Analyzing Potential Stormwater Management Projects in Charles County, MD Using Python

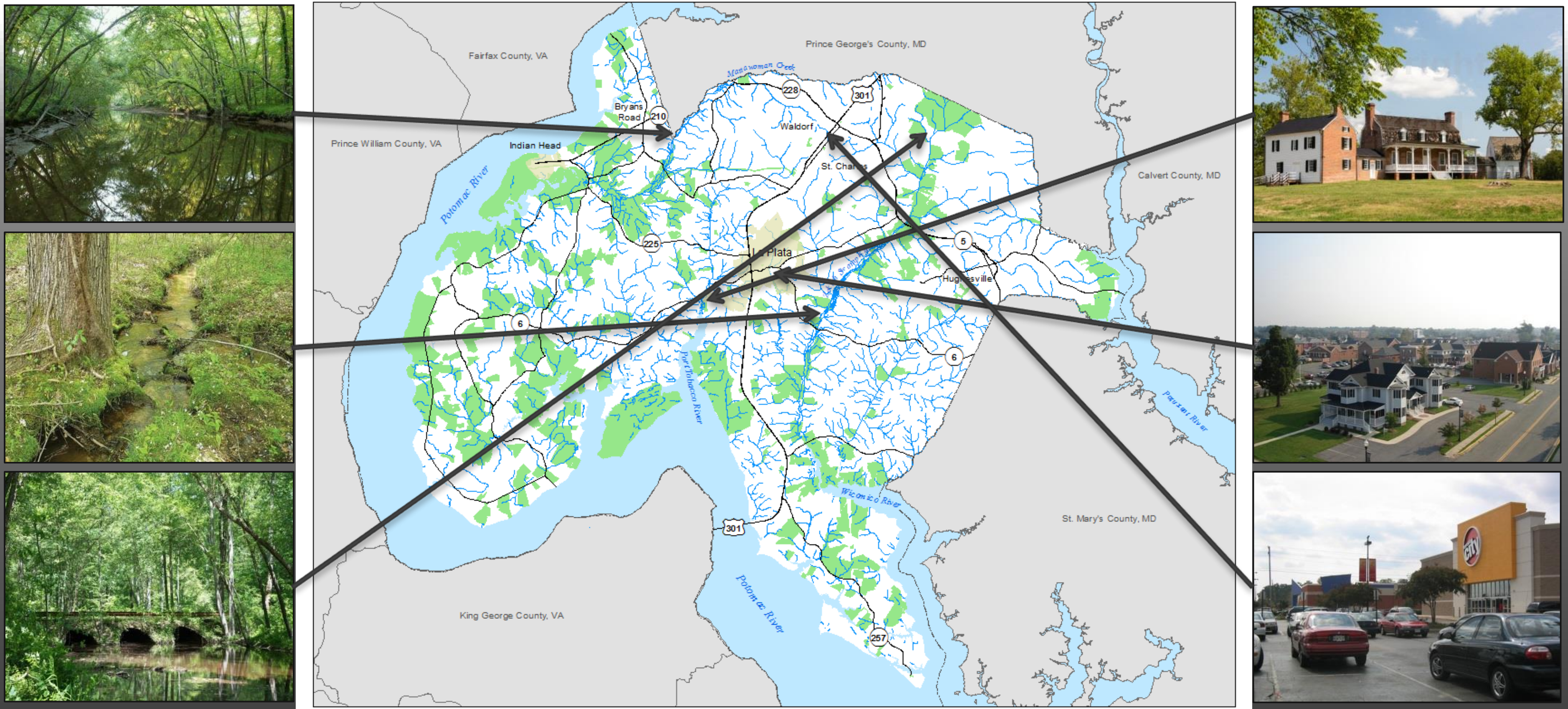
Sean Adkins
Vista Design Inc.

A bit about me

- Vista Design Inc
- B.S. & M.S. from Salisbury University
- Currently live in Ocean City
- Environmentalist, Geographer & GIS Professional
- NOT a programmer

Sean Adkins
Vista Design Inc.

CHARLES COUNTY Maryland

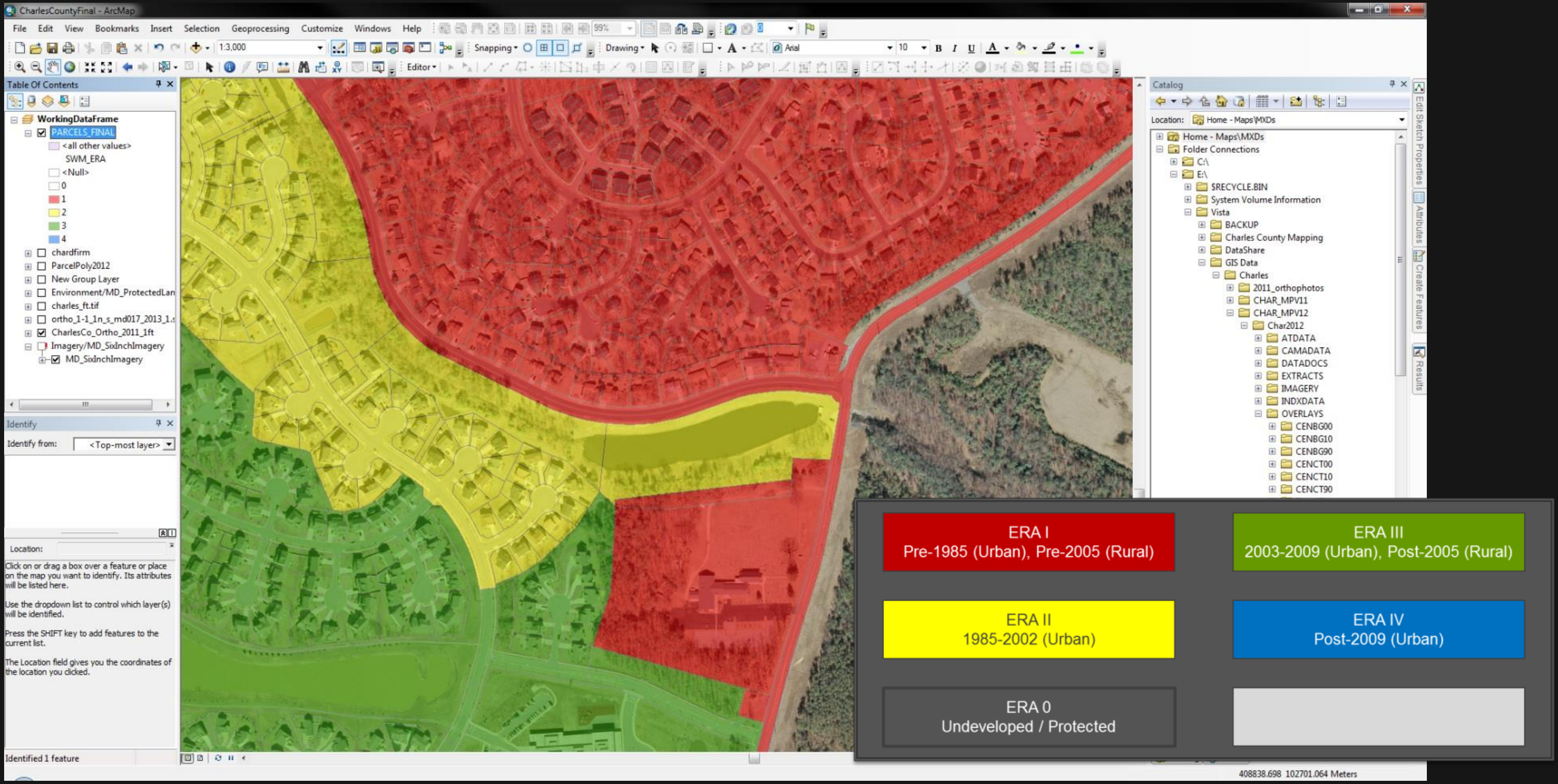


NPDES

- Clean Water Act 1972
  - National Pollutant Discharge Elimination Program (NPDES)
  - Point sources of pollution
- Water Quality Act 1987
  - Municipal Separate Storm Sewer Systems (MS4)
  - Non-point sources of pollution

- Upon NPDES permit renewal, Maryland Department of Environment's 2012 Watershed Implementation Plan requires retrofitting 20% of previously developed but currently untreated impervious surfaces

Water Quality Assessment



CharlesCountyFinal - ArcMap

1:3,000

Identify from: <Top-most layer>

Location:

Click on or drag a box over a feature or place on the map you want to identify. Its attributes will be listed here.

Use the dropdown list to control which layer(s) will be identified.

Press the SHIFT key to add features to the current list.

The Location field gives you the coordinates of the location you clicked.

Identified 1 feature

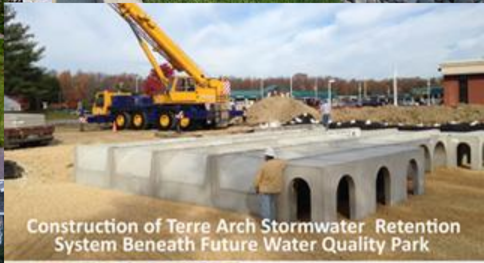
Location: Home - Maps\MXDs

408838.698 102701.064 Meters

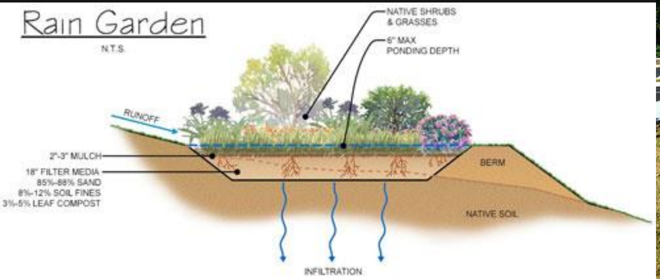
- 🟥 ERA I Pre-1985 (Urban), Pre-2005 (Rural)
- 🟩 ERA III 2003-2009 (Urban), Post-2005 (Rural)
- 🟨 ERA II 1985-2002 (Urban)
- 🟦 ERA IV Post-2009 (Urban)
- ⬛ ERA 0 Undeveloped / Protected

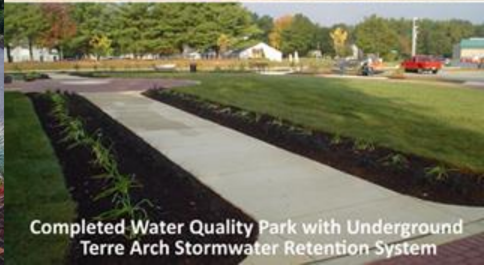
Water Quality Projects

- Large amount of capital expenditure
- Time-consuming
- Environmental Benefits
- Local impacts

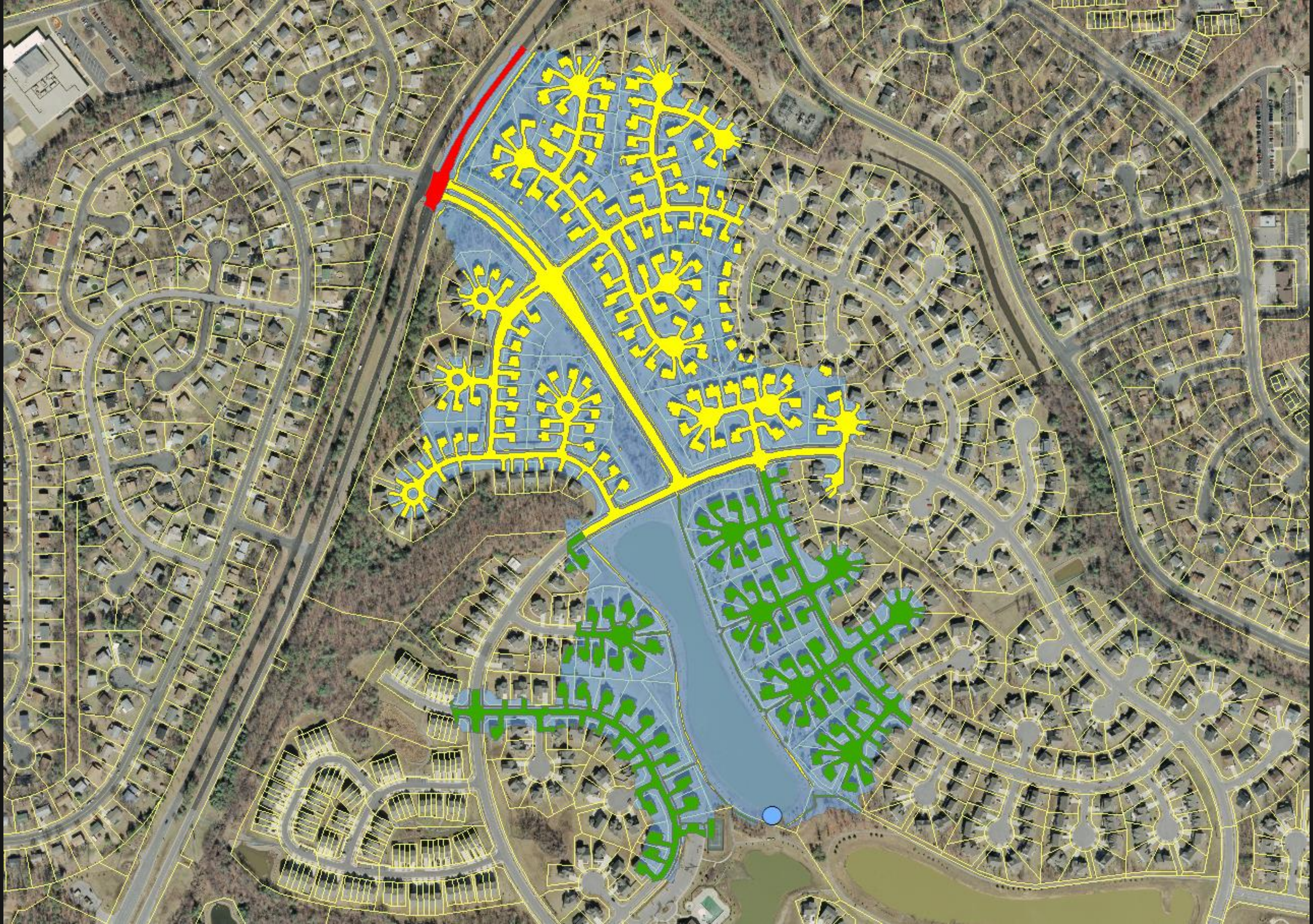


Construction of Terre Arch Stormwater Retention System Beneath Future Water Quality Park

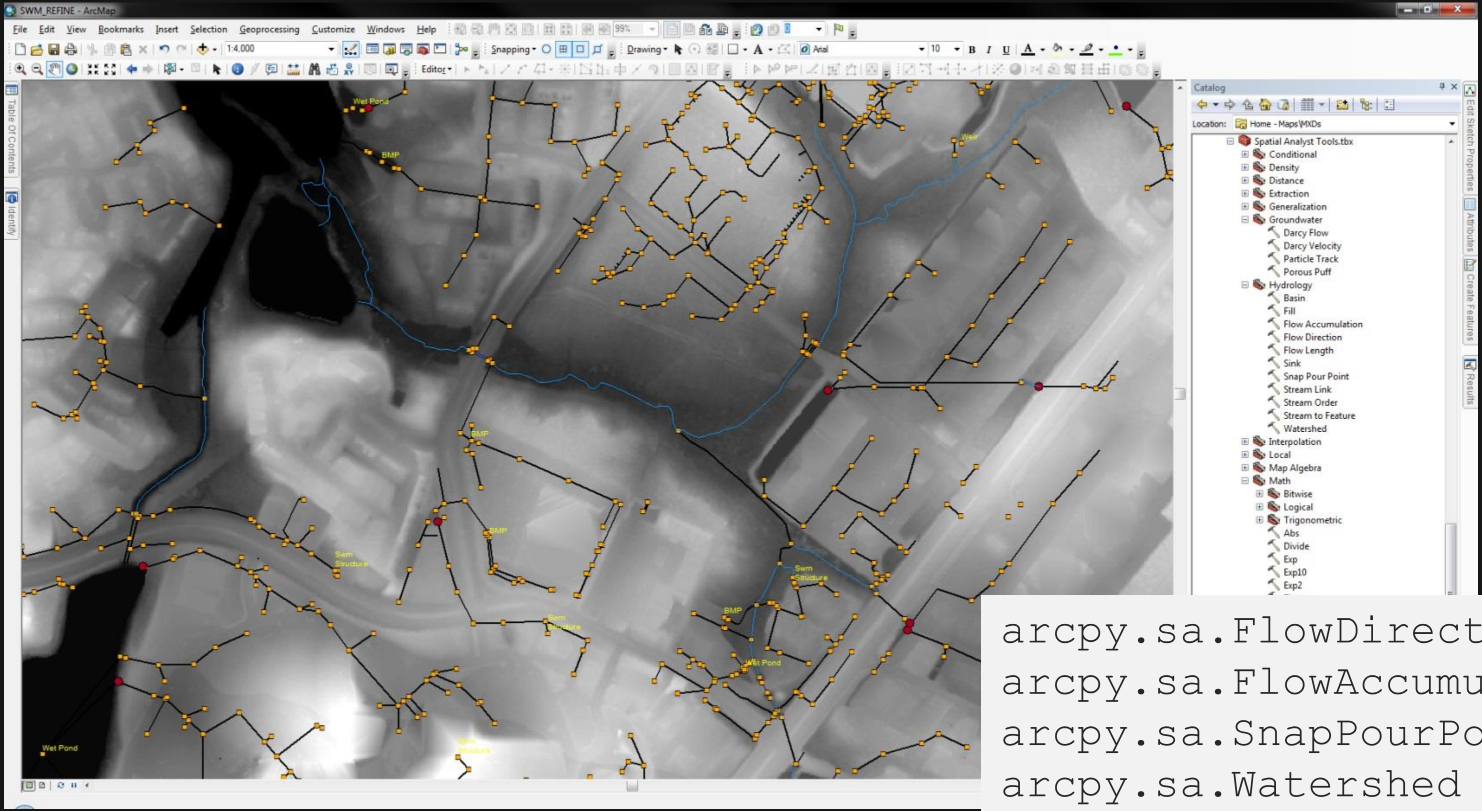




Completed Water Quality Park with Underground Terre Arch Stormwater Retention System

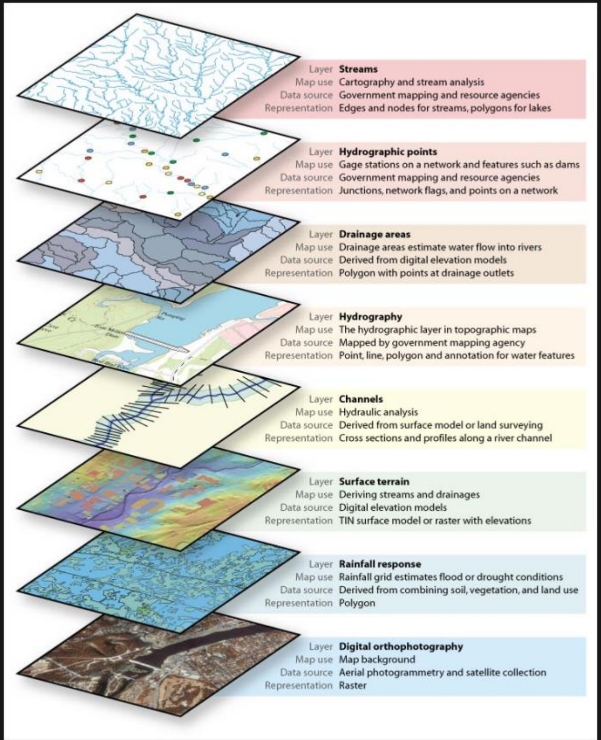


Problem: Watershed Analysis

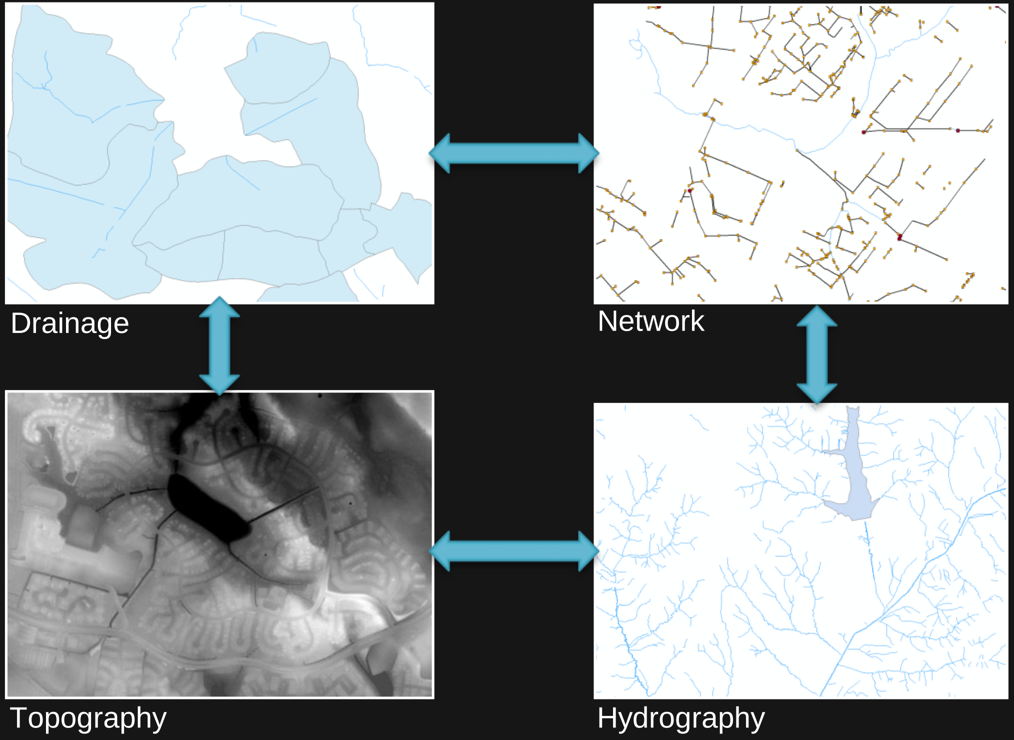


```
arcpy.sa.FlowDirection
arcpy.sa.FlowAccumulation
arcpy.sa.SnapPourPoint
arcpy.sa.Watershed
```

Solution: ArcHydro



Layer	Map use	Data source	Representation
Streams	Cartography and stream analysis	Government mapping and resource agencies	Edges and nodes for streams, polygons for lakes
Hydrographic points	Gage stations on a network and features such as dams	Government mapping and resource agencies	Junctions, network flags, and points on a network
Drainage areas	Drainage areas estimate water flow into rivers	Derived from digital elevation models	Polygon with points at drainage outlets
Hydrography	The hydrographic layer in topographic maps	Mapped by government mapping agency	Point, line, polygon and annotation for water features
Channels	Hydraulic analysis	Derived from surface model or land surveying	Cross sections and profiles along a river channel
Surface terrain	Deriving streams and drainages	Digital elevation models	TIN surface model or raster with elevations
Rainfall response	Rainfall grid estimates flood or drought conditions	Derived from combining soil, vegetation, and land use	Polygon
Digital orthophotography	Map background	Aerial photogrammetry and satellite collection	Raster



Problem: Time Constraints

- sa.Watershed
- RasterToPolygon_conversion
- AddField_management
- CalculateField_management (x4)

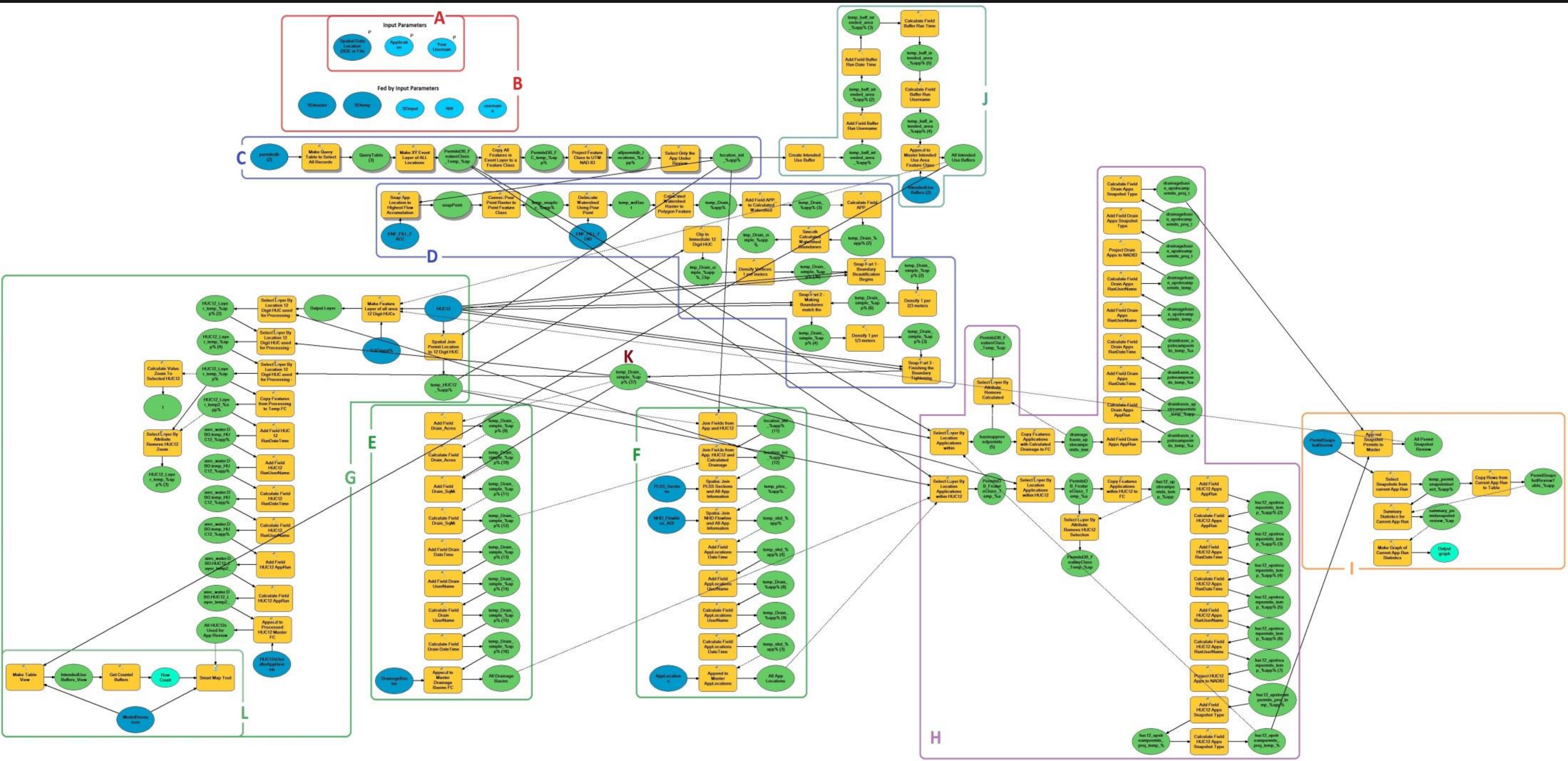
- Merge_management
- Dissolve_management

- Clip_analysis
- Dissolve_management (x2)
- Intersect_analysis
- AddField_management (x2)
- CalculateField_management (x2)

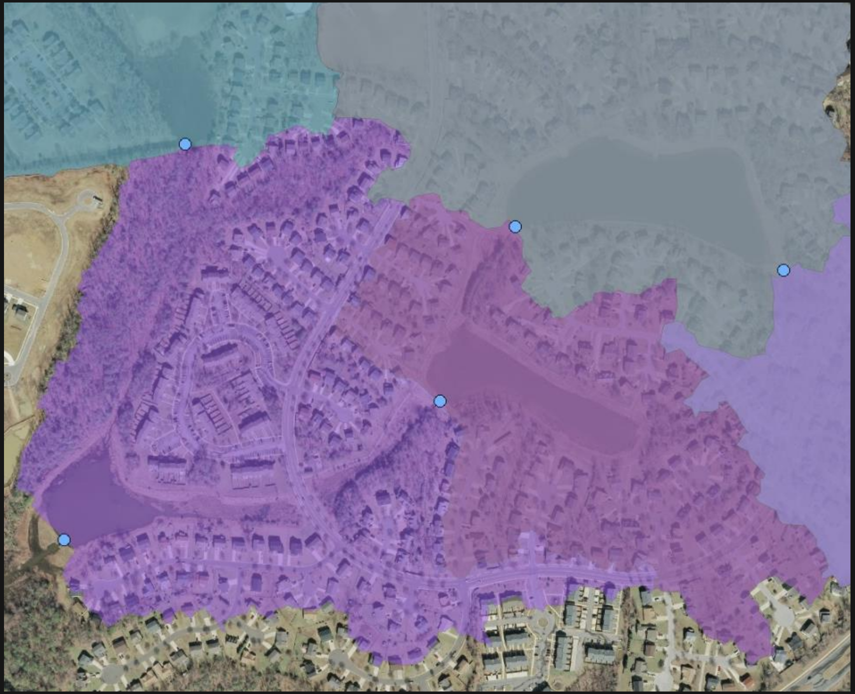
- Merge_management
- AddField_management

- SelectLayerByAttribute_managment (x3)
- CalculateField_management (x2)
- TableToDBASE_conversion

- For each study point:
  - 25 geoprocessing functions.
  - Minimum of 23 minutes per point to perform preliminary watershed analysis.
  - Assuming 190 study points, it would take at least 73 hours to complete this analysis.
  - Imperfect analysis methodology (human error).


A
Input Parameters
Spatial Data Location (SDE or File
Application
Your Username
P
P
P
B
Fed by Input Parameters
SDmaster
SDtemp
SDinput
app
username
C
permitsdb (2)
Make Query Table to Select All Records
QueryTable (3)
Make XY Event Layer of ALL Locations
PermitsDB_FeatureClass_Temp_%ap
Copy All Features in Event Layer to a Feature Class
PermitsDB_FC_temp_%app%
Project Feature Class to UTM NAD 83
allpermitdb_locations_%app%
Select Only the App Under Review
location_init_%app%
J
Create Intended Use Buffer
temp_buff_intended_area_%app%
Add Field Buffer Run Username
temp_buff_intended_area_%app% (2)
Add Field Buffer Run Date Time
temp_buff_intended_area_%app% (3)
Calculate Field Buffer Run Time
temp_buff_intended_area_%app% (5)
Calculate Field Buffer Run Username
temp_buff_intended_area_%app% (4)
Append to Master Intended Use Area Feature Class
All Intended Use Buffers
IntendedUse Buffers (2)
D
Snap App Location to Highest Flow Accumulation
ENF_FILL_FACC
snapPoint
Convert Pour Point Raster to Point Feature Class
temp_snappic_%app%
Delineate Watershed Using Pour Point
ENF_FILL_FDIR
temp_wsRast
Calculated Watershed Raster to Polygon Feature
temp_Drain_%app%
Add Field APP_ to Calculated Watershed
temp_Drain_%app% (3)
Calculate Field APP
temp_Drain_%app% (2)
Smooth Calculated Watershed Boundaries
tmp_Drain_simple_%app%
Clip to Immediate 12 Digit HUC
tmp_Drain_simple_%app%_Clip
Densify Vertices 1 per meters
temp_Drain_simple_%app% (36)
Snap Part 1 - Boundary Beautification Begins
temp_Drain_simple_%app% (2)
Densify 1 per 2/3 meters
temp_Drain_simple_%app% (6)
Snap Part 2 - Making Boundaries match the
temp_Drain_simple_%app% (4)
Densify 1 per 1/3 meters
temp_Drain_simple_%app% (3)
Snap Part 3 - Finishing the Boundary Tightening
K
temp_Drain_simple_%app% (37)
G
HUC12
Make Feature Layer of all area 12 Digit HUCs
Output Layer
%SDinput%
Spatial Join Permit Location to 12 Digit HUC
temp_HUC12_%app%
Select Layer By Location 12 Digit HUC used for Processing -
HUC12_Layer_temp_%app% (2)
Select Layer By Location 12 Digit HUC used for Processing -
HUC12_Layer_temp_%app% (4)
Select Layer By Location 12 Digit HUC used for Processing -
HUC12_Layer_temp_%app%
Calculate Value Zoom To Selected HUC12
1
Select Layer By Attribute Remove HUC12 Zoom
HUC12_Layer_temp_%app% (3)
Copy Features from Processing to Temp FC
HUC12_Layer_temp2_%app%
Add Field HUC 12 RunDateTime
anrc_water.DBO.temp_HUC12_%app%
Add Field HUC12 RunUserName
anrc_water.DBO.temp_HUC12_%app%
Calculate Field HUC12 RunDateTime
anrc_water.DBO.temp_HUC12_%app%
Calculate Field HUC12 RunUserName
anrc_water.DBO.temp_HUC12_%app%
Add Field HUC12 AppRun
anrc_water.DBO.HUC12_Layer_temp2_
Calculate Field HUC12 AppRun
anrc_water.DBO.HUC12_Layer_temp2_
Append to Processed HUC12 Master FC
All HUC12s Used for App Review
HUC12sUsedforAppReview
L
Make Table View
IntendedUse Buffers_View
Get Countof Buffers
Row Count
Smart Map Tool
ModelResources
E
Add Field Drain_Acres
temp_Drain_simple_%app% (9)
Calculate Field Drain_Acres
temp_Drain_simple_%app% (10)
Add Field Drain_SqMi
temp_Drain_simple_%app% (11)
Calculate Field Drain_SqMi
temp_Drain_simple_%app% (12)
Add Field Drain DateTime
temp_Drain_simple_%app% (13)
Add Field Drain UserName
temp_Drain_simple_%app% (14)
Calculate Field Drain UserName
temp_Drain_simple_%app% (15)
Calculate Field Drain DateTime
temp_Drain_simple_%app% (16)
DrainageBasins
Append to Master Drainage Basins FC
All Drainage Basins
F
Join Fields from App and HUC12
location_init_%app% (11)
Join Fields from App, HUC12 and Calculated Drainage
location_init_%app% (12)
PLSS_Sections
Spatial Join PLSS Sections and All App Information
temp_plss_%app%
NHD_Flowlines_AOI
Spatial Join NHD Flowline and All App Information
temp_nhd_%app%
Add Field AppLocations DateTime
temp_nhd_%app% (4)
Add Field AppLocations UserName
temp_Drain_%app% (8)
Calculate Field AppLocations UserName
temp_Drain_%app% (9)
Calculate Field AppLocations DateTime
temp_nhd_%app% (3)
AppLocations
Append to Master AppLocations
All App Locations
H
PermitsDB_FeatureClass_Temp_%ap
Select Layer By Attribute Remove Calculated
Select Layer By Location Applications within
basinapprovedpermits (5)
Copy Features Applications with Calculated Drainage to FC
drainage basin_upstreampermits_tem
Add Field Drain Apps AppRun
drainbasin_upstreampermits_temp_%a
Calculate Field Drain Apps AppRun
drainbasin_upstreampermits_temp_%app
Add Field Drain Apps RunDateTime
drainbasin_upstreampermits_temp_%a
Calculate Field Drain Apps RunDateTime
drainbasin_upstreampermits_temp_%a
Add Field Drain Apps RunUserName
drainagebasin_upstreampermits_temp_
Calculate Field Drain Apps RunUserName
drainagebasin_upstreampermits_temp_
Project Drain Apps to NAD83
drainagebasin_upstreampermits_proj_t
Add Field Drain Apps Snapshot Type
drainagebasin_upstreampermits_proj_t
Calculate Field Drain Apps Snapshot Type
drainagebasin_upstreampermits_proj_t
Select Layer By Location Applications within HUC12
PermitsDB_FeatureClass_Temp_%a
Select Layer By Location Applications within HUC12
PermitsDB_FeatureClass_Temp_%a
Copy Features Applications within HUC12 to FC
huc12_upstreampermits_temp_%app
Select Layer By Attribute Remove HUC12 Selection
PermitsDB_FeatureClass_Temp_%ap
Add Field HUC12 Apps AppRun
huc12_upstreampermits_temp_%app% (2)
Calculate Field HUC12 Apps AppRun
huc12_upstreampermits_temp_%app% (3)
Add Field HUC12 Apps RunDateTime
huc12_upstreampermits_temp_%app% (4)
Calculate Field HUC12 Apps RunDateTime
huc12_upstreampermits_temp_%app% (5)
Add Field HUC12 Apps RunUserName
huc12_upstreampermits_temp_%app% (6)
Calculate Field HUC12 Apps RunUserName
huc12_upstreampermits_temp_%app% (7)
Project HUC12 Apps to NAD83
huc12_upstreampermits_proj_temp_%app%
Add Field HUC12 Apps Snapshot Type
huc12_upstreampermits_proj_temp_%
Calculate Field HUC12 Apps Snapshot Type
huc12_upstreampermits_proj_temp_%
I
PermitSnapshotReview
Append Snapshot Permits to Master
All Permit Snapshot Review
Select Snapshots from current App Run
temp_permitsnapshotselect_%app%
Copy Rows from Current App Run to Table
PermitSnapshotReviewTable_%app
Summary Statistics for Current App Run
summary_permitsnapshotreview_%ap
Make Graph of Current App Run Statistics
Output graph

Problem: Flexibility & Extensibility

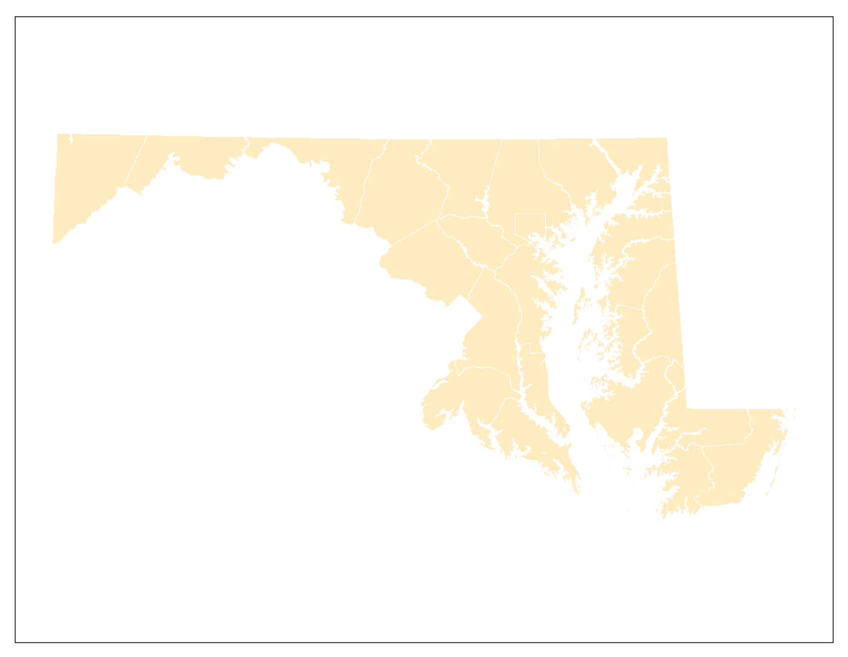


Solution: Python Scripiting

- `arcpy.da.SearchCursor`

- `arcpy.Intersect_analysis([Imperv_Merged,tempParcelERA], outputScratch + "x_" + str(row.Name) + ".shp", "ALL")`

- `import glob`
- `import xlrd`
- `import time`



Code

```
#Set up environments and directories
print "***Starting Script!***"
import os
import arcpy
import glob
import time
arcpy.CheckOutExtension("spatial")
import arcpy.sa
print "Imports complete."
###Change featName to change subdirectory folder###
featName = "county"
arcpy.env.workspace = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\outputs"
arcpy.env.scratchWorkspace = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\scratch"
outputScratch = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\scratch\\"
outputFolder = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\outputs\\"
out_w_Merged = "merged\\w_mergedWatersheds.shp"
scratch_Merged = "w_mergedWatersheds.shp"
print "Workspaces setup."
arcpy.env.overwriteOutput = True
arcpy.env.outputCoordinateSystem = arcpy.SpatialReference(102685)
flowDir = "C:\\Users\\sadkins\\Documents\\ArcGIS\\inputs\\dir"
###Change pointInput to change input points###
pointInput = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\countyPoint.shp"
print "Inputs received."
```

Code

```
#Check to see if watershed process has already been run.
#If not, run the batch watersheds for each point, calculating acreages
c = int(arcpy.GetCount_management(pointInput).getOutput(0))
pointRow = arcpy.SearchCursor(pointInput)
print ""
print "***Starting Watershed Creation Process***"
print ""
if arcpy.Exists(out_w_Merged) == False:
    for row in pointRow:
        feat = row.Shape
        flowDir = "C:\\Users\\sadkins\\Documents\\ArcGIS\\inputs\\dir"
        print "Creating watershed for " + str(row.Name) + "..."
        water_r = arcpy.sa.Watershed(flowDir,feat)
        print "Converting to polygon..."
        watershed = arcpy.RasterToPolygon_conversion(water_r, outputFolder + "w_" + str(row.Name) + ".shp", "SIMPLIFY")
        arcpy.AddField_management(watershed,"Name","LONG","","","")
        arcpy.CalculateField_management(watershed,"Name",row.Name, "PYTHON", "")
        print "Calculating acreage..."
        arcpy.AddField_management(watershed,"W_ACRES","DOUBLE","","","")
        arcpy.CalculateField_management(watershed,"W_ACRES","!" + arcpy.Describe(watershed).shapefieldname + ".AREA@ACRES!", "PYTHON", "")
        c -= 1
        print "Watershed analysis for " + str(row.Name) + " complete!"
        print "There are " + str(c) + " points remaining."
        print ""
else:
    print "Watersheds already exist!"
    print ""
```

Code

```
#Verify and prepare environments and directories
print "***All watersheds have been created.***"
print ""
arcpy.env.workspace = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\outputs"
arcpy.env.scratchWorkspace = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\scratch"
outputScratch = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\scratch\\"
outputFolder = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\outputs\\"
ParcelsFinal = "C:\\Users\\sadkins\\Documents\\ArcGIS\\inputs\\ParcelsFINAL.shp"
Imperv_Merged = "C:\\Users\\sadkins\\Documents\\ArcGIS\\inputs\\Imperv_Merged.shp"
flist = arcpy.ListFeatureClasses()
print "Merging watersheds..."
print ""

#Check to see if watersheds have already been merged. If not, merge them and dissolve by Name.
if arcpy.Exists(outputFolder + out_w_Merged) == False:
    tempMerge = arcpy.Merge_management(flist, outputScratch + scratch_Merged)
    mergeSHP = arcpy.Dissolve_management(tempMerge,outputFolder + out_w_Merged,"Name","W_ACRES SUM","MULTI_PART","DISSOLVE_LINES")
    print "***All watersheds have been merged!***"
else:
    mergeSHP = outputFolder + out_w_Merged
    print "Merged watersheds already exist!"
    print ""
```

Code

```
#Run the impervious surface assessment (by ERA) for each watershed, calculating acreages for each.
f = int(arcpy.GetCount_management(mergeSHP).getOutput(0))
polyRow = arcpy.SearchCursor(mergeSHP)
print ""
print "***Starting Impervious Surface Assessment***"
print ""

for row in polyRow:
    feat = row.Shape
    print "Clipping & dissolving parcels..."
    tempParcelClip = arcpy.Clip_analysis(ParcelsFinal,feat,outputScratch + "p_" + str(row.Name) + ".shp")
    tempParcelERA = arcpy.Dissolve_management(tempParcelClip, outputScratch + "d_" + str(row.Name) + ".shp", "SWM_ERA", "", "MULTI_PART", "DISSOLVE_LINES")
    print "Intersecting & dissolving impervious surfaces..."
    tempIntersect = arcpy.Intersect_analysis([Imperv_Merged,tempParcelERA], outputScratch + "x_" + str(row.Name) + ".shp", "ALL")
    ImpervERA = arcpy.Dissolve_management(tempIntersect, outputFolder + "i_" + str(row.Name) + ".shp", "SWM_ERA", "", "MULTI_PART", "DISSOLVE_LINES")
    arcpy.AddField_management(ImpervERA,"Name","LONG","","","")
    arcpy.CalculateField_management(ImpervERA,"Name",row.Name, "PYTHON", "")
    print "Calculating acreage..."
    arcpy.AddField_management(ImpervERA, "I_ACRES", "DOUBLE", "", "", "")
    arcpy.CalculateField_management(ImpervERA, "I_ACRES", "!" + arcpy.Describe(ImpervERA).shapefieldname + ".AREA@ACRES!", "PYTHON", "")

    f -= 1
    print "Impervious Surface Assessment for " + str(row.Name) + " complete!"
    print "There are " + str(f) + " watersheds remaining."
    print ""
```

Code

```
#Merge all feature classes (including watersheds) and export table for use in excel.
arcpy.env.workspace = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\outputs"
flist = arcpy.ListFeatureClasses()
finalMerge = arcpy.Merge_management(flist, outputFolder + "merged\\all_Merged.shp")
arcpy.AddField_management(finalMerge, "CALC_ACRES", "DOUBLE", "", "", "")
print "Merged watershed polygon is found in " + str(finalMerge) + "."

#Make table view and calculate impervious acres based on 1", 1/2" and 0" treatment levels
tableView = arcpy.MakeTableView_management(finalMerge, "table_View")
arcpy.SelectLayerByAttribute_management(tableView,"NEW_SELECTION", ' "SWM_ERA" = 1 ')
arcpy.CalculateField_management(tableView,"CALC_ACRES",'!I_ACRES!',"PYTHON","")
arcpy.SelectLayerByAttribute_management(tableView,"NEW_SELECTION", ' "SWM_ERA" = 2 ')
arcpy.CalculateField_management(tableView,"CALC_ACRES",'!I_ACRES! / 2',"PYTHON","")
arcpy.SelectLayerByAttribute_management(tableView, "CLEAR_SELECTION")
arcpy.TableToDBASE_conversion(tableView,outputFolder + "merged\\")
print "Watershed analysis table is found in " + outputFolder + "merged\\."
```

Code

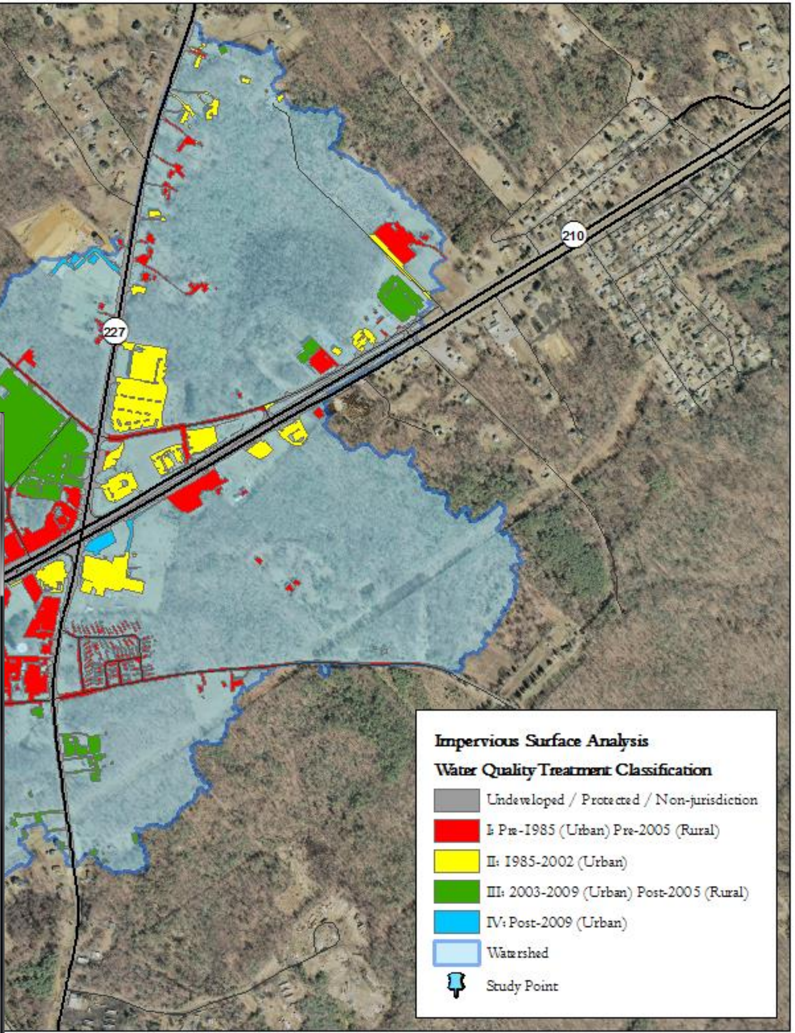
```
#Delete files in the scratch folder.
time.sleep(120)
print ""
print "Cleaning up scratch folder..."
outputScratchFolder = "C:\\Users\\sadkins\\Documents\\ArcGIS\\" + featName + "\\scratch"
for the_file in os.listdir(outputScratchFolder):
    file_path = os.path.join(outputScratchFolder, the_file)
    try:
        if os.path.isFile(file_path):
            os.unlink(file_path)
    except Exception, e:
        print e
files = glob.glob(outputScratchFolder)
try:
    for f in files:
        os.remove(f)
except Exception, e:
    print e
print "Scratch folder cleaned up!"

print ""
print "***Watershed Analysis complete!!!***"
print ""
print "Shutting down..."

time.sleep(60)
#Shutdown the computer once complete.
import subprocess
subprocess.call(["shutdown.exe","-f", "-s"])
```

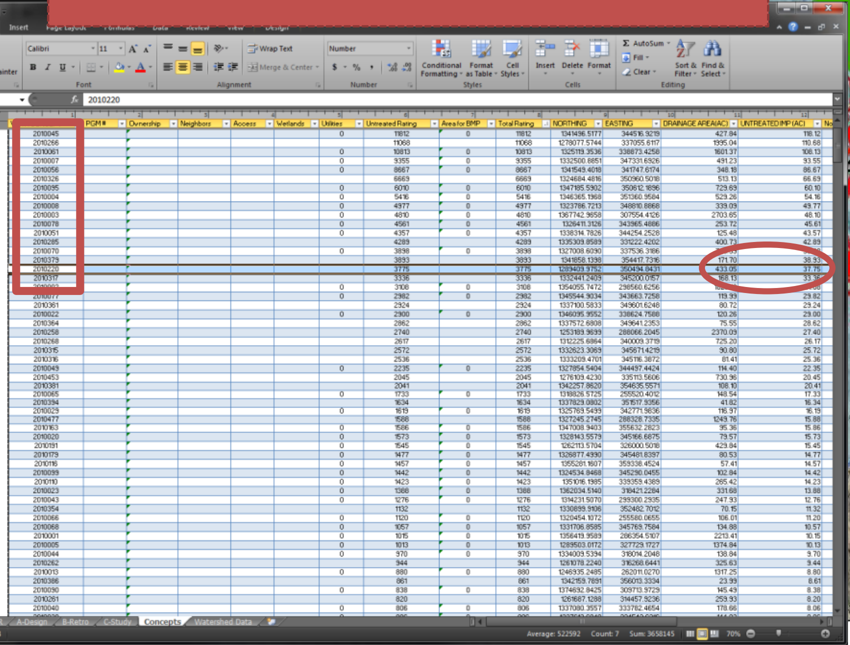
Charles County, MD
Watershed Study Point #2010220
(Bryans Road)

Watershed = **433.05 ac**
(Untreated) Impervious = **37.75 ac**



Impervious Surface Analysis
Water Quality Treatment Classification

- ▨ Undeveloped / Protected / Non-jurisdiction
- 🟥 I: Pre-1985 (Urban) Pre-2005 (Rural)
- 🟨 II: 1985-2002 (Urban)
- 🟩 III: 2003-2009 (Urban) Post-2005 (Rural)
- 🟦 IV: Post-2009 (Urban)
- ▢ Watershed
- 📍 Study Point

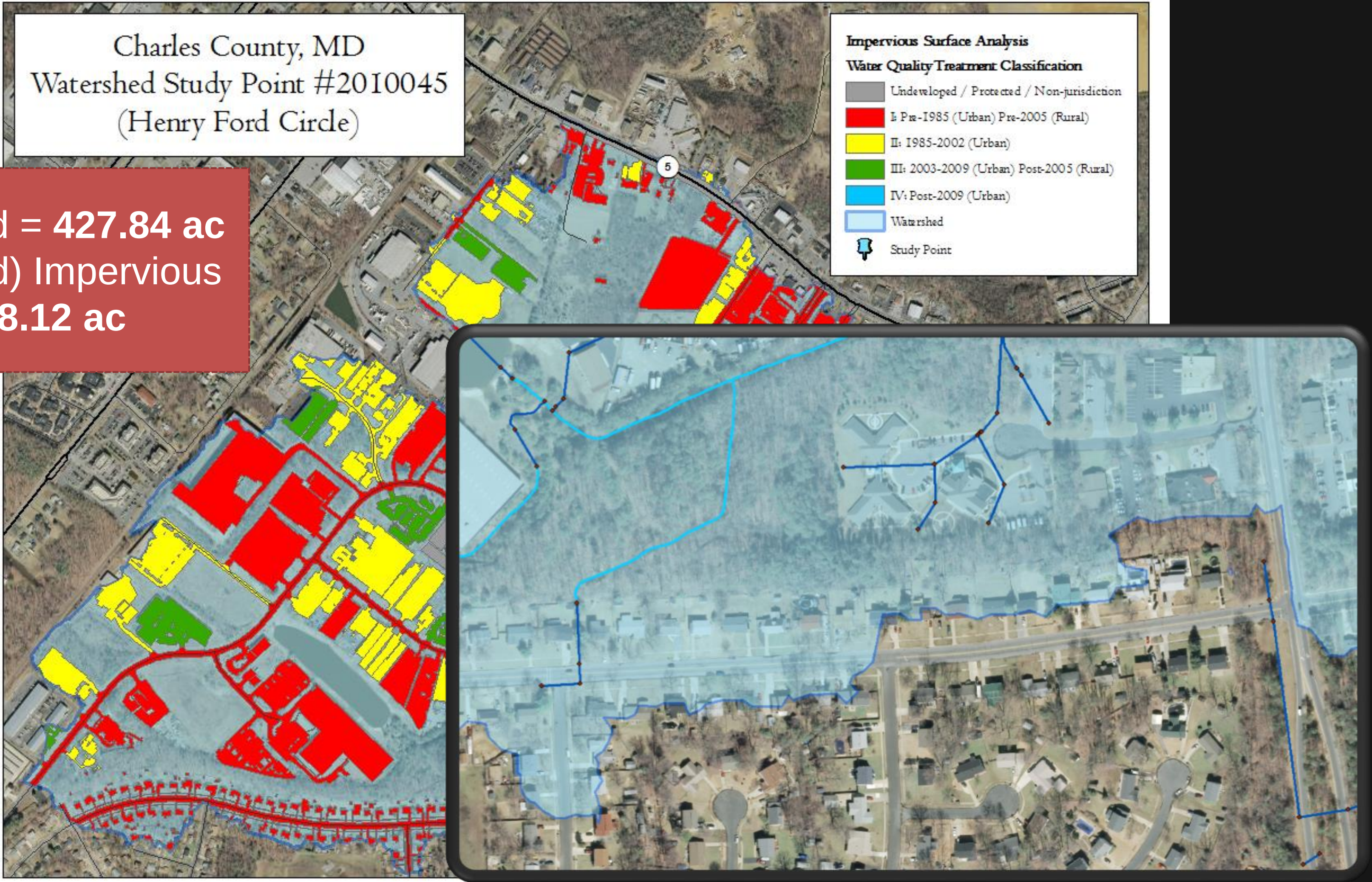


fx 2010220

	PGM #	Ownership	Neighbors	Access	Wetlands	Utilities	Untreated Rating	Area for BMP	Total Rating	NORTHING	EASTING	DRAINAGE AREA(AC)	UNTREATED IMP (AC)	No
2010045						0	11812	0	11812	1341496.5177	344516.9219	427.84	118.12	
2010266							11068		11068	1278077.5744	337055.6117	1995.04	110.68	
2010061						0	10813	0	10813	1325119.3536	338873.4258	1601.37	108.13	
2010007						0	9355	0	9355	1332500.8851	347331.6926	491.23	93.55	
2010056						0	8667	0	8667	1341549.4018	341747.6174	348.18	86.67	
2010326							6669		6669	1324684.4816	350960.5018	513.13	66.69	
2010095						0	6010	0	6010	1347185.5902	350612.1896	729.69	60.10	
2010004						0	5416	0	5416	1346365.1968	351360.9584	529.26	54.16	
2010008						0	4977	0	4977	1323786.7213	348810.8868	339.09	49.77	
2010003						0	4810	0	4810	1367742.9658	307554.4126	2703.65	48.10	
2010078						0	4561	0	4561	1326411.3126	343965.4886	253.72	45.61	
2010051						0	4357	0	4357	1338314.7826	344254.2528	125.48	43.57	
2010285							4289		4289	1335309.8589	331222.4202	400.73	42.89	
2010070						0	3898	0	3898	1327008.6090	337536.3186	[illegible]	[illegible]	
2010379							3893		3893	1341858.1398	354417.7316	171.70	38.93	
2010220							3775		3775	1289409.9752	350494.8431	433.05	37.75	
2010317							3336		3336	1332441.2409	345200.0157	168.13	33.36	
2010002						0	3108	0	3108	1354055.7472	298560.6256	[illegible]	[illegible]	
2010077						0	2982	0	2982	1345544.9034	343663.7258	119.99	29.82	
2010361							2924		2924	1337100.5833	349601.6248	80.72	29.24	
2010022						0	2900	0	2900	1346095.9552	338624.7588	120.26	29.00	
2010364							2862		2862	1337572.6808	349641.2353	75.55	28.62	
2010258							2740		2740	1253189.9699	288066.2045	2370.09	27.40	
2010268							2617		2617	1312225.6864	340009.3719	725.20	26.17	
2010315							2572		2572	1332623.3069	345671.4219	90.80	25.72	
2010316							2536		2536	1333209.4701	345116.3872	81.41	25.36	
2010049						0	2235	0	2235	1327854.5404	344497.4424	114.40	22.35	
2010453							2045		2045	1276109.4230	335113.5606	730.96	20.45	
2010381							2041		2041	1342257.8620	354635.5571	108.10	20.41	
2010065						0	1733	0	1733	1318826.5725	255520.4012	148.54	17.33	
2010394							1634		1634	1337829.0802	351517.9356	41.82	16.34	
2010029						0	1619	0	1619	1325769.5499	342771.9836	116.97	16.19	
2010477							1588		1588	1327245.2745	288328.7335	1249.76	15.88	
2010163						0	1586	0	1586	1347008.9403	355632.2823	95.36	15.86	
2010020						0	1573	0	1573	1328143.5579	345166.6875	79.57	15.73	
2010191						0	1545	0	1545	1262113.5704	326000.5018	429.84	15.45	
2010179						0	1477	0	1477	1326877.4990	345481.8397	80.53	14.77	
2010116						0	1457	0	1457	1355281.1607	359338.4524	57.41	14.57	
2010099						0	1442	0	1442	1324534.8468	345290.0455	102.84	14.42	
2010110						0	1423	0	1423	1351016.1985	339359.4389	265.42	14.23	
2010023						0	1388	0	1388	1362034.5140	318421.2284	331.68	13.88	
2010043						0	1276	0	1276	1314231.5070	299300.2935	247.93	12.76	
2010354							1132		1132	1330899.9106	352482.7012	70.15	11.32	
2010066						0	1120	0	1120	1320454.1072	255580.0655	106.01	11.20	
2010068						0	1057	0	1057	1331706.8585	345769.7584	134.88	10.57	
2010001						0	1015	0	1015	1356419.9589	286354.5107	2213.41	10.15	
2010005						0	1013	0	1013	1289503.0172	327729.1727	1374.84	10.13	
2010044						0	970	0	970	1334009.5394	318014.2048	138.84	9.70	
2010262							944		944	1261078.2240	316268.6441	325.63	9.44	
2010013						0	880	0	880	1246935.2485	262011.0270	1317.25	8.80	
2010386							861		861	1342159.7891	356013.3334	23.99	8.61	
2010090						0	838	0	838	1374692.8425	309713.9729	145.49	8.38	
2010261							820		820	1261687.1288	314457.9236	259.93	8.20	
2010040						0	806	0	806	1337080.3557	333782.4654	178.66	8.06	

Average: 522592 Count: 7 Sum: 3658145 70%

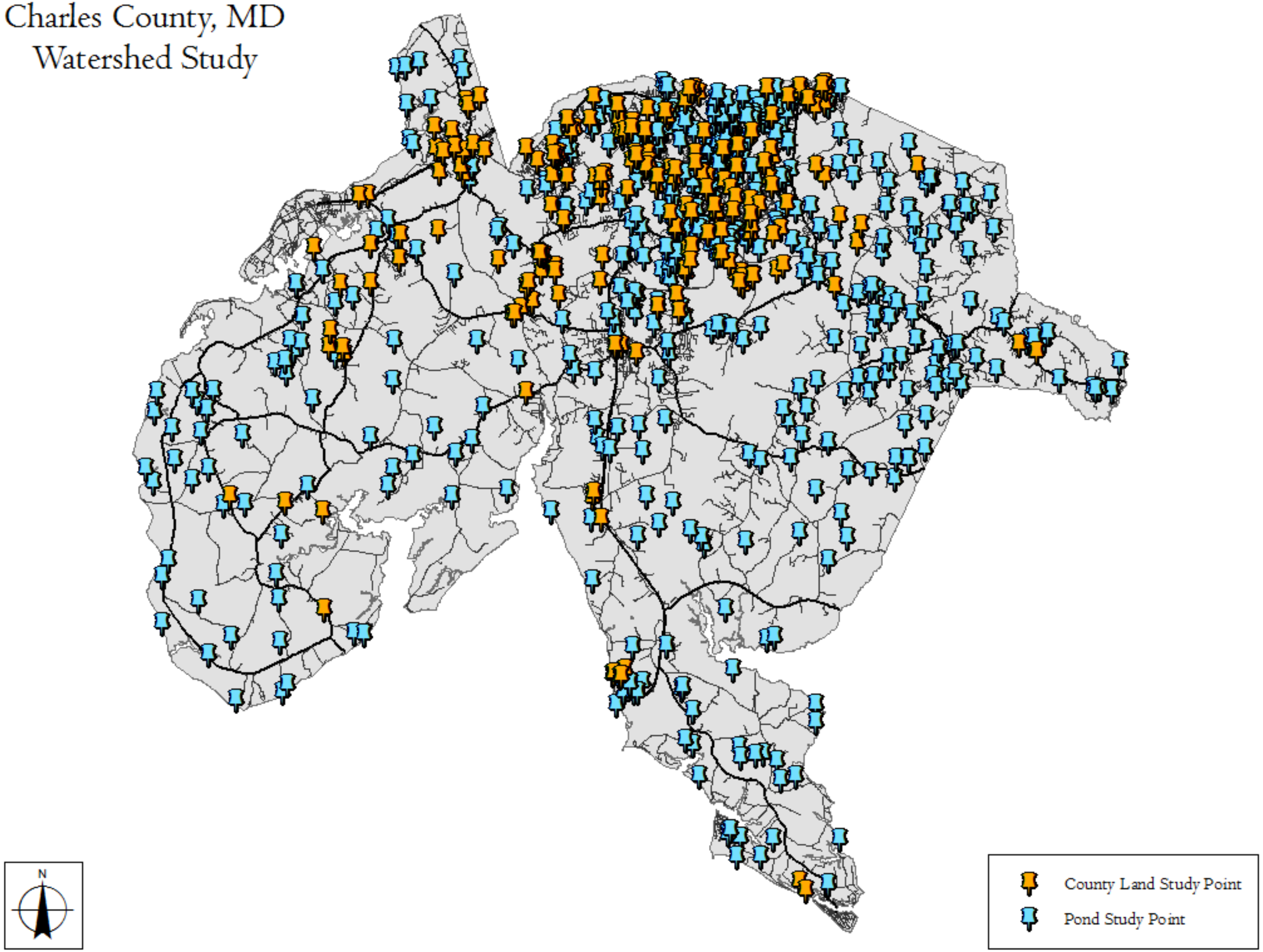
Watershed = **427.84 ac**
(Untreated) Impervious
= **118.12 ac**



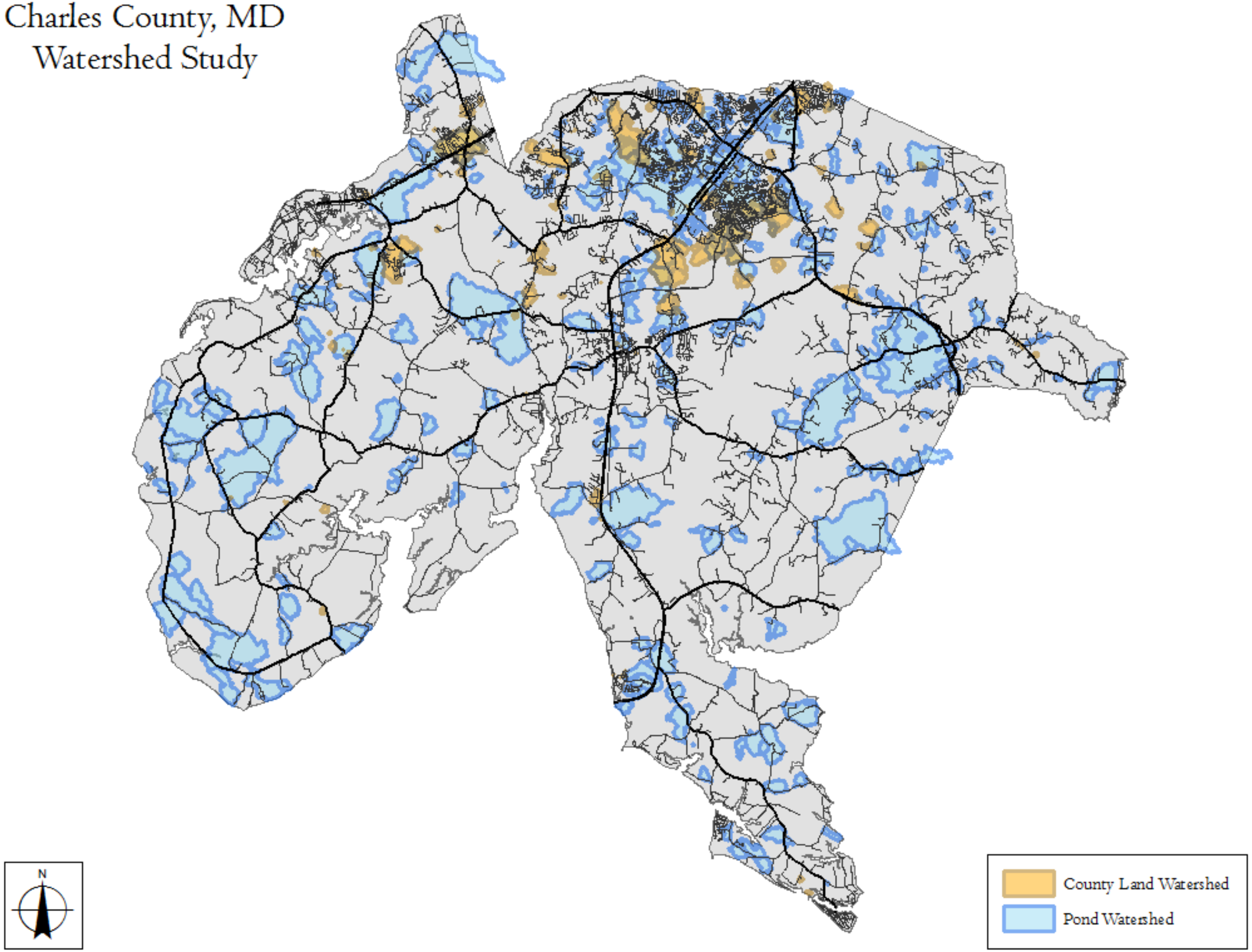
Charles County, MD
Watershed Study Point #2010045
(Henry Ford Circle)

Impervious Surface Analysis
Water Quality Treatment Classification
Undeveloped / Protected / Non-jurisdiction
I: Pre-1985 (Urban) Pre-2005 (Rural)
II: 1985-2002 (Urban)
III: 2003-2009 (Urban) Post-2005 (Rural)
IV: Post-2009 (Urban)
Watershed
Study Point
5

Charles County, MD
Watershed Study



Charles County, MD
Watershed Study



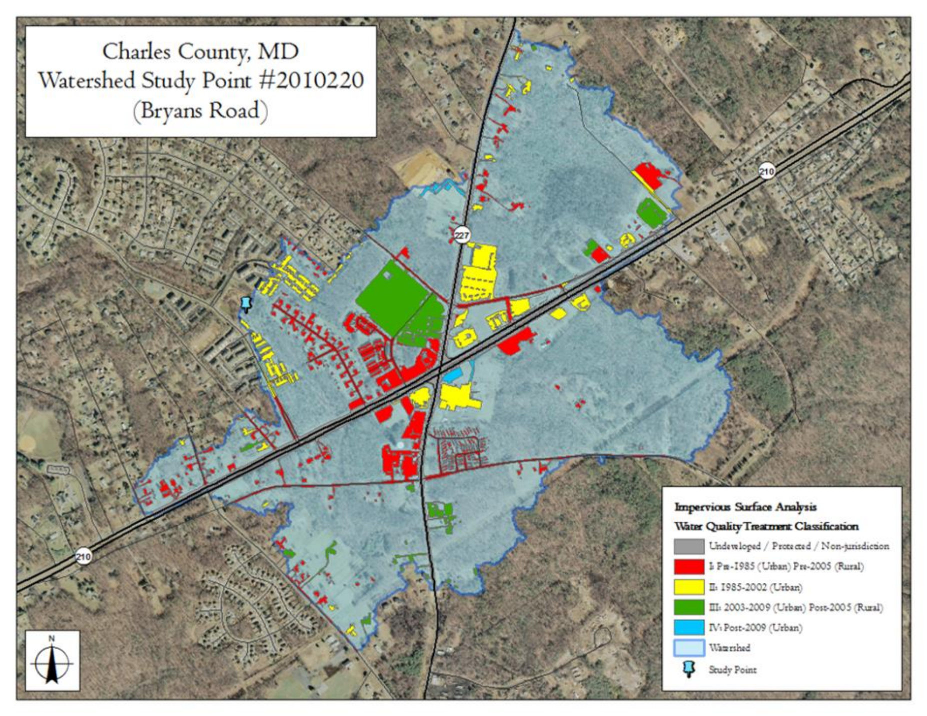
Conclusion

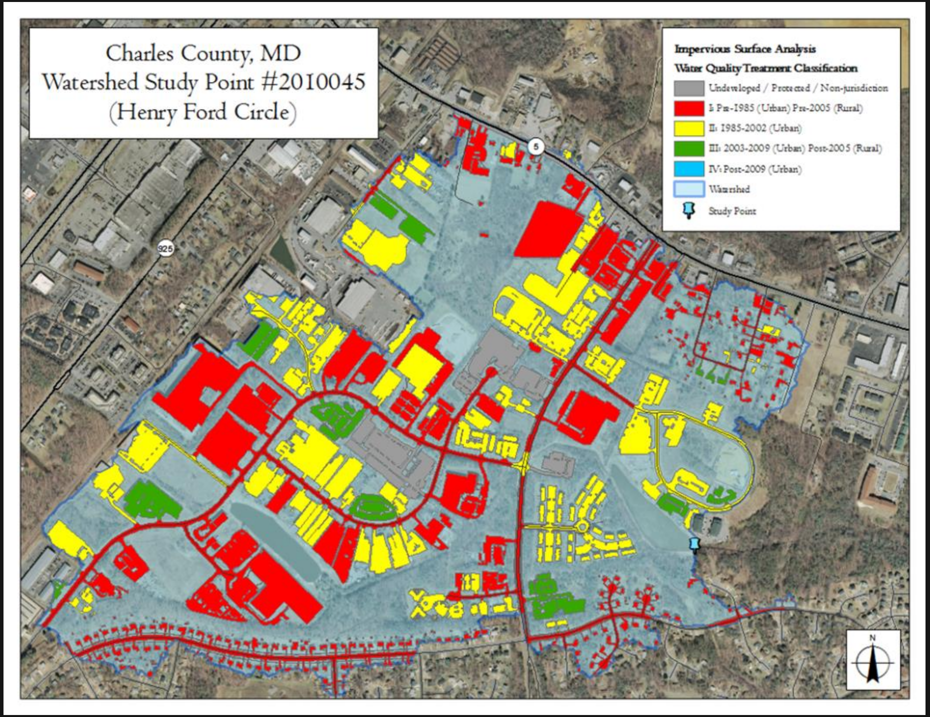
- Time Savings
- Accuracy
- High Quality Analysis
- Save client $$
- Applicable to any jurisdiction

Future?

- Higher resolution LiDAR data
- More complete LiDAR dataset
- More complete SWM network
- Cleaner code & pivot table functionality
- Help other jurisdictions with their MS4

Questions?


Charles County, MD
Watershed Study Point #2010220
(Bryans Road)
210
227
210
Impervious Surface Analysis
Water Quality Treatment Classification
Undeveloped / Protected / Non-jurisdiction
I: Pre-1985 (Urban) Pre-2005 (Rural)
II: 1985-2002 (Urban)
III: 2003-2009 (Urban) Post-2005 (Rural)
IV: Post-2009 (Urban)
Watershed
Study Point
N


Charles County, MD
Watershed Study Point #2010045
(Henry Ford Circle)
Impervious Surface Analysis
Water Quality Treatment Classification
Undeveloped / Protected / Non-jurisdiction
I: Pre-1985 (Urban) Pre-2005 (Rural)
II: 1985-2002 (Urban)
III: 2003-2009 (Urban) Post-2005 (Rural)
IV: Post-2009 (Urban)
Watershed
Study Point
5
925
N

vistadesigninc.com bit.ly/1xe5aao