

 #GWF2020



# GWFF

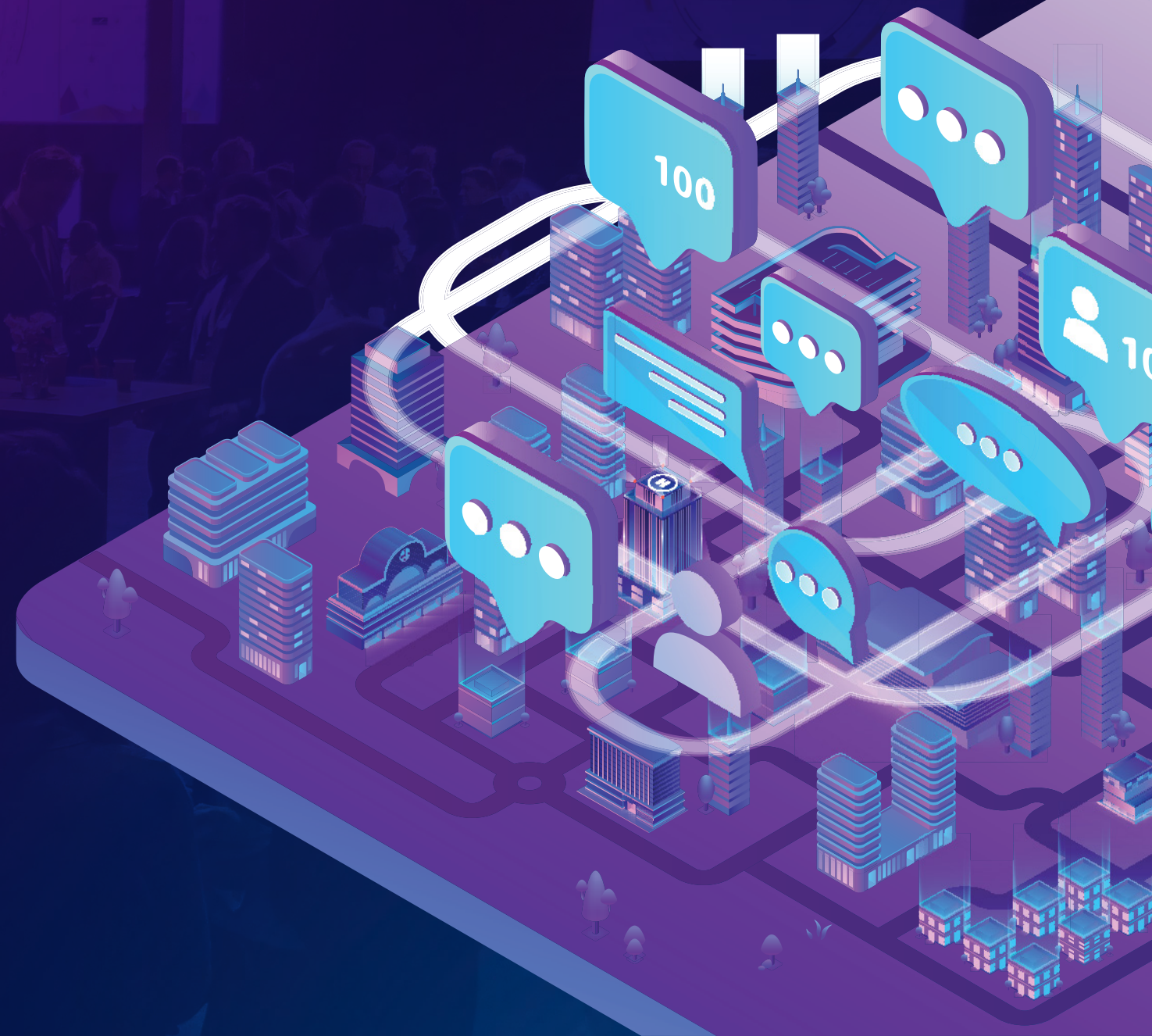
GEOSPATIAL WORLD FORUM

**TRANSFORMING  
ECONOMIES IN** **5G** **ERA**

*The Geospatial Way!*

**7-9 April 2020 /// Amsterdam**

[www.geospatialworldforum.org](http://www.geospatialworldforum.org)





# Integrating GIS data for Water Distribution Modeling

## Case Study:

General Directorate of Water

Eng. Atif Karrani - GIS Manager  
[karrani@sewa.gov.ae](mailto:karrani@sewa.gov.ae)





# Agenda

- Introduction
- Enterprise GIS in SEWA
- Building hydraulic models from Geospatial databases
- WaterGEMS and ArcGIS
- Use of hydraulic model
- Scenario analysis and master planning
- Water loss reduction
- Improving pressure management pumping scheduling
- Conclusions



# Introduction....



## ■ Authority founded in 1992

## ■ Mission

- Energy provider for Sharjah emirate of UAE including Khorfakkan and Kalba.

## ■ Challenges

- Providing Electricity to 350,000 consumers, Water to 270,000 consumers and Gas to 220,000 consumers
- More than 15,000 KMs of under ground services maintained
- More than 30,000 on ground components/assets maintained



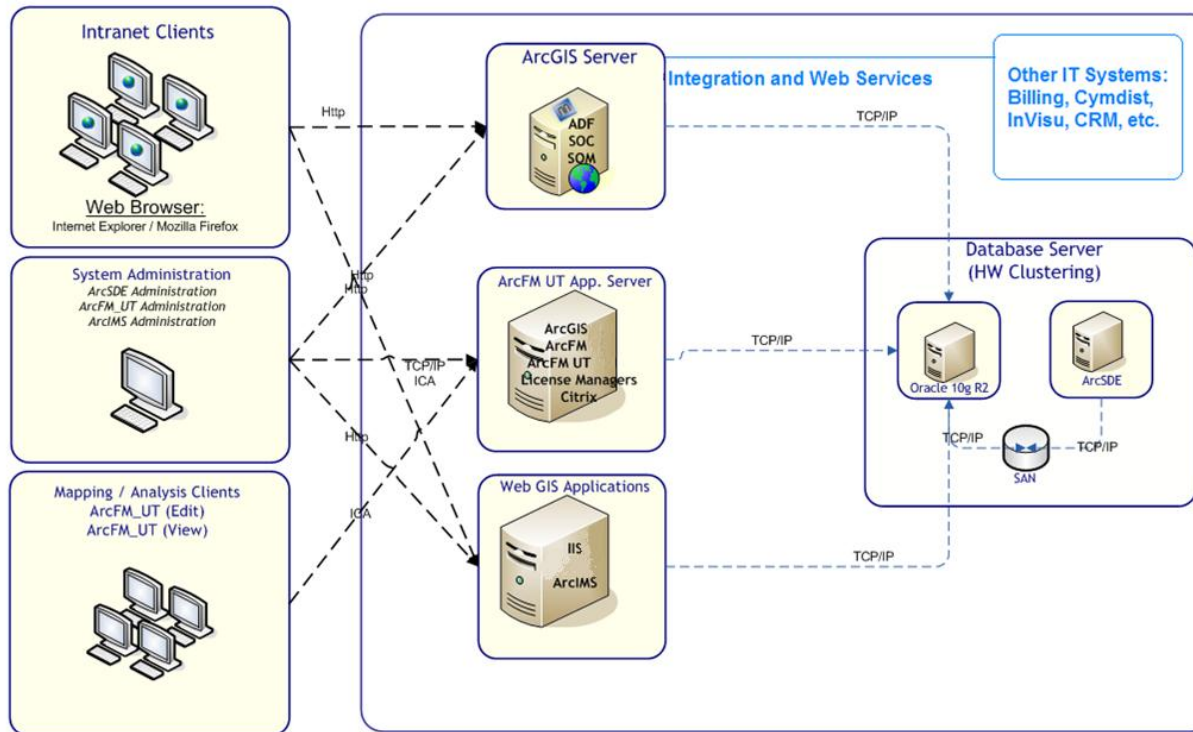
# Enterprise GIS in SEWA....

- Implementation of Enterprise GIS(2005-2007) for:-
  - Electricity
  - Water
  - Natural GAS
  - Communication (FOC)
  - Street Light
- Based on ESRI Technologies & Oracle Database
- Create, manage & distribute GIS services using ArcGIS Server
- Editing & Viewing Utilities Network using ArcFM\_UT
- Web-based mapping and applications using GeoCortex
- Customized applications using .NET & SQL Server

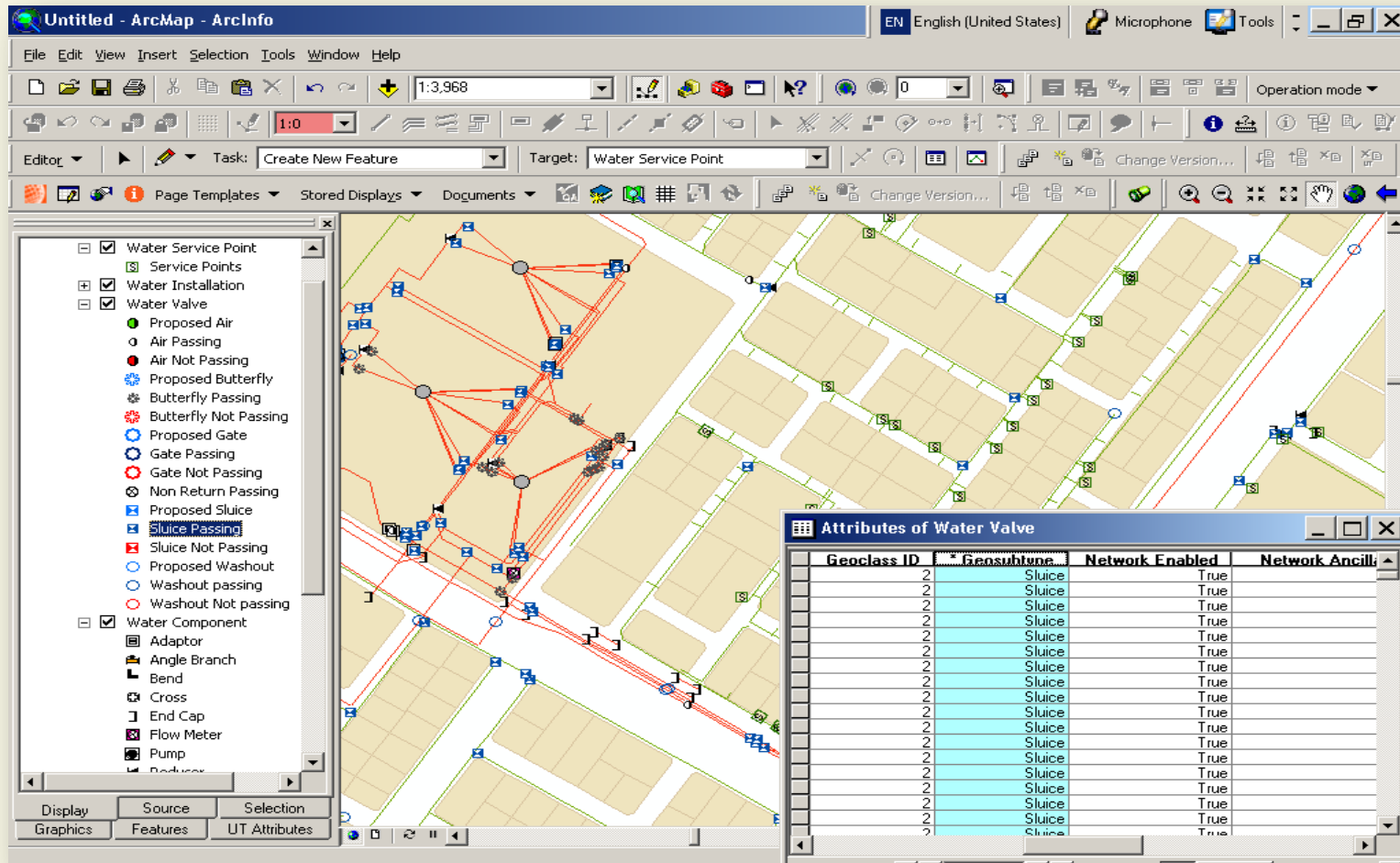


# Centralized System Architecture

## SEWA GIS System Architecture

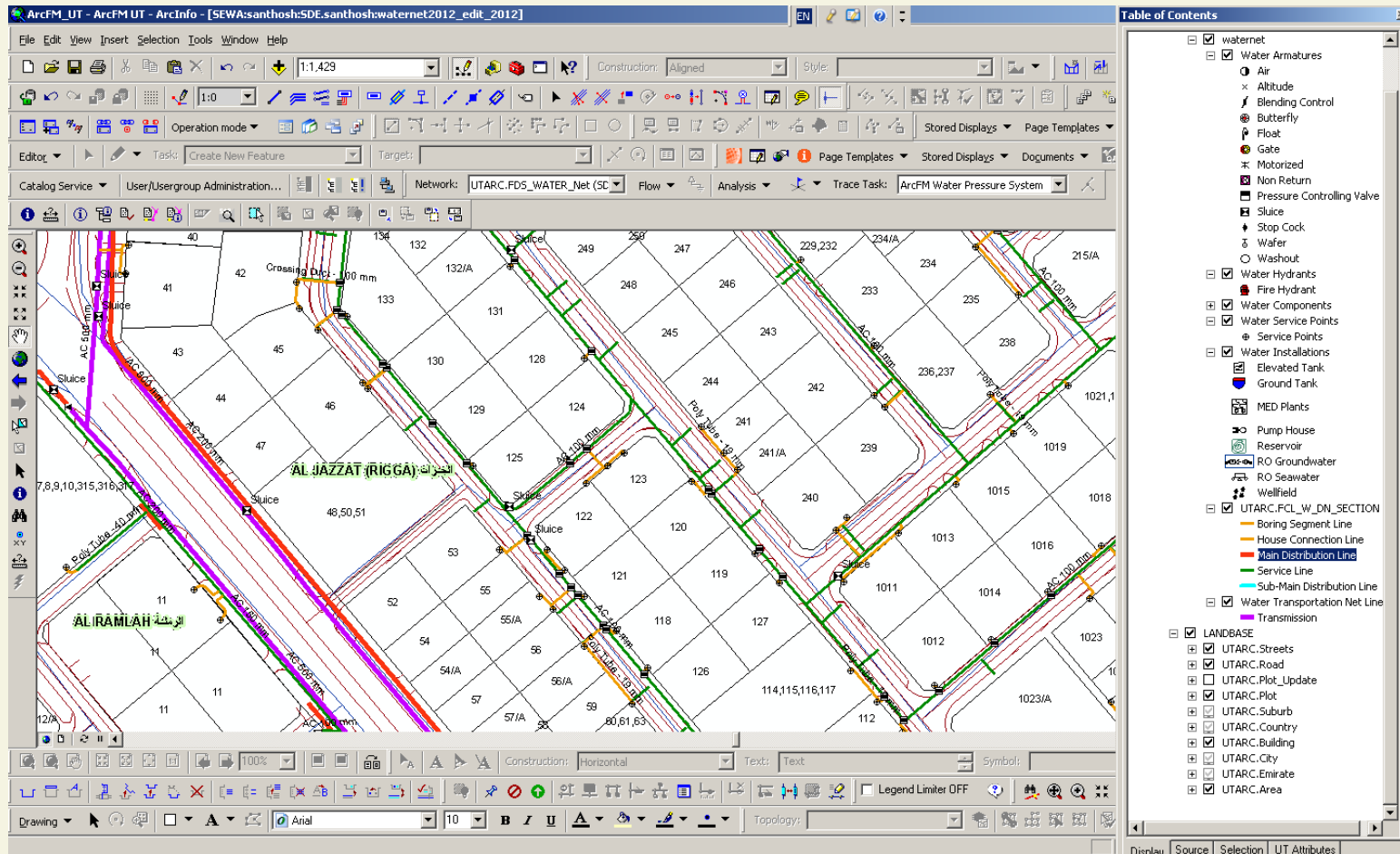


# Water Network using ArcGIS (ESRI)



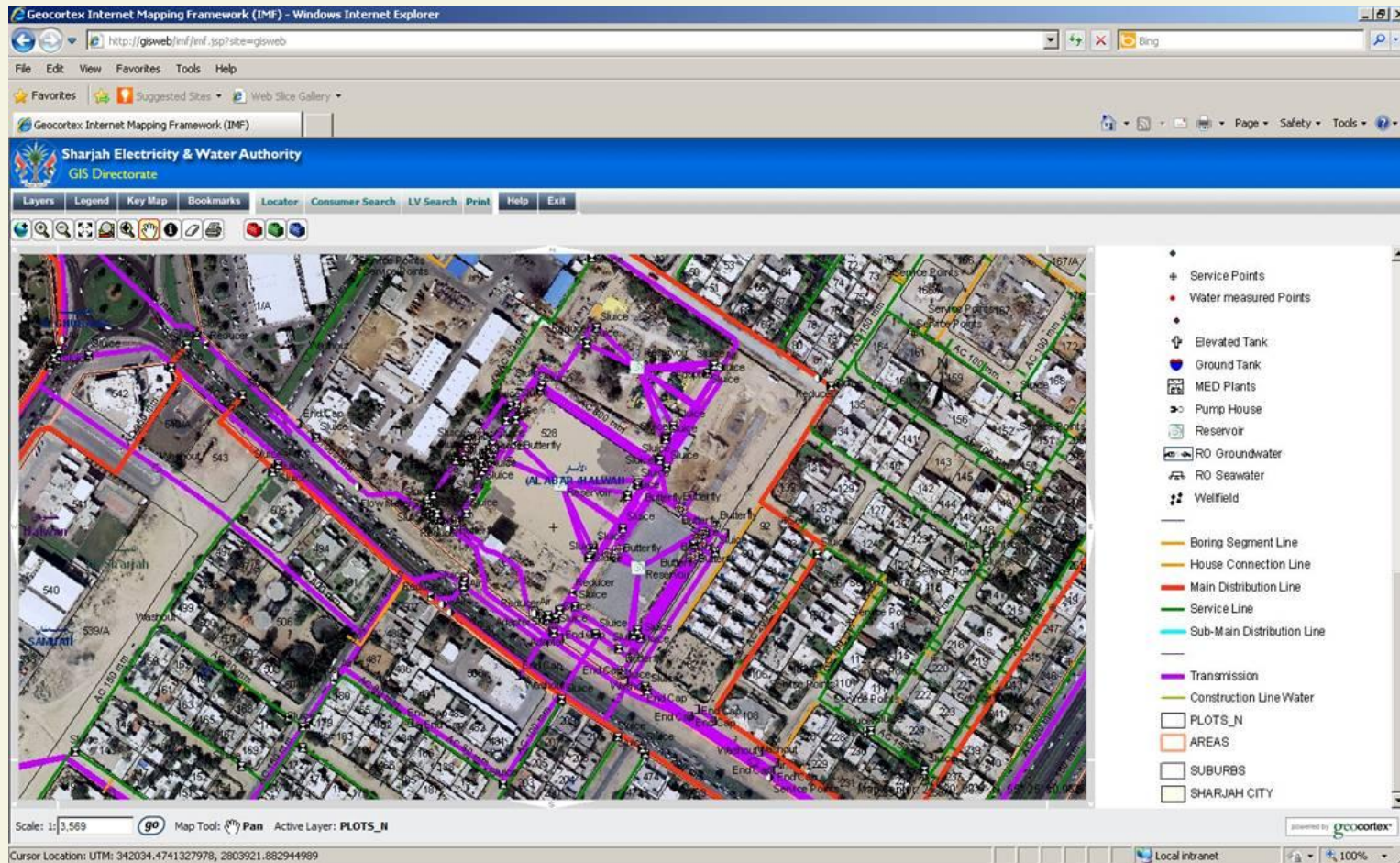


# Water Network using ArcFM\_UT (SICAD)

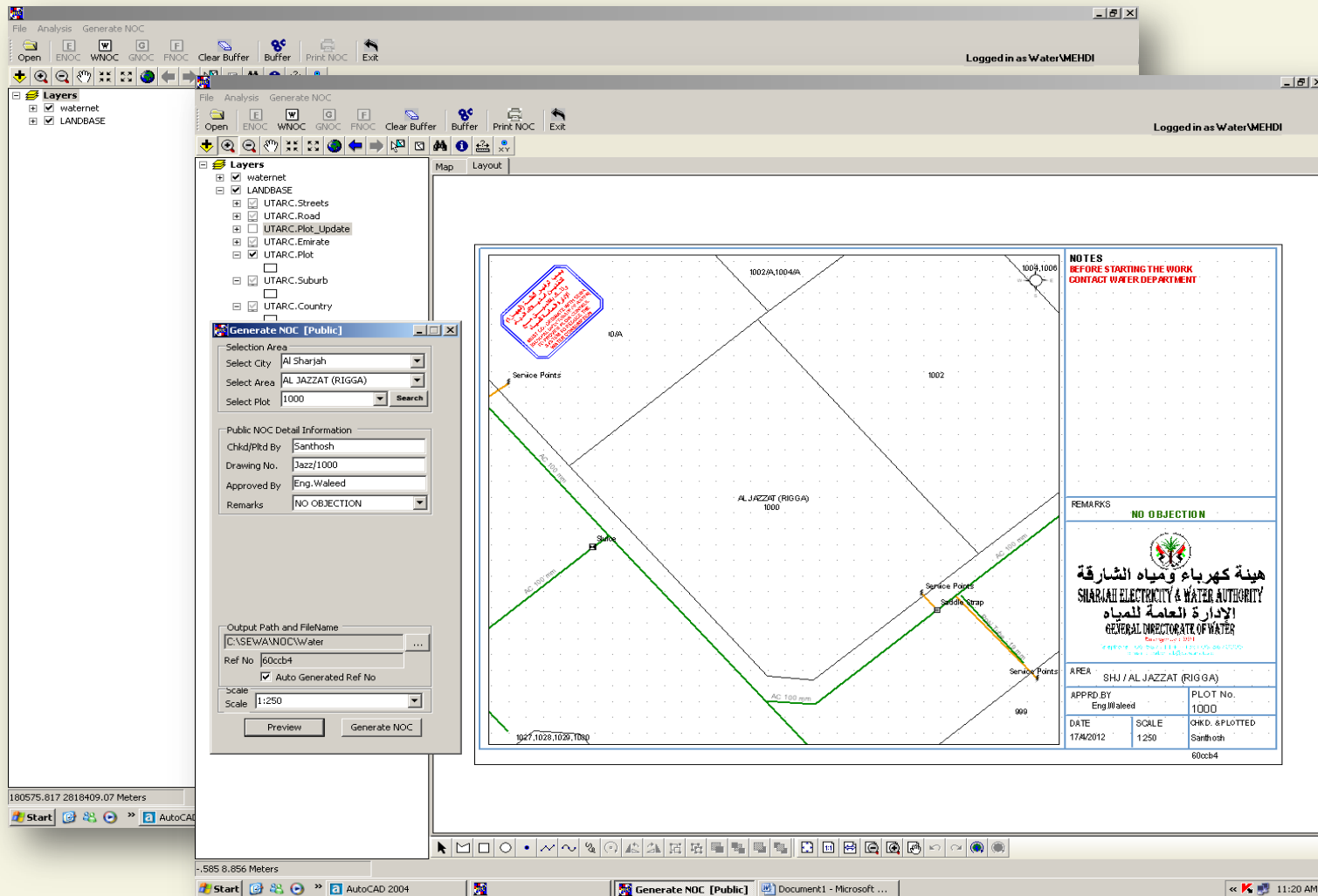




# Water Network using Web View (GeoCortex)



## No Objection Certificate





# Hydraulic model using WaterGEMS (Bentley)

**Bentley WaterGEMS V8i (SELECTseries 3) [Network-Sharjah.wtg]**

File Edit Analysis Components View Tools Report Help

Model - New header

Element Symbology

FlexTables

Tables - Project  
Tables - Shared  
Tables - Predefined  
GeoTables

Fire Flow Node Table  
Flushing Report  
Pipe Table  
Junction Table  
Hydrant Table  
Tank Table  
Reservoir Table  
Pump Table  
Variable Speed Pump Battery Table  
PRV Table  
PSV Table  
BFW Table  
FCV Table  
TCV Table  
GPV Table  
Isolation Valve Table  
Spot Elevation Table  
Air Valve Table

**FlexTable: Pipe Table (Network-Sharjah.wtg)**

	ID	Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Has Check Valve?	Minor Loss Coefficient (Local)	Flow (m³/h)	Veloc (m/s)
243: Al Ghub	243	Al Ghubaba-P-1	1.175438	Al Ghubaba-J-87	Al Ghubaba-J-35	150.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
570: Al Ghub	570	Al Ghubaba-P-42	3.079534	Al Ghubaba-J-226	Al Ghubaba-J-227	150.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
613: Al Ghub	613	Al Ghubaba-P-46	3.599604	Al Ghubaba-J-239	Al Ghubaba-J-240	75.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
650: Al Ghub	650	Al Ghubaba-P-47	3.998102	Al Ghubaba-J-247	Al Ghubaba-J-248	75.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
938: Al Ghub	938	Al Ghubaba-P-135	45.960170	Al Ghubaba-J-15	Al Ghubaba-J-13	800.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
962: Al Ghub	962	Al Ghubaba-P-144	222.178088	Al Ghubaba-J-413	Al Ghubaba-J-414	40.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
994: Al Ghub	994	Al Ghubaba-P-155	65.414570	Al Ghubaba-J-427	Al Ghubaba-J-297	40.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
1044: Al Ghub	1044	Al Ghubaba-P-168	79.735759	Al Ghubaba-J-454	Al Ghubaba-J-80	40.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
1052: Al Ghub	1052	Al Ghubaba-P-170	81.279137	Al Ghubaba-J-459	Al Ghubaba-J-460	75.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
1073: Al Ghub	1073	Al Ghubaba-P-176	121.466651	Al Ghubaba-J-248	Al Ghubaba-J-472	75.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
1092: Al Ghub	1092	Al Ghubaba-P-181	91.633837	Al Ghubaba-J-482	Al Ghubaba-J-36	50.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
1100: Al Ghub	1100	Al Ghubaba-P-185	102.331743	Al Ghubaba-J-397	Al Ghubaba-J-486	200.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
1109: Al Ghub	1109	Al Ghubaba-P-188	100.424896	Al Ghubaba-J-279	Al Ghubaba-J-490	40.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
1111: Al Ghub	1111	Al Ghubaba-P-189	143.363491	Al Ghubaba-J-491	Al Ghubaba-J-247	75.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
1119: Al Ghub	1119	Al Ghubaba-P-190	108.560959	Al Ghubaba-J-496	Al Ghubaba-J-558	200.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)
1120: Al Ghub	1120	Al Ghubaba-P-193	117.960751	Al Ghubaba-J-71	Al Ghubaba-J-13	800.0	Asbestos Cement	140.0	<input type="checkbox"/>	0.000	(N/A)	(N)

36609 of 36609 elements displayed

Properties - Pump - PMP-8 (122727)

<Show All>

**General**

ID 122727  
Label PMP-8  
Notes  
GIS-IDs <Collection: 0 items>  
Hyperlinks <Collection: 0 items>  
Downstream Pipe Al Abar-P-23

**Geometry**

X (m) 341470.70  
Y (m) 2804061.86

**Active Topology**

Is Active? True

**Initial Settings**

Relative Speed Factor (Initial) 1.000  
Status (Initial) Off

**Operational**

Controls <Collection>

**Physical**

Elevation (m) 11.98  
Installation Year 0  
Zone Al Abar  
Pump Definition Al-Falaj-Ph1  
Pump Station <None>  
Is Variable Speed Pump? False

**Pump Data**

**Transient (Operational)**

Pump Type (Transient) Constant Speed - No Pump Curve

**Water Quality**

**Results**

Results (Energy Cost Peak)  
Results (Energy Cost Summary)  
Results (Energy Costs)  
Results (Misc.)  
Results (Transient)

**Results (Energy Cost Summary)**

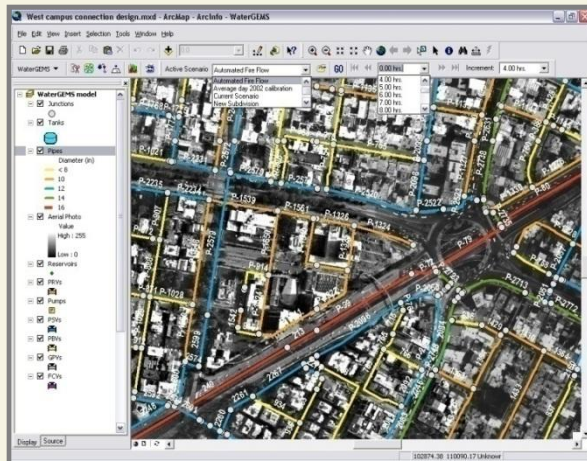
X: 344927.37 m, Y: 2800581.02 m Zoom Level: 1.1 %  
X: 341675.06 m, Y: 2804632.03 m Zoom Level: 5.8 %



# Water Network Modeling (WaterGEMS)

Water distribution design, modeling and optimization  
with GIS integration

## Hydraulic modeling



- Darwin Designer: network rehabilitation
- Darwin Calibrator: leakage detection
- Darwin Scheduler: energy efficiency

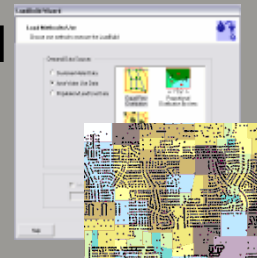
## GIS Integration

Bentley GIS Solution

or

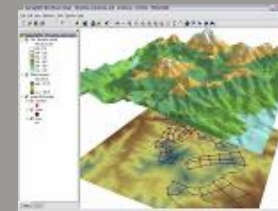
ESRI GIS Solution

Model Builder &  
LoadBuilder



Bi-directional  
GIS-model  
synchronization;  
Water demand  
assignment

TRex



Automated  
elevation  
extraction

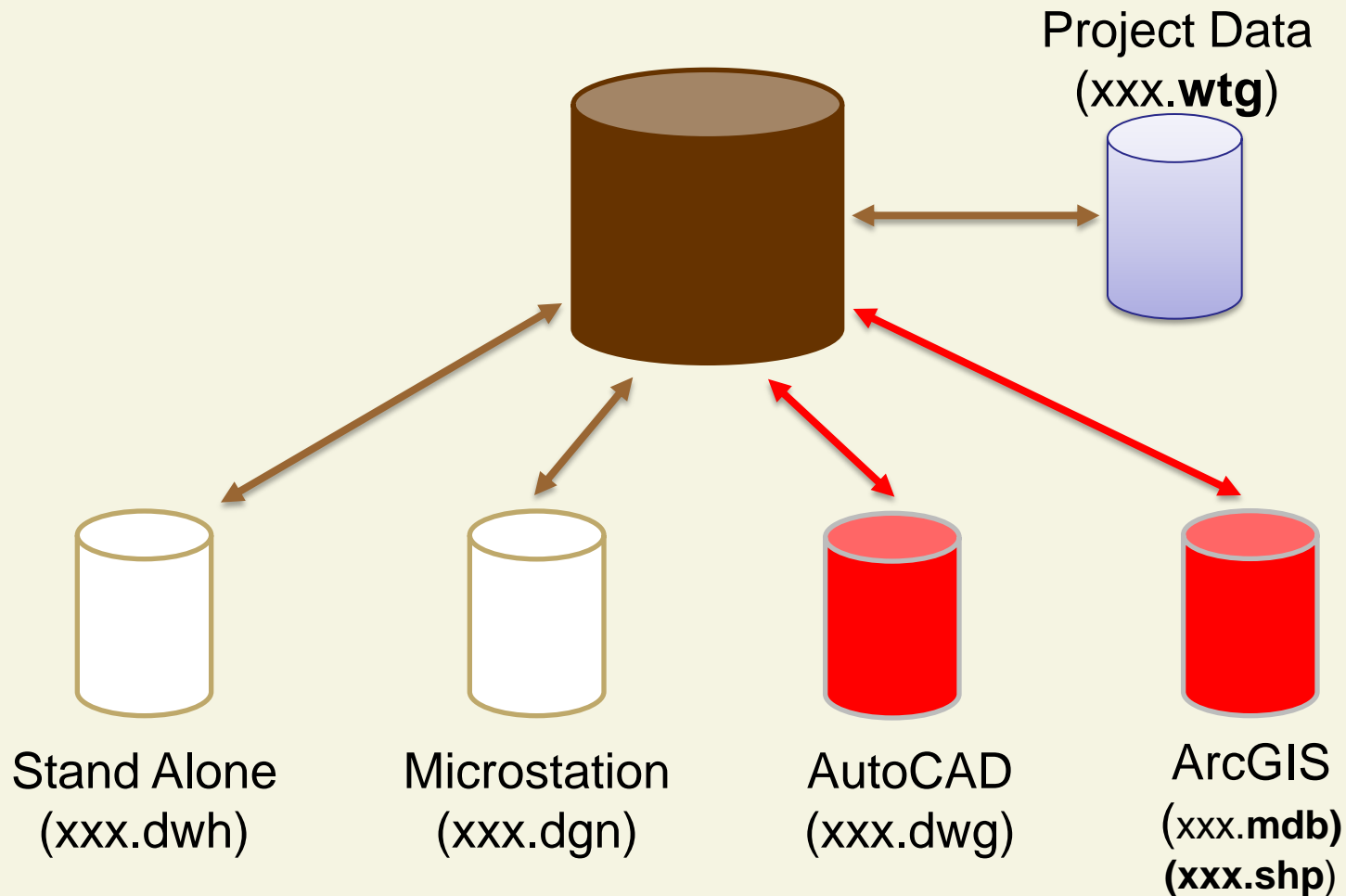


# Model Sources

- Access (Jet)
- Coverages
- **Geodatabases**
- Geometric Networks
- dBase
- FoxPro
- ODBC
- OLEDB
- Oracle Spatial
- HTML Import
- HTML Export
- Lotus
- Excel
- Paradox
- **Shapefiles**
- CAD files
- EPAnet
- Old WaterCAD



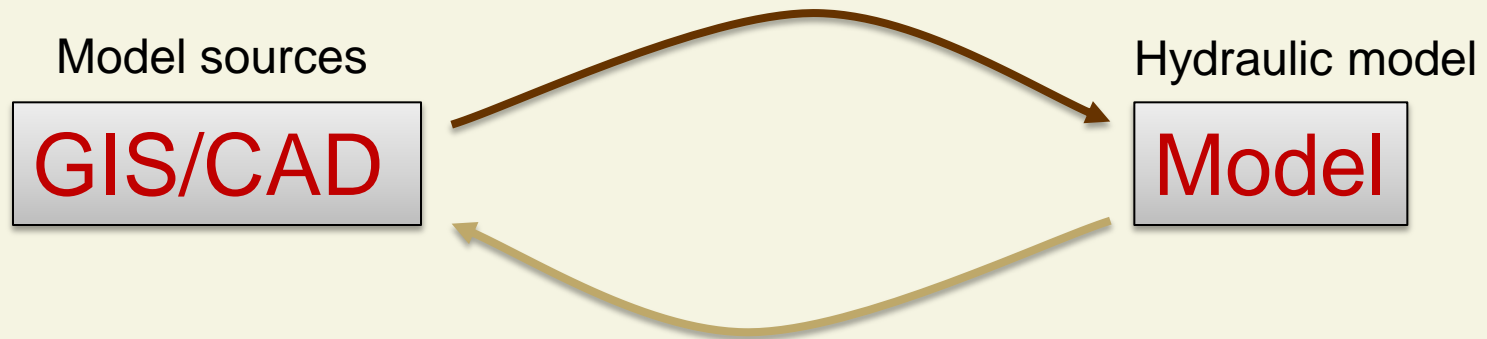
# WaterGEMS Modeling Data





# Synchronization between GIS data and Hydraulic Model

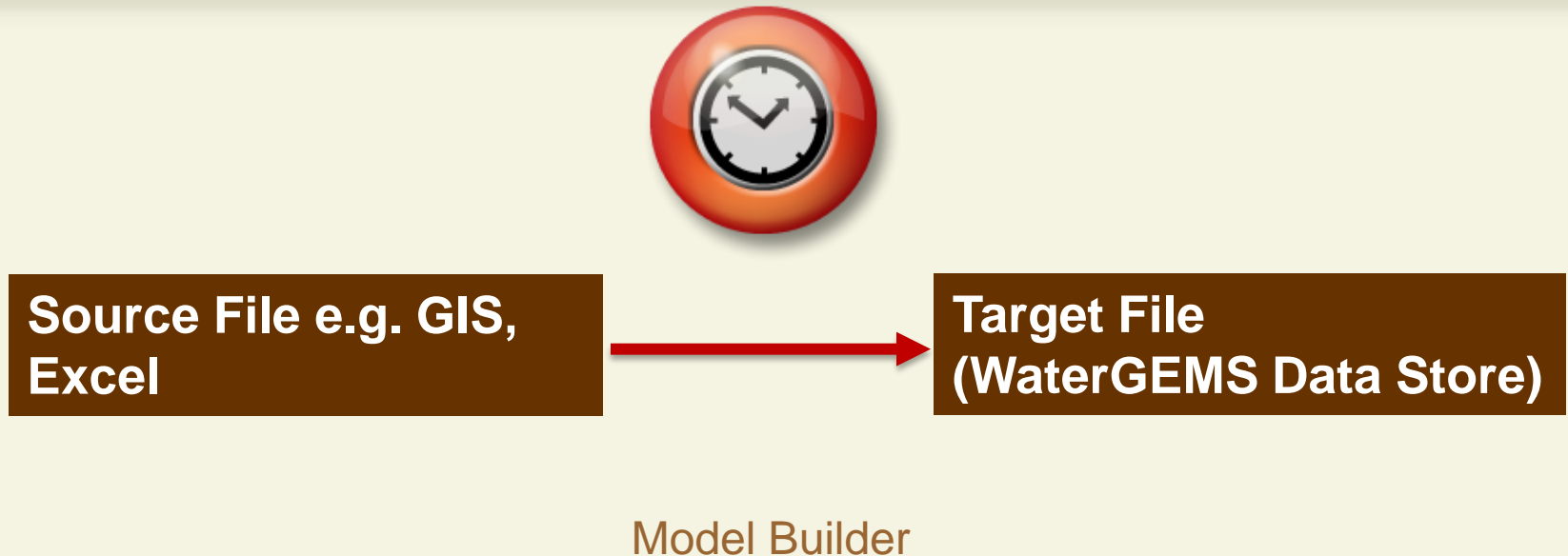
## Build model from GIS/CAD



Correct GIS/CAD when modeler  
needs to update underlying data



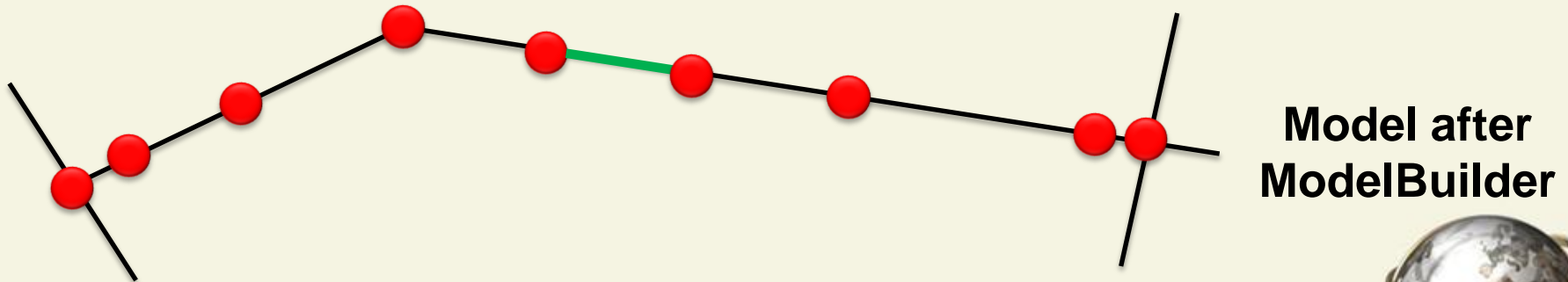
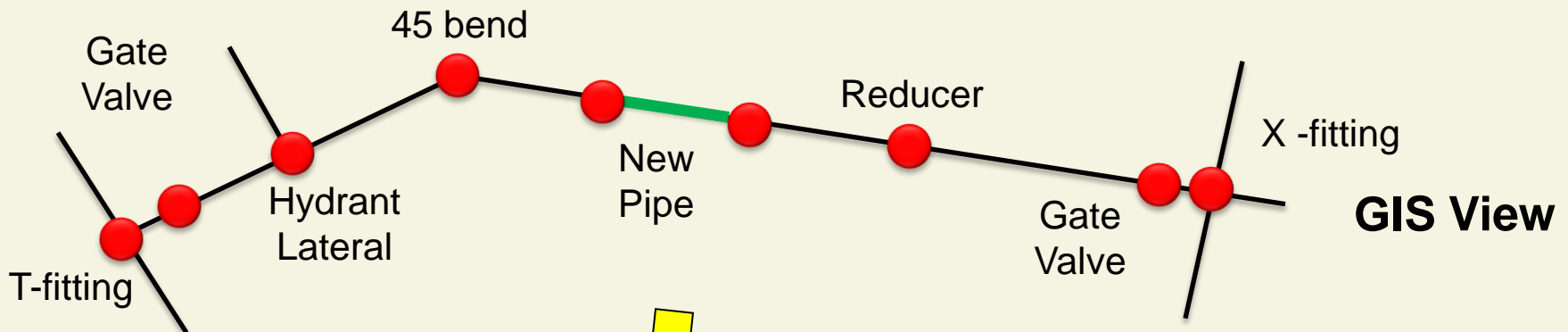
# How it Works



**The key is to map and import attributes that are relevant for hydraulic model**



# GIS Features to Model Elements





# GIS Feature → GEMS Element

Bend, fitting, negligible loss	Pressure junction
Bend, fitting, significant loss	GPV, TCV or minor loss on adjacent pipe
Isolating valve, used for criticality analysis	Isolating valve
Isolating valve, always open, negligible loss	Pressure junction
Isolating valve, always open, significant loss	GPV, TCV or minor loss on adjacent pipe GPV
Isolating valve, normally closed	Closed valve
Air release valve	Pressure junction
Air release valve	Air release valve



## GIS Feature → GEMS Element (2)

Customer/lateral	Pressure junction
Hydrant + lateral	Hydrant with lateral as property, hydrant + lateral, or just a hydrant
Check valve in-system	Property of adjacent pipe
Check valve at pump	Part of pump
System water meter	GPV, TCV or minor loss on adjacent pipe
Pump control valve	Pressure junction
Reducer	Pressure junction w/ different diameter each side
Change in material	Pressure junction



# Considerations

- Not all attributes from source GIS files need be copied (e.g. inspection date, other attributes)
- Not all attributes in target file need to come through ModelBuilder (e.g. color coding)
- x,y coordinates automatically come in from Shapefiles/geodatabases/CAD drawings
- System Demands may be better imported using LoadBuilder and customer billing data
- Elevations are best imported from DEMs using TerrainExtractor (TRex)



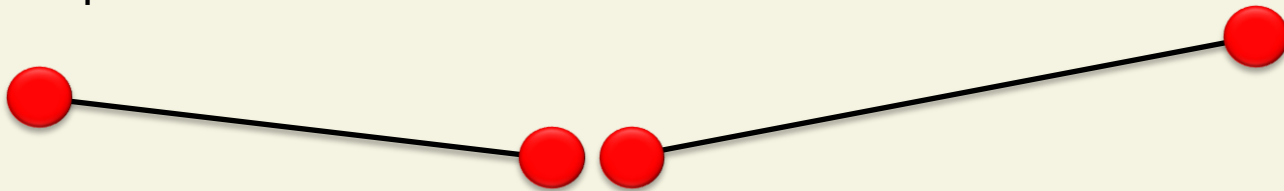


# Connectivity Issues

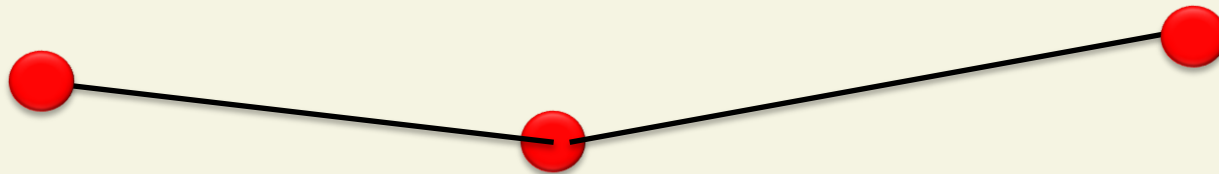
Pipes without end nodes



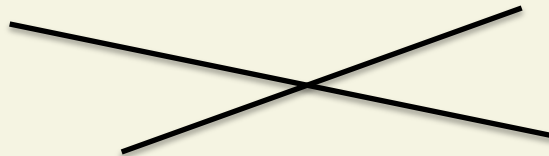
Pipes that do not connect but should



Pipes that appear to connect but are not

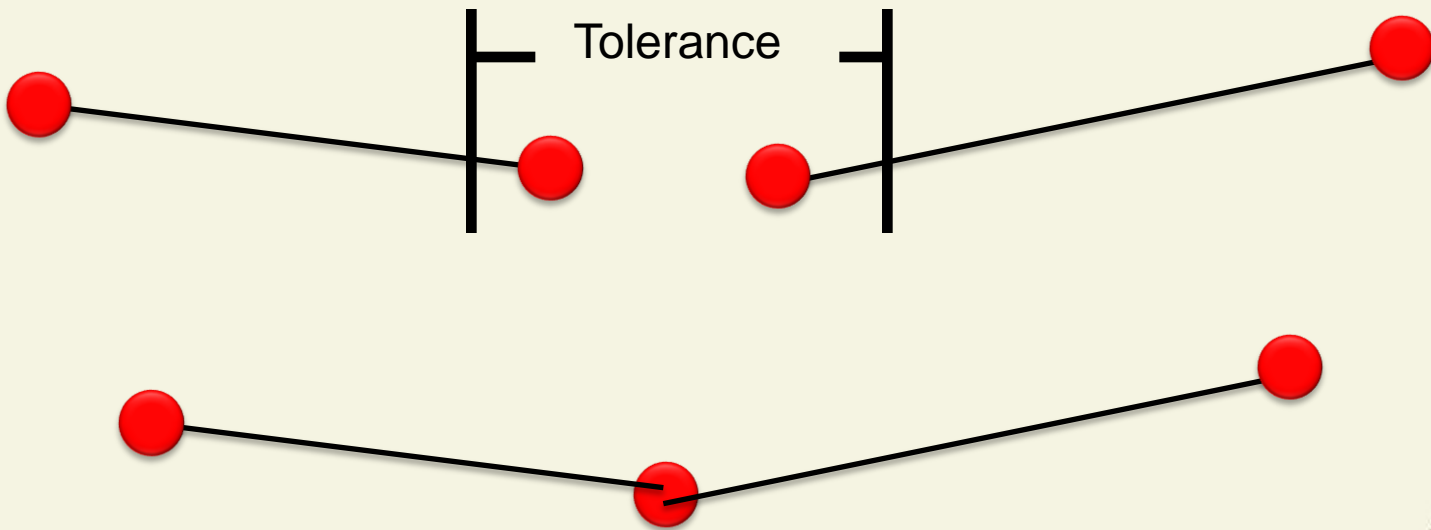


Pipes that cross without junctions



# Resolving Connectivity Problems

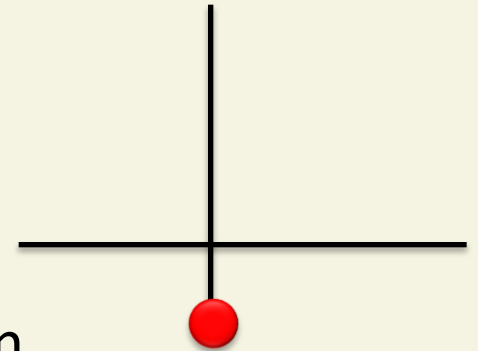
- Add end nodes to pipes without end nodes
- Snap ends of pipes to single node if within (user specified) tolerance



# Network Navigator

## Finds possible problems caused by

- Nodes in close proximity to other nodes
- Nodes in close proximity to pipes
- Orphaned nodes
- Elements with messages from previous run
- Tracing and connectivity analysis

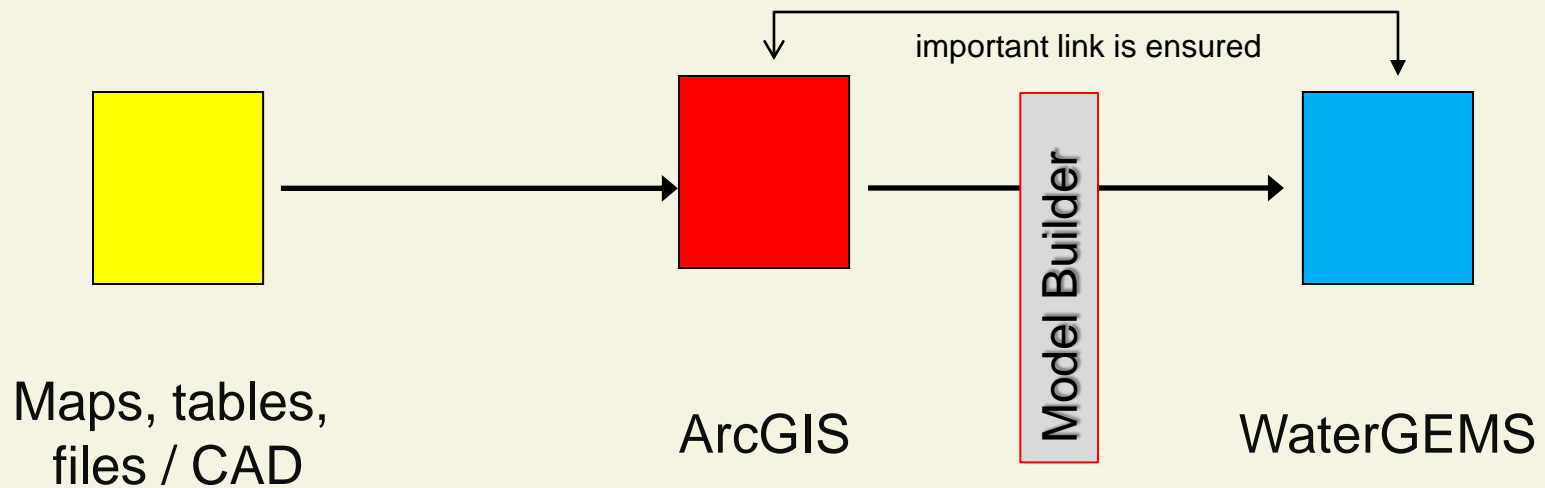


# Work Flow

Drafting

GIS registry

Hydraulic analysis





# Describe the GIS asset registry creation of SEWA

- CAD files used...
- Maps and as build drawings...
- XLS, TXT, and other data files used
- Shape files
- ArcGIS Geospatial databases (.MDB)
- OracleSpatial 10g



# Model Builder module of WaterGEMS

The screenshot displays the Bentley WaterGEMS Model Builder interface. The 'ModelBuilder Wizard' dialog box is open, showing the 'Specify your Data Source' step. The 'Select a Data Source type:' dropdown menu is set to 'ESRI Shapefiles'. The 'Select your Data Source:' text box shows the path 'C:\Documents and Settings\santhosh.wtr\Desktop\gems on 192.168.3.32'. The 'Choose the tables you would like to work with:' section has a list of tables with checkboxes: 'Air (Point)', 'Hydrants (Point)', 'Pipe (Polyline)', and 'TCV (Point)'. The 'WHERE:' field is empty. The 'Show Preview' checkbox is checked, and a preview table is displayed below it.

**Connect to Geodatabase or Shapefiles**

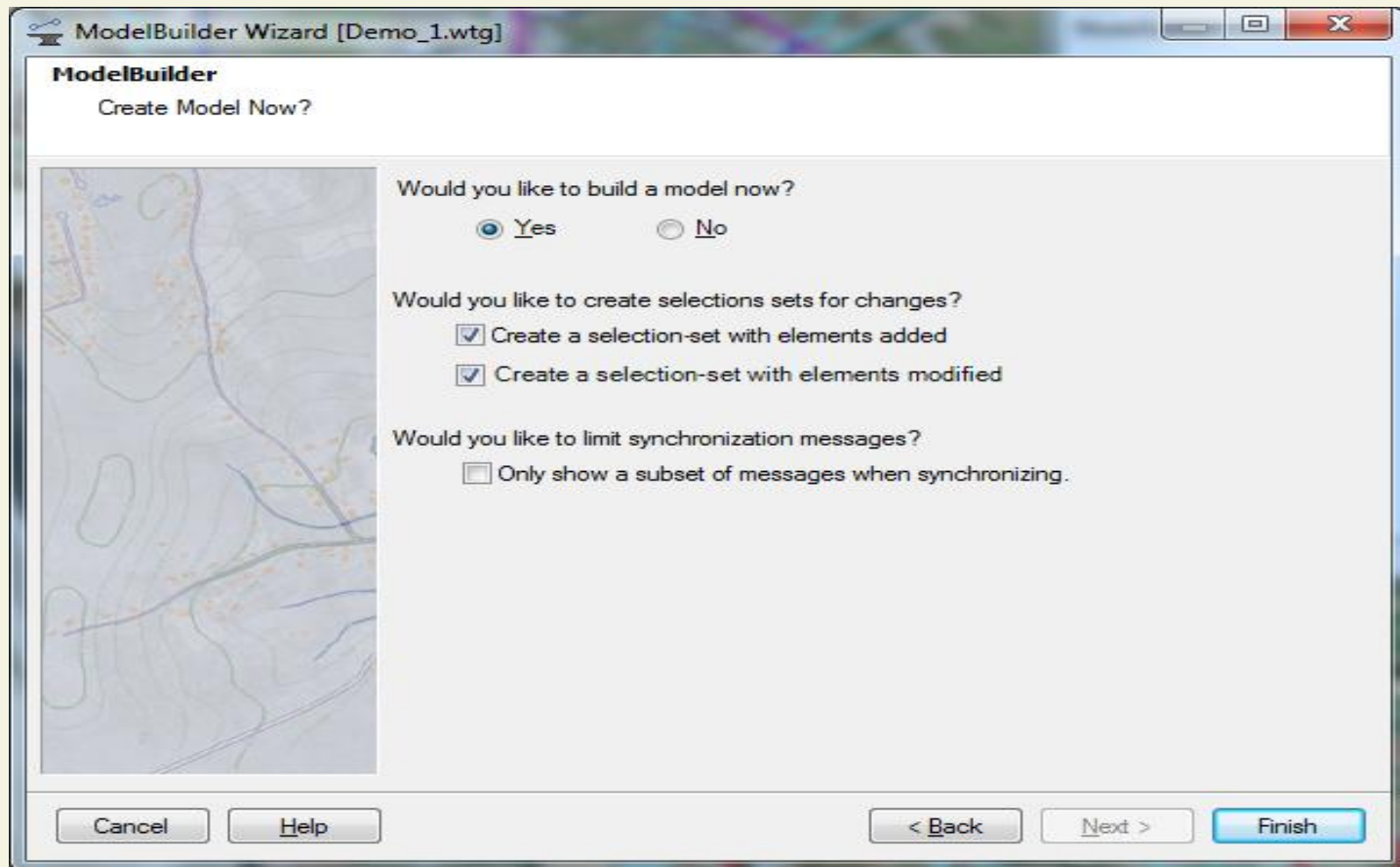
**Specify features to import**

OBJECTID	ElementTyp	ElementId	SHAPE_Leng	ID	Label	Length_Sca
1	69	918	485.903777089	918	P-2087	485.903777089
2	69	917	543.168257394	917	P-2175	543.168257394
3	69	916	480.944961027	916	P-2218	480.944961027
4	69	915	480.549981488	915	P-278	480.549981488
5	69	914	479.926564263	914	P-2576	479.926564263
6	69	913	475.127278679	913	P-438	475.127278679
7	69	912	473.084344578	912	P-2105	473.084344578
8	69	911	517.319461492	911	P-2976	517.319461492
9	69	910	469.628665669	910	P-361	469.628665669
10	69	909	510.315036648	909	P-3137	510.315036648
11	69	908	464.282383464	908	P-2496	464.282383464
12	69	907	463.306371194	907	P-2376	463.306371194
13	69	906	462.69837595	906	P-2803	462.698375948
14	69	905	462.234579845	905	P-1004	462.234579844
15	69	904	465.886640623	904	P-2188	465.886640623
16	69	903	460.130863415	903	P-1583	460.130863415
17	69	902	459.469749845	902	P-2558	459.469749845
18	69	901	455.529136631	901	P-383	455.529136629

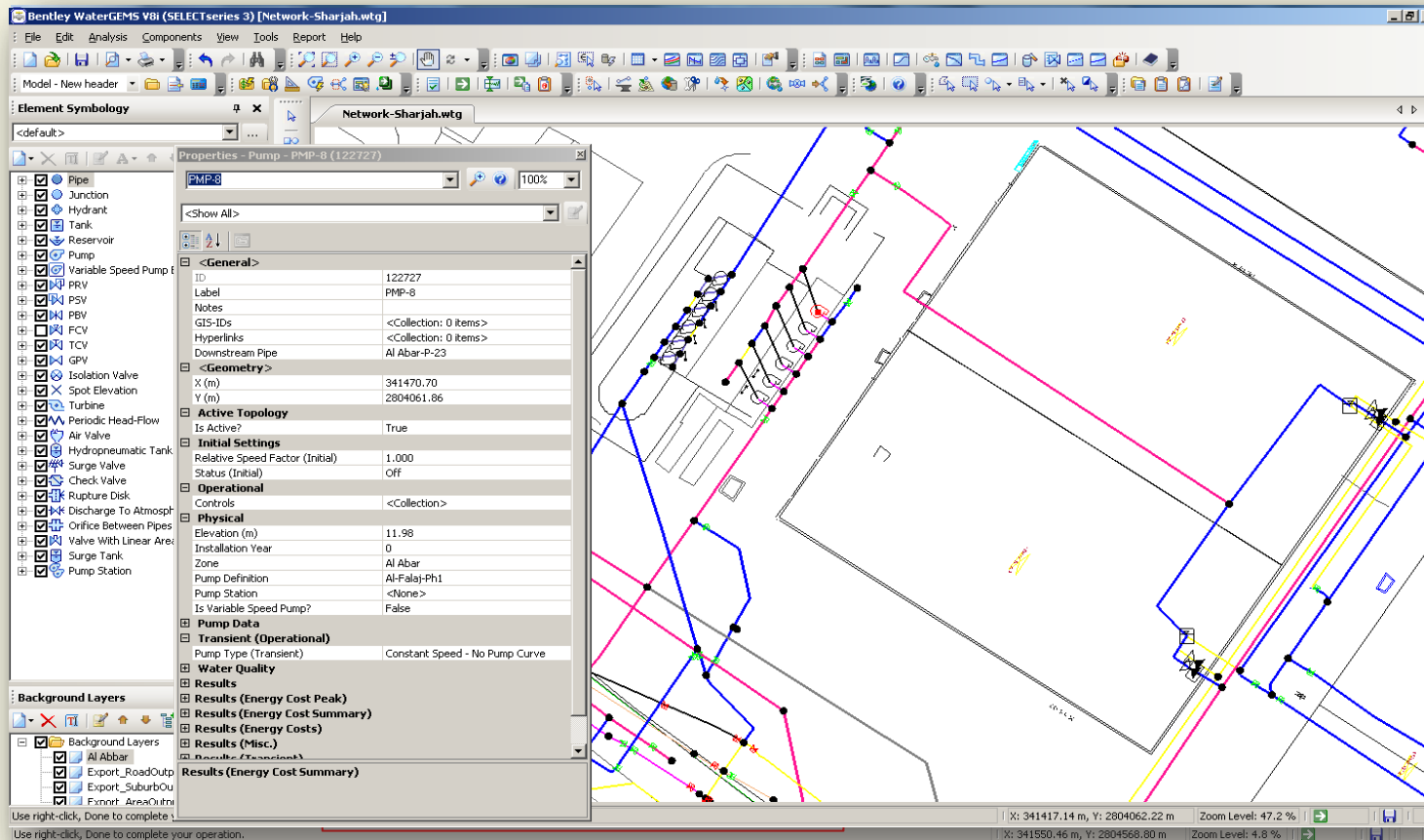


# Model Builder module of WaterGEMS

Build or Synchronize model from GIS data



# WaterGEMS hydraulic model for SEWA



**Pumping Station and Reservoir Location  
Al Abbar (Halwan) Area**





# Calibration

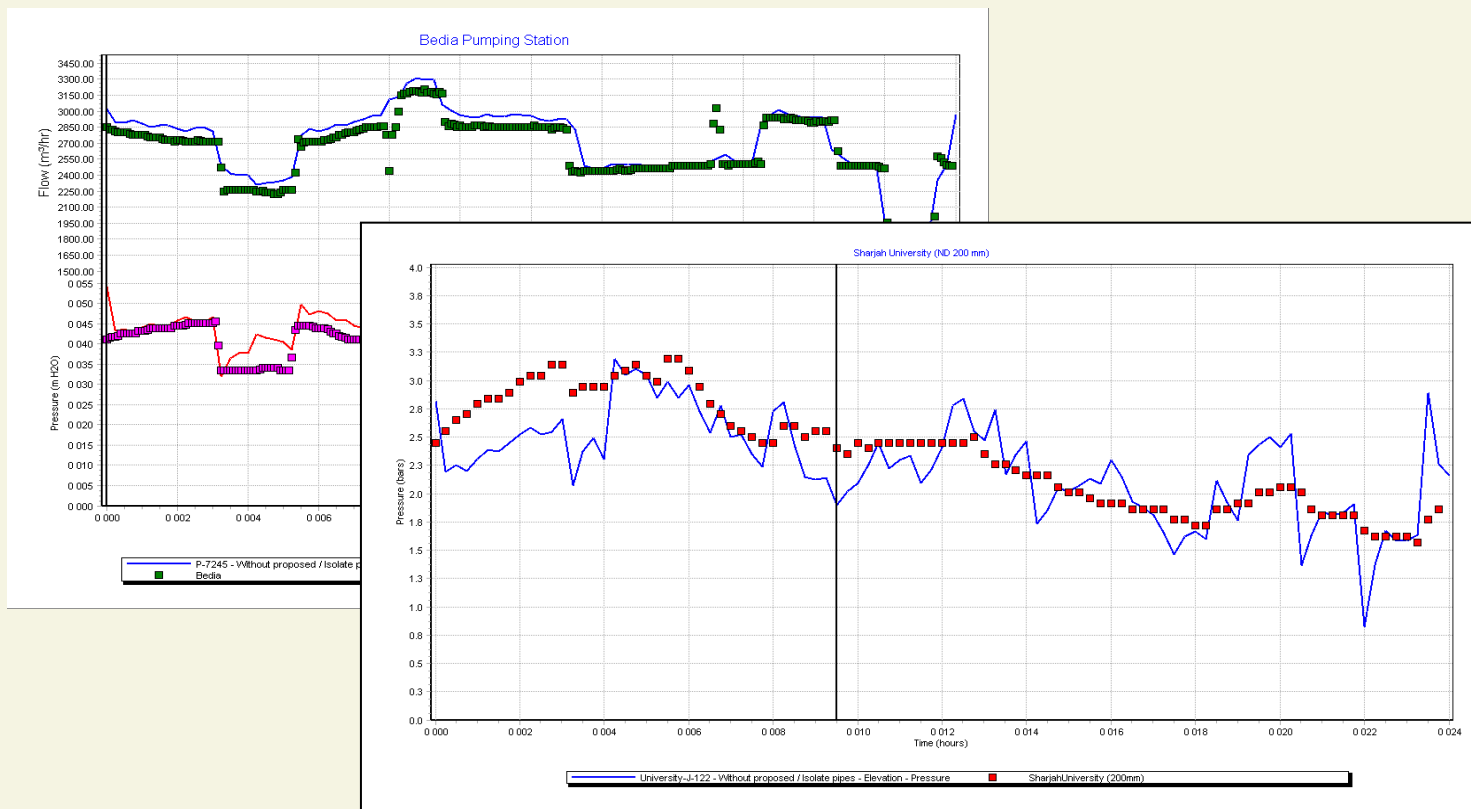
## To Guarantee the reality of the model

- Comparing the field survey measurements and the modelling results
- Adjust hydraulics parameters in order to get the same results (consumption profile, consumption coefficient, ...)
- 50 temporary locations have been prepared for the field survey



# Hydraulic model – Results – Calibration curves

## Bedia Flow and pressure

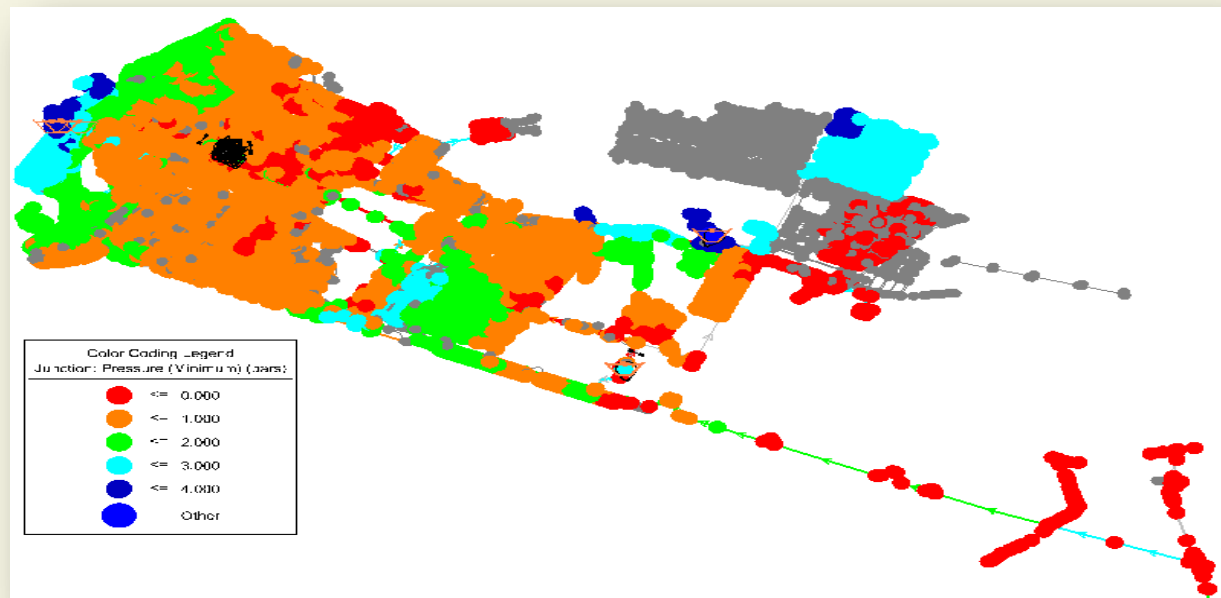


## Pressure at University



# Diagnosis of the potable water network (minimum pressure)

- Low pressure (criteria to be defined with SEWA)
- High velocities
- Major head losses



# Conclusions

1. Scenario comparisons for real-time network operational decisions
2. Finding leakages hot-spots using hydraulic model and measured flow and pressure data
3. Better pressure management and optimal pumping scheduling
4. Planning the renewal of the pipes using the Pipe Renewal Planning Module
5. Updating GIS with modeling results



Thank You 😊

karrani@sewa.gov.ae

