

AGOL Data Collection for MS4 Compliance



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Collaborating in the Cloud






The City of Winston-Salem

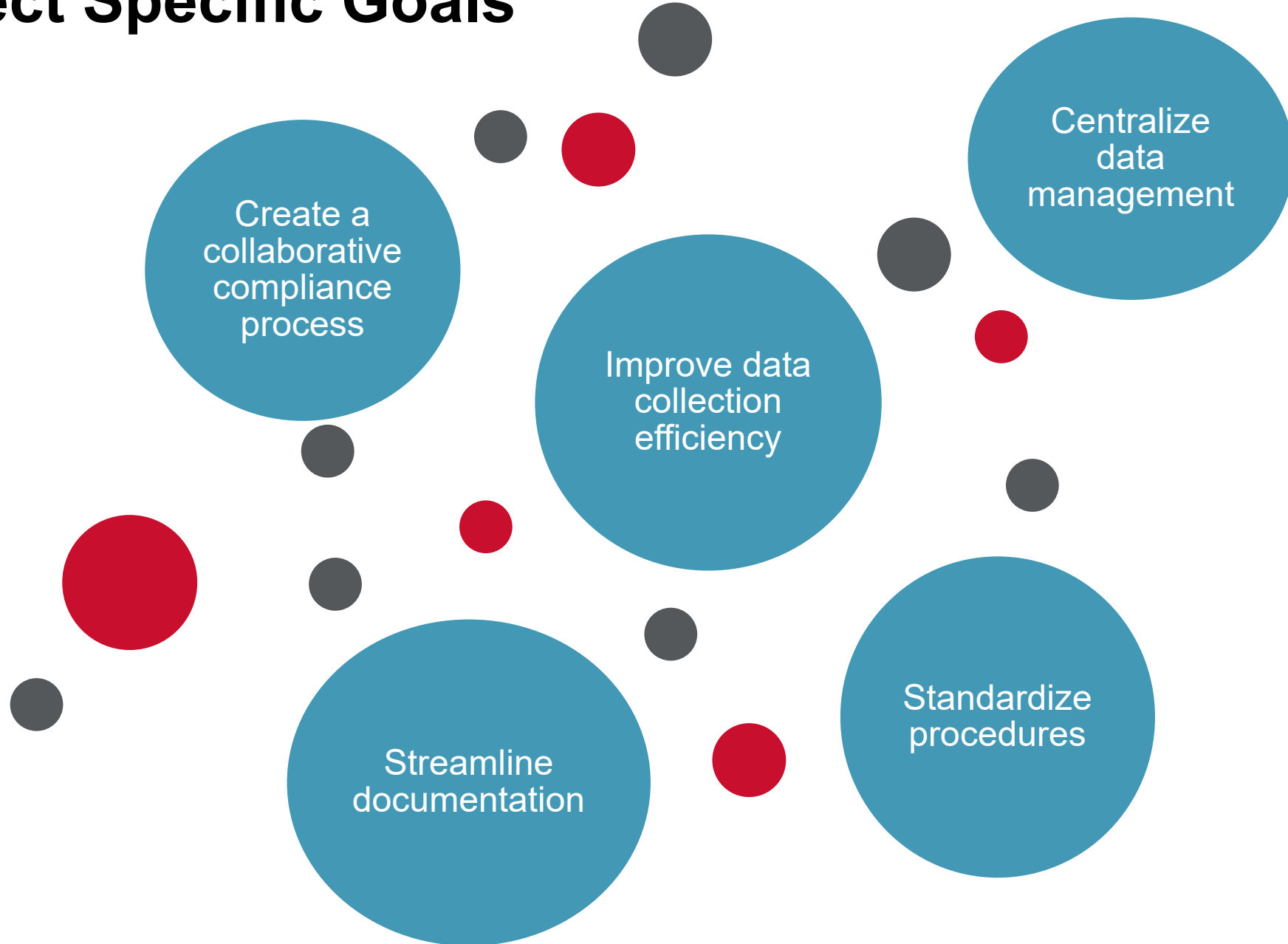
- Phase 1 MS4 stormwater community
- 15 watershed level master plans
 - MS4 Inventory
 - H & H Models
 - Baseline WQ Monitoring
 - Stormwater Retrofits
- Short-term vs Long-term needs
- TMDL impaired streams



MS4 Compliance Goals

1. Develop, update and maintain a municipal storm sewer system map including stormwater conveyances, flow direction, major outfalls, and waters of the United States receiving stormwater discharges.  Stormwater Inventory Updates
2. Detect and trace sources of illicit discharges and remove or report the sources to the State to be properly permitted.  Dry-Weather Outfall Screening
3. Develop appropriate BMPs to address impaired waters in TMDL regulated streams.  TMDL Stream Walking

Project Specific Goals



```

def five_pct():
    k = 0
    for l in survey_copies:
        k += 1
        print(k)
        if k == 1:
            arcpy.FeatureClassToFeatureClass_conversion(f"{gdb}{l}", gdb, "stormQC")
        else:
            arcpy.Append_management(f"{gdb}{l}", f"{gdb}stormQC", "NO_TEST")

stormQC = pd.DataFrame.spatial.from_featureclass(f"{gdb}stormQC")
stormQC_sample = stormQC.sample(frac=0.05, replace=False)
stormQC_sample.spatial.to_featureclass(location=f"{gdb}stormQC_sample")

def add_rows():
    newStorm_Structures = "https://utility.arcgis.com/usrvcs/servers/a4a9d73185c143d7bc2e77e922584e15/rest/services/NorthCarolina/WS Storm
    arcpy.CreateFeatureclass_management(gdb, 'storm_inventory_qc', 'POINT', newStorm_Structures, has_z='ENABLED', spatial_reference=arcpy.S

    sample = f"{gdb}stormQC_sample"
    collection = f"{gdb}storm_inventory_qc"

    with arcpy.da.SearchCursor(sample, "SHAPE@") as sCur:
        with arcpy.da.InsertCursor(collection, "SHAPE@") as iCur:
            for row in sCur:
                iCur.insertRow(row)

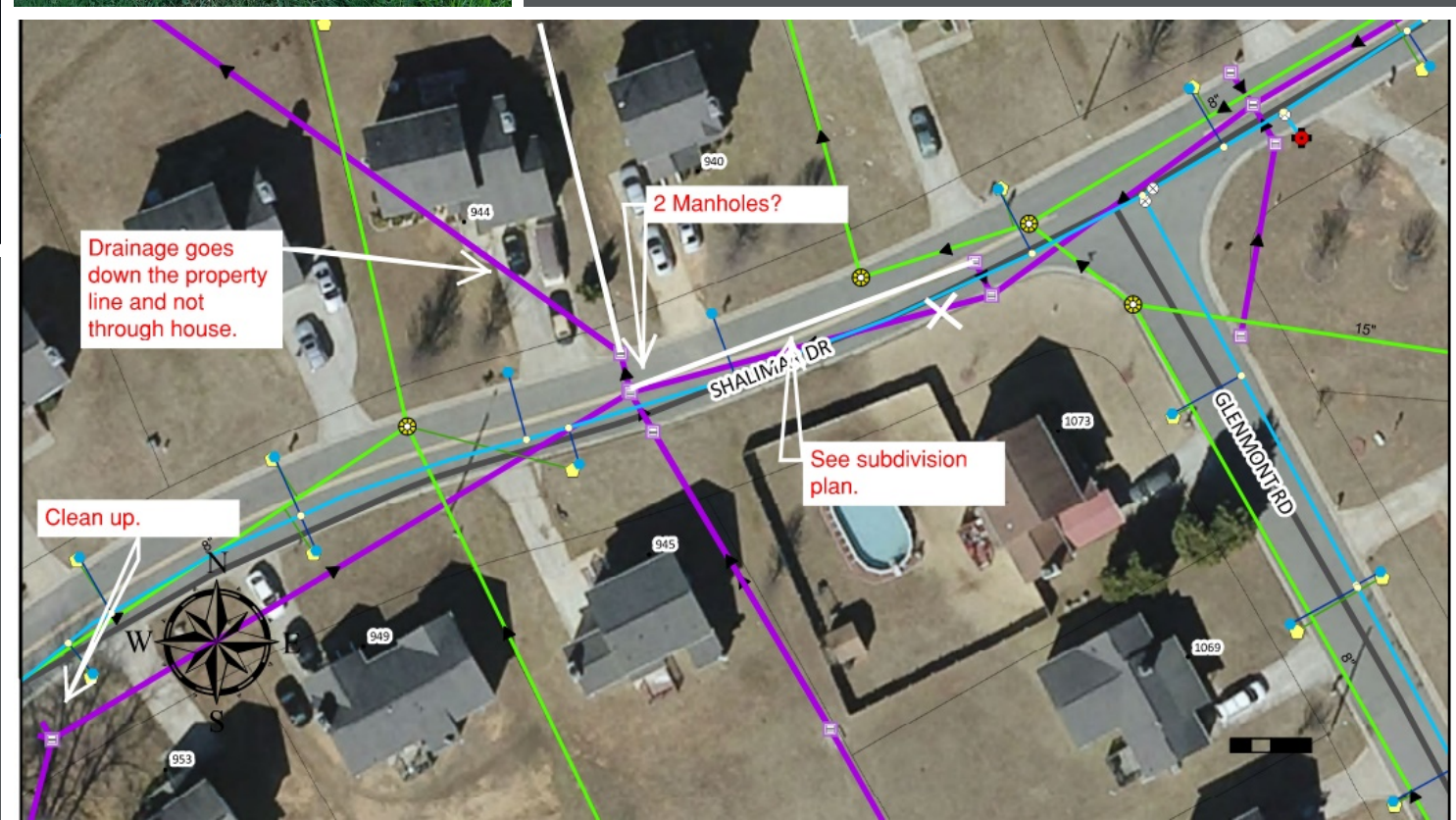
    arcpy.CreateFileGDB_management(downloads_path, f'stormQC_{date.today().strftime("%m%d%Y")}')
    arcpy.FeatureClassToFeatureClass_conversion(f'{gdb}storm_inventory_qc', f'{downloads_path}stormQC_{date.today().strftime("%m%d%Y")}.g

    shutil.make_archive(f'{downloads_path}stormQC_{date.today().strftime("%m%d%Y")}.gdb', 'zip', downloads_path, f'stormQC_{date.today().s

def publish_layer():
    dt = date.today().strftime("%m%d%Y")
    qc_lyr = f'{downloads_path}stormQC_{date.today().strftime("%m%d%Y")}.gdb.zip'
    publish_stormQC_item = gis.content.add({'title': f'Stormwater_QC_{dt}', 'qc_lyr': qc_lyr})
    publish_stormQC_item.publish()
    qc_published_source = gis.content.search(query=f'title : Stormwater_QC_{dt}', item_type="Feature **")
    qc_published_source[0].share(everyone=False, org=True, groups=['ae002d16df5b4a3fbdd62ff8879293ff', '8cc7b66a2634b8dbedbe4733f6b8a60'])
    qc_published_source[0].protect(enable=True)

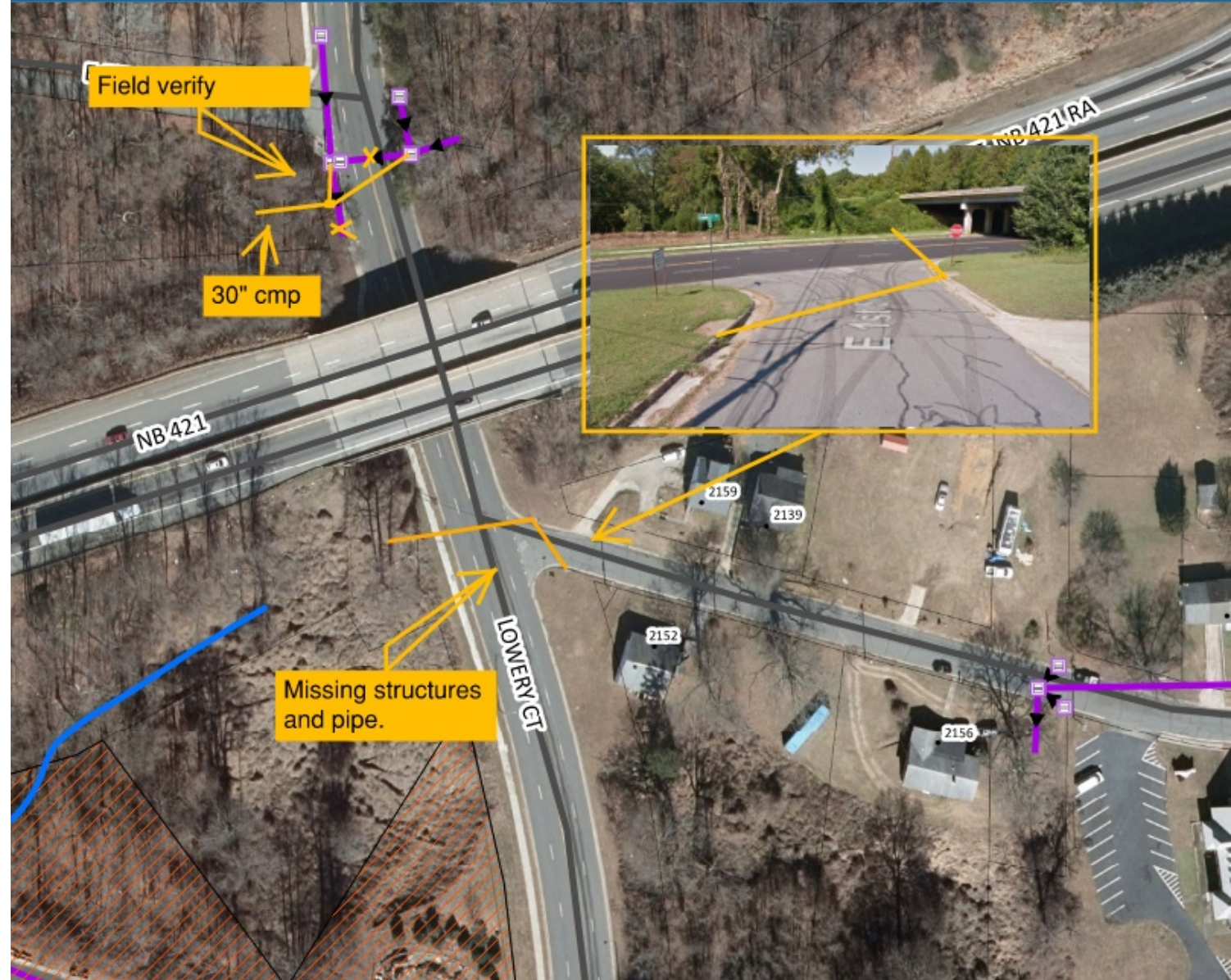
def update_editing():
    dt = date.today().strftime("%m%d%Y")
    qc_published_source = gis.content.search(query=f'title : Stormwater_QC_{dt}', item_type="Feature **")
    f1 = FeatureClassCollection.fromitem(qc_published_source[0])

```



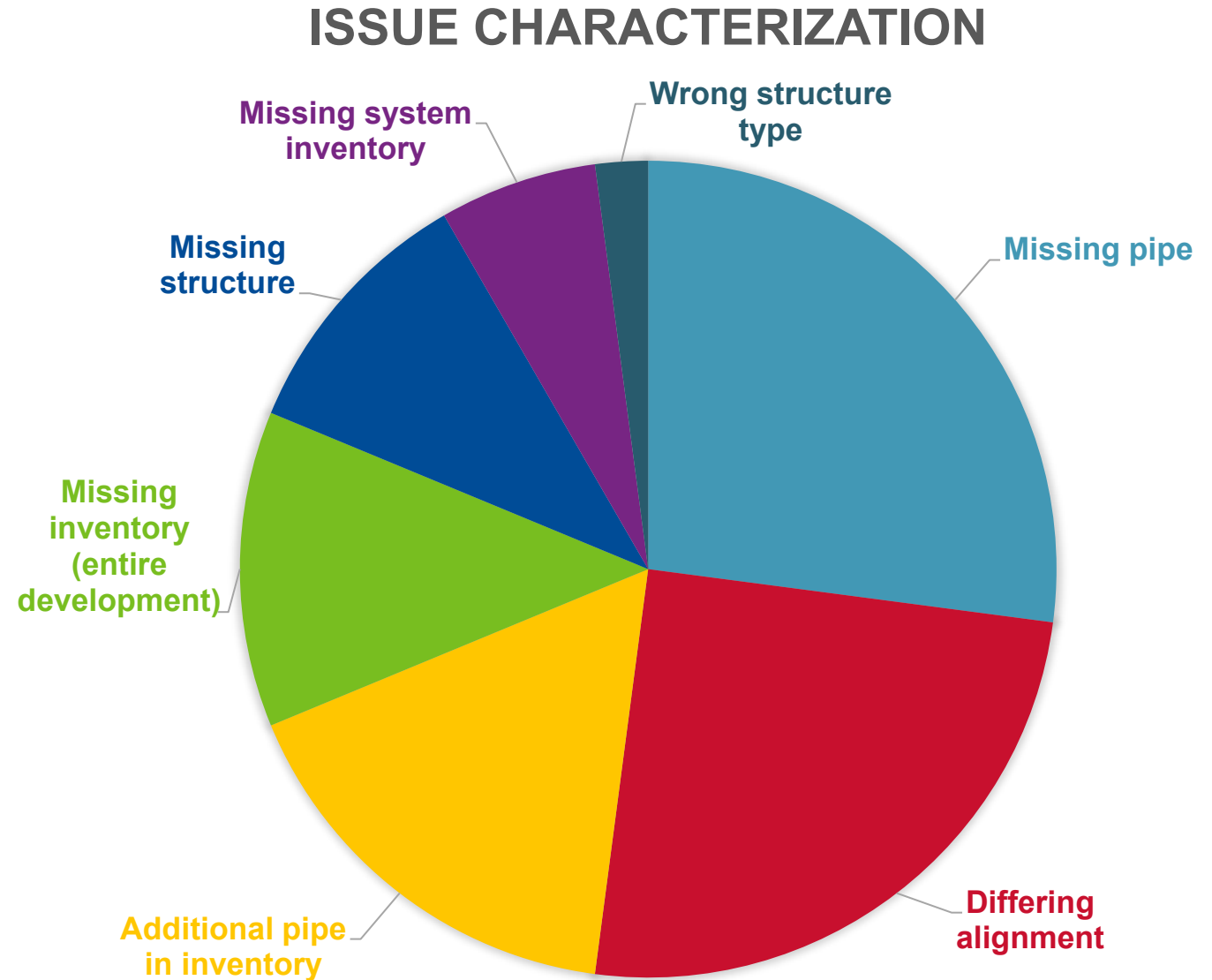
Stormwater Inventory Updates

- AGOL mobile application
 - Field Maps
- ArcGIS desktop features
 - Existing inventory geodatabase



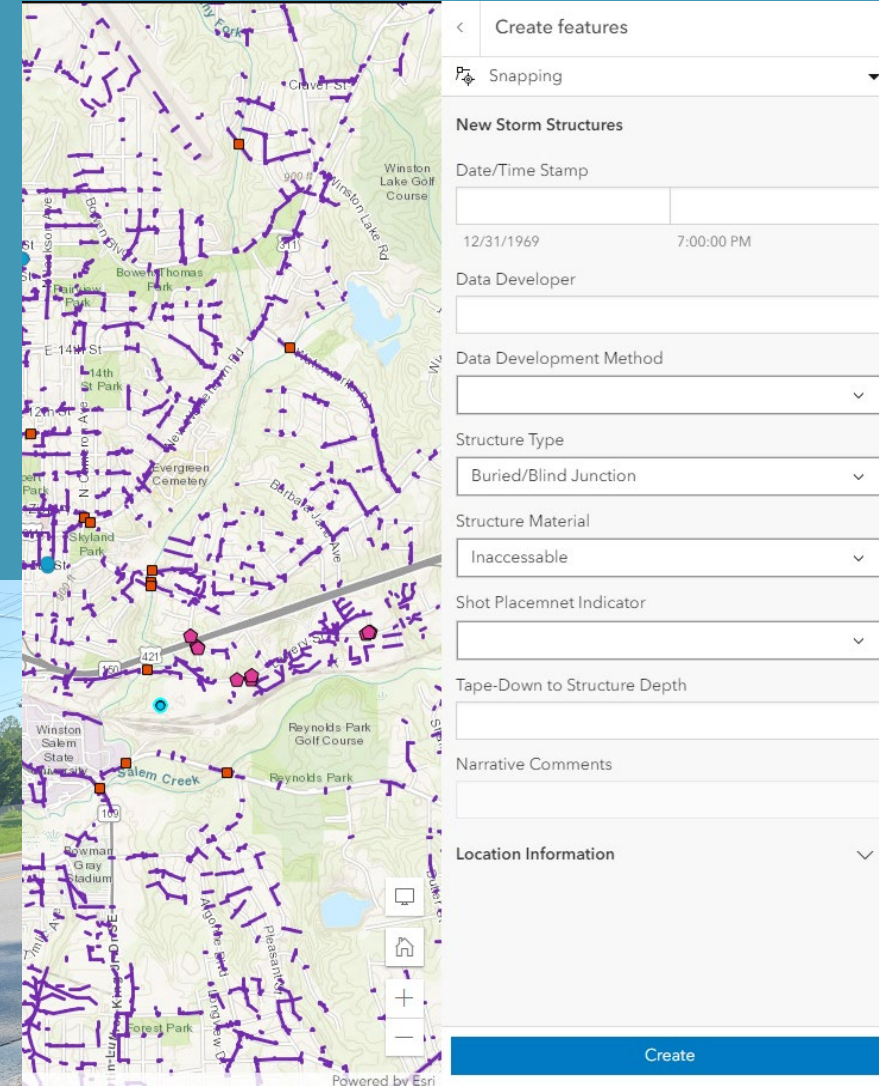
Pilot Study

- Gather information to provide direction to subconsultant
- Determine likely causes of inventory discrepancies
- Identify best practices to be implemented in future inventory collections



AGOL Field Maps App

- Existing stormwater inventory
- Documented inventory issues
- Updated inventory layers
- Survey grade data collection with Arrow Gold RTK GNSS receiver
- Initial learning curve



Automated QC Process

- Developed Python script
 - Generates random selection of points to QC
 - Compares QC data to original collection for validation
 - Calculates QC success rate

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    shutil.make_archive(f'{downloads_path}\\stormQC_{date.today().strftime("%m%d%y")}.gdb', 'zip', downloads_path, f'stormQC_{dat

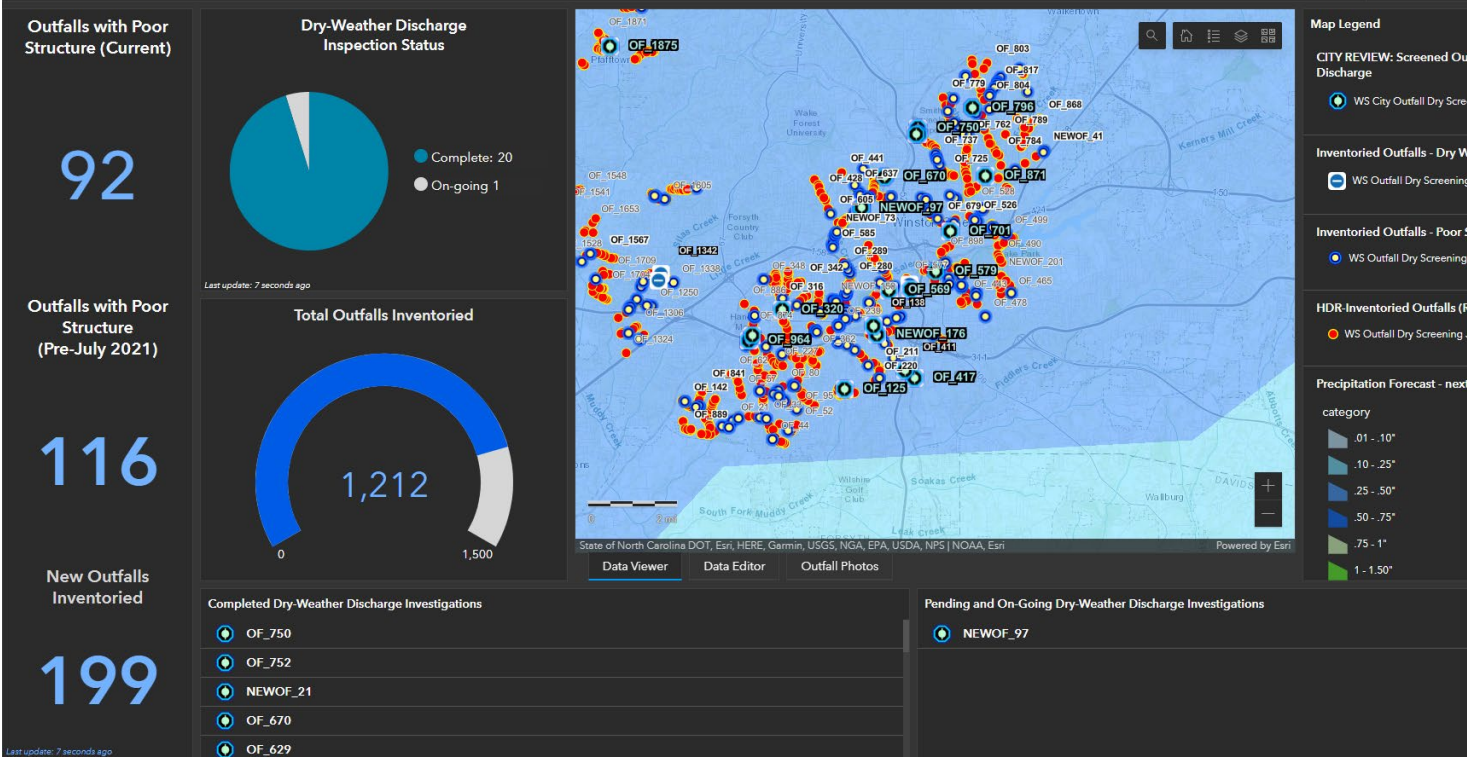
def publish_layer():
    dt = date.today().strftime("%m%d%y")
    qc_lyr = f'{downloads_path}\\stormQC_{date.today().strftime("%m%d%y")}.gdb.zip'
    publish_stormQC_item = gis.content.add({'title' : f'Stormwater_QC_{dt}'}, qc_lyr)
    publish_stormQC_item.publish()
    qc_published_source = gis.content.search(query=f"title : Stormwater_QC_{dt}", item_type="Feature *")
    qc_published_source[0].share(everyone=False, org=True, groups=['ae002d16df5b4a3fbdd62ff8879293ff', '8cc7bf66a2634b8dbedbe473
    qc_published_source[0].protect(enable=True)

def update_editing():
    dt = date.today().strftime("%m%d%y")
    qc_published_source = gis.content.search(query=f"title : Stormwater_QC_{dt}", item_type="Feature *")
    file = FeatureLayerCollection.fromitem(qc_published_source[0])
```




Dry-Weather Outfall Screening

Winston-Salem Dry Weather Screening Field Data Review

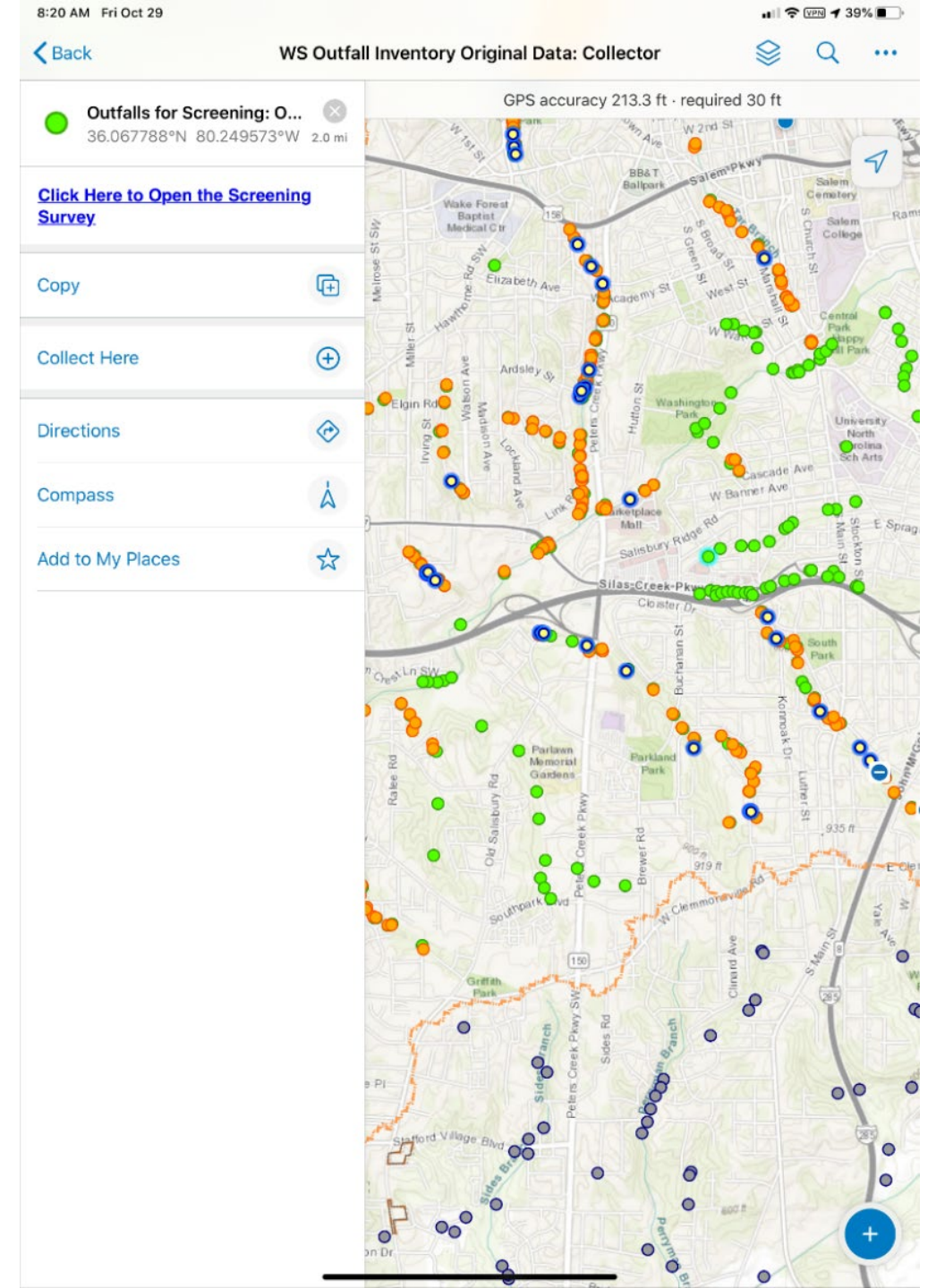


- ArcGIS Online (AGOL) mobile applications
 - Collector
 - Survey123
- AGOL desktop features
 - Dashboard tracking



AGOL Collector Application

- Outfall locations
- Outfall screenings completed
- Ability to add new outfalls
- Link to screening survey form



AGOL Survey123 App

- Outfall physical characteristics and condition
- Water quality qualitative assessment
- Photo attachments
- Recommendations for further investigation
- Report exports

Outfall ID: OF_581

Discharge Identification:
Initial screening data. This table is completed for all outfalls.

| | |
|---------------------------------------|---|
| Date and Time: December 3, 2021 | Name of Receiving Stream: Upper Salem Creek |
| Inspector: RD | Time Since Last Rainfall (days): 7 days (last rain: .02 inches on November 26) |
| Dry Weather Discharge Present: Yes | |

Dry Weather Screening:
If dry weather discharge is present, complete the following table. Determine if there is a need for further investigation.

Flow Volume: Moderate

| Indicator | Check if Present | Description |
|--|--------------------------------------|---|
| Odor | Yes | Sewage Easily Detected |
| Color | Yes | Gray Heavy |
| Clarity | Yes | Cloudy Thick cloudy grey coloration in water, along with large chunks of grey waste |
| Floatables | No | None |
| Deposits/Stains | Yes | Gray deposits |
| Abnormal Vegetation | No | Sludgy locking deposits across creek bottom |
| Conveyance Benthic Growth | No | N/A |
| Investigation status? | Identified for further investigation | |
| Comments: Strong sewage smell and grey water present in stream on either side of culvert. Grey sludge present at various points in the water bottom. Could not see any leaks in sanitary sewer line passing through culvert. | | |

Field Investigation:
If outfall is recommended for follow up investigation, perform sampling and complete the following table.

| | |
|----------------|--------------------------|
| Inspector: | Robert Dockery |
| Date and Time: | December 3, 2021 at 1:00 |

Outfall Dry Weather Screening

✕

▼ **General Information**

Outfall ID: *
OF_551

Outfall Screening ID:
HDR2021_OF_551

Date and Time: *
Friday, October 29, 2021 8:20 AM

Inspector: *

Name of Receiving Stream:
Upper Salem Creek

Location Description:
542 ft from the intersection of PARK BV and VINTAGE AV @ a bearing of 96 deg

Time Since Last Rainfall (Days):
(GIS post-processing)

Pipe Or Channel? *
 Pipe Channel

Conveyance Material:
 CM CP DI DIRT PVC RCP RR TC VEG OTHER

Type of Single Conveyance:
 DO PO OTHER

Outfall Geometry:
 ARCH BOX CIR ELLIP PARA TRAP OTHER



Field Assessments

- Initial water quality assessment
- Strip test for Iron concentration
- Recommendations for water quality sampling and further investigation



Location Description:

388 ft from the intersection of MAYBERRY LN and DELLA CRESCENT WY @ a bearing of 292 deg



Time Since Last Rainfall (Days):

(GIS post-processing)

Pipe Or Channel? *

Pipe Channel

Pipe Diameter/Height:

(Inches)

24



Conveyance Material:

CM CP DI DIRT PVC RCP RR TC VEG
 OTHER

Type of Single Conveyance:

DO PO OTHER

Outfall Geometry:

ARCH BOX CIR ELLIP PARA TRAP OTHER

Outfall Position:

DSRB DSLB HEAD

Number of Barrels:

1



Outfall Outlet Position:

Below Flush Free Partial

Drainage Area:

Drainage Acreage:

31.004635

Data Verification

- Prepopulated attributes
- Condition assessment

▼ Dry Weather Screening

Flow Volume:

Trickle Moderate Substantial

Odor?

Yes No

Color?

Yes No

Clarity?

Yes No

Clarity Description:

Slight Cloudiness

Comments:

Floatables?

Yes No

Floatable Description:

Sewage (toilet paper, etc.) Petroleum (oil sheen) Suds Other

Relative Severity:

Few/Slight Some Widespread

Deposits/Stains?

Yes No

Abnormal Vegetation?

Yes No

Conveyance Benthic Growth?

Yes No

Allowables List

Water Quality Assessment

- Visual qualitative assessment
- Recommendations for further investigation



Field Investigation:

If outfall is recommended for follow up investigation, perform sampling and complete the following ta

| | | |
|---------------------------|------------------------------------|------------------------------------|
| Inspector: | Nick Hoke | |
| Date and Time: | 12/8/21 12:36 | 12/8/21 12:37 |
| Sample Location(s): | At the outfall | Upstream of Outfall |
| Ammonia: | 0.00 mg/L | 0.00 mg/L |
| Flow Estimation: | Trickle Moderate Substantial | Trickle Moderate Substantial |
| Conductivity: | 106.3 μ S/cm | 101.9 μ S/cm |
| Detergents: | mg/L | mg/L |
| DO: | 9.40 mg/L 82.4 % Saturation | 9.30 mg/L 81.6 % Saturation |
| Nitrate: | mg/L | mg/L |
| pH: | 7.25 S.U. | 7.19 S.U. |
| Temperature: | 9.6 $^{\circ}$ C | 9.5 $^{\circ}$ C |
| Total Dissolved Solids: | 98.15 mg/L | 94.25 mg/L |
| Sample Specific Comments: | YSI | YSI |
| Over all Comments: | | |

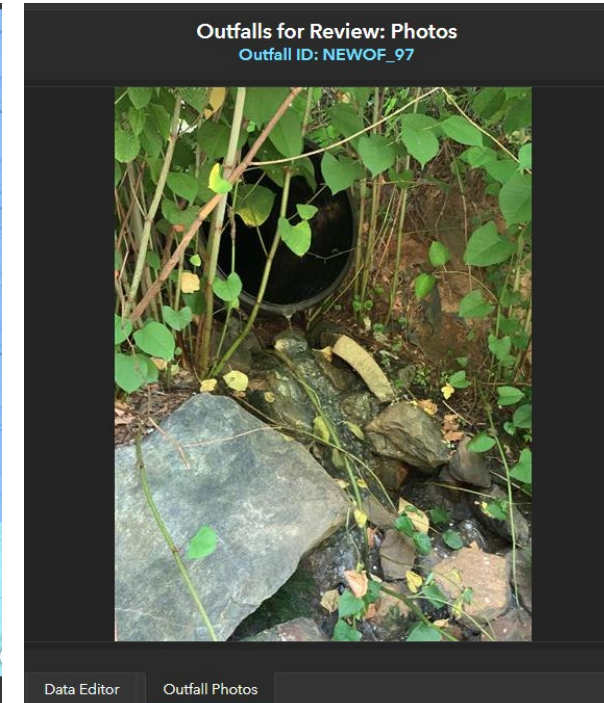
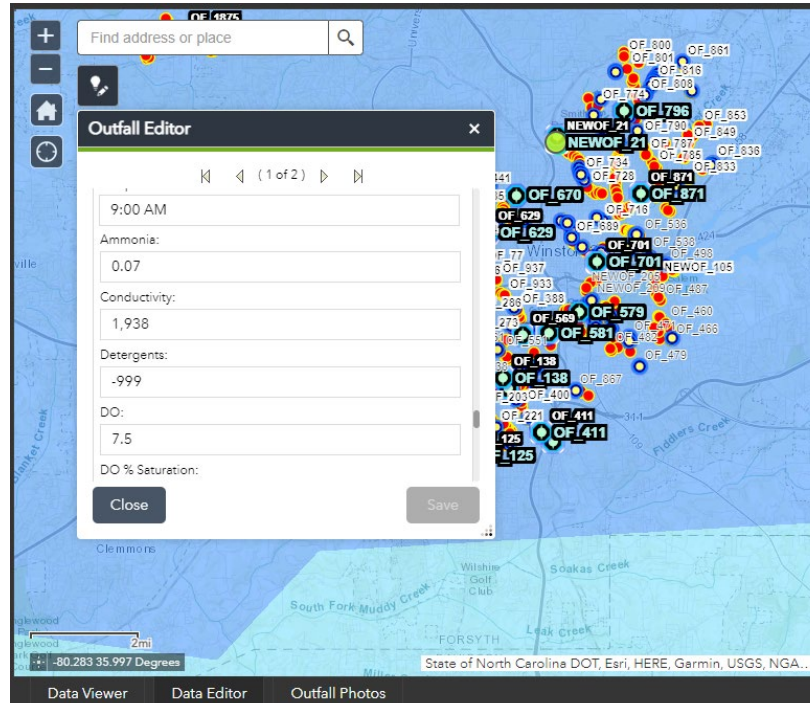
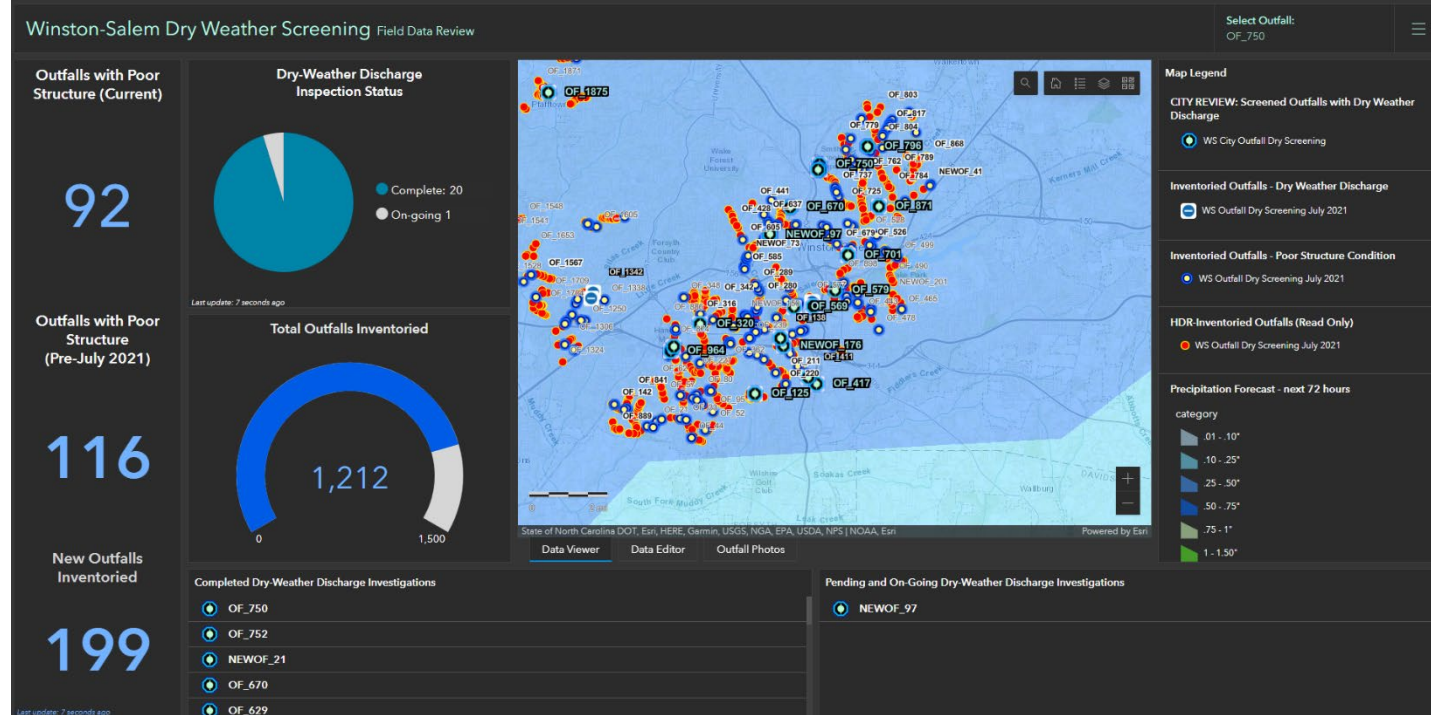
Follow-up Investigations

- Water quality sampling
- Illicit determination
- Notice of violation



AGOL Dashboard

- Progress updates
- Inspection statuses
- Data editing
- Photo and document attachments
- Collaborative effort





Enter Name or Initials

Date/Time of Inspection
Thursday, July 21, 2022 1:38 PM

Stream Reach ID: *

Point *
36° 6' N 80° 15' W ± 35 m

GPS

Bacteria Source Observation

Water Quality Assessment

Erosion Observation

Observations

Erosion Location

Downstream Left Bank

Downstream Right Bank

Stream feature:
(e.g., crossover reach, plunge pool, etc.)

Meander Straight Reach Steep Slope/Valley Wall Other

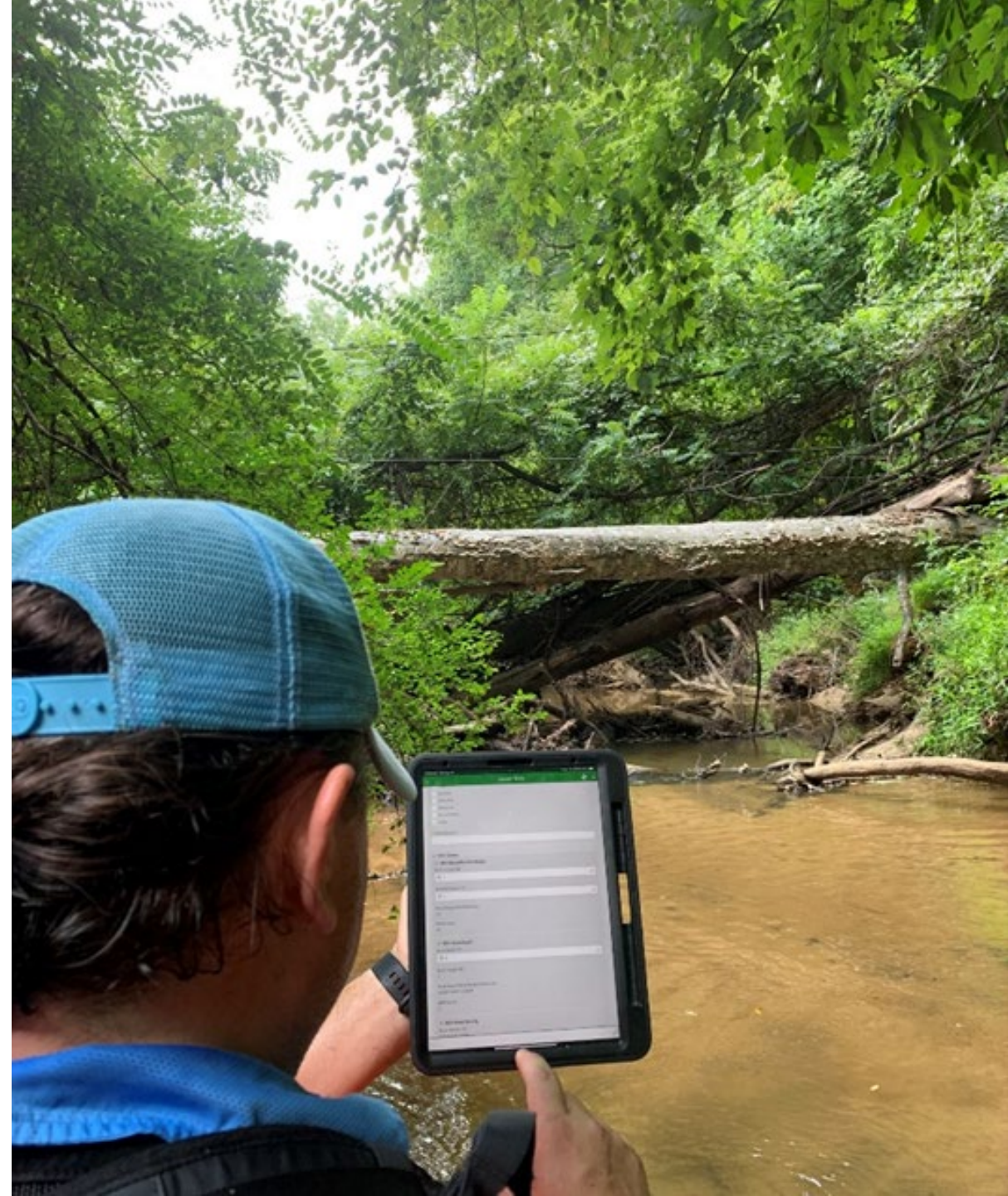
Length of Bank Erosion (ft):
(If -d estimated)

TMDL Stream Walking



AGOL mobile applications

- Survey123
 - Bacterial Source Assessment
 - Bank Erosion Assessment



AGOL Survey123 App

- Stream physical characteristics and condition
- Latitude and longitude spatial location
- Water quality qualitative assessment
- Potential bacterial source assessment
- Bank Erosion Hazard Index (BEHI) assessment
- Report exports

1:39 PM Thu Jul 21


Stream Walk

Name(s) of Inspector(s):
Enter Name or Initials

Date/Time of Inspection
Thursday, July 21, 2022 1:38 PM

Stream Reach ID: *

Point *
36°6'N 80°15'W ± 35 m



GPS

Bacteria Source Observation

Water Quality Assessment

Erosion Observation

Observations

Erosion Location

Downstream Left Bank

Downstream Right Bank

Stream feature:
(e.g., crossover reach, plunge pool, etc.)

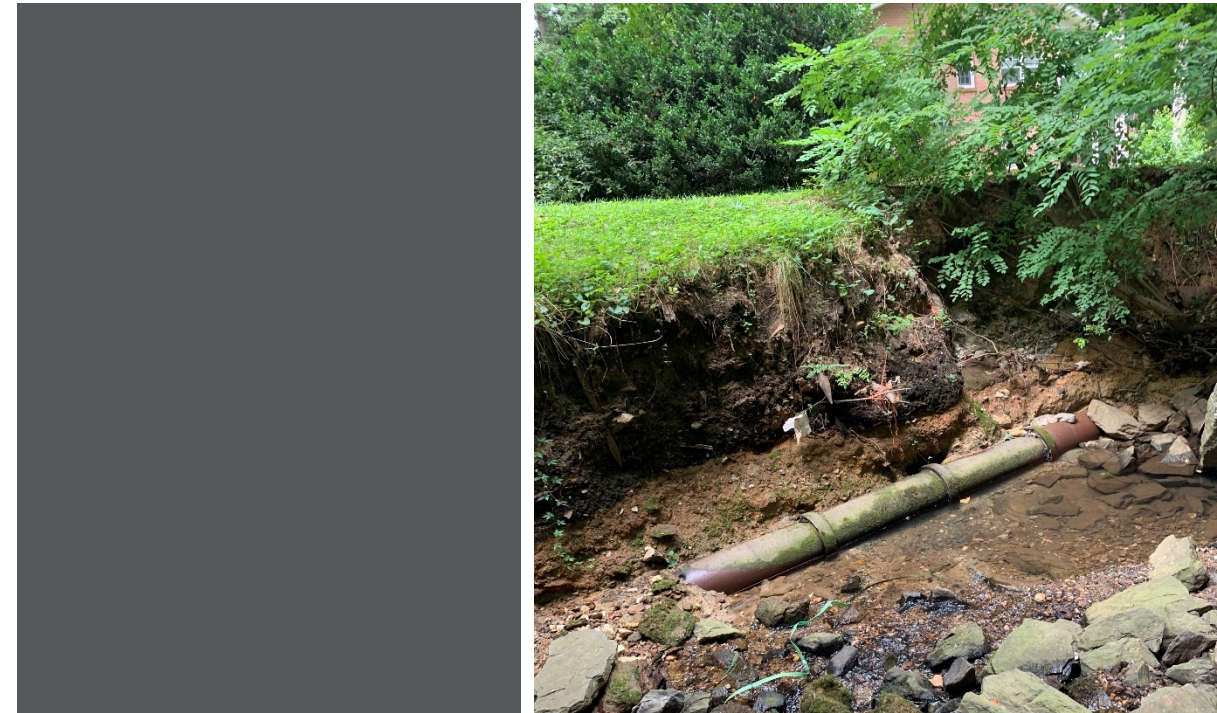
Meander Straight Reach Steep Slope/Valley Wall Other

Length of Bank Erosion (ft):
(Field estimated)

Right Bank:

Bacterial Source Assessment

- Identification of potential contributors of fecal coliforms
- Descriptions of problem areas
- May include compromised sanitary sewer infrastructure, nearby dog parks, agricultural facilities, etc.



Bank Erosion Assessment

- Bank Erosion Hazard Index (BEHI)
- Exposed bank data collected



Bank Height (ft)

5

Root Depth/Bank Height Ratio (%)

40

BEHI Score

5

▼ BEHI Root Density

Root Density (%)

Enter as whole number

50

Root Density x (Root Depth/Bank Height Ratio) (%)

20

BEHI Score

6

▼ BEHI Bank Angle

Bank Angle (Degrees)

25

BEHI Score

2

▼ BEHI Surface Protection

Surface Protection (%)

Enter as whole number

50

BEHI Score

4

BEHI Total

23

BEHI Adjective

Moderate

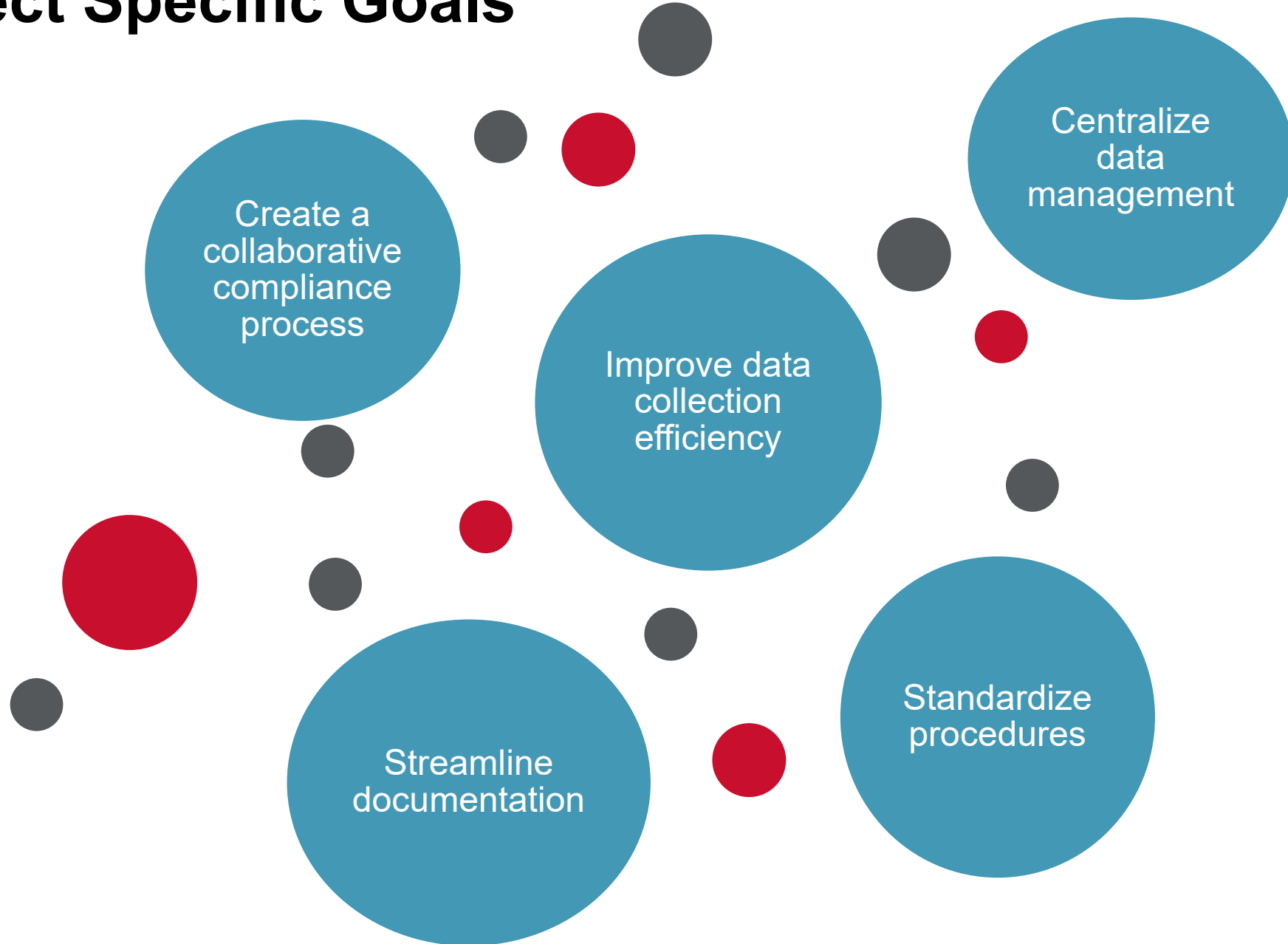
BEHI

- Calculations performed within survey automatically
- Resultant erosion severity classification

| | |
|----------------------------------|--|
| Bank Height (ft) | $\${Bank_Height}$ |
| Root Depth/Bank Height Ratio | $\${Root_Depth} \div \${Bank_Height} * 100$ |
| Root Depth/Bank Height Ratio (%) | $\${Root_Depth_Bank_Height_Ratio}$ |
| BEHI Score | if($\${Root_Depth_Bank_Height_Ratio} \leq 5$, 10, if($\${Root_Depth_Bank_Height_Ratio} < 10$, 9, if($\${Root_Depth_Bank_Height_Ratio} < 20$, 8, if($\${Root_Depth_Bank_Height_Ratio} < 39$, 6, if($\${Root_Depth_Bank_Height_Ratio} < 47$, 5, 5, |
| BEHI Score | $\${Root_Depth_Bank_Height_BEHI}$ |

| Category | | Bank Ht Ratio | Root Depth Ratio | Root Density | Bank Angle | Surface Protection | Total |
|-----------|-------|---------------|------------------|--------------|------------|--------------------|---------|
| | | (ft/ft) | (%) | (%) | (degrees) | (%) | Index |
| Very Low | Value | 1.0 – 1.1 | 100 – 80 | 100 – 80 | 0 – 20 | 100 – 90 | |
| | Index | 1 – 2 | 1 – 2 | 1 – 2 | 1 – 2 | 1 – 2 | < 10 |
| Low | Value | 1.1 – 1.2 | 80 – 55 | 80 – 55 | 20 – 60 | 90 – 50 | |
| | Index | 2 – 4 | 2 – 4 | 2 – 4 | 2 – 4 | 2 – 4 | 10 – 20 |
| Moderate | Value | 1.2 – 1.5 | 55 – 30 | 55 – 30 | 60 – 80 | 50 – 30 | |
| | Index | 4 – 6 | 4 – 6 | 4 – 6 | 4 – 6 | 4 – 6 | 20 – 30 |
| High | Value | 1.5 – 2.0 | 30 – 15 | 30 – 15 | 80 – 90 | 30 – 15 | |
| | Index | 6 – 8 | 6 – 8 | 6 – 8 | 6 – 8 | 6 – 8 | 30 – 40 |
| Very High | Value | 2.0 – 2.8 | 15 – 5 | 15 – 5 | 90 – 120 | 15 – 5 | |
| | Index | 8 – 9 | 8 – 9 | 8 – 9 | 8 – 9 | 8 – 9 | 40 – 45 |
| Extreme | Value | > 2.8 | < 5 | < 5 | > 120 | < 5 | |
| | Index | 10 | 10 | 10 | 10 | 10 | > 45 |
| Field | Value | | | | | | |
| Measure | Index | | | | | | |

Project Specific Goals



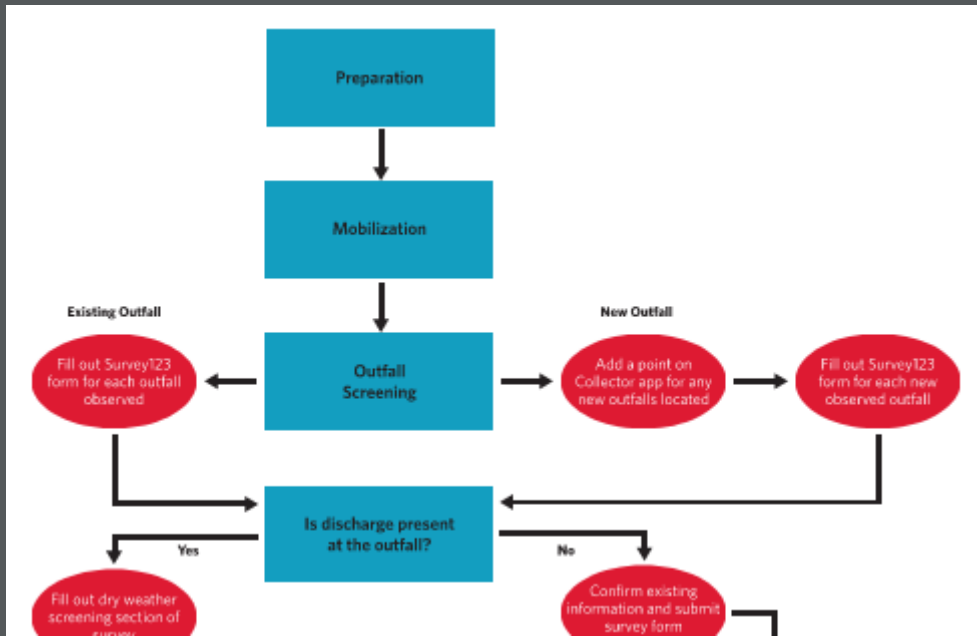
Collaboration Benefits

- Leveraged resources and skills
 - HDR data collecting in the field and compiling reports in the office
 - City performing investigations
- Improved investigation response
 - Real time reporting through dashboard
 - Stream-lined data sharing to all parties



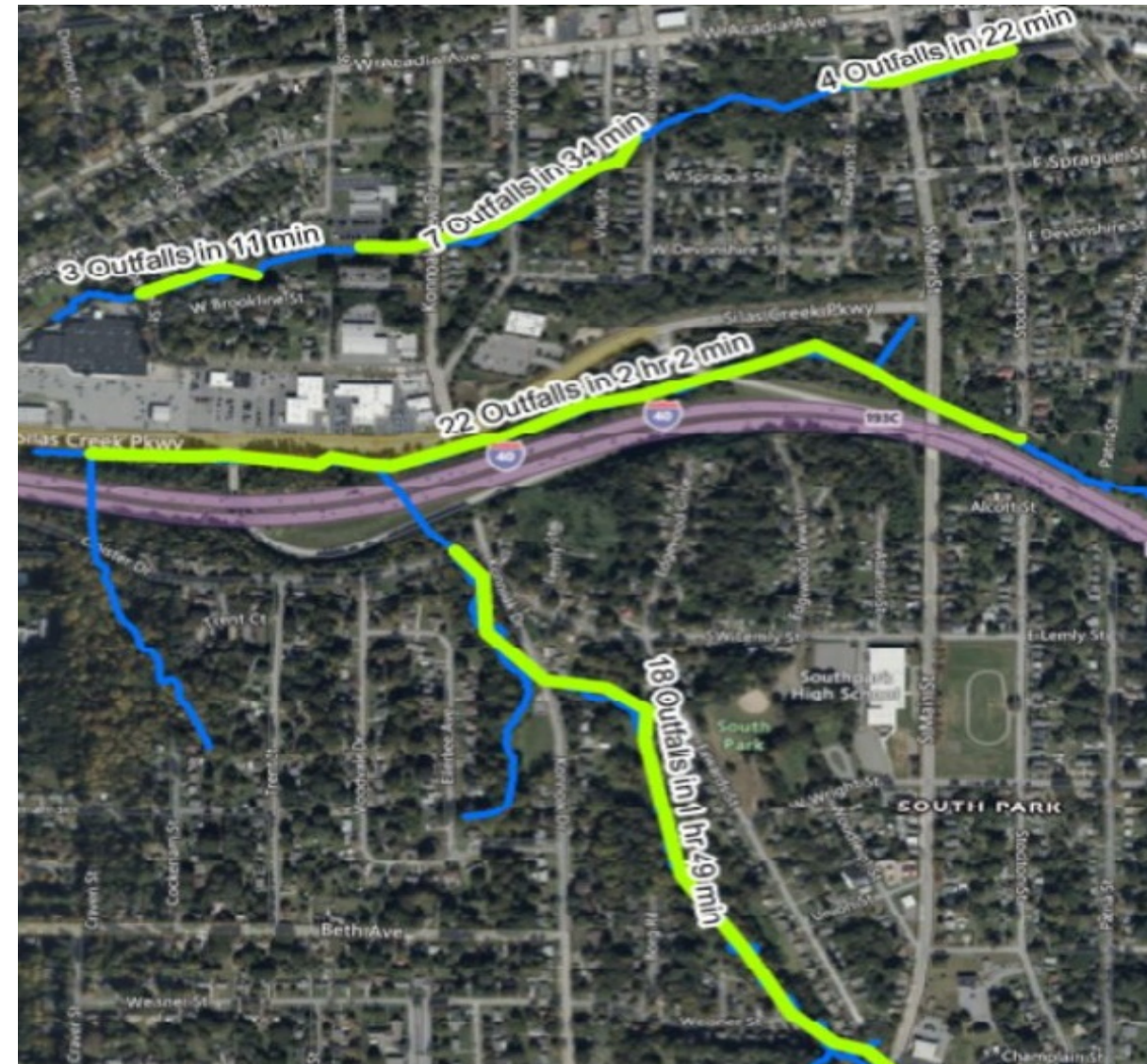
Documentation and Compliance

- Development of 3 new SOPs
 - Provide for handoff to City
 - Meet Permit requirements for procedures
- Centralized data management
 - AGOL dashboard/GDB contains full cycle documentation in one place
- Referenceable data
 - Searchable via spatial reference
 - Push reporting from the GDB



Data Efficiency Improvements and Beneficial Uses

- Data continuity involving non-stormwater observations and past investigations
- Workload planning and time budgeting using previous screening rates (outfalls/per hour)
- Proactive education and enforcement in hot spot areas



Questions?