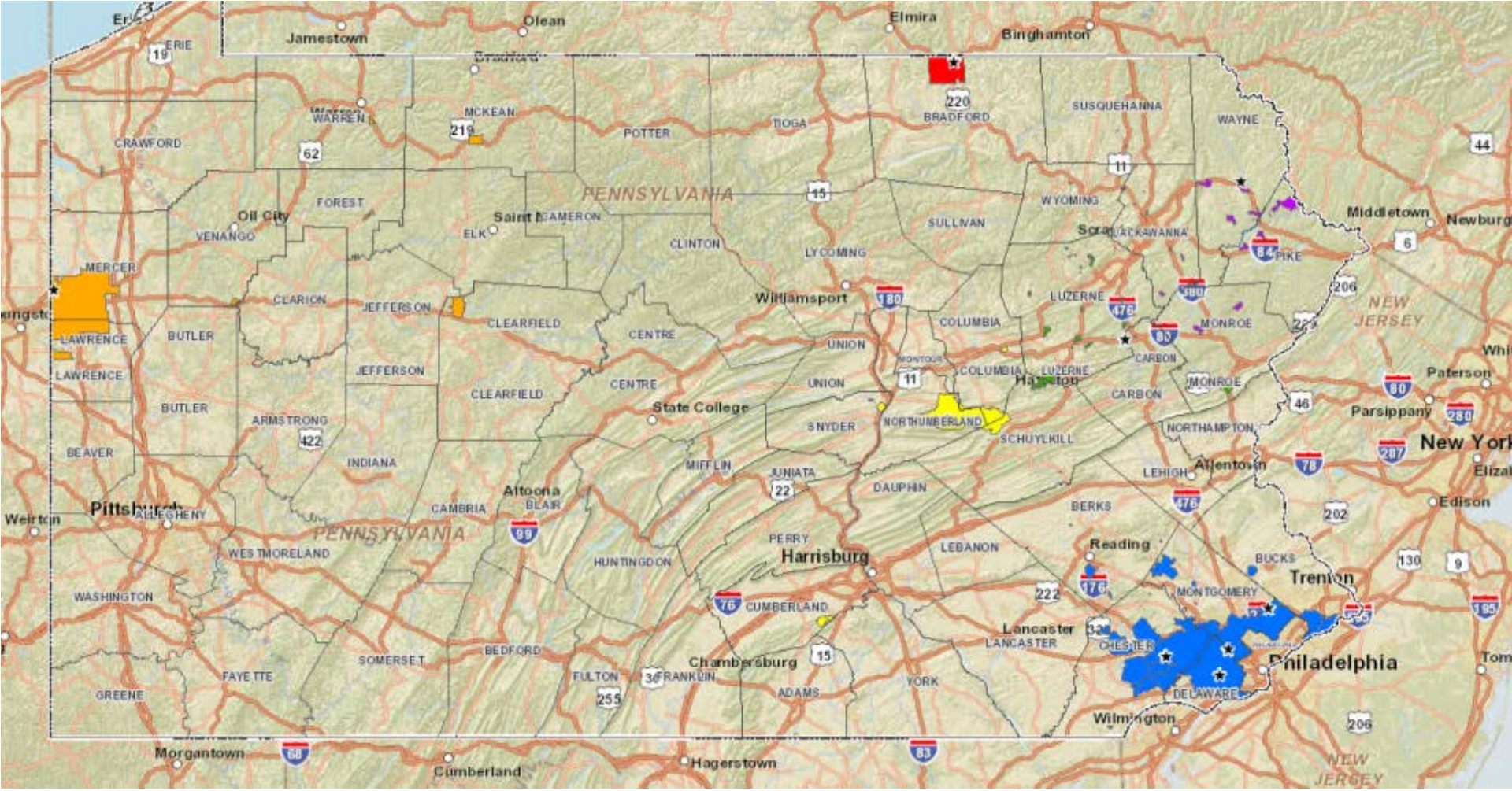
Practical Application of GIS to Hydraulic Modeling

AQUA

Esri Water Conference
February 10, 2016

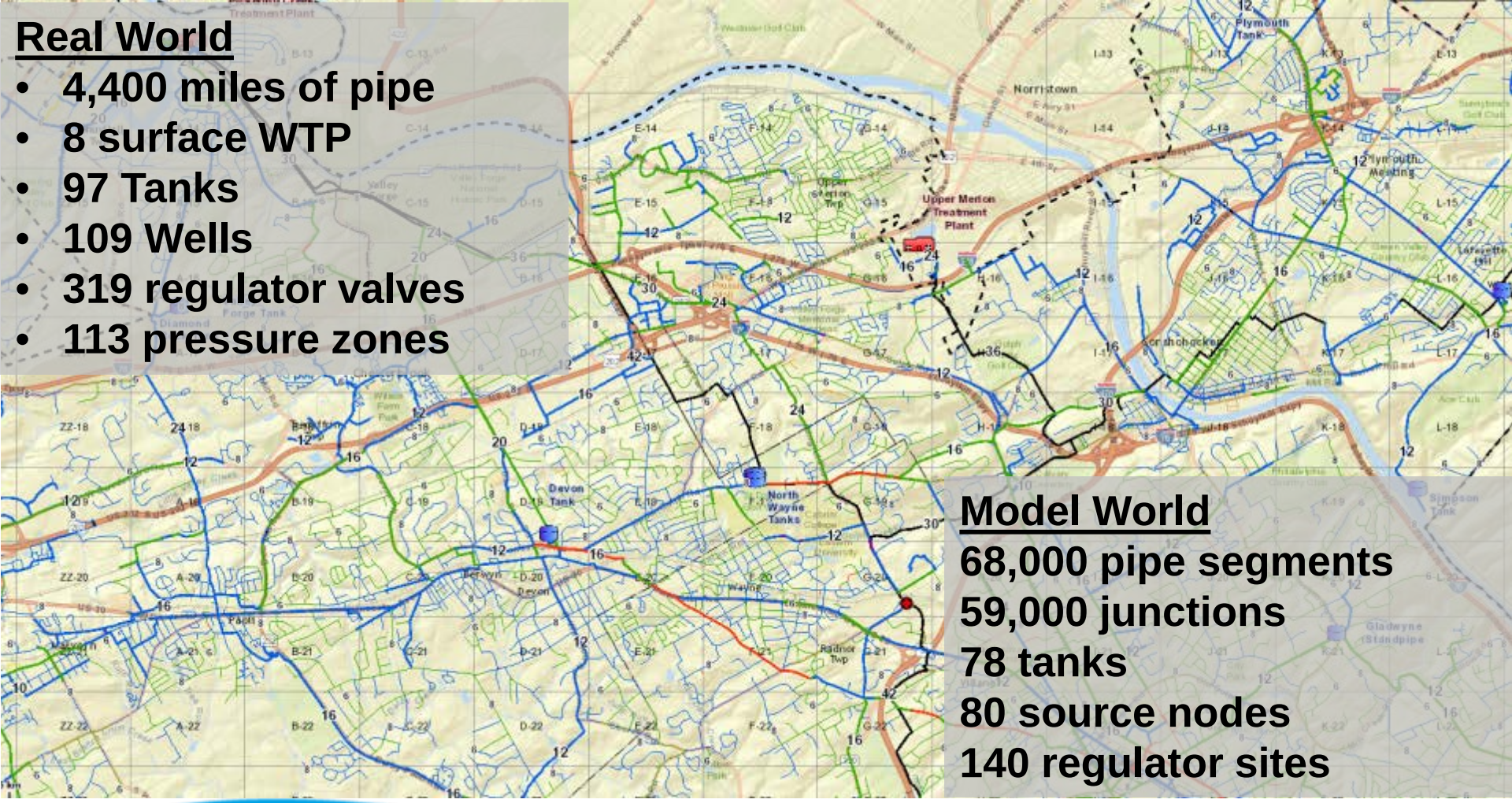
- **Aqua America**
  - Investor owned water and wastewater utility
  - 3 million people served across 8 states
  - Celebrating our 130th anniversary in 2016
- **Aqua Pennsylvania**
  - Largest operating company
  - Southeast PA surrounding Philadelphia and smaller systems throughout PA

Aqua America overview



Aqua Pennsylvania

Esri Water Conference
February 10, 2016



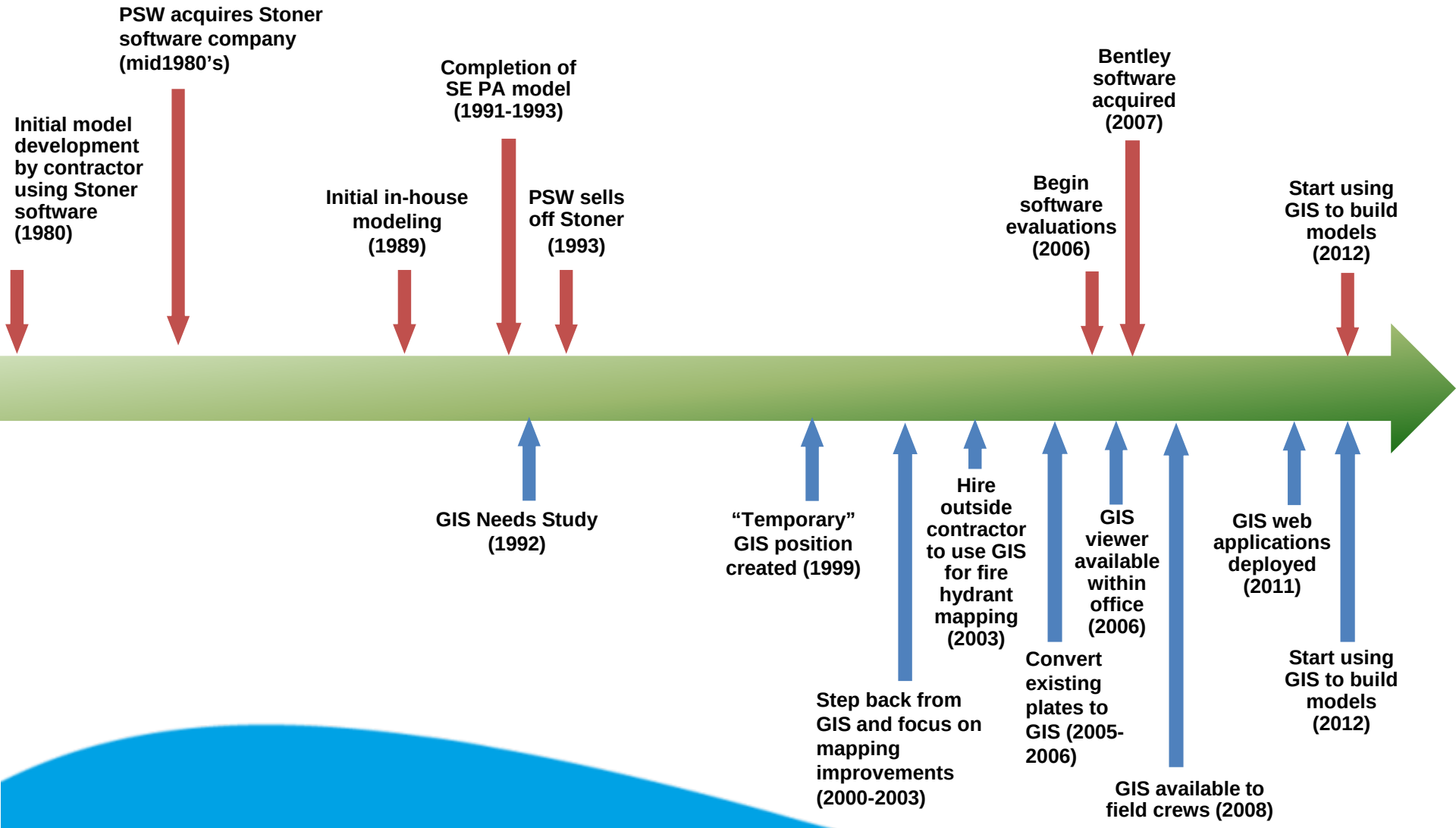
Real World

- 4,400 miles of pipe
- 8 surface WTP
- 97 Tanks
- 109 Wells
- 319 regulator valves
- 113 pressure zones

Model World

68,000 pipe segments
59,000 junctions
78 tanks
80 source nodes
140 regulator sites

Southeast PA territory



Modeling and GIS Timelines at Aqua PA

Esri Water Conference
February 10, 2016

Q: How do we meet our hydraulic modeling needs given…

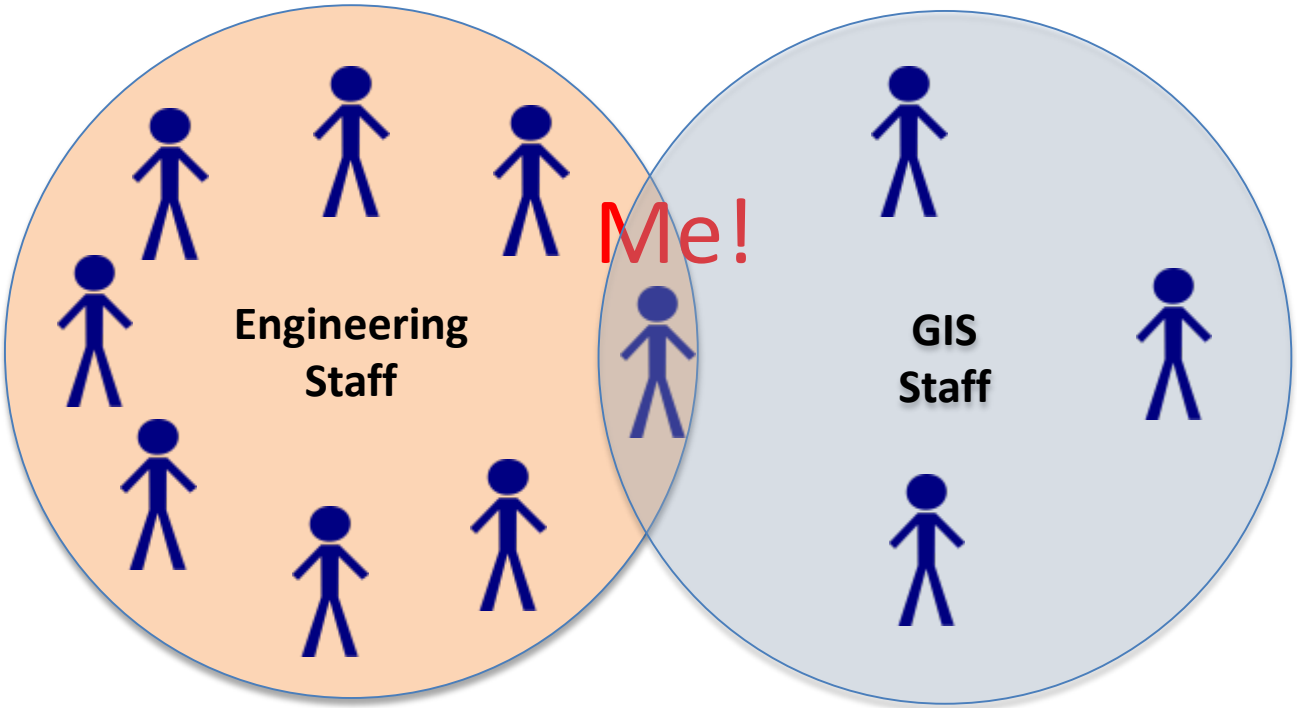
- Limited personnel resources
- Need to work across organizational boundaries
- Increased demand for hydraulic modeling
- Need to update the existing model and create a sustainable process for maintaining the model moving forward

A: We use GIS!

Hydraulic Modeling Challenges

- Limited staff experience with hydraulic modeling
- Hydraulic modeling experts busy with new responsibilities
- Losing experienced staff
  - Aqua PA had multiple 40+ year anniversaries in 2015
  - Superintendent of Network Operations nearing retirement

Personnel Challenges



Who has the skills needed to use GIS for hydraulic modeling?

Personnel Challenges

- ~~Train Aqua engineers to use GIS~~
- ~~Train Aqua GIS staff to use hydraulic model~~
- Utilize contractors ✓

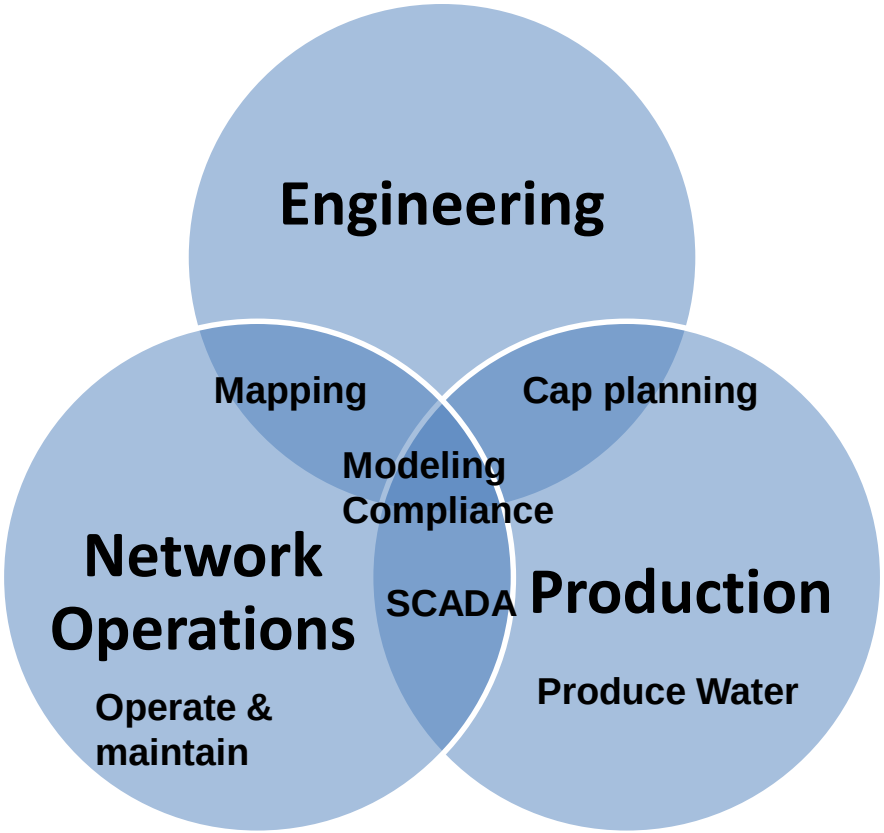
Solving the personnel challenge

Before GIS

Engineering
- Modeling
- Cap planning
- Mapping

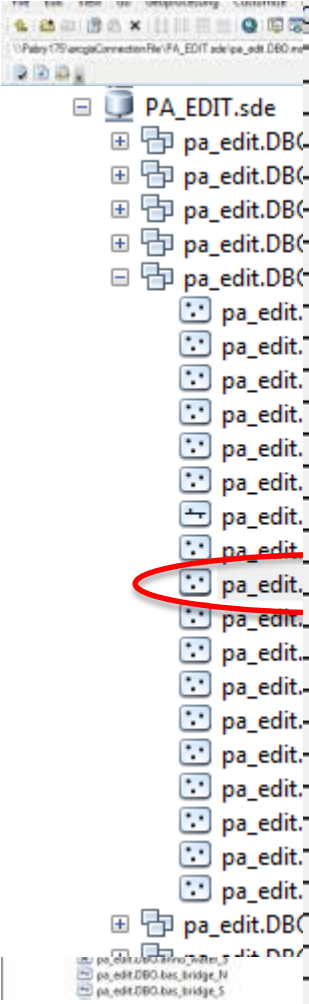
Network Operations
- Operate & maintain
- SCADA

Production
- Produce water
- Compliance



After GIS

Crossing Organizational Boundaries



Contents | Preview | Description

OBJECTID *	Name	IsActive	Elevation	Diameter	InitialPressureSetting	IPSource	Downst
300	Hillcrest & Winding Way_12	No	194	12	25	Al D'ercole	Hillcrest & Winding
301	Hillcrest & Winding Way_8	Yes	194	8	30	Al D'ercole	Hillcrest & Winding
302	Park Ave_6	No	215	6	77	Al D'ercole	Park Ave_6_Disc
303	Crumb Intermediate_8	Yes	301	8	55	Al D'ercole	Crumb Intermediate_
304	Crumb Intermediate_12	No	301	12	50	Al D'ercole	Crumb Intermediate_
305	Woodland Ave_10	Yes	264	10	52	Al D'ercole	Woodland Ave_10_
306	Country Club Lane_8	No	182	8	60	Al D'ercole	CountryClub Lane_
307	I33_2_PRV	<Null>	<Null>	12	22	Al D'ercole	I33_2_PRV_Disc
308	Kedron Ave_8	No	125	8	40	Al D'ercole	Kedron Ave_8_Disc
309	H35_2_PRV	<Null>	<Null>	8	50	Al D'ercole	H35_2_PRV_Disc
310	Woodlawn Ave_8	Yes	90	8	55	Al D'ercole	Woodlawn Ave_8_
311	Chester Pk & Clifton Ave_12	Yes	93	12	60	Al D'ercole	Chester Pk & Clifton
312	14th & Main_12	No	43	12	70	Al D'ercole	14th & Main_12_Dis
313	14th & Main_6	Yes	43	6	75	Al D'ercole	14th & Main_6_Disc
314	J33_2_PRV	<Null>	<Null>	6	57	Al D'ercole	J33_2_PRV_Disc
315	J33_1_PRV	<Null>	<Null>	3	62	Al D'ercole	J33_1_PRV_Disc
316	W Springfield Rd_8	No	213	8	70	Al D'ercole	W Springfield Rd_8
317	W Springfield Rd_4	Yes	213	4	75	Al D'ercole	W Springfield Rd_4
318	W Chester Pike_6	Yes	212	6	45	Al D'ercole	W Chester Pike_6_
319	W Chester Pike_8	No	212	8	40	Al D'ercole	W Chester Pike_8_
320	Fulton St	No	107	6	60	Al D'ercole	Fulton_6_Disc
322	Hickory Rd	No	198	8	84	Al D'ercole	Hickory_8_Disc
323	Hickory Rd	Yes	198	4	89	Al D'ercole	Hickory_4_Disc
324	Sugar Maple Ln_6	Yes	198	6	35	Al D'ercole	Sugar Maple Ln_6_
325	E 10th Ave	No	225	6	35	Al D'ercole	E10th_3_Disc
326	E 10th Ave	Yes	225	3	40	Al D'ercole	E10th_3_Disc
327	Church Rd	No	212	6	50	Al D'ercole	R17_2_PRV_Disc
328	Church Rd	Yes	212	3	55	Al D'ercole	ChurchRd_3_Disc
329	Ashbourne Rd	No	271	6	15	Al D'ercole	Ashbourne_8_Disc
330	Penrose PRV_3	Yes	254	3	35	Al D'ercole	Penrose PRV_3_Di

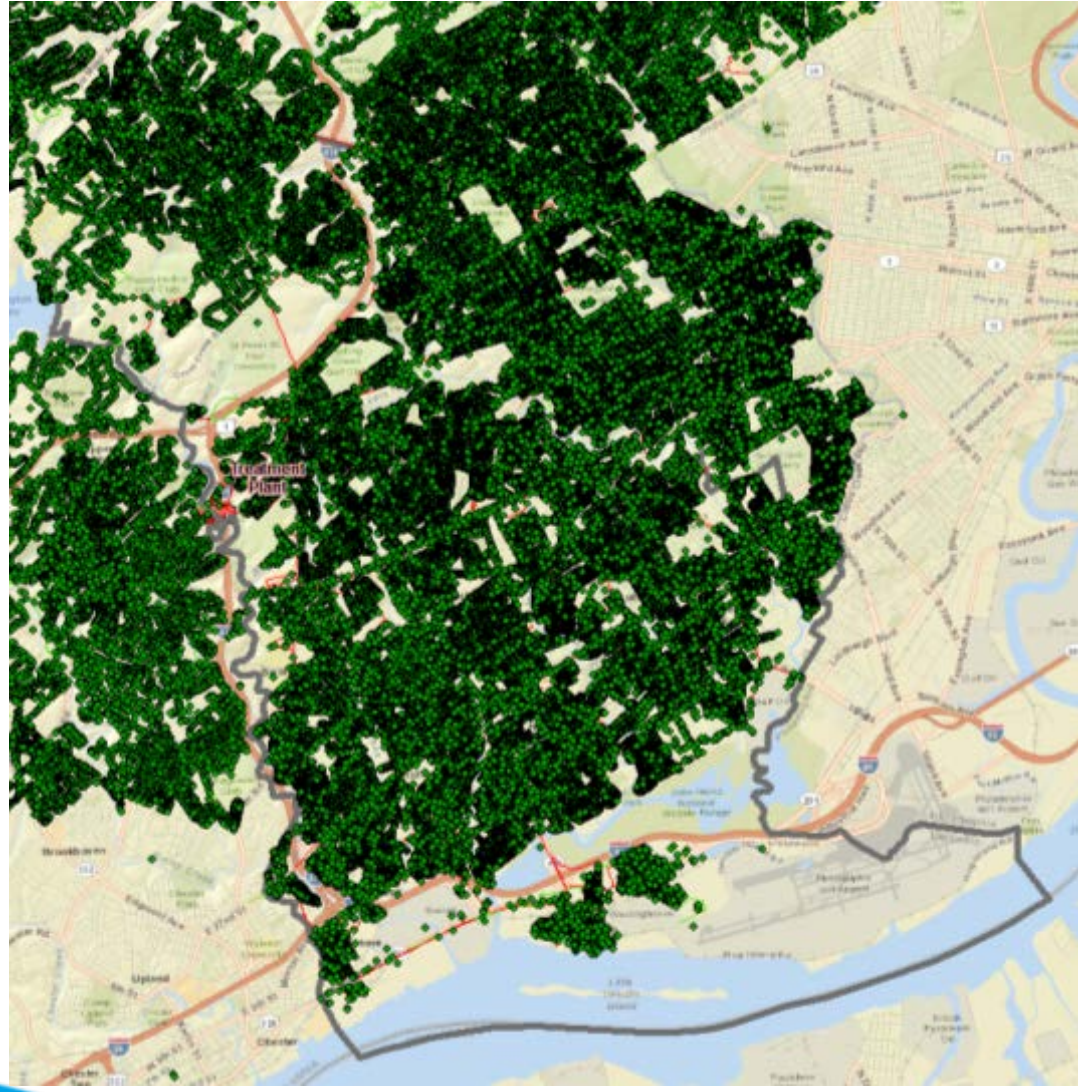
Capturing Operational Parameters

- Major source changes
- Water quality (water age)
- Wastewater modeling
- Tank painting
- Other states

Increasing Hydraulic Modeling Requests

- Hydraulic model used to "trace" water source
- Pipes in red receive > 90% of water from treatment plant
- But the model alone cannot relate these results to customers

- Incorporating model results into GIS allows for spatial analysis of customers affected
- <u>80,000</u> customers potentially impacted



Water quality tracing

Scenario 1

Existing hydraulic model → Open in ArcGIS and spatially adjust → Extract relevant features to GIS → Initial GIS

Scenario 2

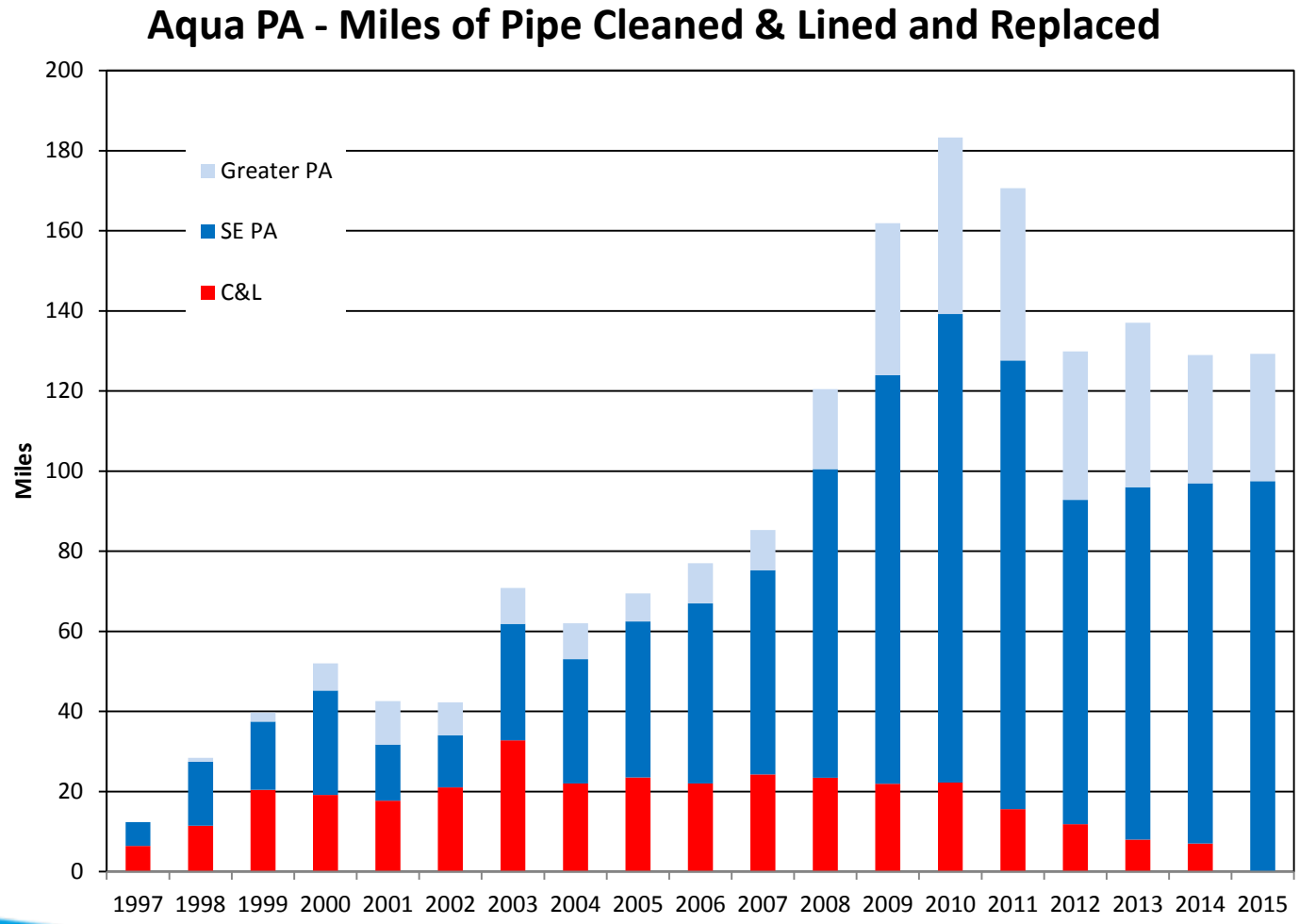
Build basic GIS → Export to SewerGEMS → Evaluate growth potential

Scenario 3

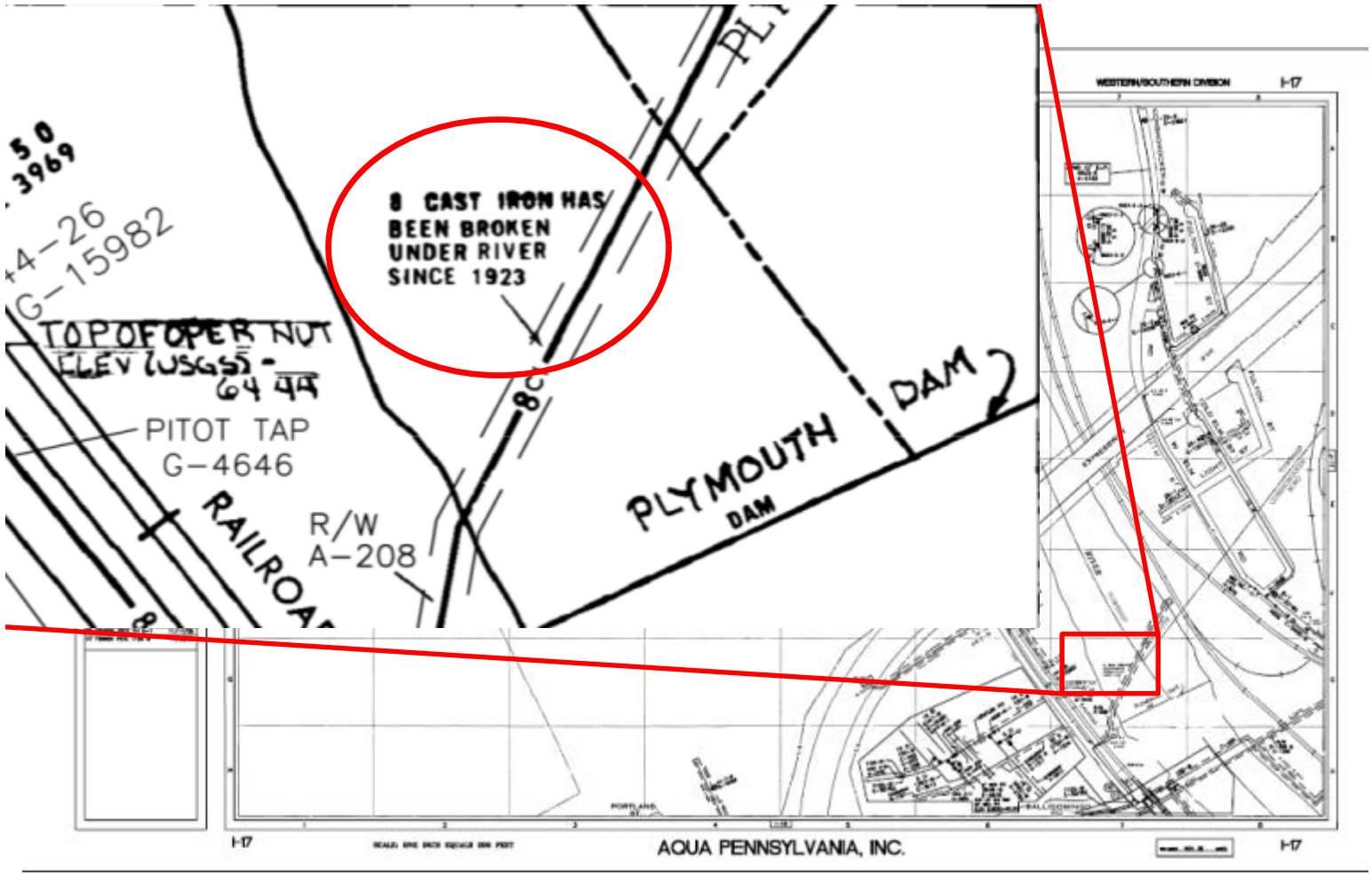
Outdated hydraulic model → Open in GIS and update → Export back for modeling

Other Aqua States

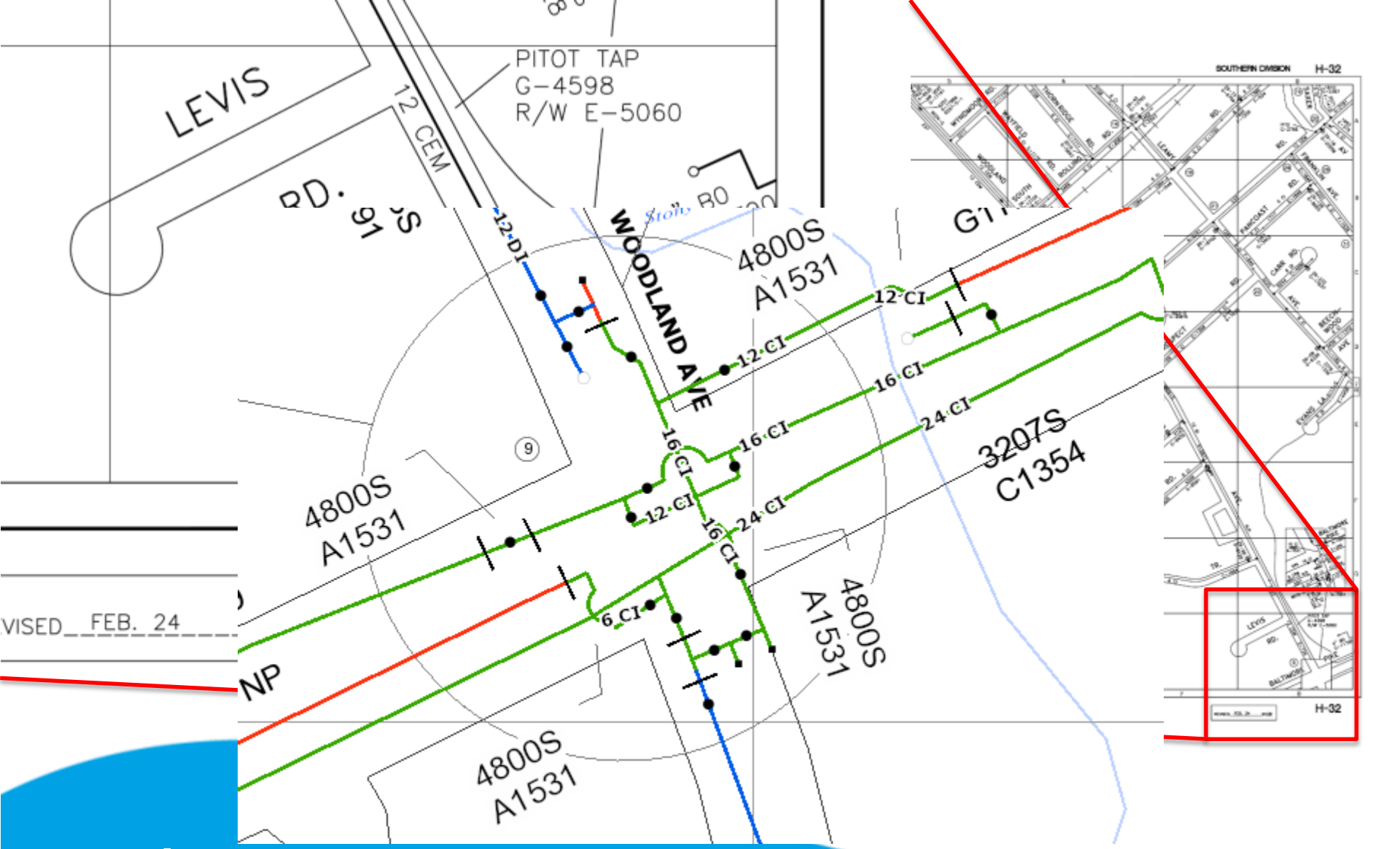
1,743 Miles (31%) Replaced or Rehabilitated over 19 Years



Why is updating our model so important?



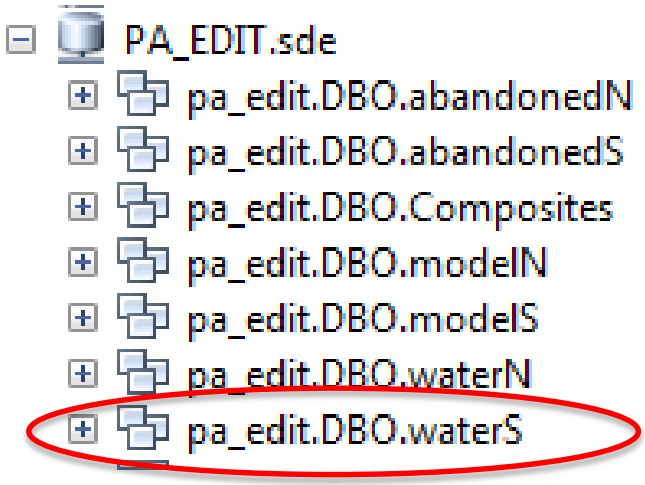
Data challenges

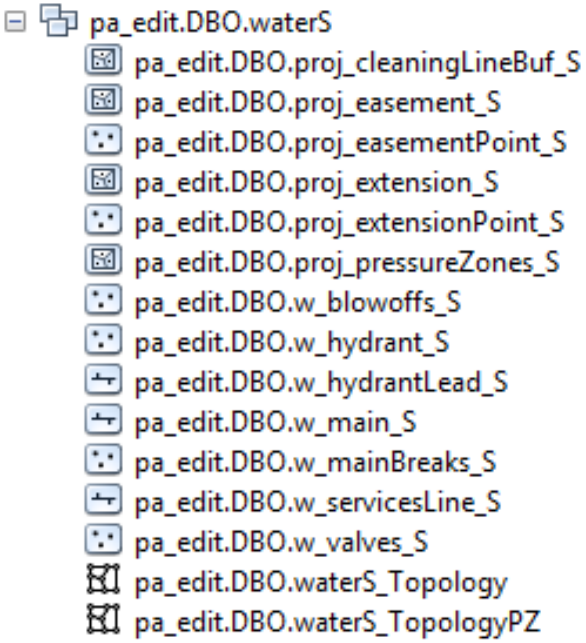


Why not use geometric network?

- Data structure
- Facility simplification
- Water Demands
- C values
- Node elevations

“Standard” feature dataset





GIS Data Structure:

Additional fields to support modeling

Contents | Preview | Description

OBJECTID *	MainType	System	PipeMaterial	PipeSize	MainInstallYear	Model	ModelCValue	ModelCheckValve	ModelLength	ModelStatus	ModelName	ModelSystem	ShowLabel	MapDisplay
122195	Distribution	Main	DI	8	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122196	Distribution	Main	DI	12	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122197	Distribution	Main	DI	12	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122198	Distribution	Main	AC	6	<Null>	Yes	100	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122199	Distribution	Main	AC	6	<Null>	Yes	100	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122200	Distribution	Main	DI	6	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122201	Distribution	Main	DI	8	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	Yes	<Null>
122202	Distribution	Main	DI	8	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	Yes	<Null>
122203	Distribution	Main	DI	8	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	Yes	<Null>
122204	Distribution	Main	DI	8	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122205	Distribution	Main	DI	8	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122206	Distribution	Main	DI	8	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122207	Distribution	Main	DI	12	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122208	Distribution	Main	DI	8	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122209	Distribution	Main	DI	12	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122210	Distribution	Main	DI	12	<Null>	Yes	120	<Null>	<Null>	<Null>	<Null>	SEPA	<Null>	<Null>
122211	Distribution	Main	CI	20	<Null>	No	90	<Null>	<Null>	<Null>	<Null>	<Null>	No	<Null>
122212	Distribution	Main	S	36	<Null>	No	100	<Null>	<Null>	<Null>	<Null>	<Null>	No	<Null>
122213	Distribution	Main	CI	30	<Null>									
122214	Distribution	Main	CI	12	<Null>									
122215	Distribution	Main	CI	12	<Null>									
122216	Distribution	Main	CI	24	<Null>									
122217	Distribution	Main	DI	24	<Null>									
122218	Distribution	Main	DI	42	<Null>									
122219	Distribution	Main	CI	24	<Null>									
122220	Distribution	Main	DI	16	<Null>									
122221	Distribution	Main	S	30	<Null>									
122222	Distribution	Main	CI	30	<Null>									
122223	Distribution	Main	CI	20	<Null>									
122224	Distribution	Main	CI	20	<Null>									
122225	Distribution	Main	CI	24	<Null>									
122226	Distribution	Main	CI	24	<Null>									
122227	Distribution	Main	DI	12	<Null>									
122228	Distribution	Main	DI	6	<Null>									
122229	Distribution	Main	COP	1	<Null>									
122230	Distribution	Main	CI	6	<Null>									
122231	Distribution	Main	CI	12	<Null>									
122232	Distribution	Main	DI	6	<Null>									
122233	Distribution	Main	S	42	<Null>									
122234	Distribution	Main	S	42	<Null>									
122235	Distribution	Main	DI	42	<Null>									
122236	Distribution	Main	S	24	<Null>									
122237	Distribution	Main	S	24	<Null>									
122238	Distribution	Main	S	24	<Null>									
122239	Distribution	Main	DI	48	<Null>									

GIS Field	Purpose
Model	Yes/No - Controls whether the pipe is exported to model
ModelCValue	C Value for pipe
ModelCheckValve	Yes/No - Defines whether the pipe includes a check valve
ModelLength	Defines the length of the pipe to be used in the model
ModelStatus	Yes/No - Defines whether the pipe is active in the model
ModelName	Defines a name to be used by controls in the model
ModelSystem	Defines modeling “subsystems”

Fields added to “Water Mains” feature class

Simplify piping around treatment plant for modeling

Why did we add “Model” field?

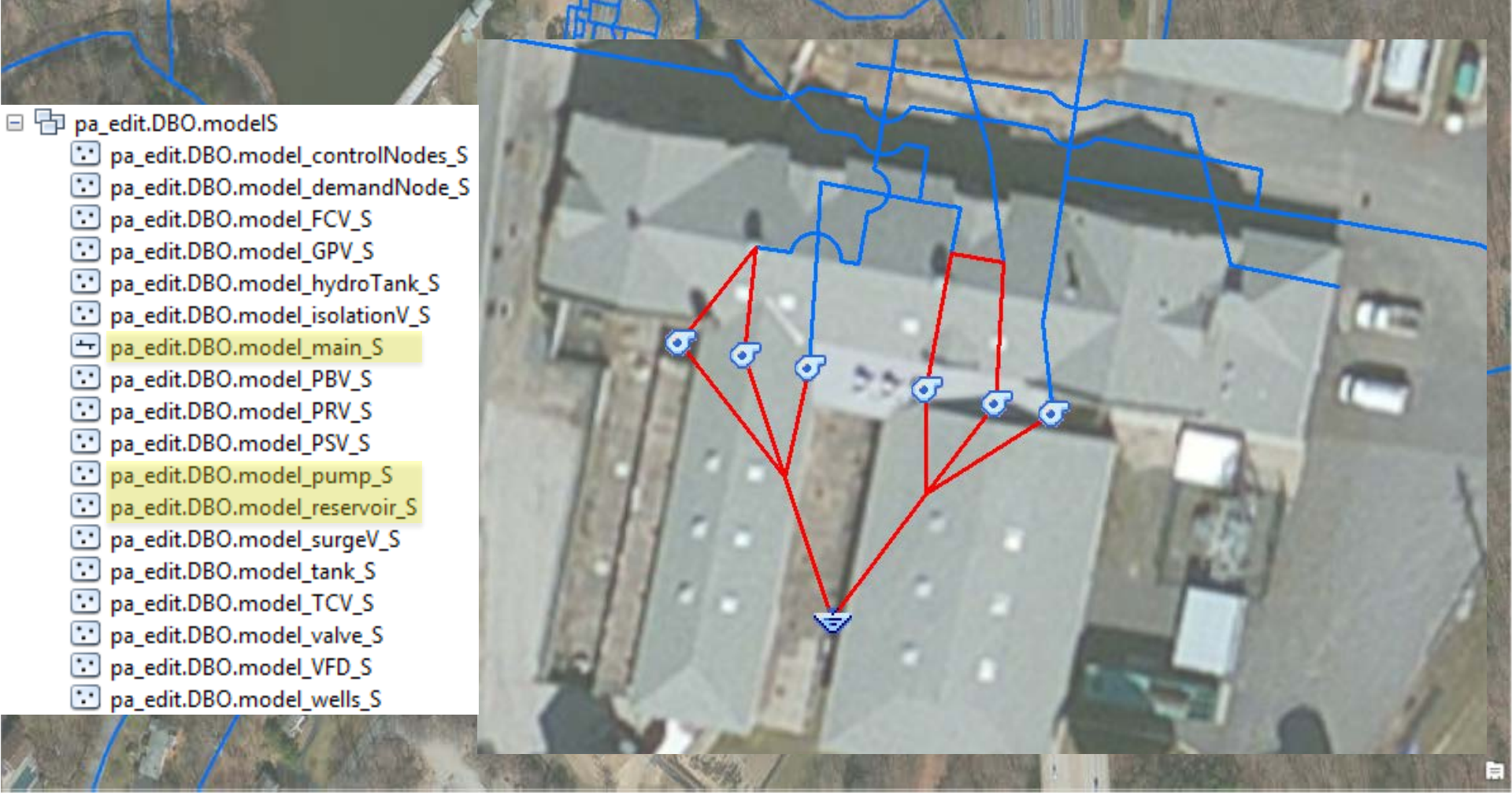
“Model” feature dataset

- pa_edit.DBO.modelS
  - pa_edit.DBO.model_controlNodes_S
  - pa_edit.DBO.model_demandNode_S
  - pa_edit.DBO.model_FCV_S
  - pa_edit.DBO.model_GPV_S
  - pa_edit.DBO.model_hydroTank_S
  - pa_edit.DBO.model_isolationV_S
  - pa_edit.DBO.model_main_S
  - pa_edit.DBO.model_PBV_S
  - pa_edit.DBO.model_PRV_S
  - pa_edit.DBO.model_PSV_S
  - pa_edit.DBO.model_pump_S
  - pa_edit.DBO.model_reservoir_S
  - pa_edit.DBO.model_surgeV_S
  - pa_edit.DBO.model_tank_S
  - pa_edit.DBO.model_TCV_S
  - pa_edit.DBO.model_valve_S
  - pa_edit.DBO.model_VFD_S
  - pa_edit.DBO.model_wells_S

- PA_EDIT.sde
  - pa_edit.DBO.abandonedN
  - pa_edit.DBO.abandonedS
  - pa_edit.DBO.Composites
  - pa_edit.DBO.modelN
  - pa_edit.DBO.modelS
  - pa_edit.DBO.waterN
  - pa_edit.DBO.waterS

GIS Data Structure:

Additional feature dataset to support modeling



How do we use “Model” feature dataset?

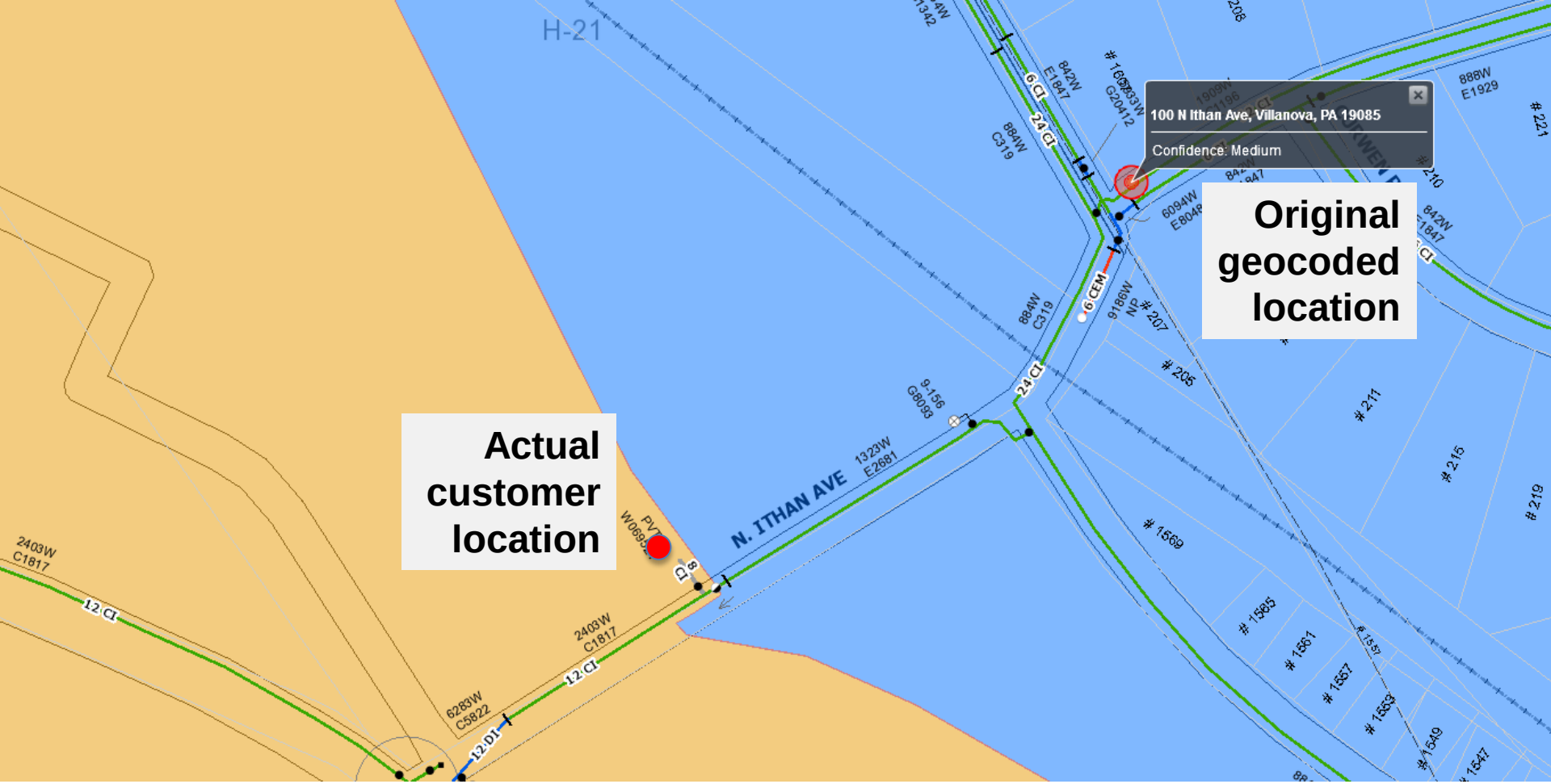
- Obtained annual water use for every meter (375,000) from Customer Information System (CIS)
- Geocoded customer locations using addresses from CIS
- Assigned demand to nearest node using LoadBuilder

Water Demands

Customer points using existing Banner (CIS) coordinates

1,570 gpm demand assigned to 8-inch pipe (nearest node) instead of 30-inch transmission main

Demand allocation for large customers

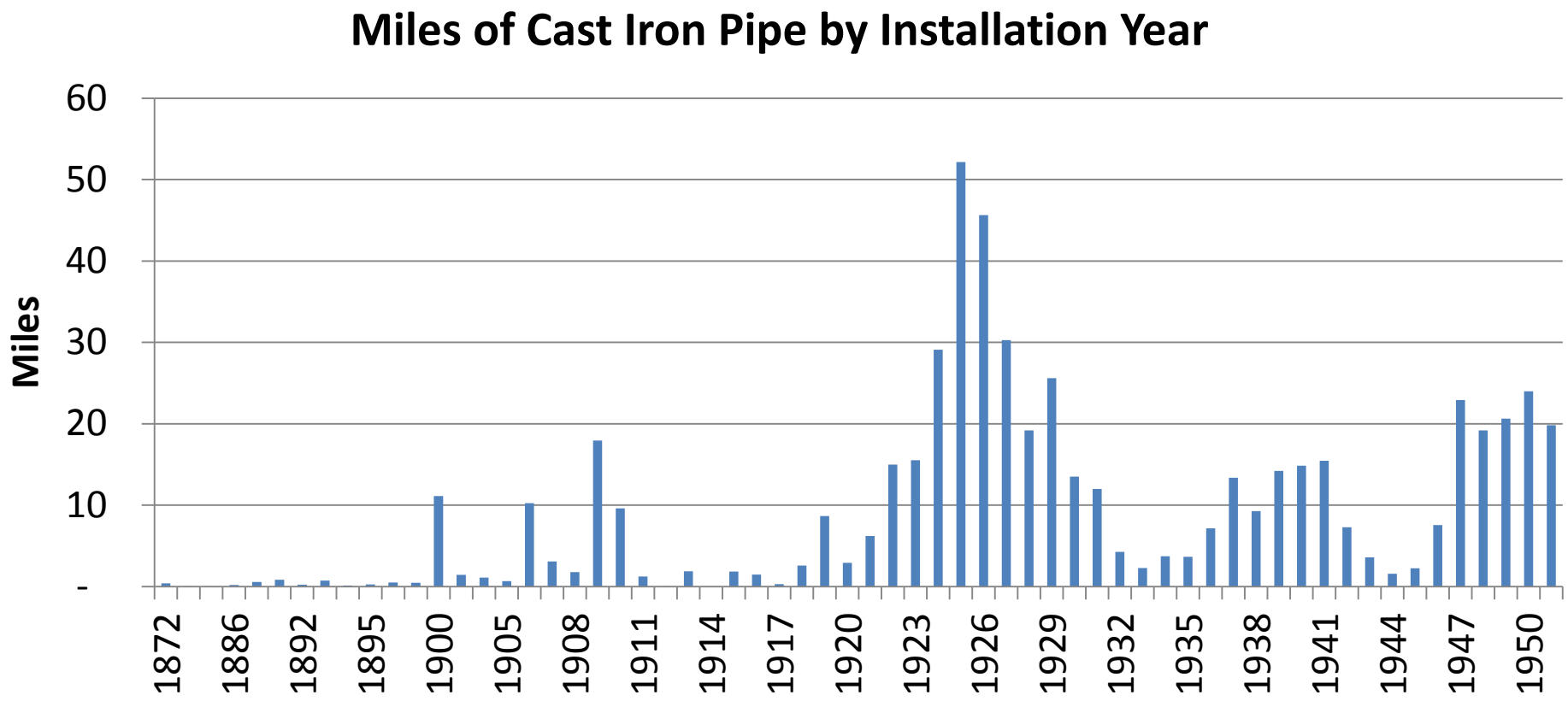


157 gpm demand assigned to wrong pressure zone

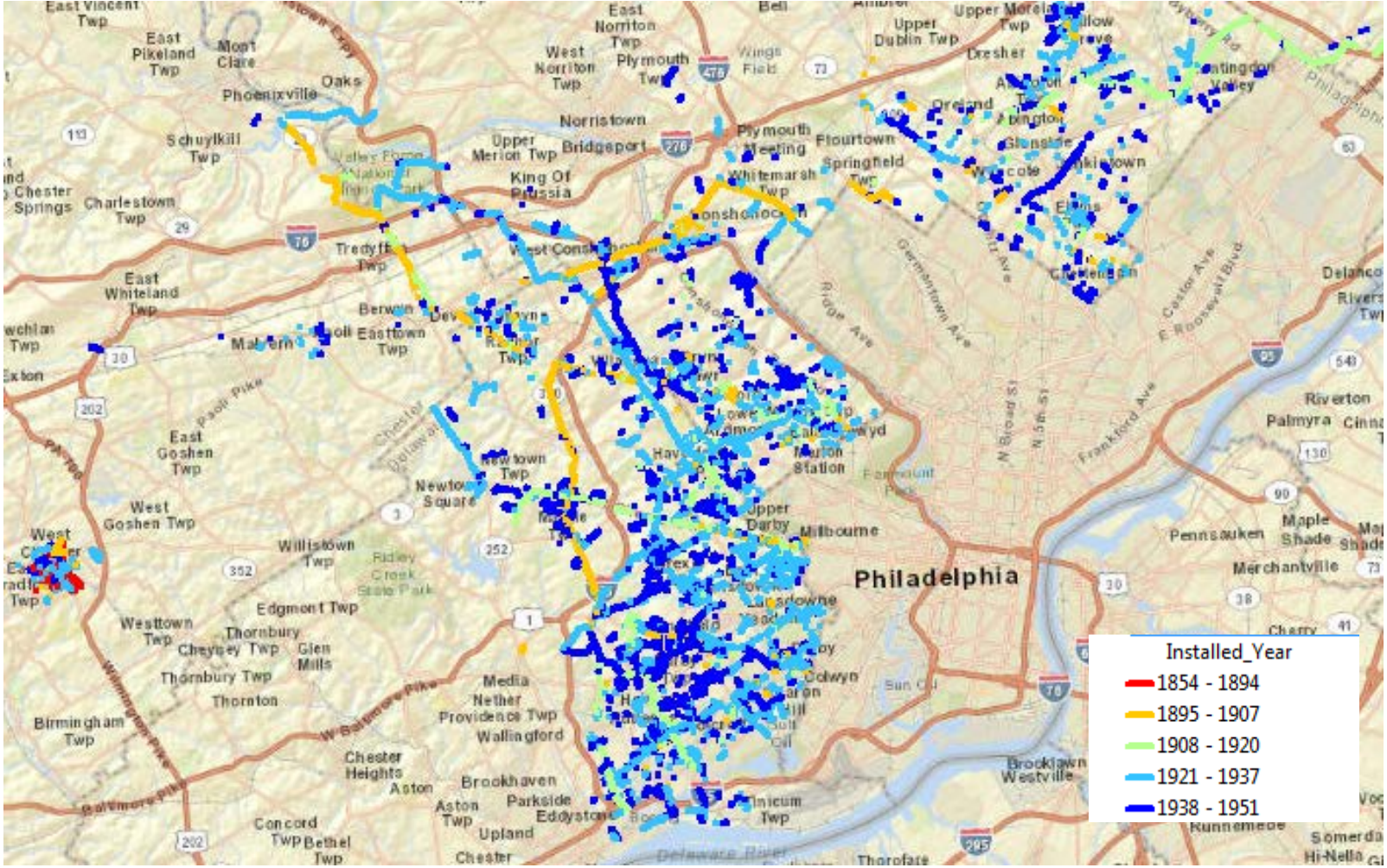
Demand allocation for large customers

Customer points using improved geocoding and manual placement

Esri Water Conference
February 10, 2016

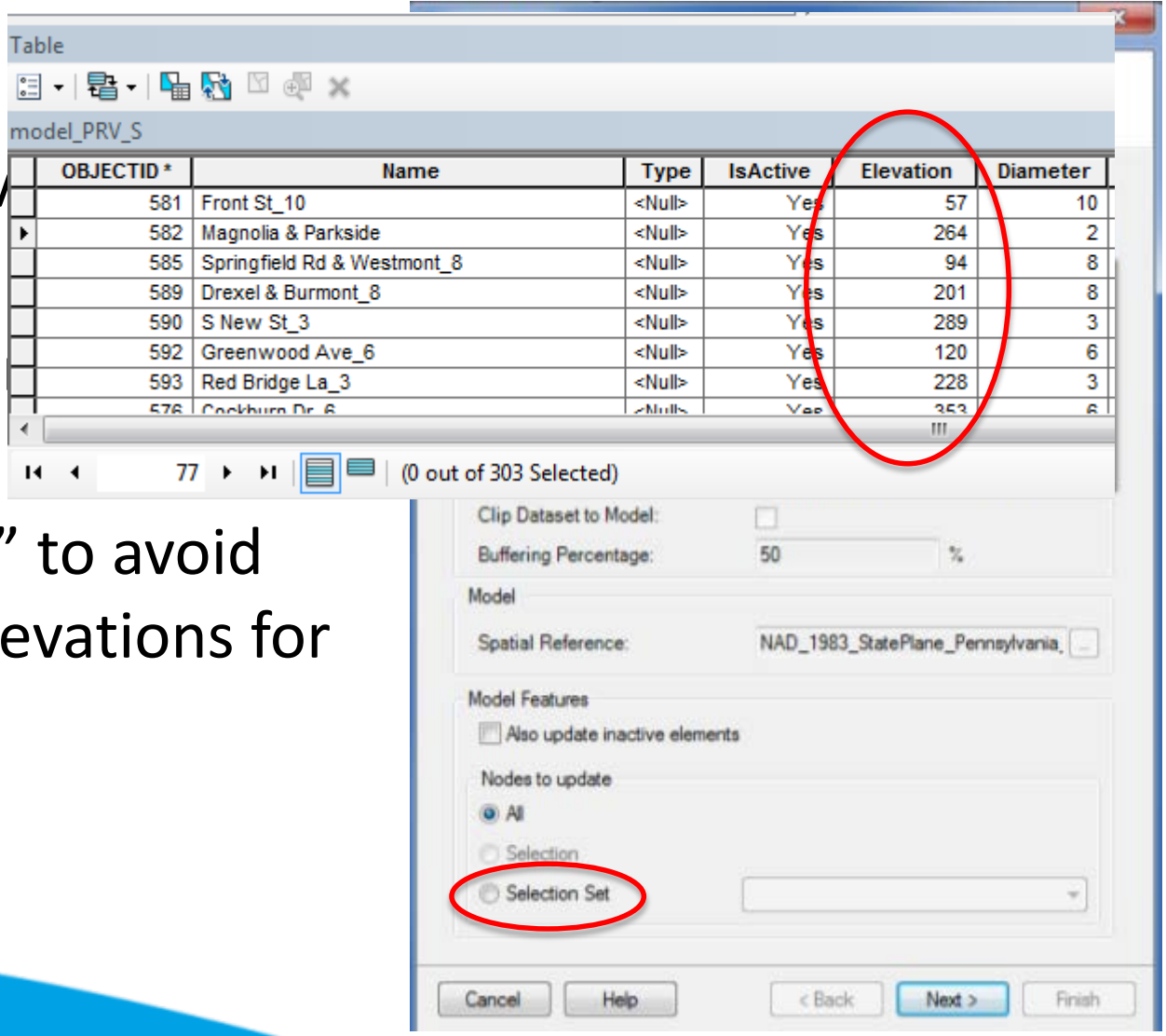


Assigning C-values by material and installation year



Spatial distribution of unlined Cast Iron by installation year

- Tools to assign elev nodes
- Variety of data sou supported
- Use “Selection Set” to avoid updating known elevations for key facilities



OBJECTID *	Name	Type	IsActive	Elevation	Diameter
581	Front St_10	<Null>	Yes	57	10
582	Magnolia & Parkside	<Null>	Yes	264	2
585	Springfield Rd & Westmont_8	<Null>	Yes	94	8
589	Drexel & Burmont_8	<Null>	Yes	201	8
590	S New St_3	<Null>	Yes	289	3
592	Greenwood Ave_6	<Null>	Yes	120	6
593	Red Bridge La_3	<Null>	Yes	228	3
576	Cockburn Dr_6	<Null>	Yes	353	6

Assigning elevations to nodes

- Sustainability is as important as the initial build
- Identify the right combination of people & skills
- Don’t be afraid to modify data structure to accommodate different needs of GIS and hydraulic model
- Take advantage of software tools, but recognize potential issues
- Capture data before it’s too late
- Look for opportunities to break down organizational barriers
- It is practical to use GIS to support hydraulic modeling

Summary

THANK YOU!

Contact:

Frank Grablutz
FMGrablutz@AquaAmerica.com