Leveraging GIS data and tools for maintaining hydraulic sewer models

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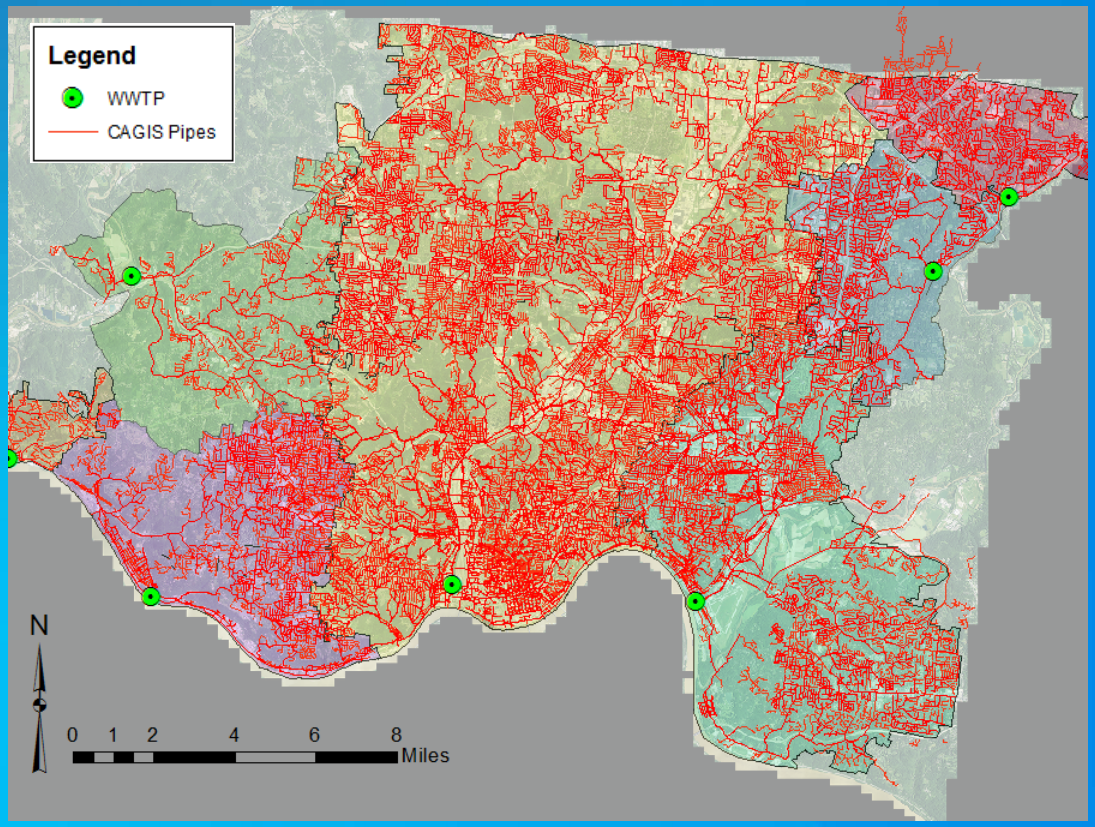
- 14 years of experience with MSDGC SWMM model
- Licensed Professional Engineer: Ohio
- B.S. Civil Engineering, University of Cincinnati
- Interests: Outdoor Activities with my Family

Agenda

- Background
- Challenges and Goals
- Update Process & GIS Tools
- Lessons Learned

Background
Metropolitan Sewer District of Greater Cincinnati

- Serving 855,000 people
- Annual Operating budget: $234 Million
- 290 Square Mile Service Area
- 7 Wastewater Treatment Plants
- 120 Pump Stations
- Over 100,000 pipes and manholes



Background

Cincinnati Area Geographic Information System (CAGIS)

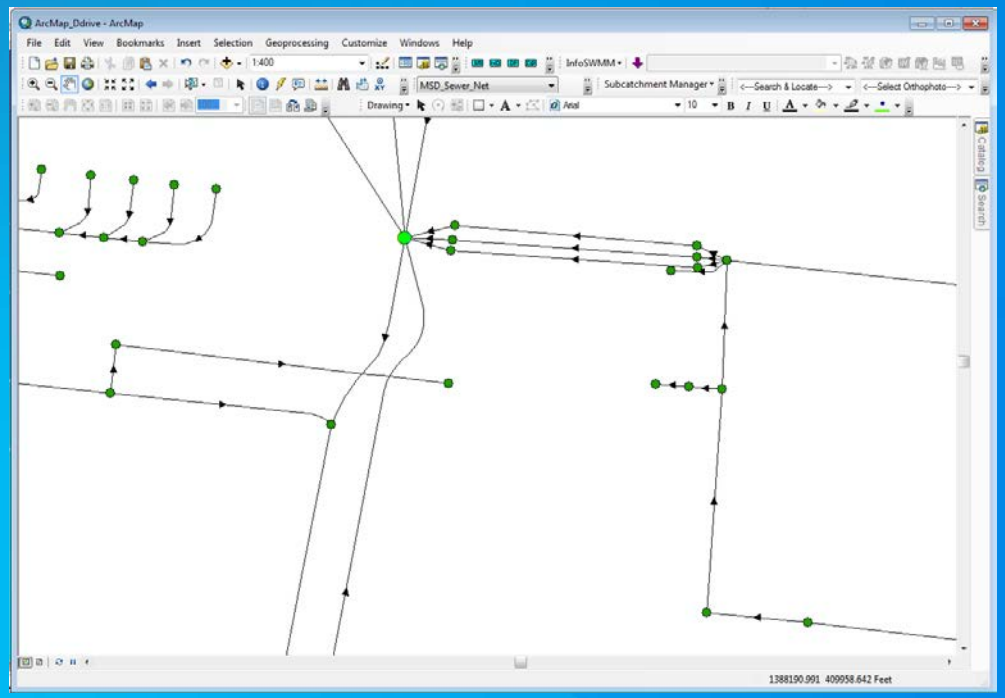
- Established in 1987 as a cooperative agreement
- Centralized data
- "CAGIS offers governments, utilities, companies, groups, or citizens a new, intelligent, and cost effective tool to make informed decisions based on shared data within a standard framework"

http://cagismaps.hamilton-co.org/cagisportal/About/history

Background

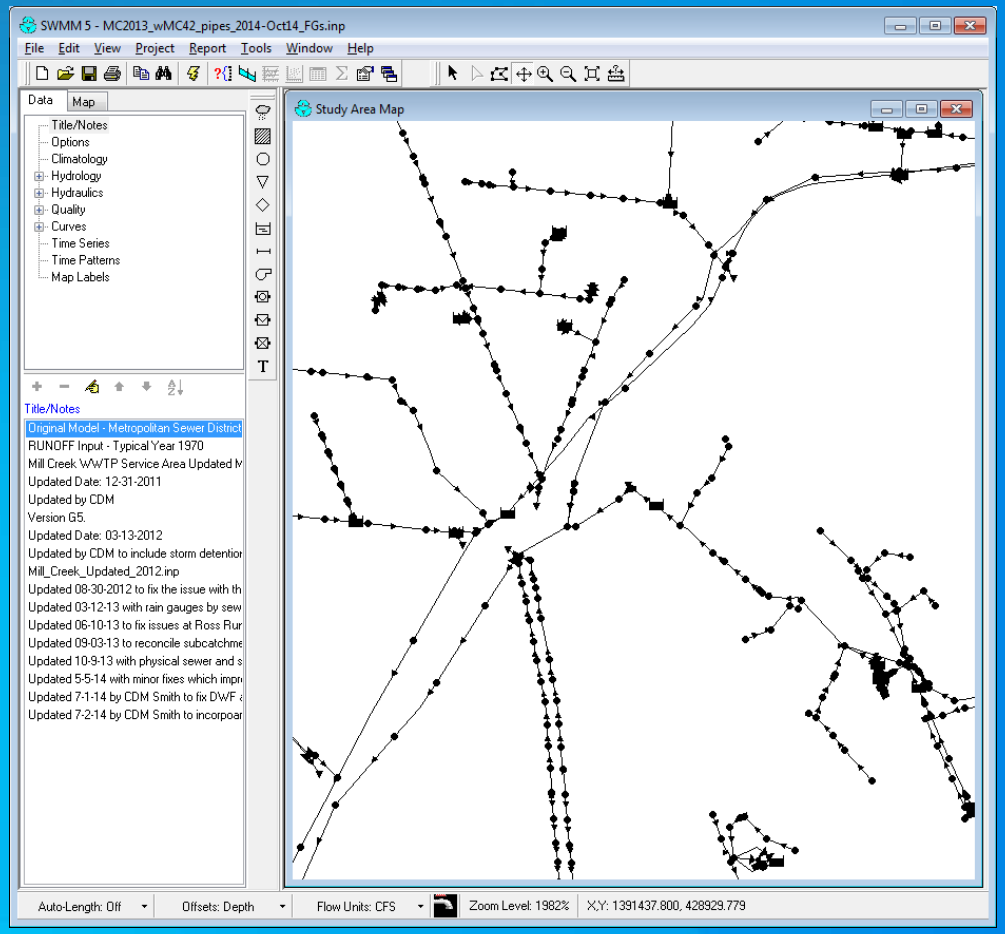
Cincinnati Area Geographic Information System (CAGIS)

- Contains most up-to-date information
- Reflecting most recent completed CIPs
- Contains Attributes of all MSDGC Assets
  - Manhole X,Y coordinates
  - Pipe Invert/size Information

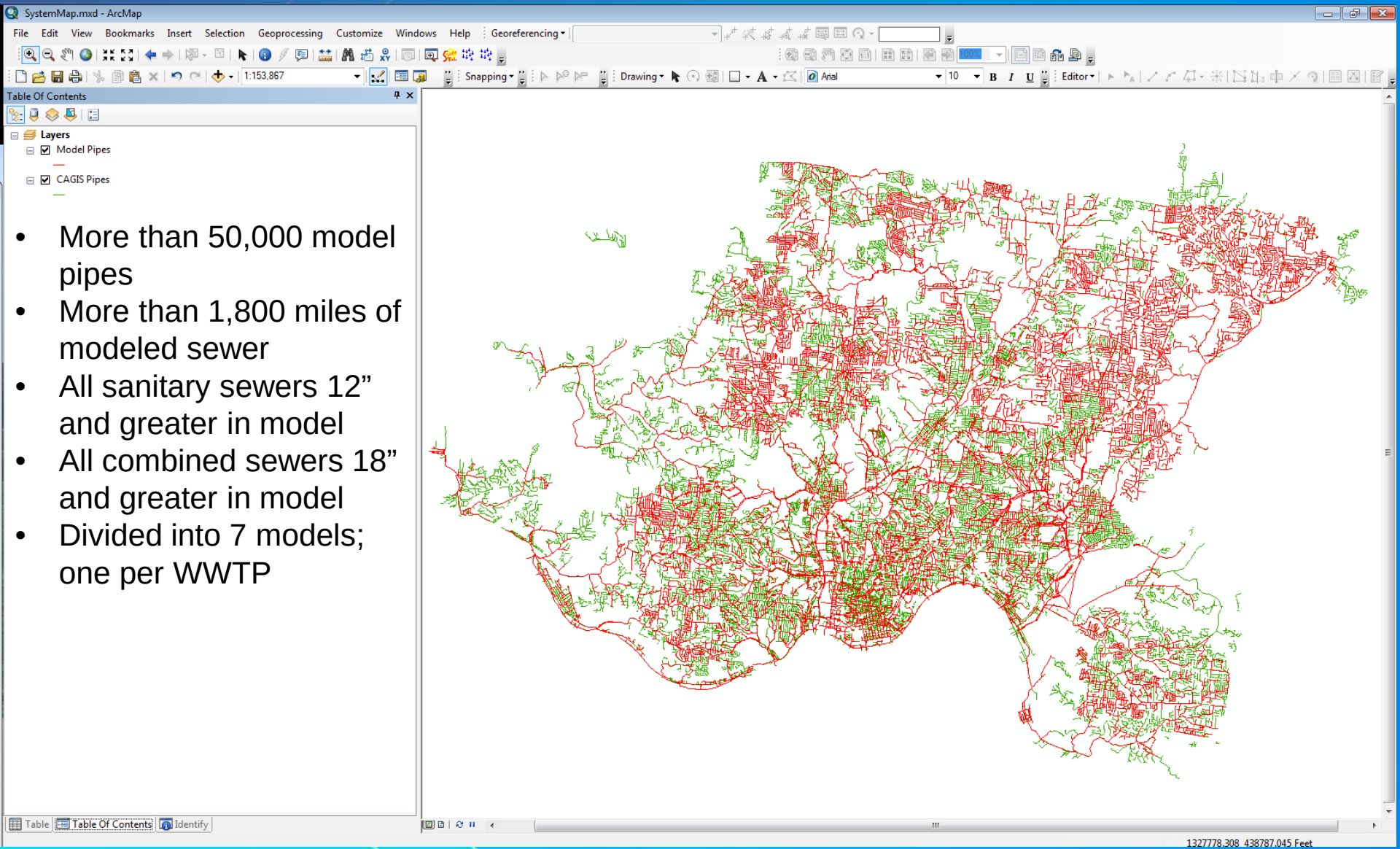


Background
System Wide Model

- Developed between 2000-2003 using CAGIS data
- A planning tool to support Capital Improvement Projects (CIP) and Wet Weather Improvement Program (WWIP)
- WWIP – as a result of Consent Decree, over $1.14B of Phase I improvement projects



Background
System Wide Model



- More than 50,000 model pipes
- More than 1,800 miles of modeled sewer
- All sanitary sewers 12” and greater in model
- All combined sewers 18” and greater in model
- Divided into 7 models; one per WWTP

MSDGC's Challenge

- Maintaining an accurate, up-to-date model
  - Essential for assessing the merits of proposed projects
- CAGIS is continuously updated
- Model attributes vs. GIS attributes

Review	Decision	MH Depth	Pipe Invert	Length
Manual Review	Updated	1,617	1,786	4,968
	Not Updated	3,995	1,391	151
No Review	Bulk Updated	5,155	2,478	35,506

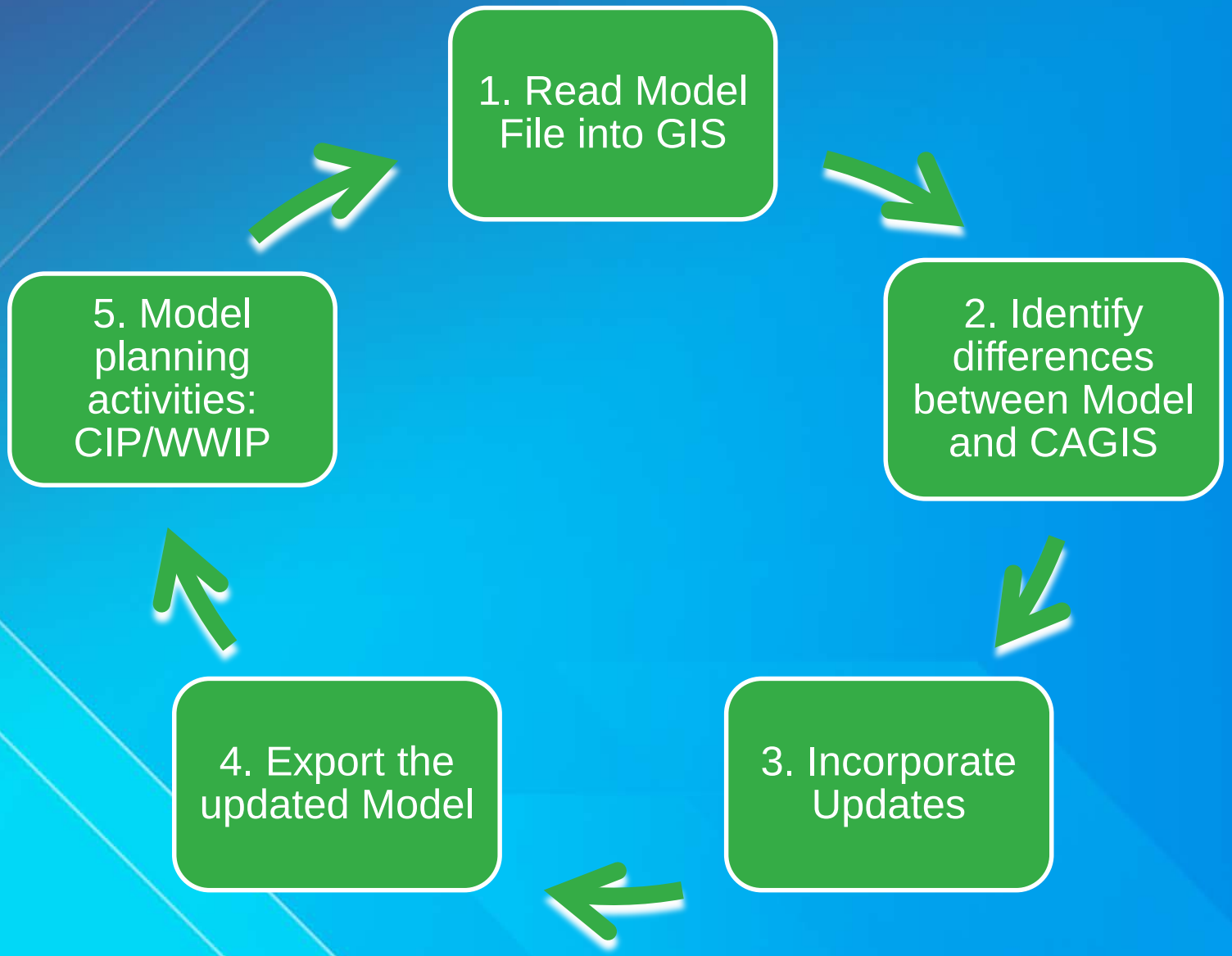
Project Goals

- Continue to keep SWM up-to-date, including recent completed projects
- Develop GIS Tools that can make update process efficient with built-in quality control
- Provide user with the ability to decide which value to update and which to keep; and document user decisions

MSDGC’s GIS Tools

- Model Input Tool
- Comparison Tool
- Model Updates Decision Support Tool

Model Update Workflow



Step 1: Read Model File into GIS

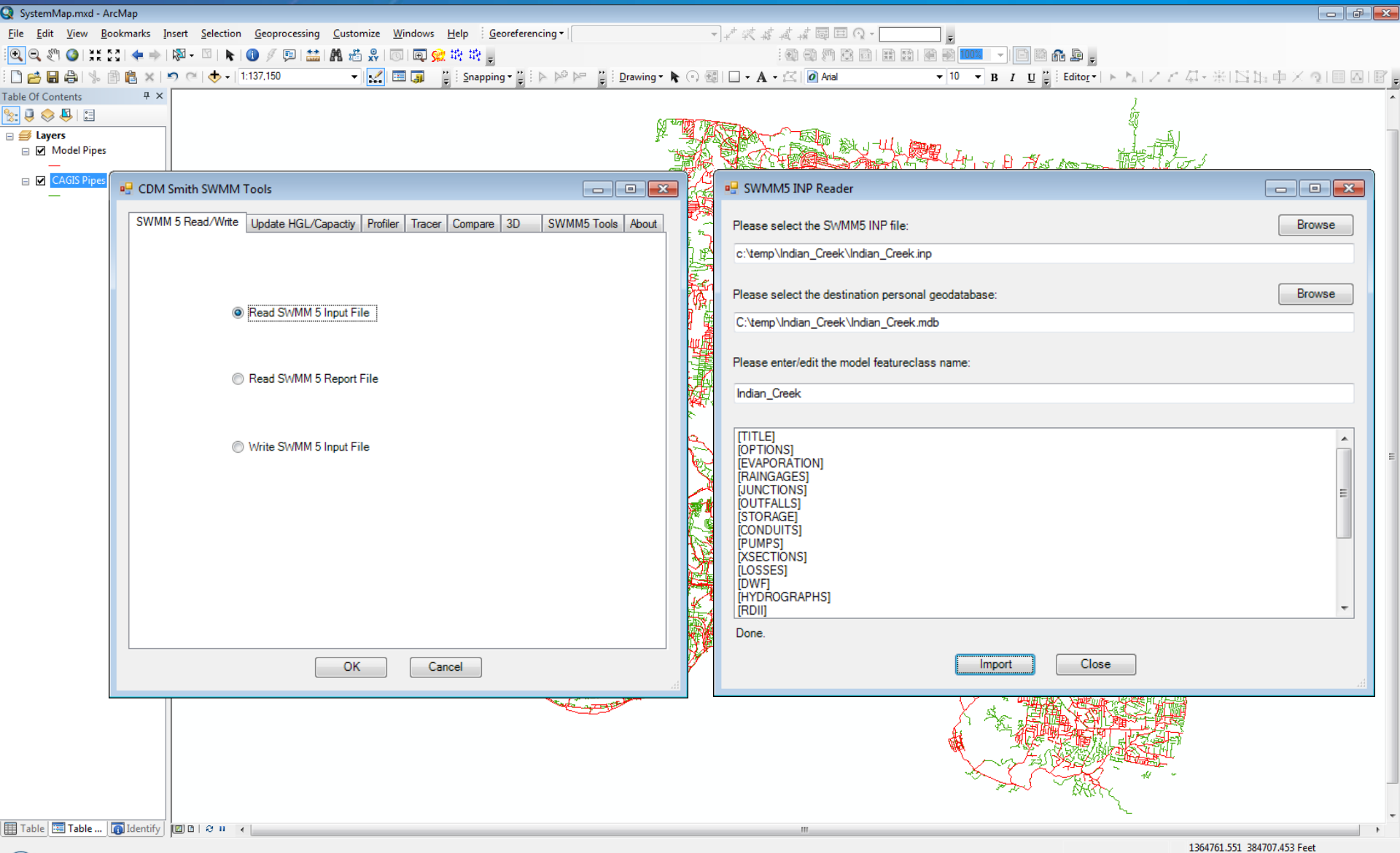
- The SWM is in the U.S. EPA Storm Water Management Model (SWMM) INP file format, a text-based format
- The model input tool consolidates many different sections from the INP file and creates three GIS layers:
  - Point Layer: Junctions (manholes)
  - Line Layer: Conduits (pipes)
  - Polygon Layer: Subcatchments (drainage areas)
- The model input tool reads the remaining sections of the input file (settings, dry weather loading, rainfall, etc.) and stores these in a database table

MC2013_wMC42_pipes_2014-Oct14_FGs10yr.inp - Notepad

File Edit Format View Help

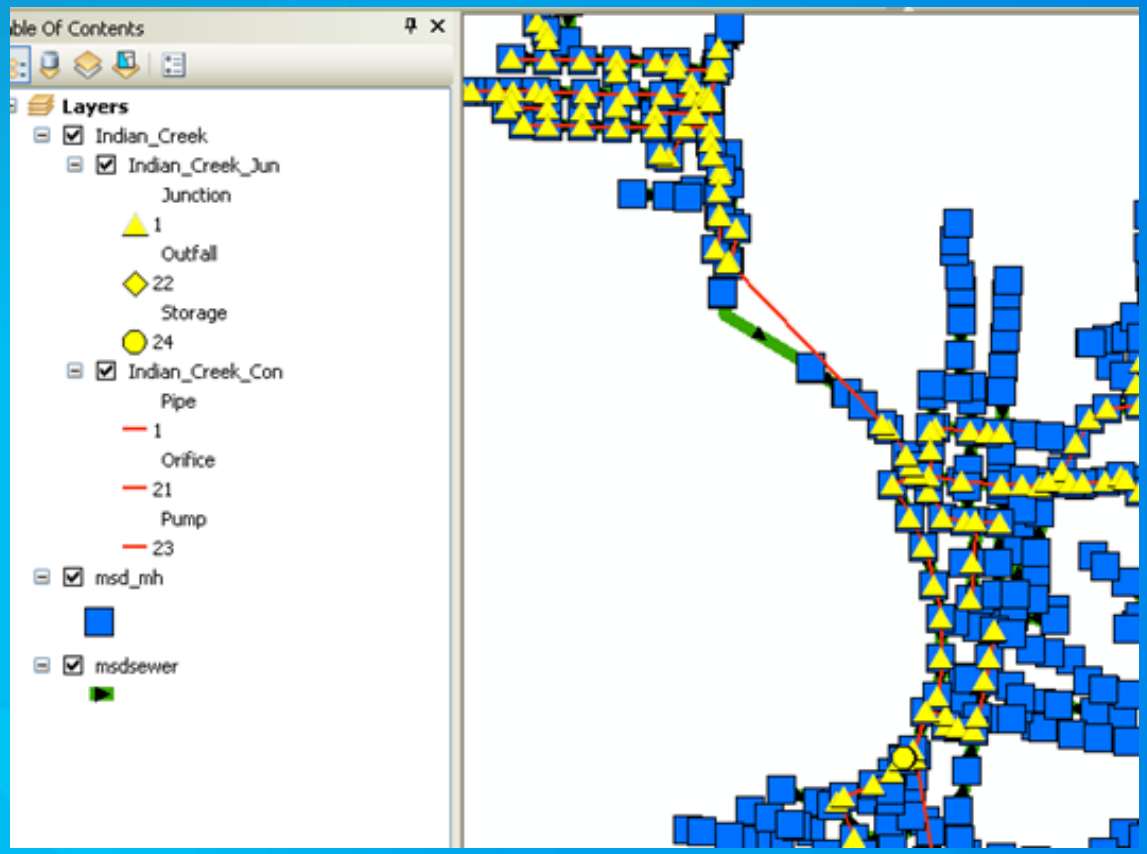
```
[STORAGE]
;;                Invert    Max.      Init.     Storage   Curve                                Ponded    Evap.
;;Name            Elev.     Depth     Depth     Curve     Params                               Area      Frac.     Infiltration Parameters
;;--------------- --------- --------- --------- --------- --------- --------- --------- --------- --------- ----------------------
28602028          550.3     18        0         FUNCTIONAL 0        0         0.001     0         0
; Blind
28709017          642.92    9.08      0         FUNCTIONAL 0        0         0.001     0         0
; Blind
28605038          478.74    15        0         FUNCTIONAL 0        0         0.001     0         0
25409003          709.49    10.51     0         FUNCTIONAL 0        0         1000      0         0
25409008          737.58    6         0         FUNCTIONAL 0        0         1000      0         0
```

Step 1: Read Model File into GIS – Model Input Tool



Step 2: Identify Differences between Model and CAGIS – Comparison Tool

- Different symbols/colors for Model and CAGIS
- Make both visible simultaneously
- Use direction arrows

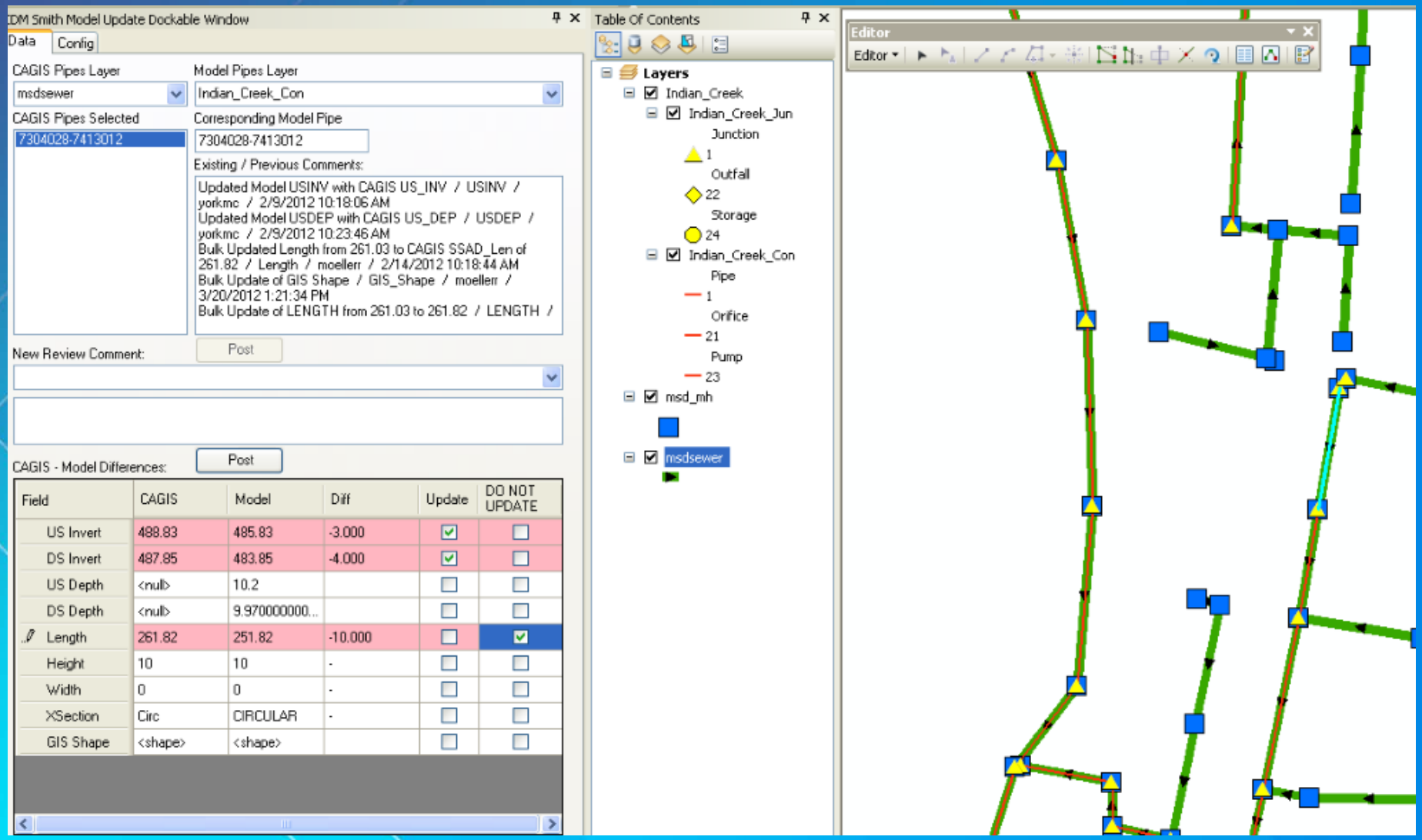


Step 2: Identify Differences between CAGIS and Model

- Decision Tree Logic to classify differences
- User-defined thresholds
- Ease of tracking

All	High 447	Med-High 129	Medium 473	Med-Low 480	Auto Update 4245	None 4438	Override 0
Length 4319	> 100 0	> 25 23	> 10 128	> 5 203	> 0 3725	= 0 240	0
USINV 4087	> 10 5	> 2.5 20	> 1.0 24	> 0.5 34	> 0 210	= 0 3794	0
DSINV 4061	> 10 9	> 2.5 32	> 1.0 28	> 0.5 44	> 0 242	= 0 3706	0
Height 4198	> 2 0	> 1 2	> 0.5 2	> 0.25 9	> 0.04 5	<= 0.04 4180	0
USDEP 4104	> 100 135	> 25 13	> 10 124	> 5 83	> 0 681	= 0 3068	0
DSDEP 3470	> 100 156	> 25 14	> 10 164	> 5 103	> 0 737	= 0 2296	0
GIS Length 4127	> 100 3	> 25 47	> 10 102	> 5 101	> 0 3874	= 0 0	0

Step 3: Incorporate Updates – Decision Support Tool



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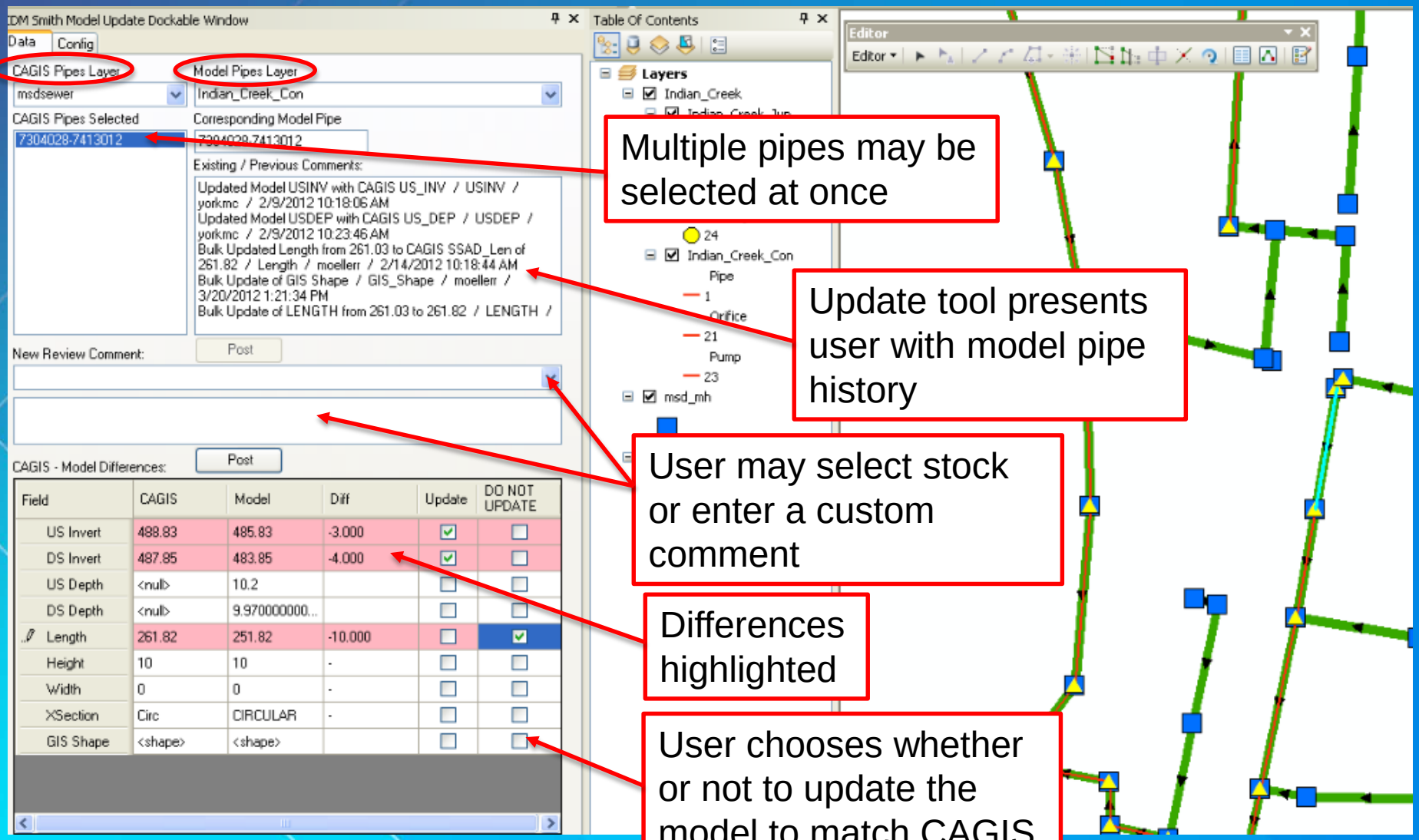


Step 3: Incorporate Updates

- All comments and model changes are automatically logged in a database
- Documents rational behind decisions

ReviewComments

PIPEID	Comment	User	Date
11705013-11705012	CAGIS data newer than previous model update/mod	yorkmc	03/29/2011 2:00:30 PM
11705013-11705012	Updated Model DSINV with CAGIS DS_INV	yorkmc	03/29/2011 2:00:20 PM
11705013-11705012	Updated Model USINV with CAGIS US_INV	yorkmc	03/29/2011 2:00:18 PM
11705013-11705012	Updated Model GIS SHAPE with CAGIS GIS SHAPE	yorkmc	03/29/2011 1:57:35 PM
11705013-11705012	Bulk Update of LENGTH from 271.53 to 271.5	moellerr	03/11/2011 2:38:30 PM
11705014-11705013	CAGIS data newer than previous model update/mod	yorkmc	03/30/2011 3:10:06 PM
11705014-11705013	Updated Model DSINV with CAGIS DS_INV	yorkmc	03/30/2011 3:10:02 PM
11705014-11705013	Updated Model USINV with CAGIS US_INV	yorkmc	03/30/2011 3:10:00 PM
11705014-11705013	Updated Model GIS SHAPE with CAGIS GIS SHAPE	yorkmc	03/29/2011 1:57:53 PM
11705014-11705013	Bulk Update of LENGTH from 151.11 to 151.15	moellerr	03/11/2011 2:38:30 PM
11705015-11705014	CAGIS data newer than previous model update/mod	yorkmc	03/30/2011 3:09:07 PM
11705015-11705014	Updated Model DSINV with CAGIS DS_INV	yorkmc	03/30/2011 3:09:02 PM
11705015-11705014	Updated Model USINV with CAGIS US_INV	yorkmc	03/30/2011 3:09:01 PM
11705015-11705014	Updated Model GIS SHAPE with CAGIS GIS SHAPE	yorkmc	03/29/2011 1:57:41 PM
11705015-11705014	Bulk Update of LENGTH from 168.77 to 171.94	moellerr	03/11/2011 2:38:30 PM
11705016-11705010	Updated Model GIS SHAPE with CAGIS GIS SHAPE	moellerr	03/16/2011 5:56:00 PM
11705016-11705010	Bulk Update of USINV from 763.79 to 763.72	moellerr	03/11/2011 2:39:18 PM
11705016-11705010	Bulk Update of LENGTH from 254.05 to 254.02	moellerr	03/11/2011 2:38:30 PM
11705016-11705010	Bulk Update of DSINV from 686.9 to 687.38	moellerr	03/11/2011 2:37:02 PM
11706001-11706002	Updated Model GIS SHAPE with CAGIS GIS SHAPE	yorkmc	03/30/2011 3:13:40 PM
11706001-11706002	Bulk Update of USINV from 563.69 to 564.17	moellerr	03/11/2011 2:39:18 PM
11706001-11706002	Bulk Update of LENGTH from 49.55 to 49.42	moellerr	03/11/2011 2:38:30 PM
11706001-11706002	Bulk Update of GIS Shape	moellerr	03/11/2011 2:37:40 PM
11706001-11706002	Bulk Update of DSINV from 557.45 to 557.49	moellerr	03/11/2011 2:37:02 PM
11706002-11707005	CAGIS data newer than previous model update/mod	yorkmc	03/30/2011 3:12:59 PM
11706002-11707005	Updated Model GIS SHAPE with CAGIS GIS SHAPE	yorkmc	03/30/2011 3:12:54 PM
11706002-11707005	Updated Model USINV with CAGIS US_INV	yorkmc	03/30/2011 3:12:51 PM
11706002-11707005	Bulk Update of LENGTH from 295.63 to 296.54	moellerr	03/11/2011 2:38:30 PM
11706002-11707005	Bulk Update of GIS Shape	moellerr	03/11/2011 2:37:40 PM

Record: 1 of 62627 No Filter Search

Step 3: Incorporate Updates

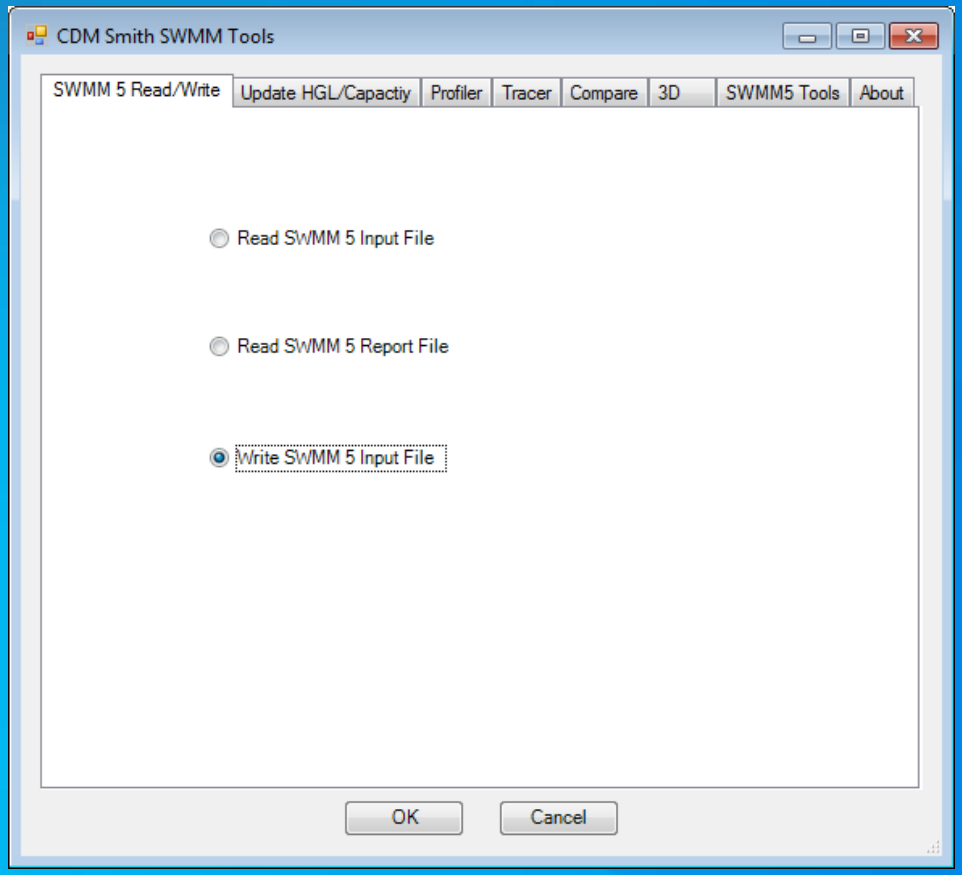
- Minor/marginal changes are updated in bulk without manual review
- This is done with queries in Microsoft Access to perform and document the changes

LM2012_Add_Bulk_Update_Comments_DSINV

```
INSERT INTO ReviewComments ( PIPEID, Comment, [USER], [Date], Category, ModelUpdatedwCAGIS )
SELECT PIPE, "Bulk Updated DSINV from "+CStr(DSINV)+" to CAGIS Value of "+CStr(DS_INV), "yorkmc", Now, "DSINV", TRUE
FROM LM2012_Bulk_DSINV;
```

Step 4: Export the Updated Model

- An INP file is exported from GIS using the custom tools
- Exported file is reviewed and debugged
- Model is now available for Step 5 : Planning activities for CIP/WWIP



Lessons Learned

- Model Inputs and GIS data are not the same
  - 1 : 1 relationship between model and GIS is impractical
- Both the model and GIS are evolving, requiring periodic model updates
- GIS can be a powerful tool for keeping the model current
  - Needs a systematic method to streamline the updates and decision making
- Integration with a database to track model changes and decisions allows for tools to streamline the update process

Questions?