed discharges listed in Section E. Prohibited discharges include but are not limited to: oil, anti-freeze, grease, chemicals, wash water, paint, animal waste, garbage, and litter.

The Tale of the Odiferous, Mysterious, Mid-Summer Day's Illicit Discharge

A routine outfall inspection on a mid-summer's day…

An unpleasant discovery…



During one weekly inspection, we discovered an unsightly, smelly substance in the stream

Observation and testing indicated a possible sewage leak

An investigation begins…

Desk Work

Used GIS to **create map** of area surrounding outfall where sewage was observed

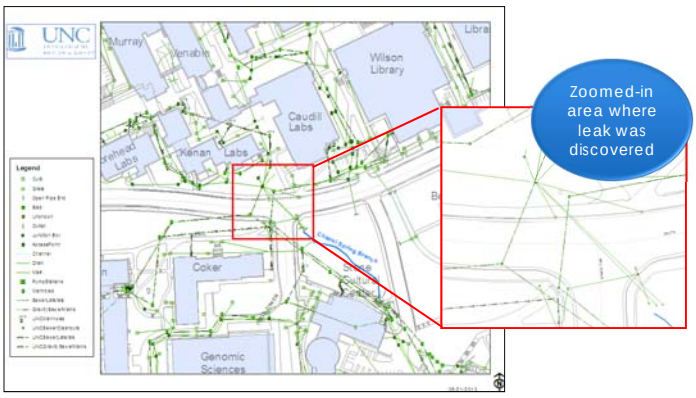
Field Work

Used printed copy of GIS map to **follow the path of storm drain pipes** to upstream manholes

Desk Work

Used GIS as a **communication tool** to update customers throughout investigation

First, create map of area surrounding outfall where sewage was observed.



Next, change map symbology to make it easier to see the different features...

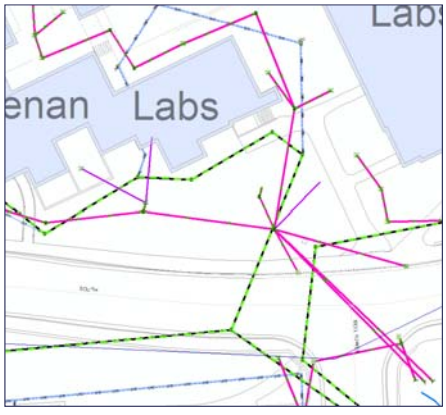
Storm drain pipes:
thicker green lines

Sanitary sewers:
dashed green lines

...change map symbology to make it easier to see the different features.

Legend
- Drain
- Main
- SewerLaterals
- GravitySewerMains
- UNCSewerLaterals
- UNCGravitySewerMains
- UNCAbandonedSewerMains

It can be helpful to use bright colors for the different types of pipes. Color-coding can improve field work efficiency.

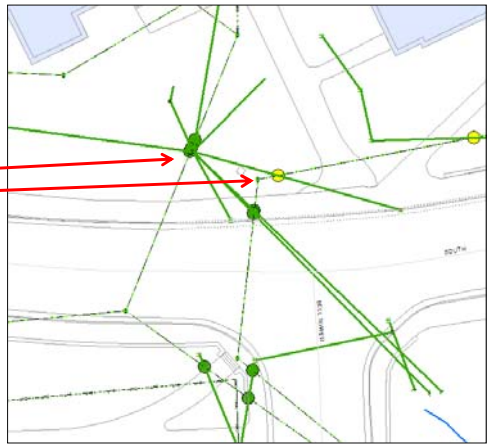


Check for cross-connections

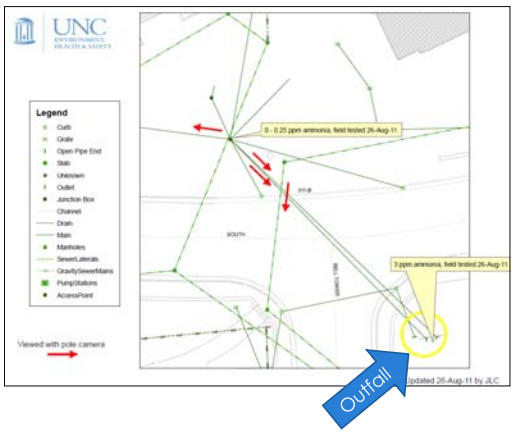
Intersections of storm and sanitary pipes:

- low risk
- "need more info"

(more on this later in presentation)

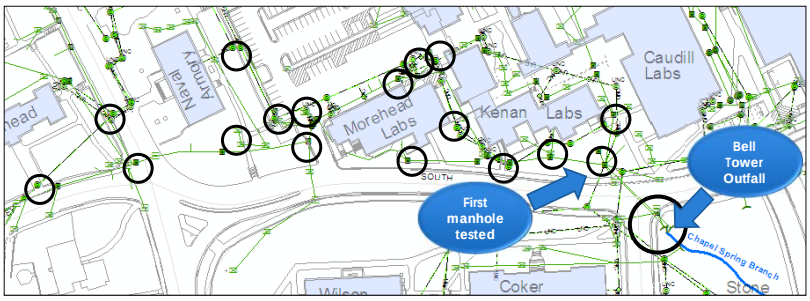


Follow path of storm drain pipes to upstream manholes



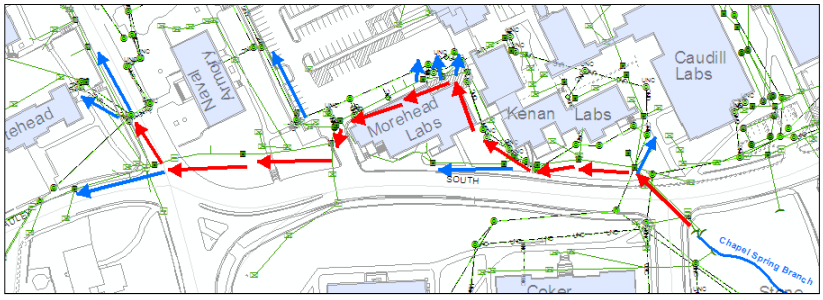
- At each manhole/inlet, we did a visual observation to check for odors or solids in the storm pipes
- If odors or solids were detected, we lowered ammonia test papers into storm drain to measure magnitude of ammonia
- We then used pole cameras to view insides of pipes to check for signs of damage

Follow path of storm drain pipes to upstream manholes, continued…



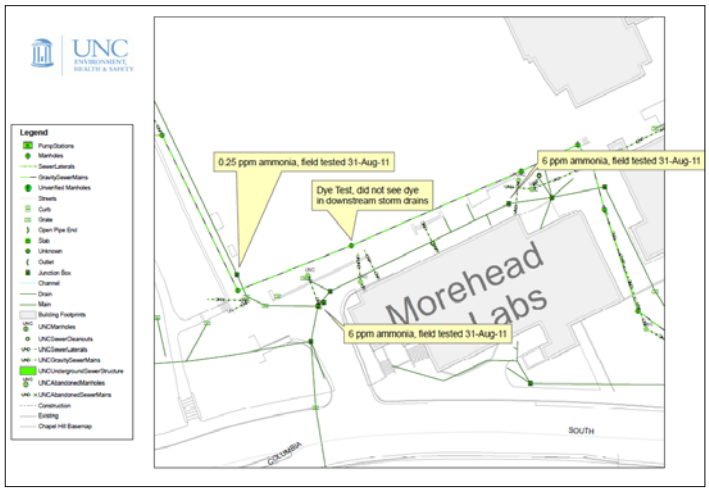
Circles indicate manholes/inlets tested for ammonia. If still present, we went up the line. If not present, the sewage leak was between that point ad the last manhole/inlet, or came from a different section of pipe.

Follow path of storm drain pipes to upstream manholes, continued…



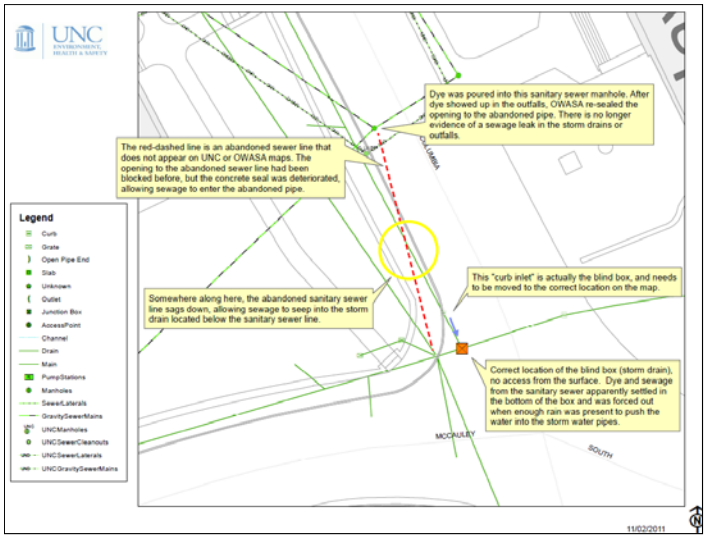
Red arrows – higher levels of ammonia
Blue arrows – decreased or no ammonia

Add text and send out periodic updates



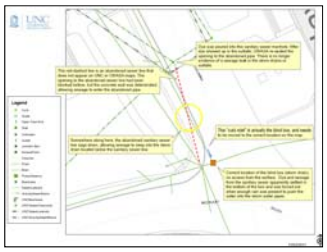
Text was added to GIS map to provide detailed information to UNC managers and OWASA (Orange Water And Sewer Authority)

Final Result

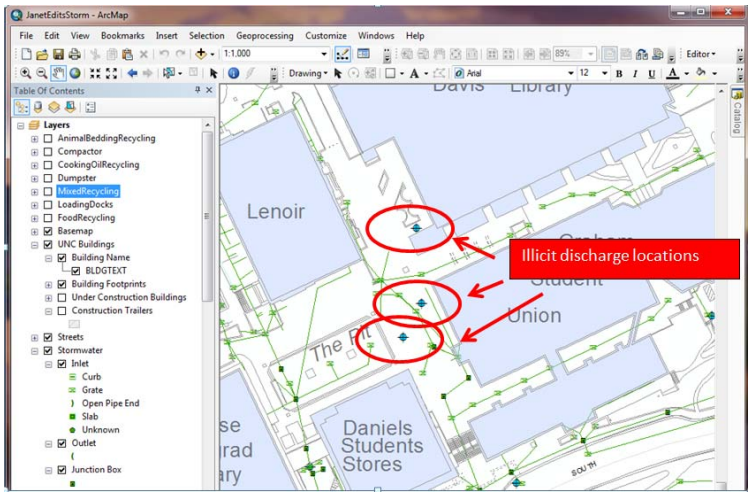


IDDE investigation summary

- The map created in GIS enabled us to **efficiently track** the path of the contamination
- **Text and drawings** were easily added to maps to tell the investigation story and keep folks informed
- The **final map** was sent to OWASA, and they used their specialized equipment to verify the location of the broken pipe and conduct repairs.



Tracking IDDE Events



Tracking IDDE Events

Instructions for how to look up information on a specific incident in ArcMap

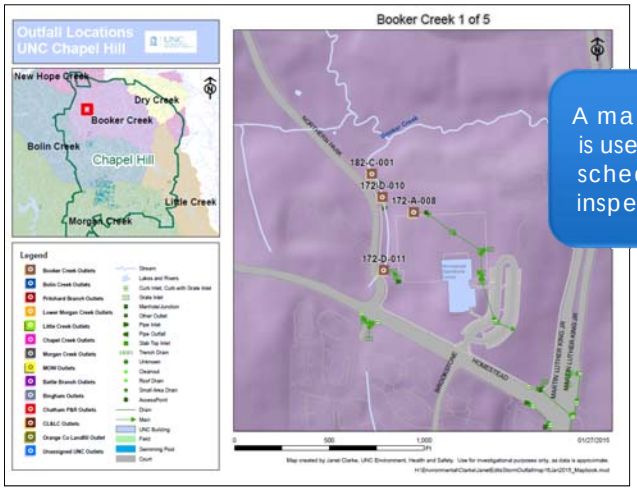
Illicit Discharge Detection & Elimination

Section D.2.d: Detection and Elimination

- Dry weather **outfall inspections**
- Inspect **1/5 of geographic area** or community per year during dry weather conditions, test flows found at discharge points as needed
- Maintain outfall inspection **database**:
  - Inspection date
  - Tests conducted
  - Findings
  - Corrective actions

Illicit Discharge Detection & Elimination

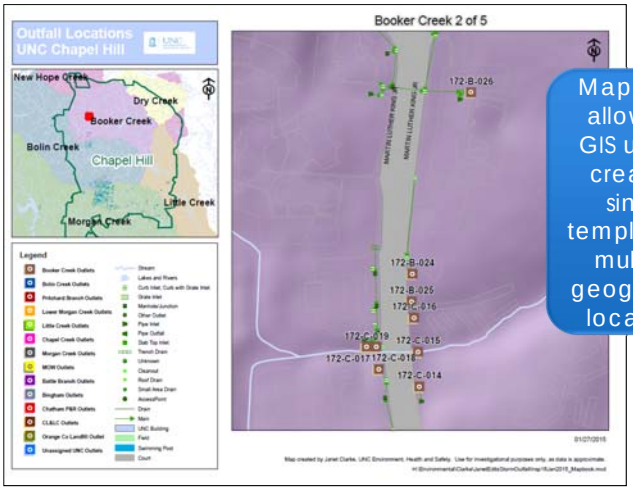
Section D.2.d: Detection and Elimination



A mapbook is useful for scheduling inspections

Illicit Discharge Detection & Elimination

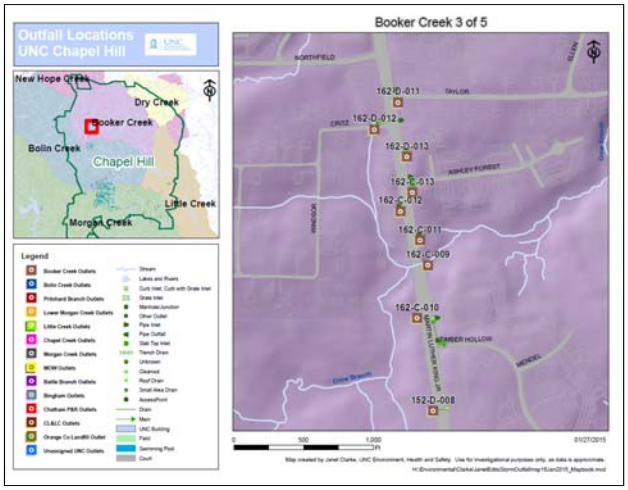
Section D.2.d: Detection and Elimination



Mapbooks allow the GIS user to create a single template for multiple geographic locations

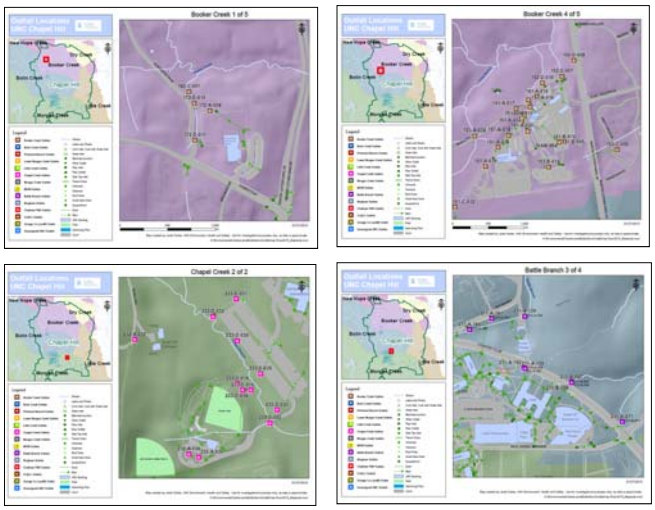
Illicit Discharge Detection & Elimination

Section D.2.d: Detection and Elimination



Illicit Discharge Detection & Elimination

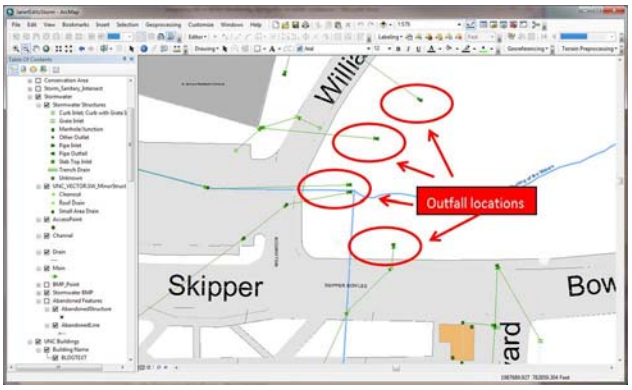
Section D.2.d: Detection and Elimination



Illicit Discharge Detection & Elimination

Section D.2.d: Detection and Elimination

Outfall inspections



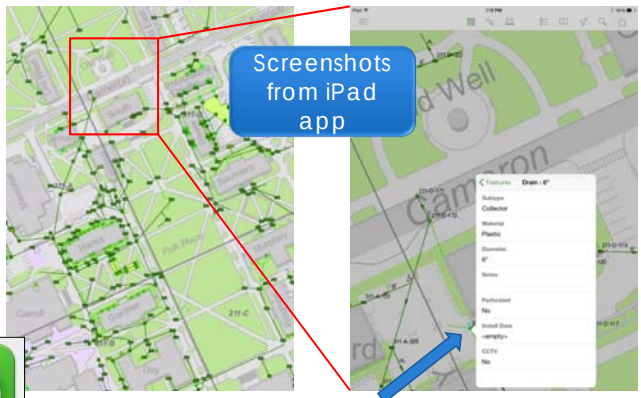
Illicit Discharge Detection & Elimination

Section D.2.e: Storm Sewer System Mapping

- Maintain a **storm sewer map** showing outfalls and the receiving body of water.
- Visual **inspections** of the storm sewer system including outfalls
- Maintain an **inventory** of drainage structures and storm sewer system maps.
- Categorize outfalls by the **receiving water**
- **Information included:**
  - Location
  - Reference number
  - Size and type of structure
  - Condition
  - Dry-weather flow

Illicit Discharge Detection & Elimination

Section D.2.e: Storm Sewer System Mapping



Explorer for ArcGIS

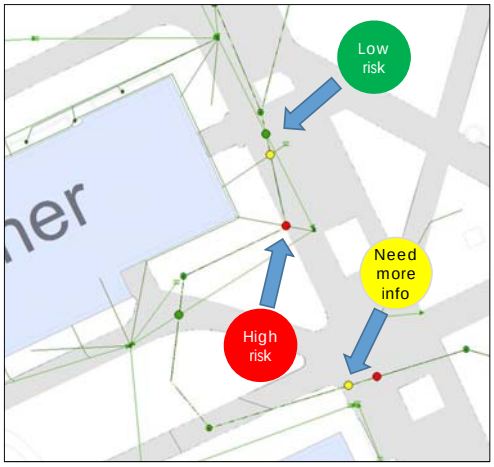
Apps are excellent for basic field work

Tap on a feature to see more information

Illicit Discharge Detection & Elimination

Section D.2.g: Local Wastewater Program

- Identify and potential **cross-connections**
- Cross-connections are where **storm and sanitary pipes** are in **close proximity**
- High risk of SW and SS liquids **intermingling**
- Risk determined by **pipe age, material & vertical placement**



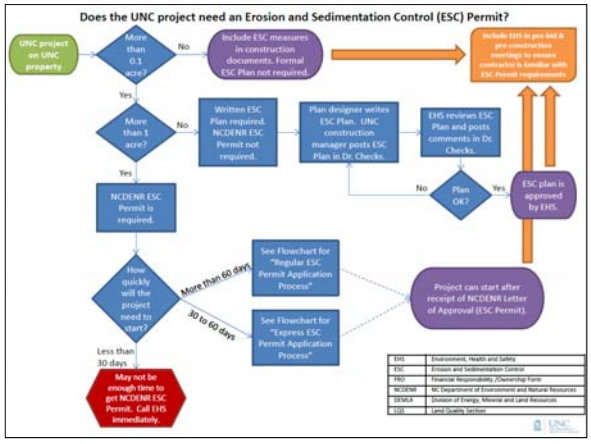
Construction Site Runoff Control

Section E.2.c: Sediment and Erosion Control Plan (Sites greater than 1 acre)

- All construction projects that impact **greater than one acre** must submit a **Sediment and Erosion Control Permit** application to NC DENR Land Quality for review and approval.
- ESC Permit **must contain**:
  - Site size
  - Location of infrastructure
  - Location of natural areas
- **Permit is required** prior to start of construction!

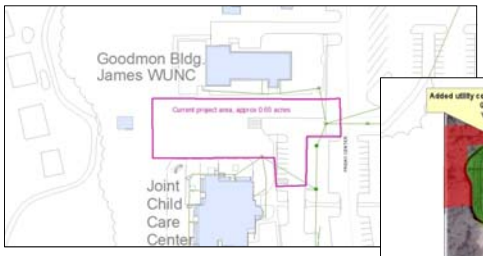
Construction Site Runoff Control

Section E.2.c: Sediment and Erosion Control Plan (sites greater than 1 acre)



Construction Site Runoff Control

Section E.2.c: Sediment and Erosion Control Plan (Sites greater than 1 acre)

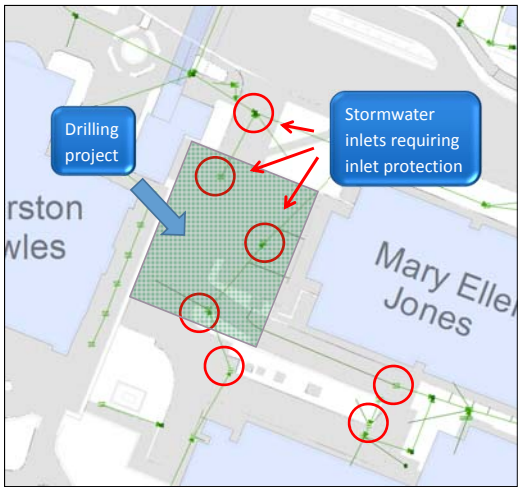


- Use GIS to delineate size of projected construction site
- Calculate area, add text, use color to clarify information

Construction Site Runoff Control

Section E.2.c: Sediment and Erosion Control Plan (Sites greater than 1 acre)

- Use GIS to determine location and magnitude of erosion & sediment control measures
- Can add contours, elevations, barriers, etc.



Construction Site Runoff Control

Section E.2.c: Sediment and Erosion Control Plan (Sites greater than 1 acre)

- Use GIS to delineate stream buffers
- Add natural areas:
  - Conservation Areas
  - Wetlands
  - Flood Plains
  - Natural Heritage Program Sites

Post-Construction Runoff Control

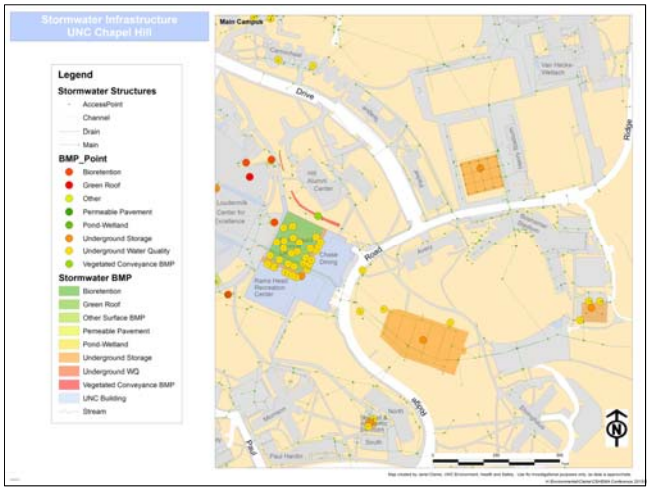
Section F.2.a: Standards and Policies on BMPs for Post-Construction Controls

- Post-construction BMP Inspections:
  - Inspect for structural or functional **deficiencies** & determine follow-up actions
  - Identify specific **preventive maintenance**
  - Identify potential **retrofits**

Inspector is required to have current NCSU BMP Inspection & Maintenance Professional certification

Post-Construction Runoff Control

Section F.2.a: Standards and Policies on BMPs for Post-Construction Controls



Post-Construction Runoff Control

Section F.2.a: Standards and Policies on BMPs for Post-Construction Controls

- BMP inspections conducted **annually** (some quarterly)
- Inspections **documented using forms and photos**, then added to ArcMap
- In the future, hope to use **apps to collect data**
- BMP inspection data is stored in a **related table** and joined with stormwater geodatabase

Post-Construction Runoff Control

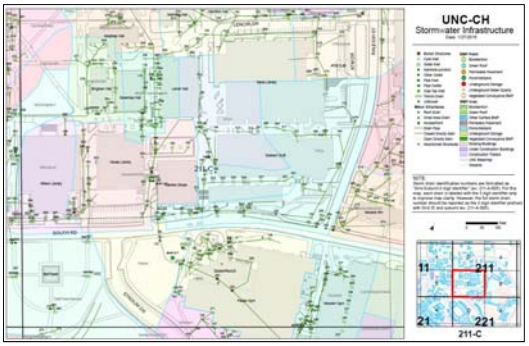
Section F.2.a: Standards and Policies on BMPs for Post-Construction Controls

- Storm Drain Preventive Maintenance:
  - Inspect each inlet and junction **annually**
  - Check for structural or functional **deficiencies** & determine **follow-up** actions
  - Identify specific **preventive maintenance**
  - Identify **potential retrofits**
  - **Update geodatabase** with corrections and updates

Post-Construction Runoff Control

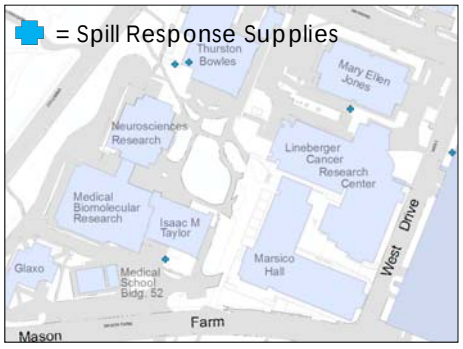
Section F.2.a: Standards and Policies on BMPs for Post-Construction Controls

- Energy Services maintains strormdrain **mapping and database**
- Data exported to **Work Management System**
- Stormwater Maintenance team uses **mapbook and Esri Explorer app** in the field
- Corrections and updates are sent back to Energy Services to **update in GIS**



Pollution Prevention & Good Housekeeping

Section G.2.b: Spill Prevention and Response



- The University shall maintain storage procedures that include:
  - Provision of **secondary containment**
  - Development of **spill prevention**
  - Spill containment, control and countermeasure plans and/or safety plans (**SPCC Plan**)
  - Preferred **sheltering of all chemicals** and other hazardous substances

Pollution Prevention & Good Housekeeping

Section G.2.e: Storm Sewer System Maintenance

- Storm Sewer System Maintenance
  - **Inlet and catch basin** cleaning
  - **Pipe** cleaning
  - Curbside **leaf removal**
  - Parking lot and road **sweeping**
  - **Planting** and **mulching** of erosion-prone areas.

Pollution Prevention & Good Housekeeping

Section G.2.g: BMP Inspection and Maintenance

- Non-Structural BMP Inspection and Maintenance
  - Evaluate non-structural BMPs **annually**
  - Implement **more stringent BMPs** where needed
  - Develop **written program**:
    - ✓ Inspection and maintenance requirements
    - ✓ Frequency of inspections
    - ✓ "How-to" instructions for maintenance
    - ✓ Inspection and maintenance tracking system

Pollution Prevention & Good Housekeeping

Section G.2.h: Waste Management

Dumpsters, recycling, kitchen waste, and animal recycling locations are **tracked in GIS**

Public Participation and Involvement

Section C.2.a: Faculty and Student Involvement

- **Stencil** minimum of **100 storm drain inlets annually**
  - Student worker installs storm drain markers
  - Uphill battle keeping them installed (weather, scavenger hunts)
  - Marked drains documented in GIS
- **Research projects** involving faculty and grad students
  - Capstone class
  - Battle Grove 319 Grant (Regenerative Stormwater Conveyance)

So, how can your organization get started?

Crawl → Walk → Run

So, how can your organization get started?

Crawl

- Get **management support**
- Create **sample map**
  - Use GIS to solve a problem
- **What's already available?**
  - Basemap:
    - Aerial photography
    - Buildings
    - Streams & watersheds
    - Start easy: outfalls

So, how can your organization get started?

Crawl

- **Software & Apps**
  - Does your organization already have a program & site license?
  - Or, look into open source (free)
- **Partnerships**
  - County GIS Department
  - Schools

So, how can your organization get started?

Walk

- **Funding**
  - GIS is a budget item
- Building a **program**
  - Internal
  - Hire a GIS consultant
- GIS is **institutionalized**
  - Other departments "want in"
  - Multiple users
  - Workload efficiency improved with GIS

So, how can your organization get started?

Run

- **Funding**
  - GIS program is funded
  - Enough GIS staffing
  - Resources to outsource big projects
- GIS **Users Groups**
  - Involve different departments
- **Organization** sees GIS as a valuable resource
- Publish maps on your **website**

Resources and Training

- Find someone in your department **already using GIS**
- **ArcGIS online:** free! **arcgis.com**
- **esri.com:** free, excellent training!
- **FEMA training:** free! Do online search for "GIS for Emergency Managers"
- **Google Earth** and **Google Pro:** free!
- Take a GIS class at **local college** or **university**

Where can you find GIS data?

- **Government Websites**:
  - Federal
  - State: NC OneMap is a great start
  - County
  - Municipal
  - Local
- **University GIS Libraries**
- **Esri** and other **mapping services**
- Some **non-profit agency websites**

Conclusion

- GIS is an excellent tool for **NPDES permit compliance**:
  - Tracking minimum measures
  - Solving problems
  - Answering questions
- Using GIS to **capture**, **manage**, **analyze** and **display** geographic information will help your organization **measure and maintain** compliance goals
- Once your organization is using GIS, you will wonder how you managed without it!

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Questions?

When you wash your car in the driveway, you aren't just washing your car in the driveway.

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