

# Sustaining Water Infrastructure using Bentley Water Solutions February 2010.

Slavco Velickov, PhD  
Water Industry Director, EMEA



# Agenda

1. Bentley at a Glance
2. Bentley Water Solutions
3. Water Products Overview
4. Contact Information





SOLUTIONS

PRODUCTS

LEARNING

SUPPORT & SERVICES

CORPORATE

COMMUNITIES



LEARN MORE

## Sustaining Infrastructure

Comprehensive software solutions for the infrastructure lifecycle: from buildings to bridges, transit to utilities, clean energy to clean water, Bentley is *Sustaining* Infrastructure.

### Communities

3,800+ members

Connect and communicate with other members of the world's infrastructure community.

JOIN NOW!

Forums | Wiki | Blogs [More](#)

### Bentley in the News

July 8 - From ENR.com: Bentley and Autodesk Agree To Exchange Keys To Sharing of Data

July 8 - Autodesk and Bentley to Advance AEC Software Interoperability

[More](#)

### Project Showcase



2008 BE Award of Excellence Winner, Innovation in Power Generation, Sargent & Lundy, LLC, Dry Fork Station Unit 1



BE Awards of Excellence Project Yearbook

[More](#)



GenerativeComponents at AIA: Unthinkable Designs Made Possible



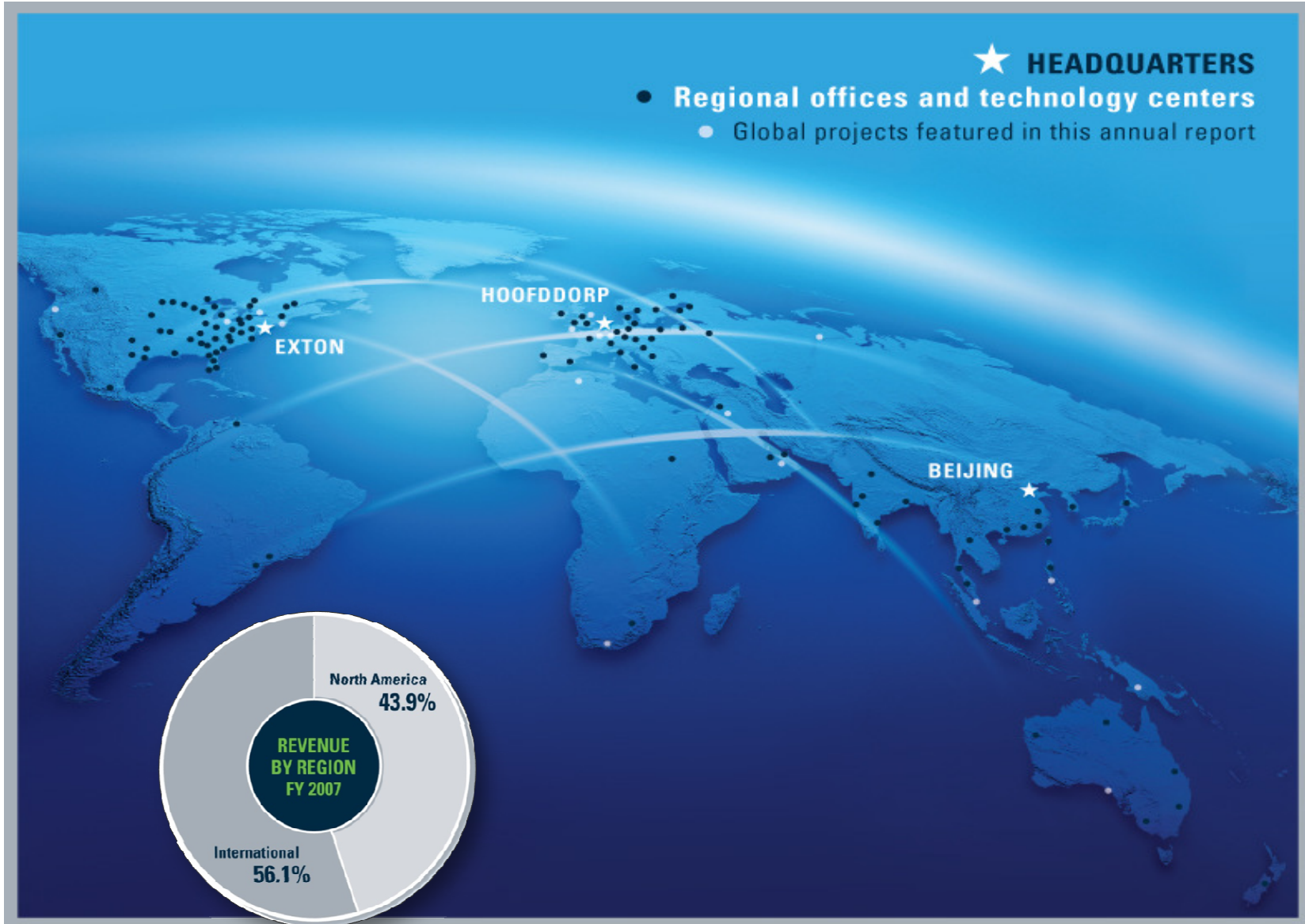
Bentley's May 2008 Annual Report How Available



Sustaining Infrastructure White Paper



# Global Company

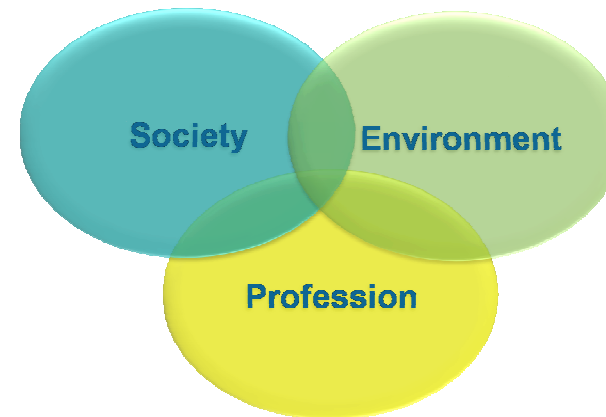


# Bentley: *Sustaining Infrastructure*



*Our mission is to provide solutions to Design – Build – Operate the world's infrastructure with the goal of:*

- Sustaining our society
- Sustaining the environment
- Sustaining the profession



# Solutions



Bridges



Buildings



Cadastre and Land Development



Campuses



Power Generation



Rail and Transit



Communications



Electric and Gas Utilities



Factories



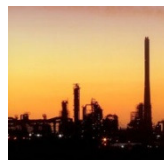
Roads



Metals and Mining



**Water and Wastewater**



Oil and Gas



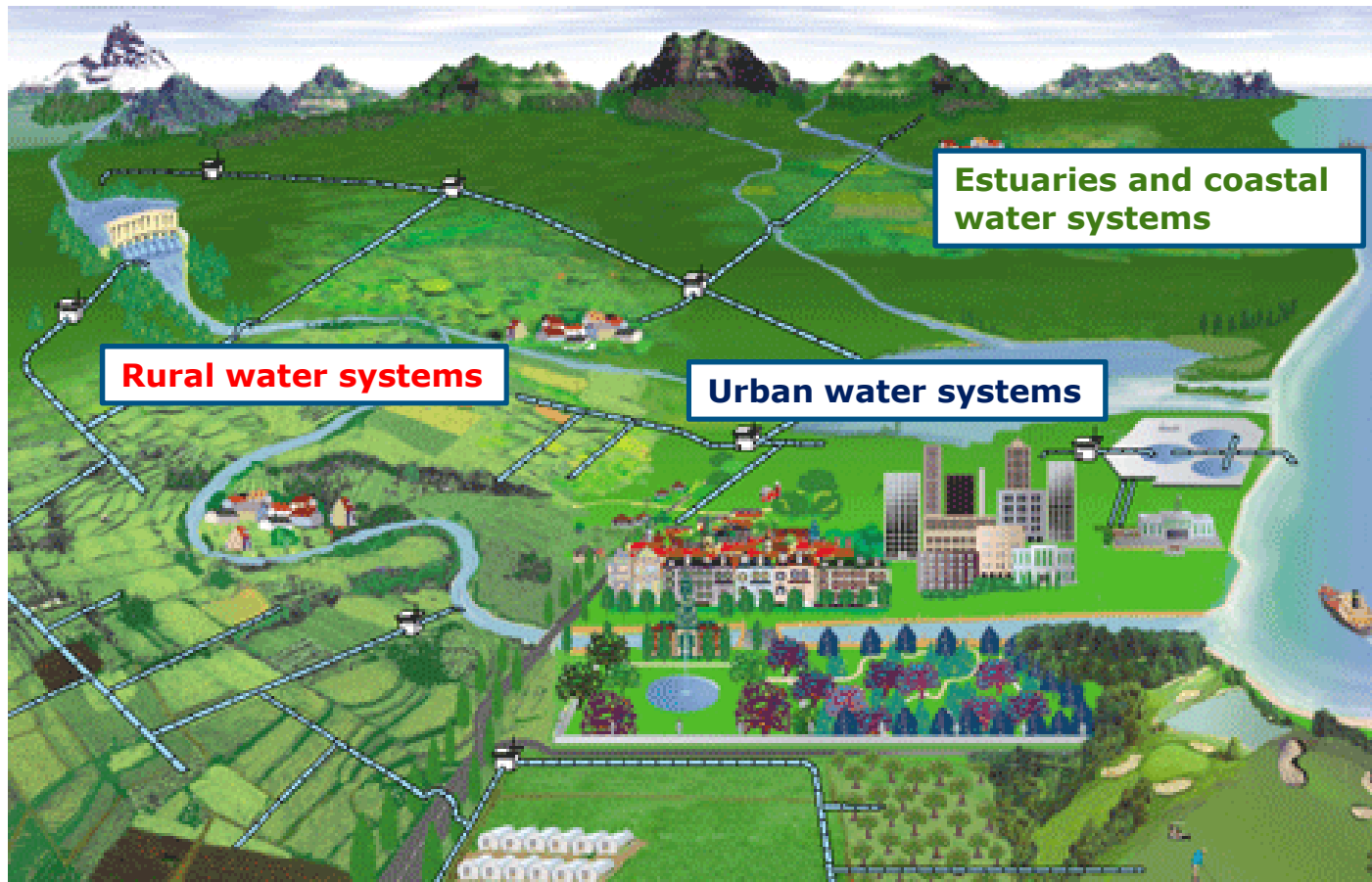
# Bentley Solutions

1. Intra-operable infrastructure software portfolio
  - Multi-discipline built on a common V8i platform
  - Supports the Design-Build-Operate lifecycle
  - Encompasses the full spectrum of infrastructure
2. Professional services and learning
  - Support for implementation and all change issues
3. Professional communities networking
  - Local and global communication opportunities



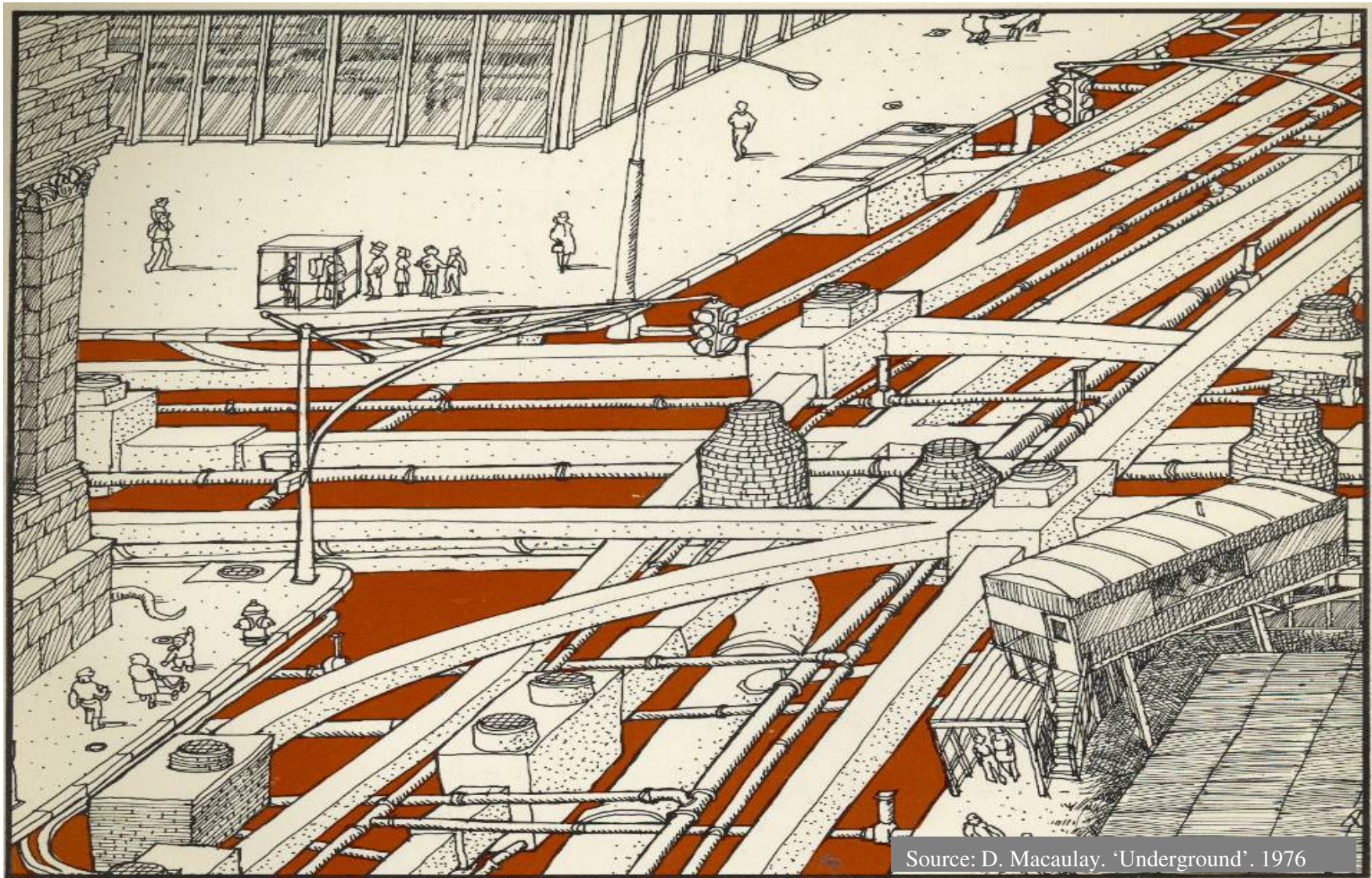


# The World of Water





# The Urban Water Challenges



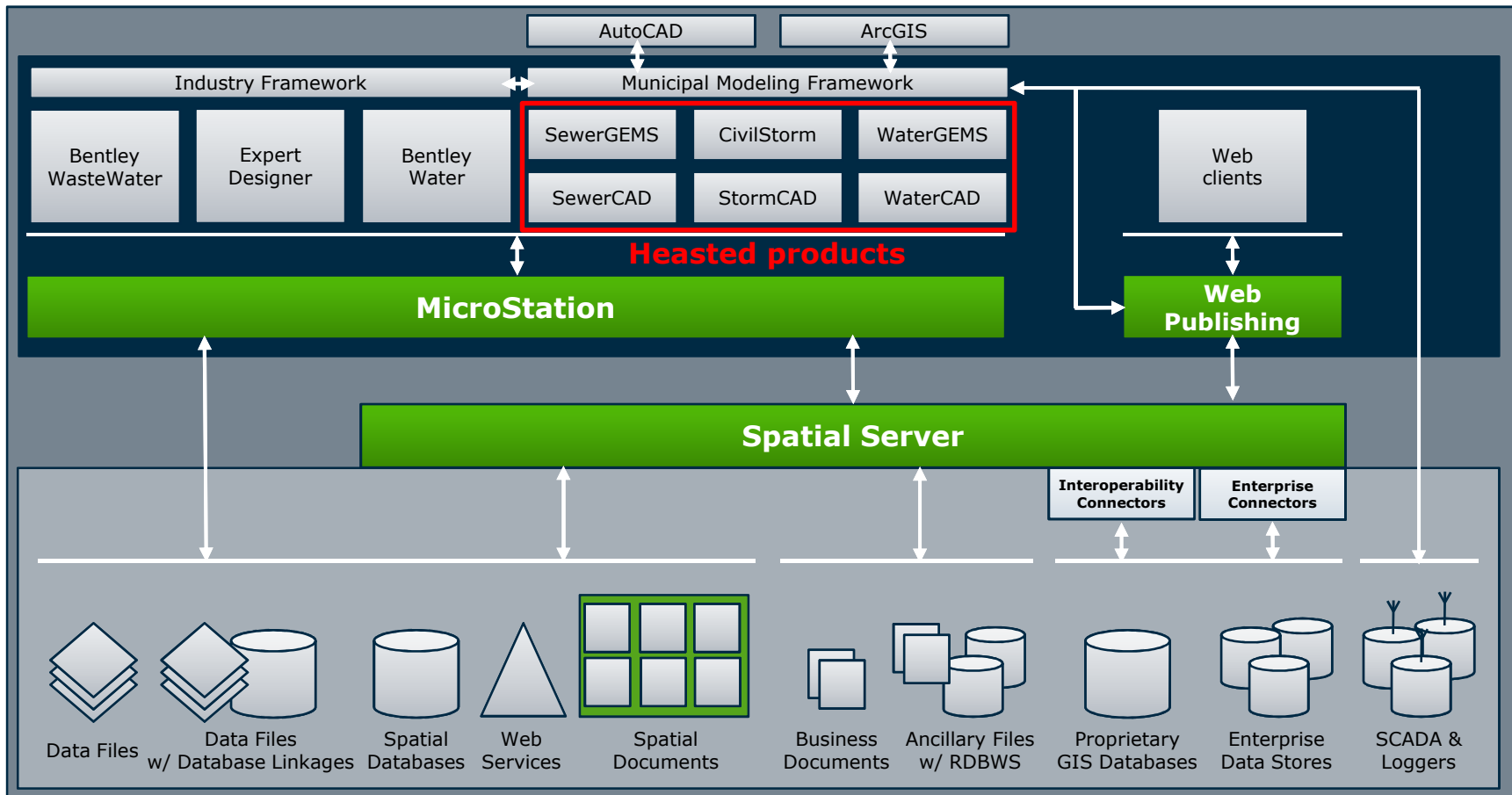
Source: D. Macaulay. 'Underground'. 1976

# Water & Wastewater Industry Challenges

- Regulatory Compliance
  - Adequate Supply & Treatment capacity
  - Protecting Water Quality
  - Business performance
- Reliability
  - Consistently achieving target levels of services
  - Maintaining aging infrastructure
  - Avoiding failure
- Budget
  - Reducing costs while improving services
  - Asset investment planning for aging infrastructure
  - Aging workforce



# Water Solutions Architecture



Hydrology & Hydraulics Products





# Bentley Haestad Product Line

**HAESTAD  
METHODS**  
WATER SOLUTIONS

**26 years**  
**130,000 users**  
**170 countries**

## WATER

WaterGEMS. Water distribution modeling with geospatial integration

WaterCAD. Water distribution modeling and design

— Darwin Designer. Network design automation

— Darwin Calibrator. Model calibration optimization

— Darwin Scheduler. Pumping scheduling optimization

— Skelebrator. Network reduction or simplification

HAMMER. Transient flow analysis and modeling

SCADAConnect. Supervisory and control data integration

## SEWER

SewerGEMS. Urban sewer modeling with GIS integration

SewerCAD. Sanitary sewer design and modeling

CivilStorm. Stormwater management and dynamic modeling

StormCAD. Storm sewer design and modeling

PondPack. Detention pond design and analysis

## STORM

HEC-Pack. Floodplain modeling

CulvertMaster. Culvert design and analysis

FlowMaster. Hydraulics calculator

## Other..

GISConnect. CAD / GIS Interoperability

WaterObjects. .Net development environment

Mohid. Catchment, costal and estuarial modelling solution





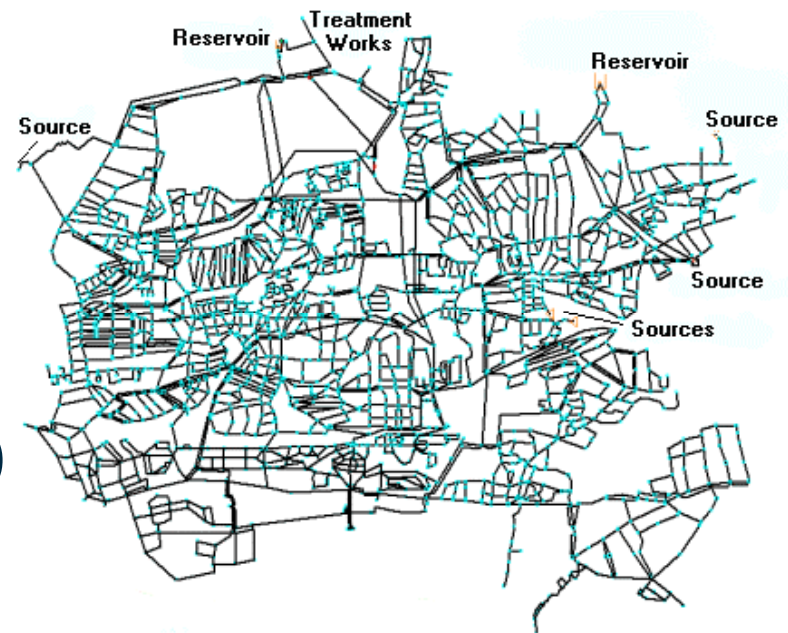
**SOLUTION**

# Example Applications



# Rehabilitation Planning

- Pipe network rehabilitation
- Find the most cost-effective solution
- Overcome pressure deficiencies
- Projected demand increases (20 years ahead)
- WaterCad and Darwin Designer (genetic algorithm optimisation)



**Thames Water DMA in UK:  
1,500 pipes**

# Rehabilitation Planning (cont.)



**“Manual” Solution**

**£4.16M**

**GA Optimised Solution**

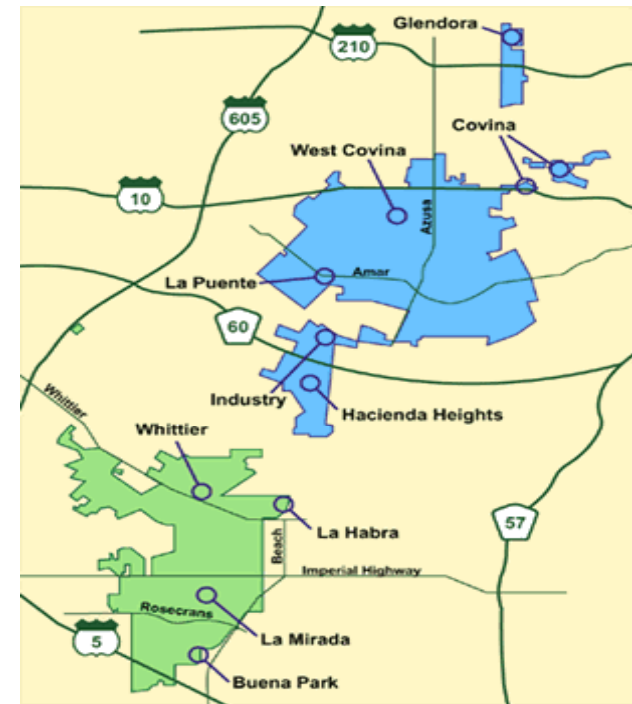
**£2.14M**



**Bentley**

# Capital Investment Planning (CIP)

- Growing demand
- Service level improvements
- Optimise design
- Meet criteria
  - Flow
  - Pressure
  - Tank storage
  - Minimum cost
- Master plan



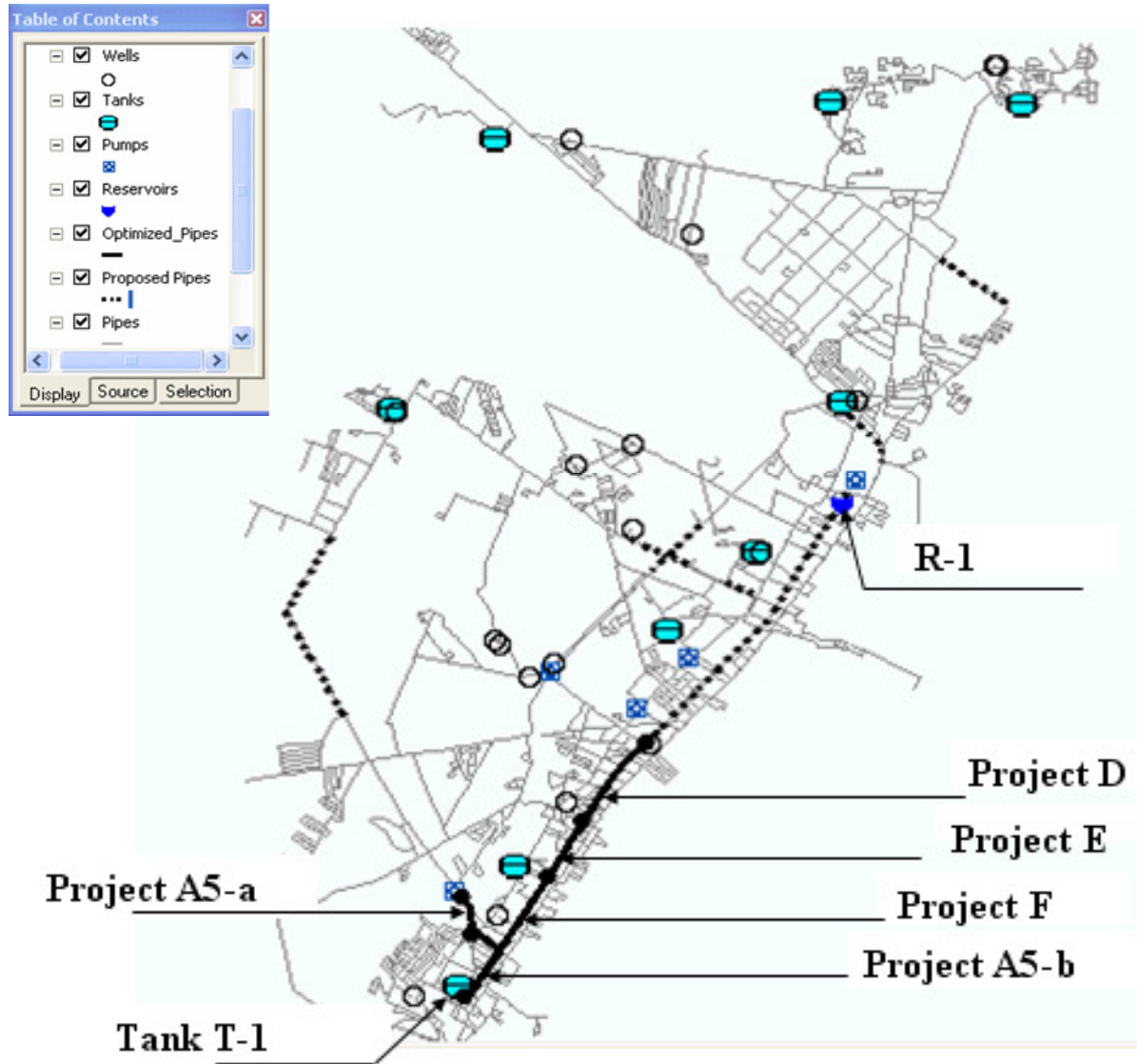
## City in USA:

- 300 000 inhabitants
- Contain 31 reservoirs, 14 wells, 116 pumps and more than 1600 km of pipelines





# CIP: Example Results

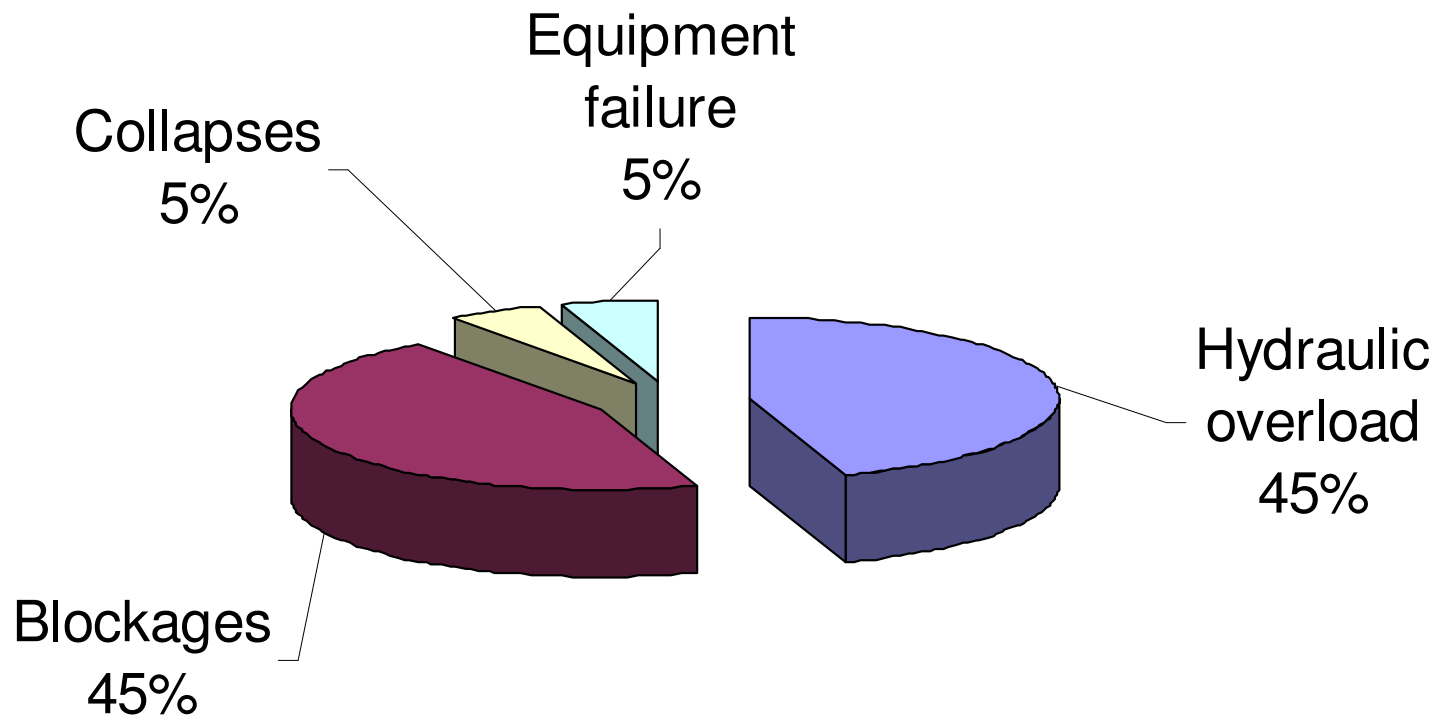


# CIP: Pipe Installation Priority

Pipeline Project	8% Growth (20.06 mgd)		13% Growth (21.00 mgd)		18% Growth (21.92 mgd)		24% Growth (23.03 mgd)		30.4% Growth (24.22 mgd)	
	Dia	Cost (10 <sup>3</sup> )	Dia	Cost (10 <sup>3</sup> )	Dia	Cost (10 <sup>3</sup> )	Dia	Cost (10 <sup>3</sup> )	Dia	Cost (10 <sup>3</sup> )
PROJECT A5-a	12	169.8	16	212.3	16	212.3	16	212.3	24	283.0
PROJECT A5-b	20	511.3	20	511.3	24	568.1	16	426.0	24	568.1
PROJECT E	0	0	0	0	0	0	16	340.0	24	453.3
PROJECT F	0	0	0	0	0	0	20	874.8	24	972.0
PROJECT D	0	0	0	0	0	0	0	0	24	681.9
<b>Total Cost (\$)</b>	681,090		723,540		780,350		1,853,100		2,958,300	



# Sewer Deterioration Modelling



**Causes of Sewer Flooding**

# Sewer Deterioration Modelling

## Sewer Attribute Base

- Pipe performance
- Pipe service
- Installation age / era
- Size
- Material
- Depth
- Gradient
- Function
- Cross section
- Soil, traffic load, mining etc.



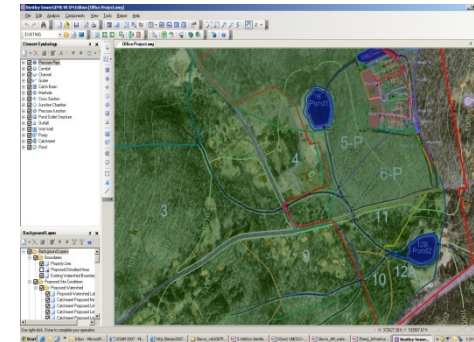
**Timisoara city in Romania:  
combined sewer system**



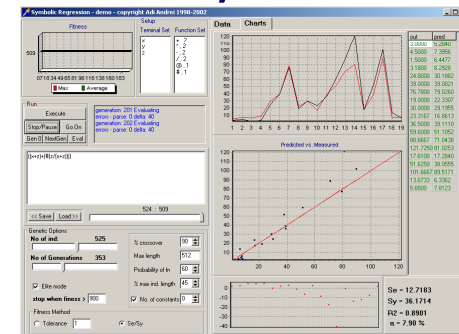
# Solution Techniques

- Bentley SewerGEMS for Hydraulic performance assessment
- Genetic Programming for deterioration modeling
- Bayesian Probabilistic Network for Failure Risk Assessment and Uncertainty

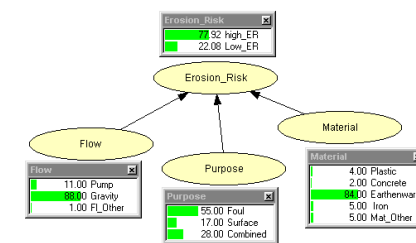
**SewerGEMS**



**Bentley GP kernel**

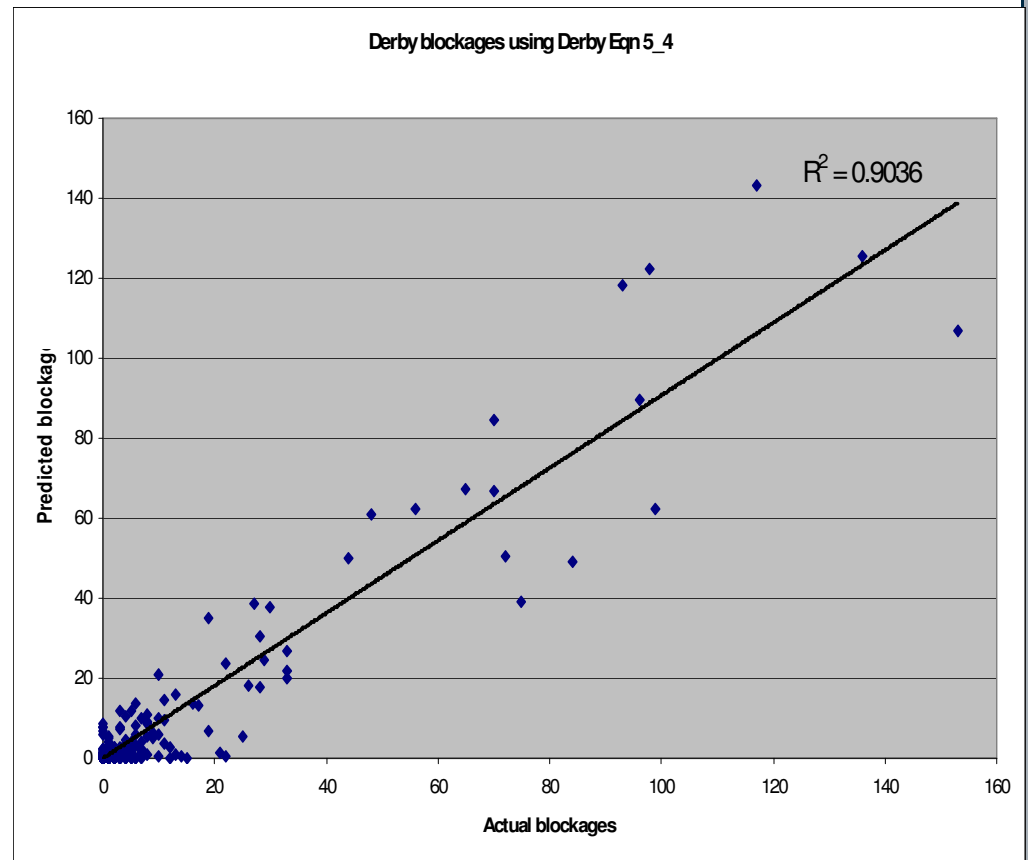


**Bayesian Network**



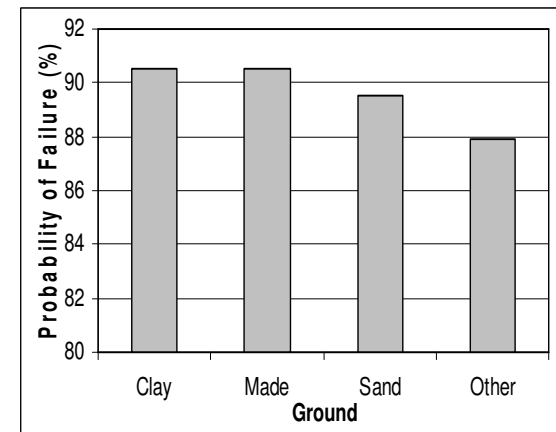
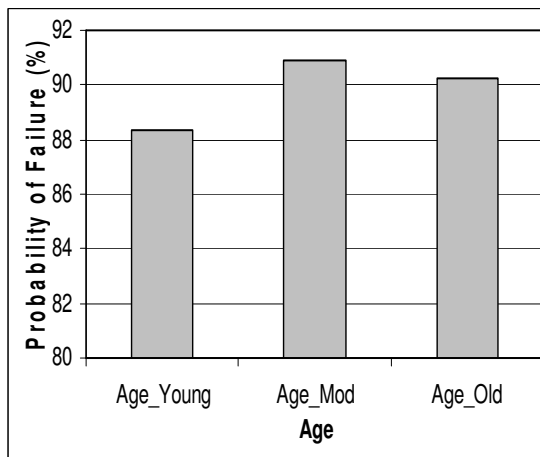
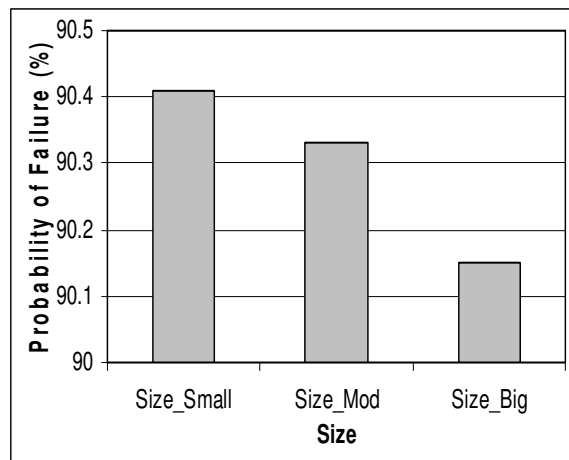
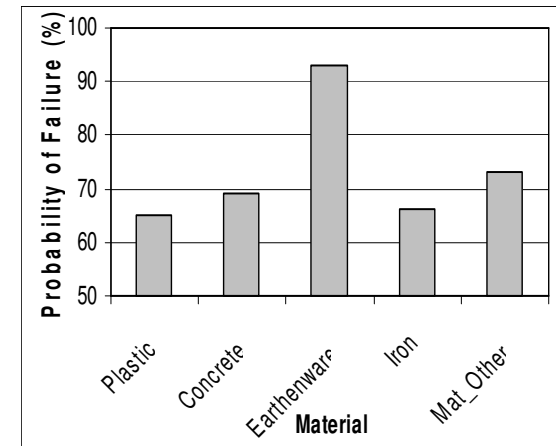
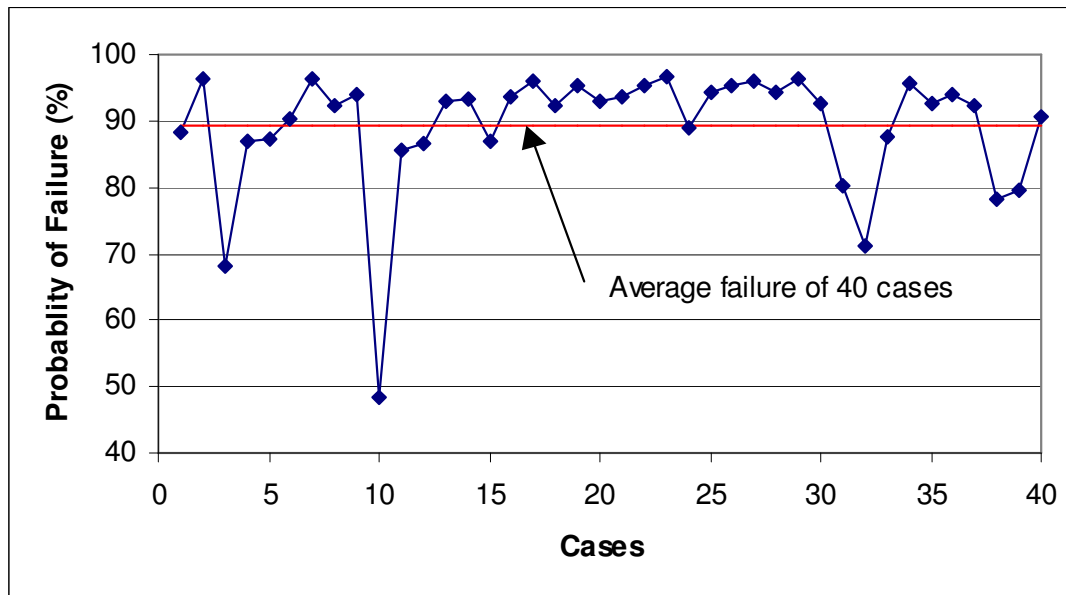
# Deterioration Model Example

- CoD = 90%
- op – operational condition grade
- Age – age of sewer
- s24 – 'section 24 sewers' (old, small bore)



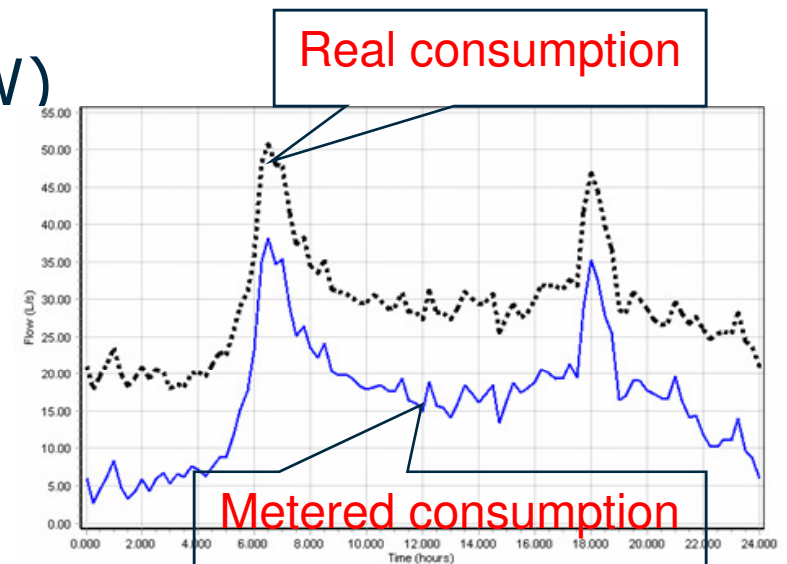
$$BL = 0.091978 \cdot op + 0.10927 \cdot Age \cdot s24$$

# Failure Risk Model Example



# Leakage Detection

- Cause water companies / utilities lose revenues (NRW)
- Use hydraulic model as a base
- Integrate with optimization technology
- Predict leakage hotspots (unreported leakages)

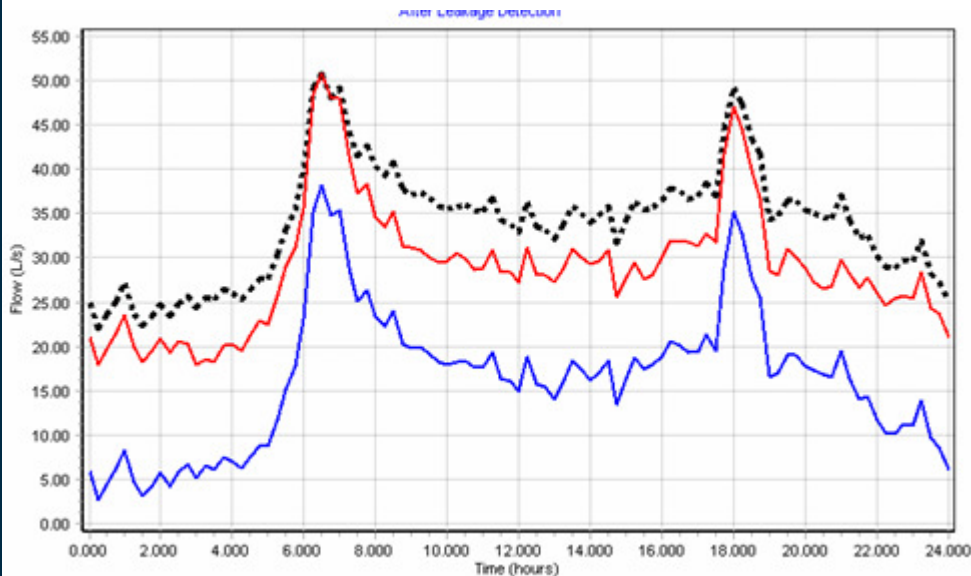
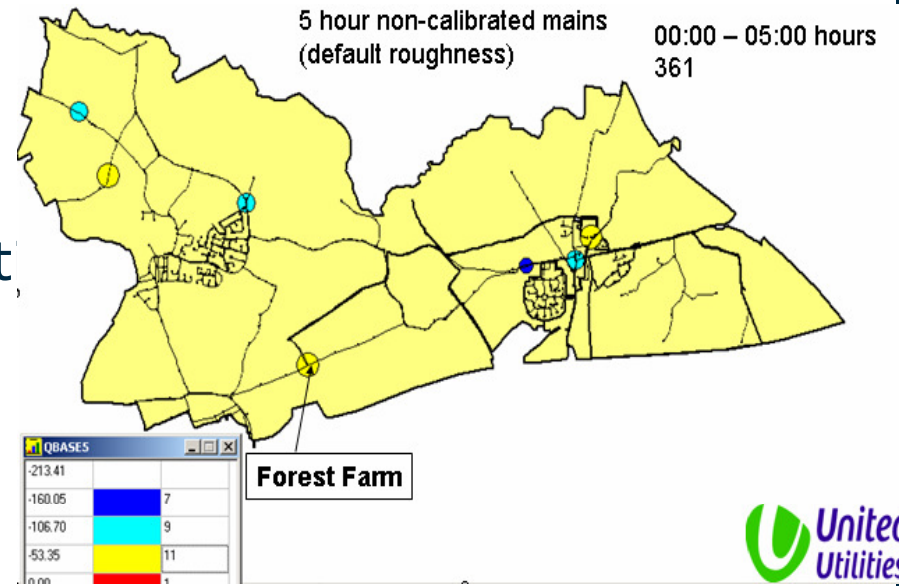


**DMA in UK: Oldham area**



# Leakage Detection Benchmark

- A DMA water system in UK
- High leakage rate
- Apply the latest leakage detect model in **WaterGEMS**
- Enable informed field survey



# Real-time SCADA Modelling

## Security

- Planning and outage analysis
- Real time predictions
- Leakage detection & Demand inversion
- Forensics

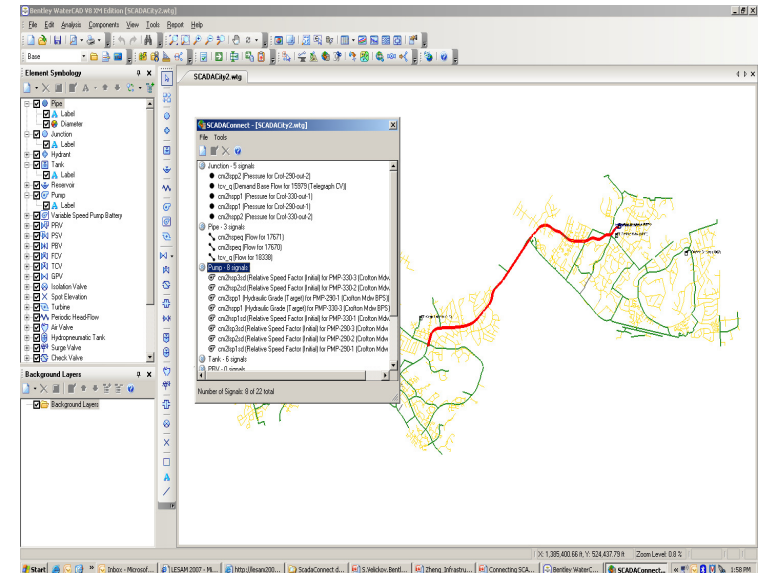
## Energy Management

- Optimal pumps scheduling

## Water Quality

- Emergency management
- Planning
- Forensics

## Operator Training & Learning



### City in US:

**- 47 signals were mapped and used in WaterGEMS for real-time decision support**



# Bentley Institute Learning Offerings



What	How	Options
Classroom Learning	Instructor-led	Scheduled Courses Account-Specific Courses Enterprise Training Subscription
Distance Learning	Instructor-led	Scheduled Courses Account-Specific Courses Enterprise Training Subscription
OnDemand eLearning	Self-paced	Bentley LEARN Enterprise Training Subscription

# Bentley Institute Press





## Be Careers Network

### Communities

▶ Be Communities

▶ Be User Group

▼ Be Careers Network

• Software and Textbooks

• Blended Learning

• Networking and Development

▶ Be Connected Seminars

▶ Be Inspired Awards

▶ Be Conference

## Be Careers Network



Never has the importance of infrastructure been more evident than today. At the same time design and engineering firms are demanding the next generation of engineers and architects be prepared to enter the workforce equipped with in-depth knowledge of the technology and tools used to design, build, and operate the infrastructure of tomorrow.

That's where the Be Careers Network comes in, making access to software and training possible, affordable, and going the extra step by connecting new graduates with firms seeking their skills.

The Be Careers Network offers value to **Students, Educators, and Bentley Users** through:

- **Comprehensive Software Suites and Textbooks** – Cost-effective software subscriptions encompassing the full range of infrastructure disciplines, textbooks, and tracking of student progress.
- **Blended Learning** – Self-service training, product videos, and eSeminars, as well as curricula for educators, allows professors to focus on core concepts while providing students with the technology training required to be “job-ready.”
- **Professional Networking and Development** – Students, educators, and professionals gain networking and development opportunities through the Be Communities networking website, Resume Center, academic competitions and the Be Employable program.



[Download: Future City](#)

### NEWS



Bentley is making software and training available at no charge! [Read more.](#)



Bentley announces the 2009 Academic Be Inspired Award Winners. [Read more.](#)

### VIDEO



[Hear what students have to say about the Be Careers Network.](#)



[View a demo](#) of Be Careers latest Hevacomp offering, software for building energy design, analysis, and simulation.



Meet the 2009 Future



## Contact Information and Resources

**[www.bentley.com/water](http://www.bentley.com/water)**  
**[communities.bentley.com](http://communities.bentley.com)**  
**[www.bentley.com/waterloss](http://www.bentley.com/waterloss)**

Bentley Systems Europe BV  
Wegalaan 2, Hoofddorp  
The Netherlands  
Tel : +31 235560560

[slavco.velickov@bentley.com](mailto:slavco.velickov@bentley.com)



# Tank You for Your Attention

## A SUSTAINABLE BUILT ENVIRONMENT



[Slavco.Velickov@bentley.com](mailto:Slavco.Velickov@bentley.com)

[www.bentley.com](http://www.bentley.com)

