Basics of Asset Management and GIS

What's it all about?

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Asset Management, broadly defined, refers to any system that monitors and maintains things of value to an entity or group.

Asset management is a systematic process of operating, maintaining, upgrading, and disposing of assets cost-effectively.

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What's it all about?

From the engineering perspective…..

The process of monitoring and maintaining facilities systems, with the objective of providing the best possible service to users (appropriate for public infrastructure assets).

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Basics of Asset Management and GIS

What's it all about?

EAM

- Enterprise Asset Management

IAM

- Infrastructure Asset Management

PAM

- Public Asset Management
- Physical Asset Management

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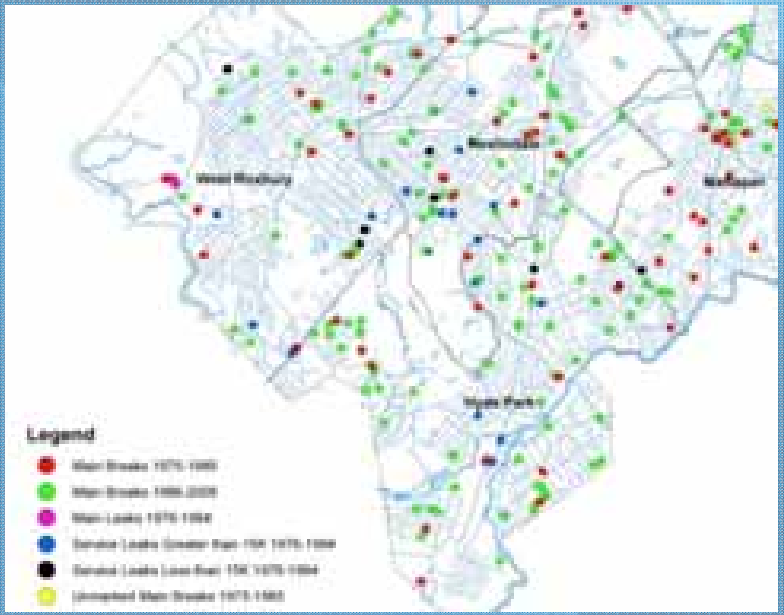
What's it all about?

Public asset management expands the definition of enterprise asset management (EAM) by incorporating the management of all things of value to a municipal jurisdiction and its citizens' expectations.



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What's it all about?

EAM requires…

- Asset Registry…
  - inventory of assets and their attributes
- CMMS…
  - Computerized Maintenance Management System

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Asset Registry = GIS

Hard Assets = typical physical assets
or infrastructure

Soft Assets = permits, license, code enforcement,
right-of-ways and other
land-focused work activities.

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CMMS = Computerized Maintenance Management System

A software package designed to maintain a database for an organization's maintenance operations and human resources functions.

Typically a CMMS will address the following…

- Work Orders and Descriptions
- Managing Inventory
- Managing Assets
- Safety

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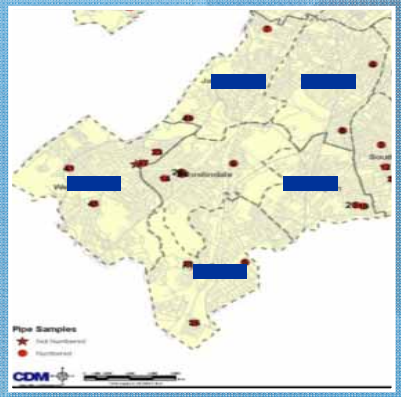
Pulling it all together



Field Data

Failure Data

Location Data

Anecdotal/Historical Data

Modeling Data

HM - Criticality

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1. Gather Raw Data – Field Data, GIS Coverages, Location Data, etc.

Pipe Coupons

Location of Rails & Roads

Break Data

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Failure Data – Leaks and Break

- Data Opportunities
- Shows the impact of all parameters (age, materials, soils, etc.)
- Helps establish pipe performance over a time period
- Can be readily analyzed with statistical software to find correlations (patterns)
- Cheap and easy to collect
- GIS capable

- Data Challenges
- Data only exists for a short "window" of time (i.e. 20 years) relative to pipe life
- Many pipe types have not reached the end of their service lives – data is incomplete
- Inconsistent reporting and QA/QC data problems
- Often lacks failure mode data
  - Corrosion induced
  - Mechanical
  - Construction related

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Field Data – Soils, Pipe Samples, etc.

Data Opportunities

- Detailed information on specific pipe segments
- Several parameters can be collected at the same time
- Good for assessing failure modes – forensic analysis
- Can be combined with other data sources
- GIS capable, but requires a lot of data collection to be useful

Data Challenges

- Snapshot of conditions
- Expensive to collect and/or requires a long time to collect (opportunistic sampling)
- Pipe testing can be expensive
- Data can be readily analyzed with statistical software to find patterns – if there is enough data

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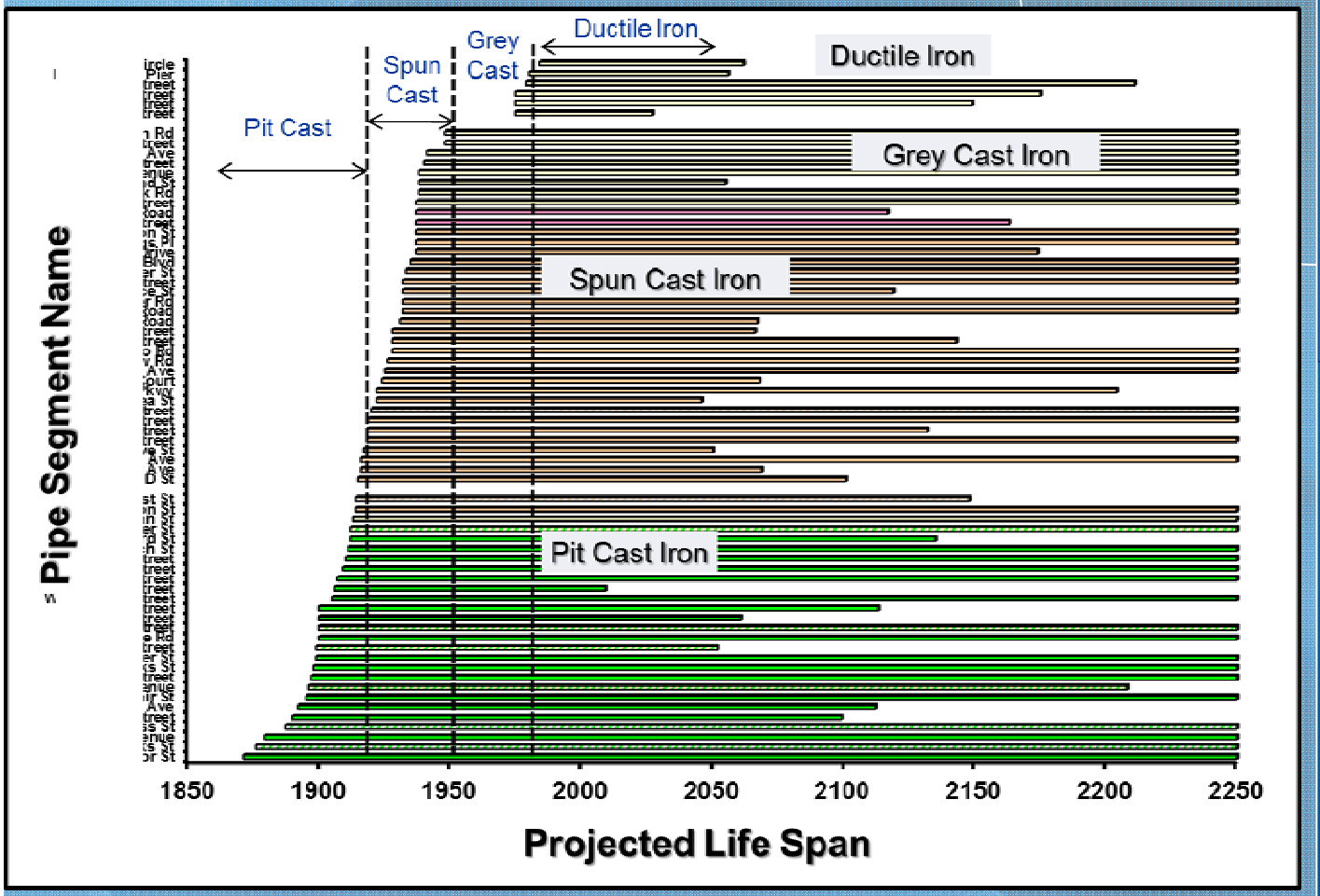
Sample Field Data – Predicted Lifespan Based on Corrosion Rate Data



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Location Data

Data Opportunities

- Often available as a GIS coverage from government agencies and other utilities
- Can be cheap to obtain
- Powerful for viewing many factors simultaneously
- Can be readily combined with other data sources
- Data is available to modeling software

Data Challenges

- Too much data can be distracting – what's important and what's not?
- Requires GIS expertise to fit data into models
- Inconsistent reporting and QA/QC data problems

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Anecdotal and Historical Data

Data Opportunities

- Obvious patterns can be spotted without analysis
- Cheap to obtain (record search sometimes required)
- Powerful for looking at many factors simultaneously
- Helpful for starting data validation and analysis
- Can narrow data sources to be reviewed

Data Challenges

- Inconsistent reporting and QA/QC data problems
- Knowledge is not well preserved over time
- Difficult to combined with other data sources
- Not really used for modeling with software

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Using the Tools Together

2. Clean and QA/QC Data
   - Make sure pipe data is consistent (for example, material is consistent with the age)
   - Use known information to fill in blanks (for example, pipe installed before 1920 must be pit cast iron)
3. Perform Statistical Analysis
   - Using Failure Data, calculate predicted break rate (PBR) by characteristic (age, size materials, etc.)
   - Determine if Location Data (i.e. proximity to rail lines) or Field Data (i.e. soils) plays a significant role in failures
   - Use PBR and other key variables found from statistics for Macro Modeling
   - "Truth check" with Anecdotal Data

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Using the Tools Together - LEYP

LEYP – Linear Extended Yule Process

- **Advanced multiple linear regression model**
- **Considers the inter-relation of risk factors, pipe characteristics and time between breaks**

LEYP Model Definition

Key function → Intensity of the process

$$\lim_{h \to 0_+} \frac{P\{N(t+h)-N(t)=1 \mid N(t)=j\}}{h}$$

$$= \underbrace{(1+\alpha j)}_{\text{Yule Factor}} \underbrace{\delta t^{\delta-1}}_{\text{Weibull Factor}} \underbrace{\exp(\boldsymbol{Z}^T \boldsymbol{\beta})}_{\text{Cox Factor}}$$

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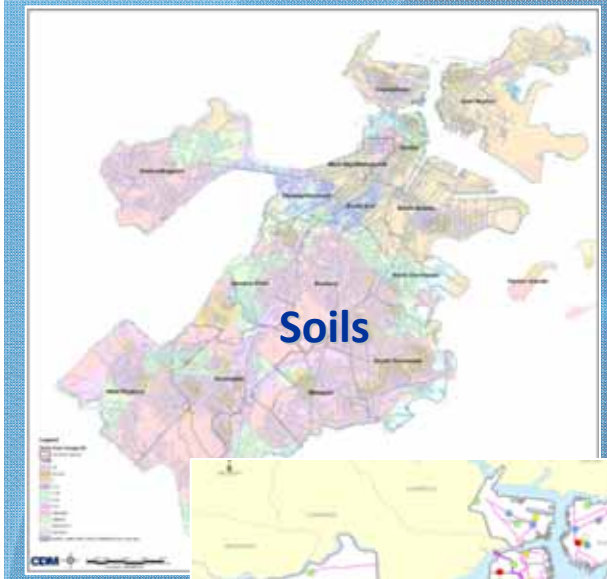
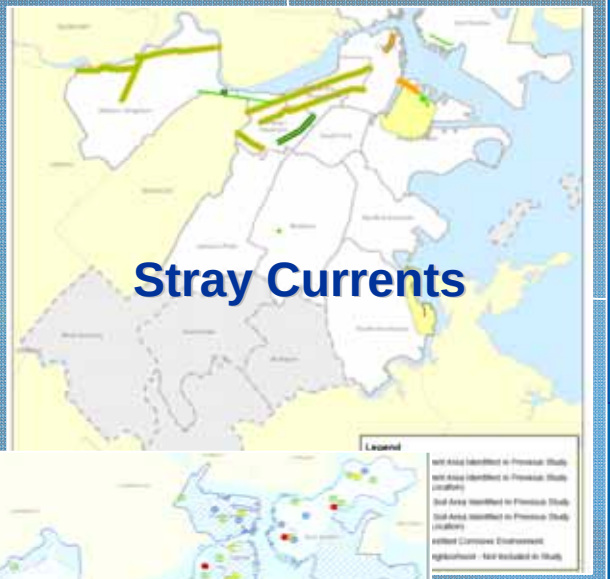
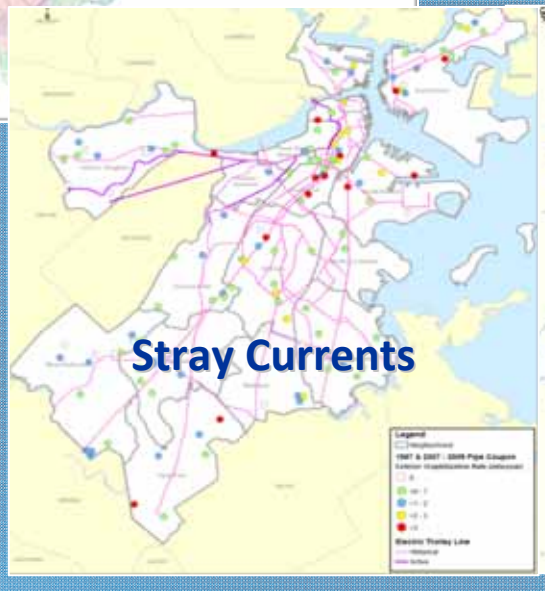
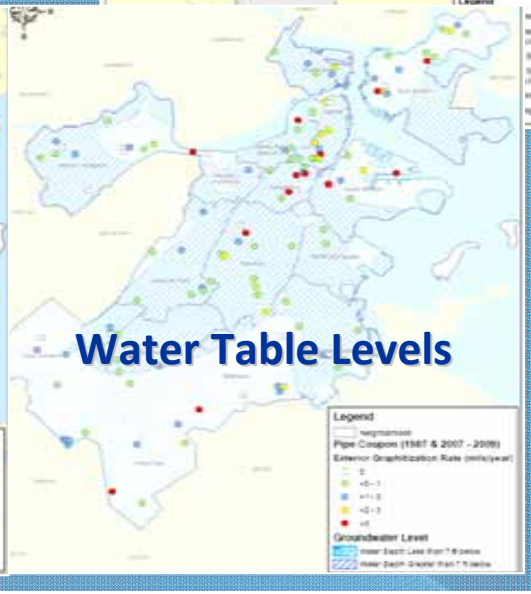
LEYP Data Sources









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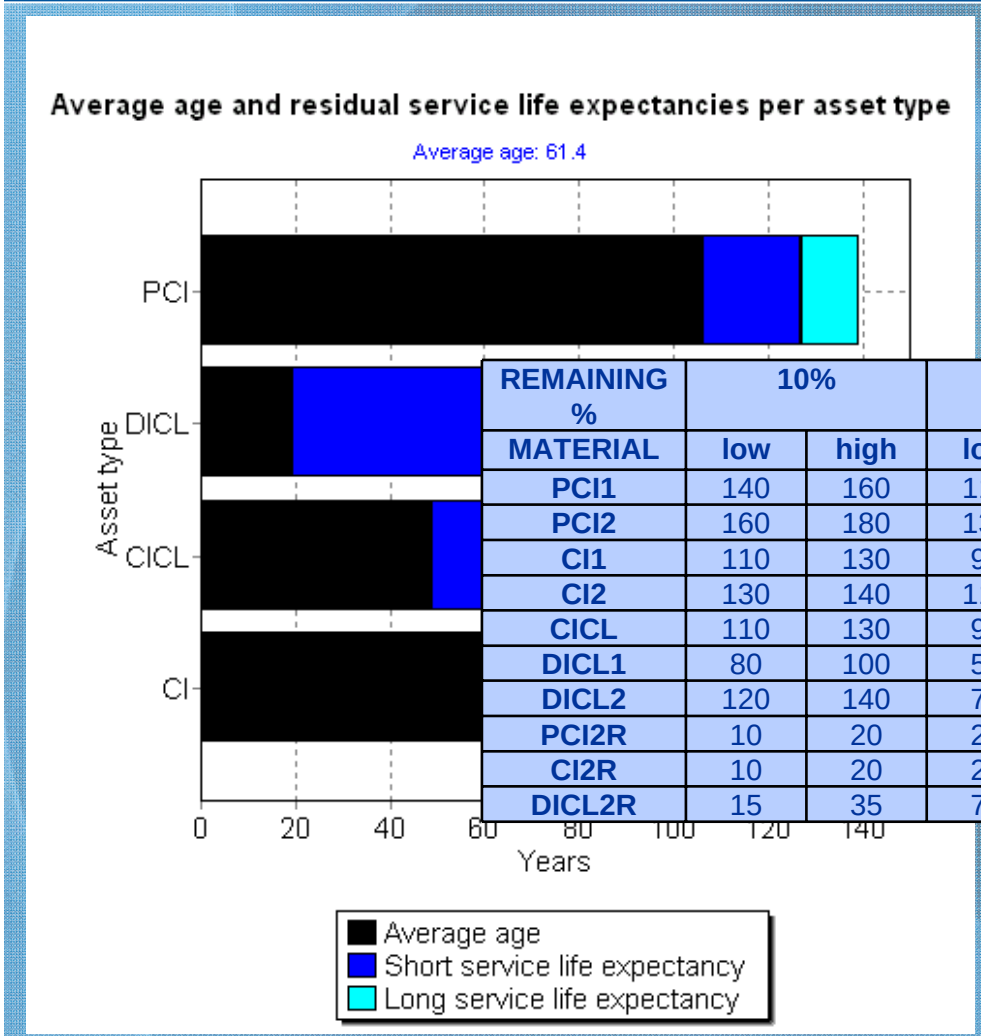
Average Age and Service Life Expectancy



REMAINING %	10%		50%		100%	
MATERIAL	low	high	low	high	low	high
PCI1	140	160	115	135	70	100
PCI2	160	180	135	155	90	120
CI1	110	130	90	110	50	60
CI2	130	140	110	130	70	80
CICL	110	130	90	110	50	60
DICL1	80	100	55	75	5	15
DICL2	120	140	75	95	15	35
PCI2R	10	20	20	30	30	40
CI2R	10	20	20	30	30	40
DICL2R	15	35	75	95	120	140

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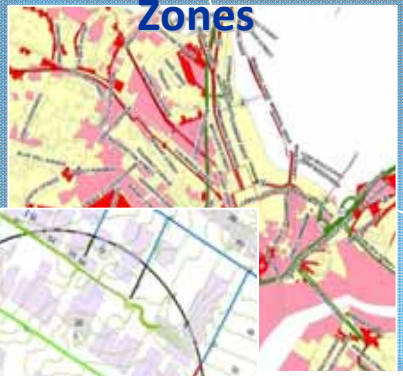
Spatial Data Sources

Water Age

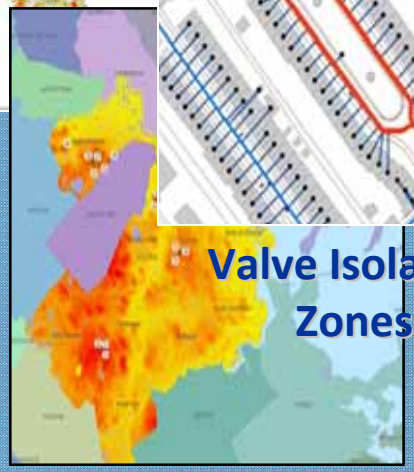
Historic Shorelines

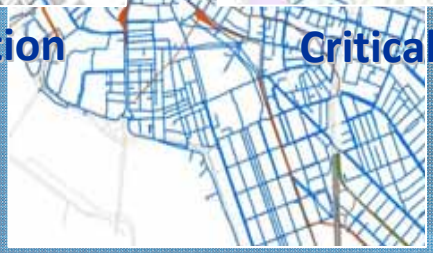
Economic Zones

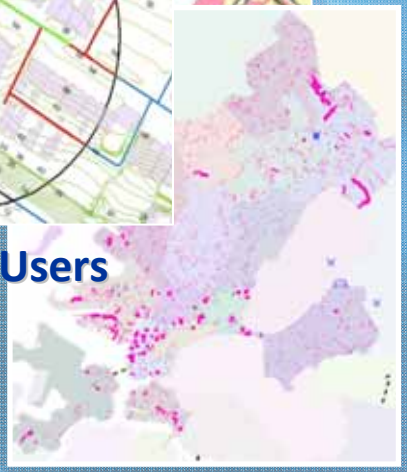


Valve Isolation Zones

Critical Users







Low Pressure Areas

Roads and Tunnels

Hydraulic Criticality

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Summary

- A combination of data sources and modeling tools is needed to develop a complete asset management plan
  - Data is often lacking or suspect in certain areas
  - One set of data can help “shore up” another source – data from one source can validate another source
  - Tools rely on information provided by other tools
- Statistics packages are powerful for spotting trends and weighting decision factors
- A good plan studies both the macro level (entire system) and the micro model (pipe segments)

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GIS RULES!

Questions?

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HOW IS ASSET MANAGEMENT DEFINED?

- *A management paradigm* and a *body of best appropriate management practices*
- Applied to the *entire portfolio* of infrastructure assets at all levels of an organization
- Seeking to *minimize total costs* of acquiring, operating, maintaining, and renewing assets…
- Within an environment of *limited resources*
- While *continuously delivering the service levels that* **customers** desire and **Regulators** require…
- And at an acceptable level of *risk* to the organization.

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