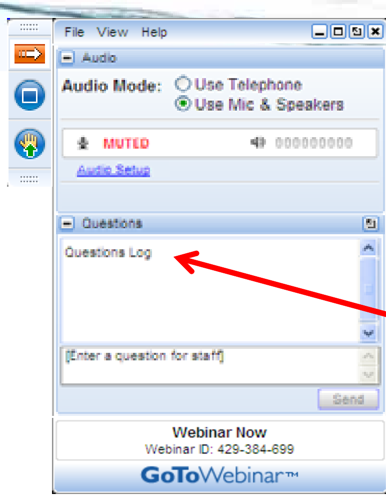
Intelligent Water Systems: A Smart Start

November 2, 2016
Moderated by: Fidan Karimova
Water Technology Collaboration Manager
Water Environment & Reuse Foundation

Hosted By:



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Today's Moderator

Fidan Karimova
Water Technology Collaboration Manager
Water Environment & Reuse Foundation

Intelligent Water Systems Knowledge Development Forum

Corey Williams, PE
President and CEO
Optimatics

Introduction

Corey Williams, P.E. – President and CEO of Optimatics

- Intelligent Water Systems: Topics and Concepts
- Knowledge Development Forum: Purpose and Introduction

Intelligent Water Systems – Technology Buzz

- Analytics Engines
- IoT – Internet of Things
- Natural Language Processing
- Open Source Software for Large Data Sets
- Optimization Modeling and Simulation
- Pattern Recognition / Artificial Intelligence
- Rapid Data Quality Validation
- Sensor Technologies
- Smart Devices
- Uncertainty Evaluation

Intelligent Water Systems – Hype? Reality?

"Intelligent Water Systems derives its foundational principles from Smart Grid and its emphasis on integrating advanced technologies to streamline operations value streams."

"Intelligent Water Systems emphasizes the opportunity the Water Sector has to take advantage of advanced technologies and dramatically shift management decision making permanently."

"Intelligent Water Systems focuses on building a data processing value chain – data capture; data storage; data blending; data analytics; knowledge sharing – that enables actionable decision making. It is critical for today's complex decisions."

What Do We Do With All of the Data?

IDG conducted a survey of over 200 IT leaders throughout all industries in the U.S.

Is the notion of "Intelligent Water Systems" only about capturing more and more data? Is "Intelligent Water Systems" only about making more and/or faster decisions?

It's Not a Data Gap…but Rather a Fact Gap!

Are Water Sector organizations aware of the growing Fact Gap? Are Water Sector organizations ready to address the Fact Gap?

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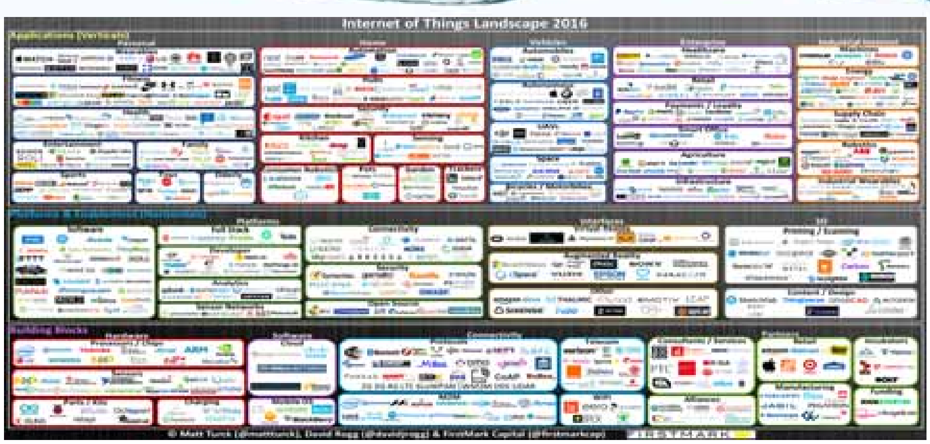
But Here's What You are Up Against…



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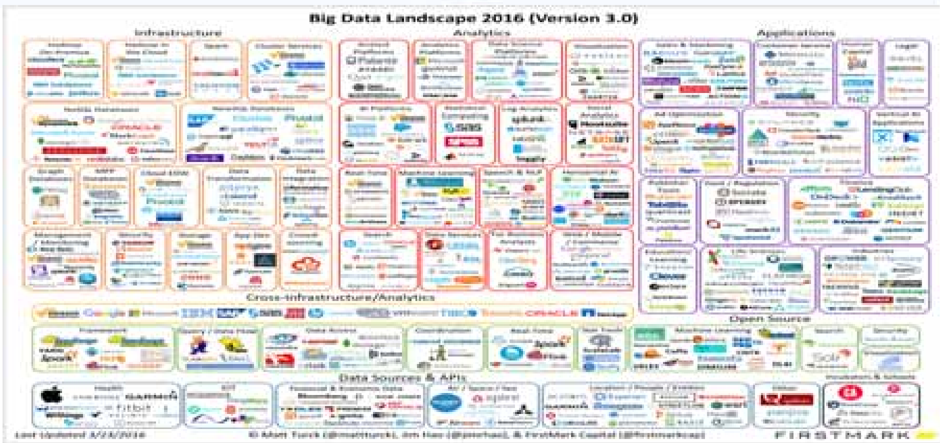
And If You Think it Ends There…



Learning from Other U.S. Industries

Moving Ahead – If Corporate Managers Stick to their Plans…*

* Survey of 450 Data Scientists and Business Analysts, Executives, IT Application Managers – in a wide range of industries; research sponsored by Cloudera, SAS, SAP, and other vendors

Learning from Other U.S. Industries

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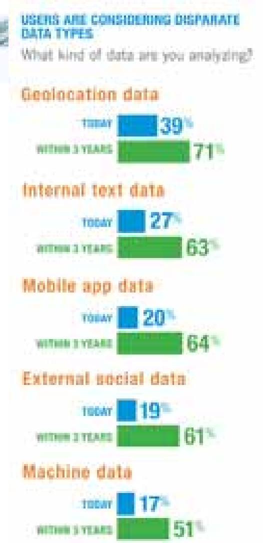

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Intelligent Water Systems (IWS) KDF Purpose:

Water & Wastewater utilities are rapidly evolving, and the areas of concern that need to be addressed are increasing in number and complexity. Smart Water is potentially the solution to these issues- providing a platform for more efficient technology use and more informed decision making. The Smart Water Knowledge Development Forum will provide an opportunity for industry leaders to collaborate and discuss the vision of Smart Water, improvements to technology and practices, and steps to set the future of Smart Water in motion.

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Intelligent Water Systems KDF Objectives:

- Perspectives – Trends; Drivers; Motivations
- Readiness – Maturity; Challenges; Obstacles
- Definitions – Terminology

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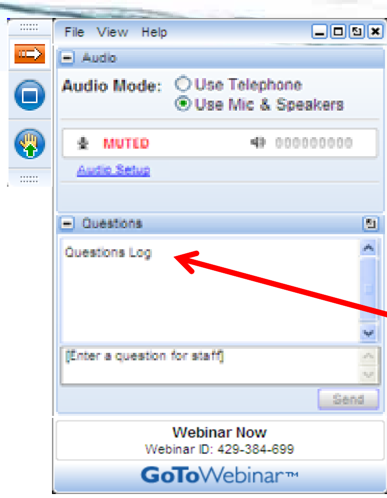

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Big Data Analytics

Raja R. Kadiyala, Ph.D.
Director of Intelligent Water Solutions
CH2M

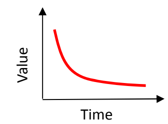
Overview

- Themes
- Definitions
- Examples
- Architecture
- New skillsets required

Raja R. Kadiyala, Ph.D.
Director of Intelligent Water Solutions, CH2M

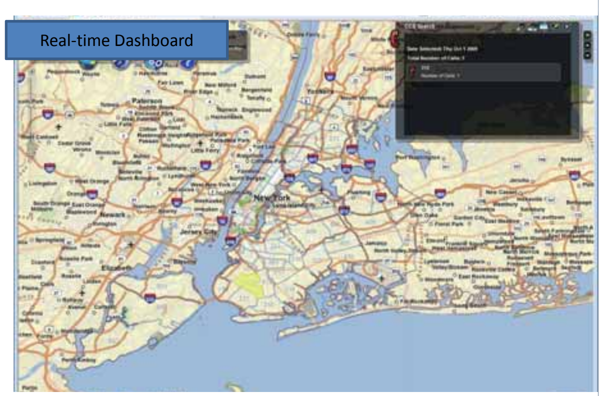
Key Themes

- The Value of Now
  - There is certain information whose value decays exponentially over time. Need to perform real-time analytics on data to provide real-time intelligence



- Enabling the Edge
  - Resources on the perimeter of the distribution/collection system (aka the *edge*) often lack the ability to provide/generate real-time or consume real-time information. By enabling these resources, value can be achieved.

Tracking algal incident in NYC based on customer calls expedites remediation



Definitions

Big Data

Definition: Datasets whose "size" is beyond the ability of typical/traditional database software tools to **capture**, store, **manage**, and **analyze**

Differentiators (NIST)

- Volume (i.e., the size of the dataset)
- Variety (i.e., data from multiple repositories, domains, or types)
- Velocity (i.e., rate of flow)
- Variability (i.e., the change in other characteristics)

Drivers

- Amount of data generated is growing by 50% each year (IDC)
- Storage costs decreasing: $600 – cost to buy a hard drive that can store all of the world's music
- Wealth of ever increasing data, in turn, drives advances in computing, algorithms and learning
- What does your credit card company know about you?
  - Patterns are established
  - Water utilities will need to establish their patterns

Trends

Hype Cycle for Smart City Technologies (7/2011)

By 2015, > 30% of Smart Grid projects will utilize big data elements (Gartner)

Smart Water Layers

Definition: Processes and technology used to optimize the combination of water **quality**, **quantity** and treatment **cost**

Mapping of SWAN Layers

Optimization and Visualization

- Water Quantity
- Water Quality
- Operational Efficiency (Cost)

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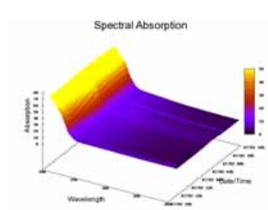
Analytics and Visualization

- Automated analysis (analytics) improve decision making – turning data into information to:
  - Unearth valuable insights that would otherwise remain hidden
- Utilities currently use at best 10% of the data they generate
- Leverage data by providing:
  - Sophisticated visualization techniques
  - Advanced automated algorithms



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Data Analytics

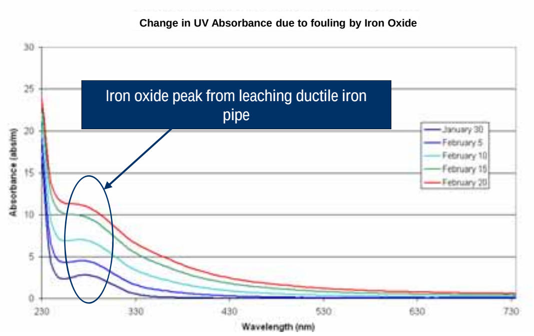
- **Predictive analysis**
  - Determine the probable future outcome for an event or the likelihood of a situation occurring
  - Also identify relationships (Cause and Effect)
  - Algorithms: Random forests (trained 'forest' of decision trees)
- **Pattern recognition**
  - Identification of a previous occurrences in the current time frame
  - Algorithms: Time series data analysis (convolution, blind source separation, frequency domain conversion)
- **Anomalous detection**
  - Identification of multivariate data excursions from the norm
  - Algorithms: Multi-dimensional (for our case, > 100 dimensions) clustering

Analytic Maturity Level

Basic Analytics	
Performance Management	What happened in the past
Advanced Analytics	
Complex Event Processing	What is happening now
Multivariate Statistical Analysis	What is happening now
Time-series Analysis	What is happening now
Predictive Modeling	What might happen going forward

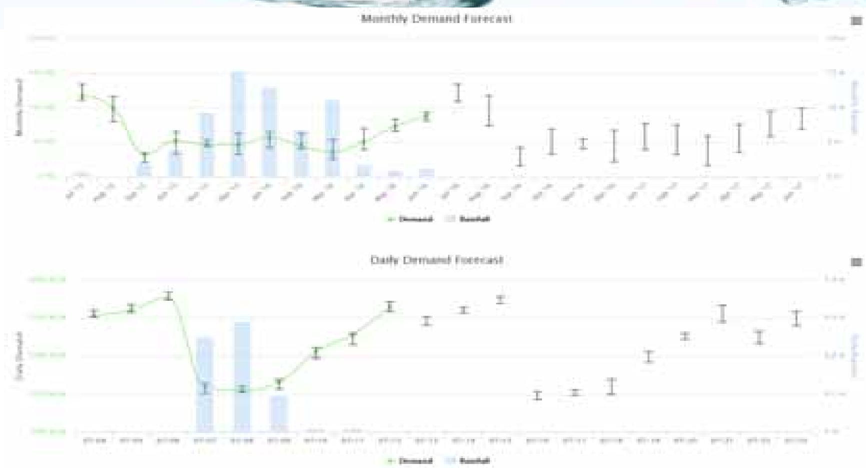
Examples

Detection of Aggressive Water

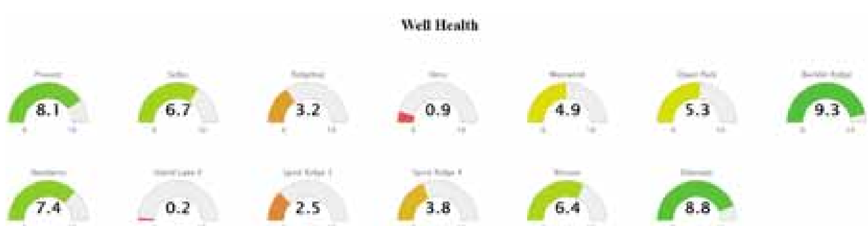


Early identification of aggressive water problem saved the utility $20M in early replacement costs

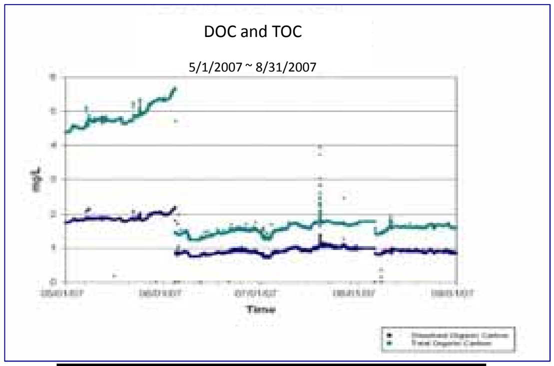
Demand forecast prediction to manage water rights



Advanced analytics – well management



Optimizing Treatment Plant GAC Filter Performance



Reduced annual GAC replacement costs by $100K at each WTP

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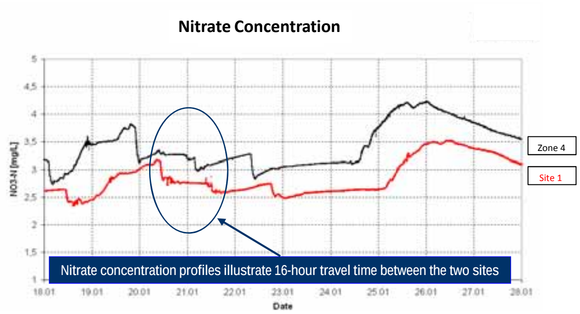
Tracking Water Age Real-Time



Nitrate or other water quality parameter profiles compared over time can be used to determine travel times between sites.
Can be used to verify hydraulic model.

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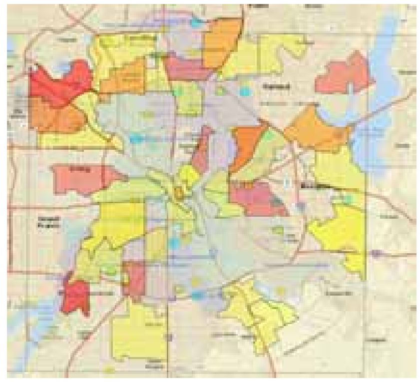
Real-time analysis of hospital visits

- Process emergency room visits (rash, GI, neurological)
- Perform analytics and display event 'hot-spots'



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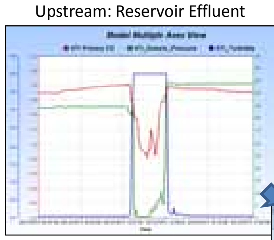
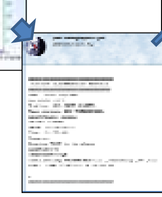
Operational Benefits – Main Break Detection & Response

Upstream: Reservoir Effluent

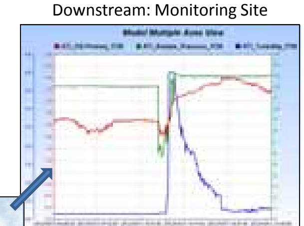


- 48" main break produced flow surge in distribution system
- Surge stirred up particulates and created a turbidity spike at reservoir



Algorithm detected anomaly, email notification sent to staff

Downstream: Monitoring Site



Correlated event detected downstream as turbid water traveled through the system

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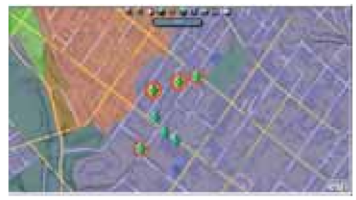
Case Study – Rusty Water Event

- Algorithm detected "CCS Alerts" email/text notifications received at 7:28 & 8:36 AM
  - 2 WQ – Discolored
  - 3 WQ – Rusty Brown

In the same pressure district

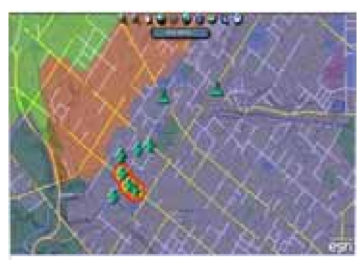
- Complaints were spatially and hydraulically related due
- Additional discolored and rusty brown complaints came in later in AM

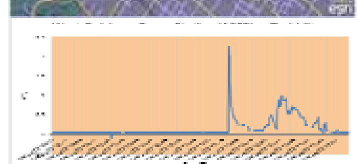


Case Study – Rusty Water Event

Alert Investigation

- Suspected a main break or a construction activity
- 2 NTU turbidity spike observed downstream of complaints starting the night before followed by 1 NTU bump ongoing at the time of investigation
- Elevated turbidity levels were noticed at two sampling locations near rusty water complaints

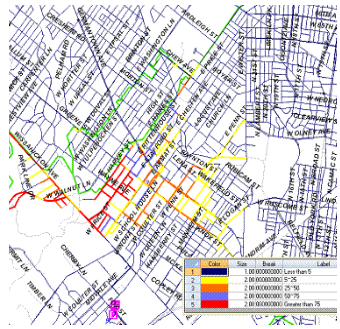




Case Study – Rusty Water Event

Response

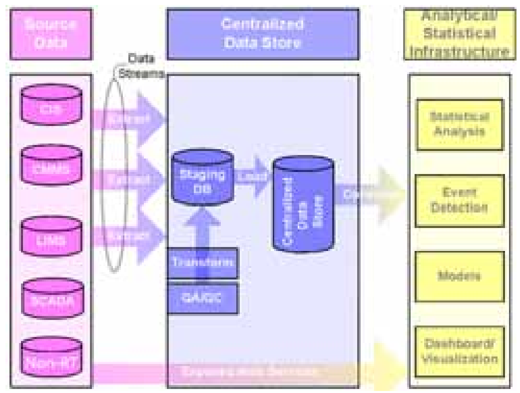
- Cause for the alert was determined to be related to work done on a 30” control valve



- Hydraulic model identified how rusty water would spread after 6, 12, and 24 hours to guide flushing
- Confirmation water quality samples collected following flushing

Business Intelligence Architecture for real-time processing

Business intelligence architecture for real-time processing



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News skillsets at utilities

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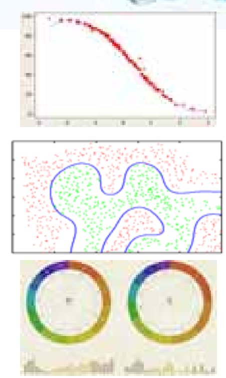
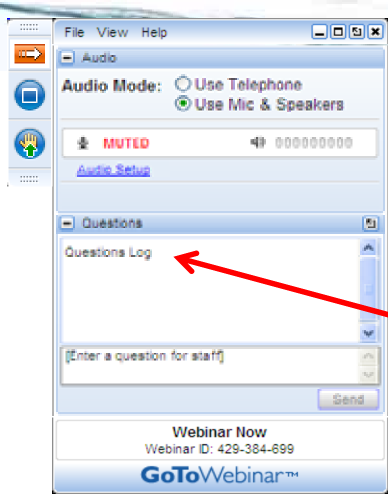
Data science skills

- Data Science – extracting insight from data
  - Statistical analysis (regression, Bayesian methods, clustering, time series methods)
  - Machine learning (classification, validation, supervised/unsupervised methods)
  - Visualization (commercial – Tableau, Qlik, Power BI; open source – D3.js, matplotlb, plot.ly, GIS/spatial)
  - Scripting (Python, R)



Data engineering skills

- Data Engineering – architecture/infrastructure to support data science
  - Data processing (ETL, caching/persistence, reduction, joins, key value processing)
  - Data objects (RDBMS vs NoSQL, data frames, JSON, compression methods)
  - Stream processing (batching, real-time, checkpointing, parallelization)
  - Security (transactional, at rest, access control, SSL, certificates)
  - Data optimization (sharding/partitioning, optimizing joins, performance monitoring)
  - Cloud Services (AWS, Azure, Rackspace, etc.)



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Optimization of Energy, Operations, and CIP

Luis Montestruque, Ph.D
EmNet

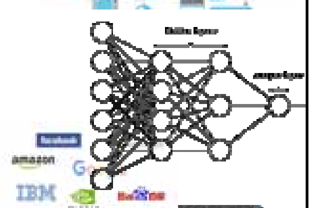
Lina Belia
Primodal

The Problem

- Energy: increasing OPEX costs, decreasing revenues, climate change, energy neutral or positive.
- Operations: aging infrastructure, higher compliance requirements, resilience to climate change and other disasters, retiring institutional knowledge, competing operational objectives.
- CIP: increased population, aging infrastructure, higher compliance requirements, resilience to climate change and other disasters, plants as resource recovery facilities.

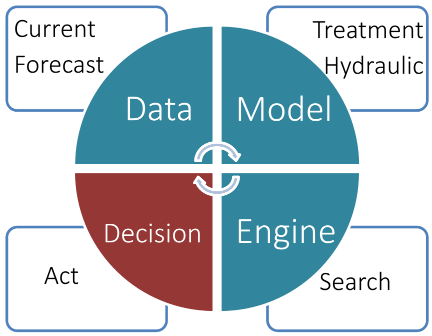
Enabling Technologies

- Computational Power/Big Data: combine large quantities of diverse data with complex models in the cloud.
- Internet of Things: economically deploy large number of sensors.
- Optimization Engines / Artificial Intelligence: ability to intelligently search for the "best solution".



How is Optimization Applied?

- Formulate problem to solve
- Determine a method of quantifying success
- Determine the parameters that can be adjusted



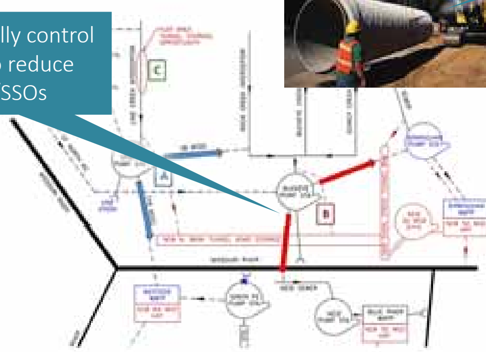
- Use Optimization engine to searches parameters.

The Possibilities

Actively reduce storm water runoff.

Optimize and prioritize CIP.

Dynamically control flows to reduce CSO/SSOs



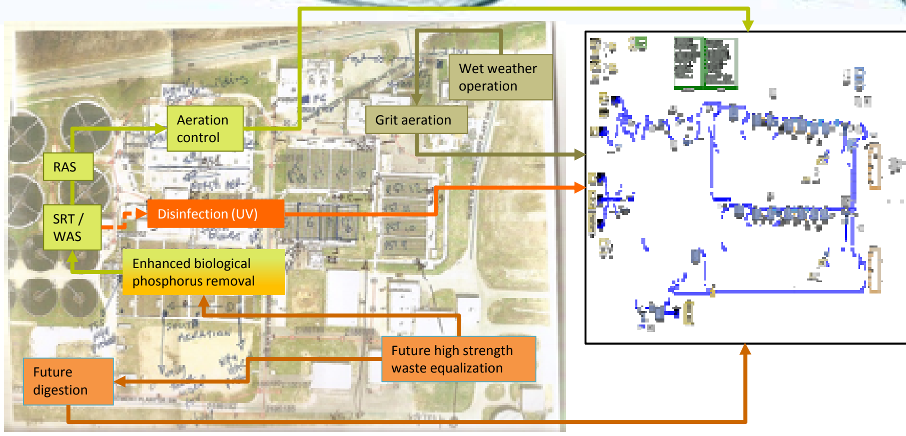
Optimize energy usage and sludge management.

Optimizing WRRF

WRRF Optimization: City of Grand Rapids, Mich.

- Population Served: 260,000
- Water Resource Recovery Facility capacity: 61.1 MGD
- GR ESD objectives:
  - Reduce operational costs
  - Reduce energy consumption
  - Maintain or increase water quality

Plant-Wide Real-Time Control



Control loop dependency

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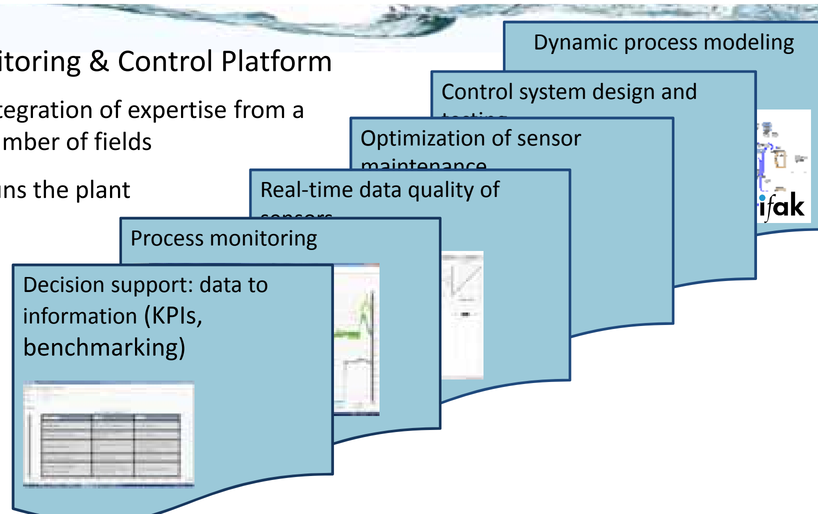
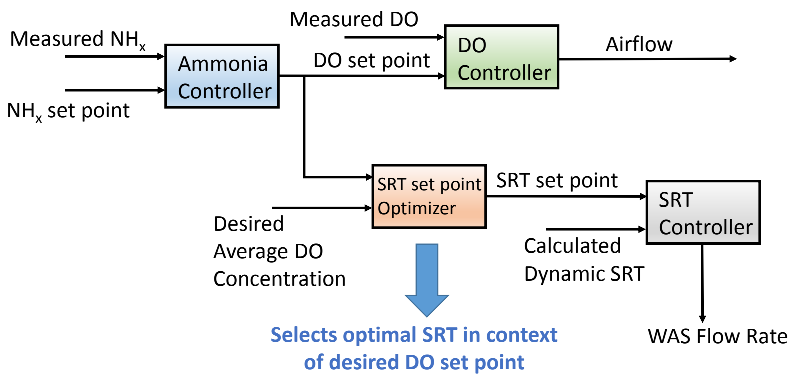
Real-time data quality and plant control

Monitoring & Control Platform

- Integration of expertise from a number of fields
- Runs the plant



Integrating ABAC-SRT control



Schraa, O., Rieger, L. and Alex, J. (2016). Coupling SRT Control with Aeration Control Strategies. *Proceedings of WEFTEC.16*, New Orleans, LA, USA.

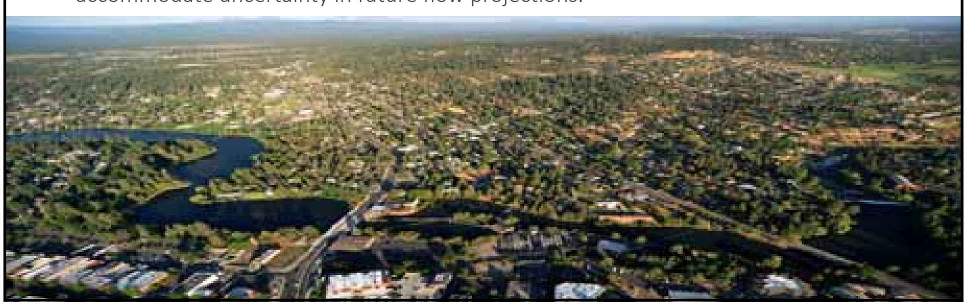
Grand Rapids WRRF Optimization Outcome

- $113,800 /year : ammonia based aeration control
- $65,000 /year : UV e-coli based control
- $60,000 /year : analytical costs & headworks monitoring

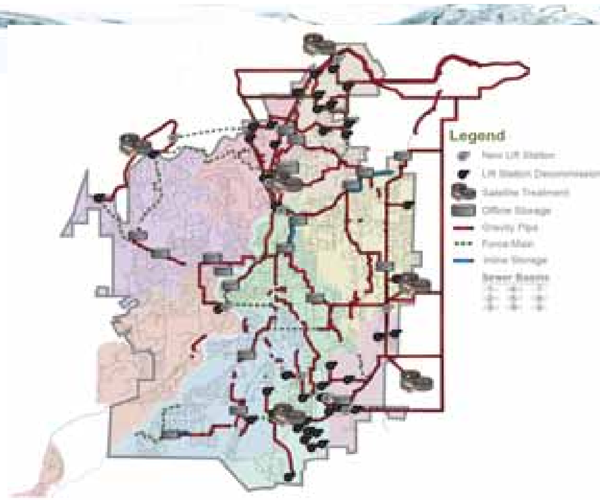
Optimizing CIP

Optimization of CIP: City of Bend, Oregon

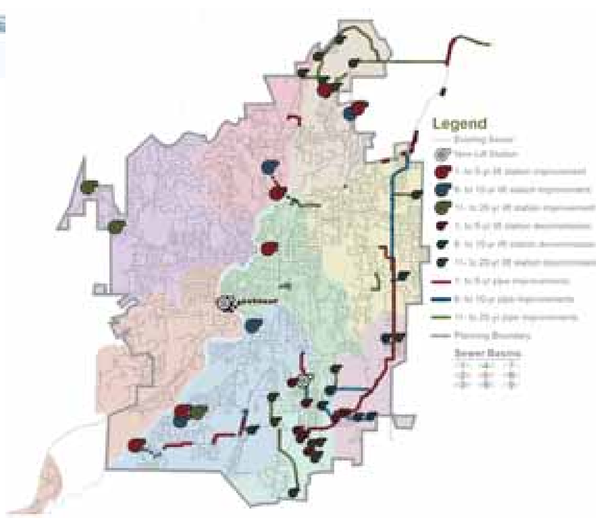
- Population served: 85,000
- City is growing and needs to upgrade services in unsewered areas and areas with inadequate service levels.
- In 2012 City of Bend initiated a Collection System Master Plan (CSMP).
- CSMP objectives: create a plan to meet hydraulic performance criteria at minimum life-cycle cost while providing operational flexibility, redundancy and the ability to accommodate uncertainty in future flow projections.



Final Optimization Alternatives Considered



Optimized 20-year Solution - $85 million



Slide 59

JF1 The improvement alternatives consisted of upgrades of existing assets, alternatives identified in past planning studies, and new alternatives. All alternatives were considered and evaluated objectively. The alternatives were progressively refined in terms of size, location and cost throughout each stage of the optimization process. New alternatives were also included during each optimization iteration.

Improvement alternatives included:
•Rehabilitiation and replacement (and possibly re-sizing) of existing pipe in existing piping alignments
•New pipe in new alignments
•New lift stations
•Existing lift station upgrades
•Decommissioning of existing lift stations
•Storage tank facilities (restricted to wet-weather operation)
•Linear transport/storage facilities (restricted to wet-weather operation)
•Satellite treatment
Jeff Frey, 10/19/2016

Slide 60

JF3 Besides the base optimization run considering all identified improvement alternatives, additional scenarios and sensitivity runs were carried out as an integral part of the optimization process. An example of an optimization scenario is one in which storage alternatives are eliminated, resulting in an optimized solution without storage. The optimized solution for this scenario may be useful to compare to the optimized solution with storage to demonstrate the cost-saving benefit of the selected storage alternatives. An optimization sensitivity analysis is defined as an optimization run that tests the effect of a particular assumption/variable, such as assumed unit cost rates, population growth, or wet weather response.
Jeff Frey, 10/19/2016

JF4 The final optimization runs covered the following scenarios:
Jeff Frey, 10/19/2016

JF5 All Options - Existing, Mid-Rainfall Response
All Options - 10-Year, Mid-Rainfall Response
All Options - 20-Year, Mid-Rainfall Response
All Options - 20-Year, Mid-R +25% Loading Growth Sensitivity
All Options - 20-Year, Mid-R -10% Water Conservation Sensitivity
All Options Except NW diversion - 20-Year, Mid-R +25% Loading
Jeff Frey, 10/19/2016

City of Bend CSMP Outcome

- Optimized 20-year CSMP included 175 improvement projects to address hydraulic capacity issues and condition improvements
- Optimized 20-year CSMP projects were phased for next 5 years, years 6-10, and years 11-20
- Optimized CSMP analyzed numerous scenarios and sensitivity analyses related to higher and lower loadings compared to the base assumption, and exclusion of the NW Diversion as an option for comparison
- The 18-member Sewer Infrastructure Advisory Group that followed the project from start to finish gave unanimous approval to the final technical plans

Optimizing CIP

Underutilized upstream storage assets

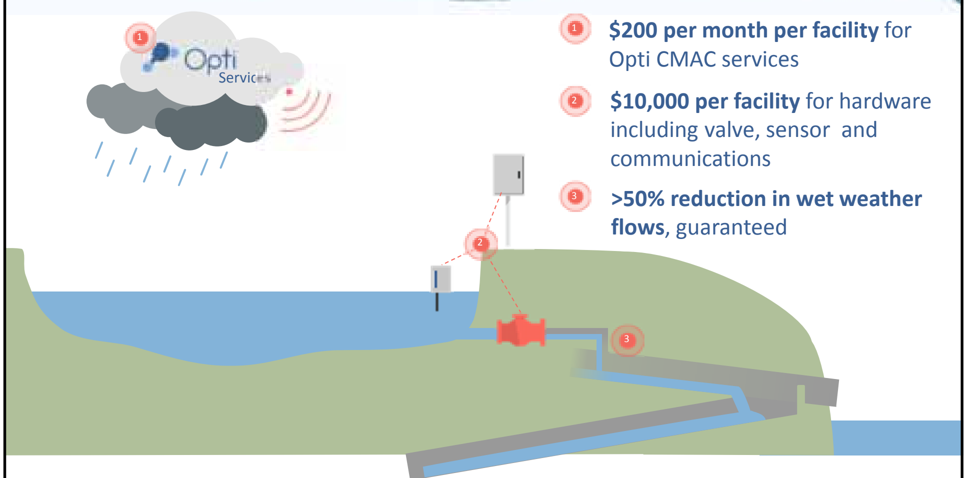
Every CSO community has existing,

passive infrastructure suitable for CMAC retrofits.

Intelligent retention to prevent flooding + CSOs

- The Beaver Creek Sewer District contributes to a combined sewer system that overflows to the Hudson River
- High intensity rain events lead to flash flooding
- Mitigation strategy: Green infrastructure, sewer separation, and adaptive control of existing storage (89 acre drainage area)
- In-system stormwater storage and pre-event drawdown to reduce wet weather discharge

Typical Costs at Scale



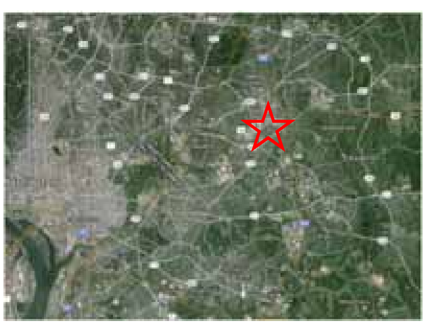
1. **$200 per month per facility** for Opti CMAC services
2. **$10,000 per facility** for hardware including valve, sensor and communications
3. **>50% reduction in wet weather flows**, guaranteed

Control of Low Impact Development Projects
Frost Pond Retrofit, Prince George's County, MD

Using technology to reduce impact:

- Mimic natural hydrology
- Maximize existing gray infrastructure
- Minimize footprint

Frost Pond
60 acre drainage area
19 acre impervious
Approx. 0.5 acre pond (2 ac-ft)
Dry pond built in 1988

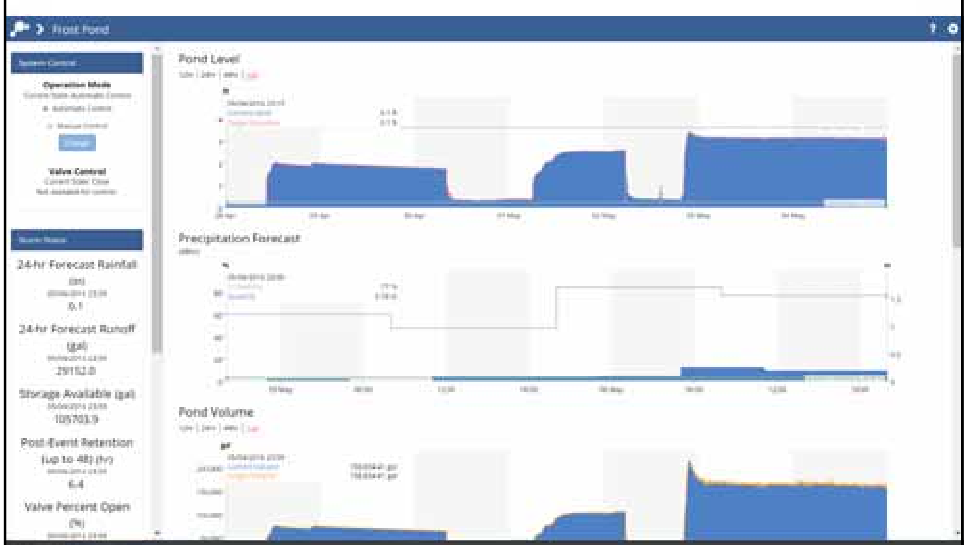


CMAC Retrofit December 2015

Hardware:	$16,500
Design:	$5,000
Modeling:	$10,000
Installation:	$15,000

$46,500

Valve Controlled by Software



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Dry Pond Retrofit Summary

Costs	Traditional Approach	CMAC Retrofit
Full Design	$60,000	$15,000
Construction, Hardware and Installation	$300,000	$31,500
Annual Maintenance	$5,000	$5,000
Annual CMAC Services	-	$5,000
30-Year Present Value	$446,460	$219,420
Benefits		
Water quality	●	●
Channel protection	●	●
Low cost		●
Low impact		●
Adaptive design		●

Optimizing Collection Systems

emnet

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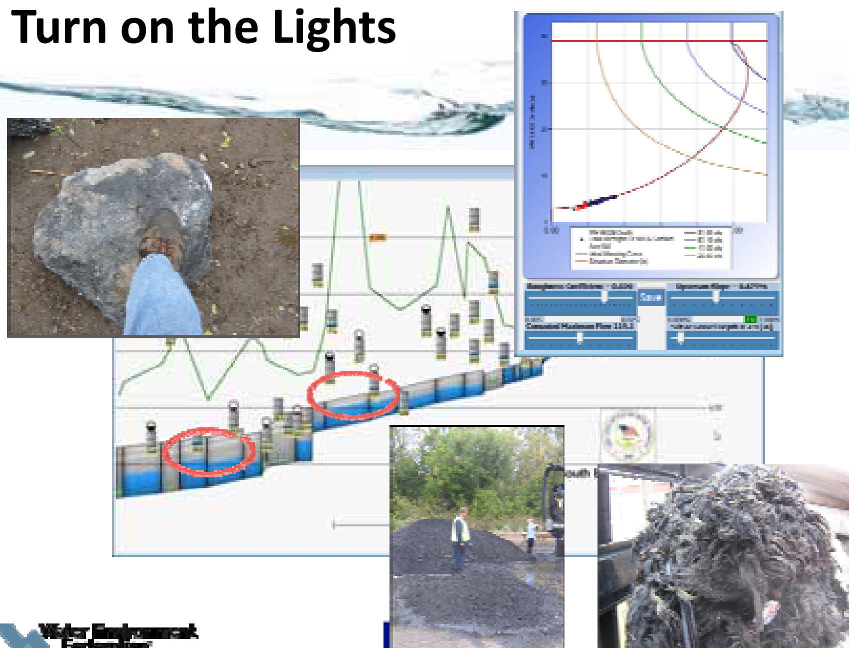
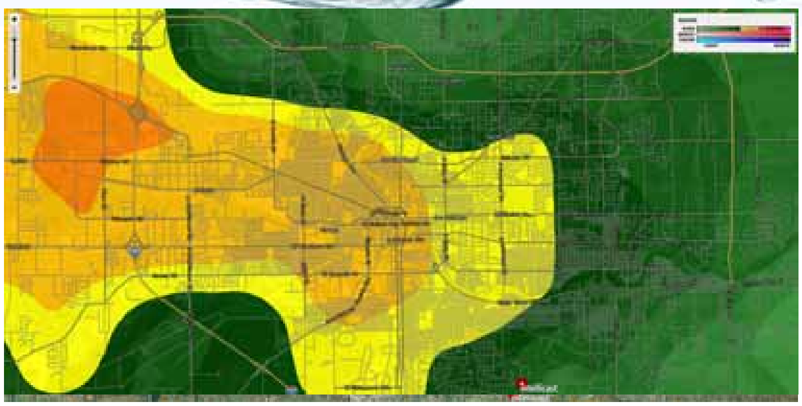
Intelligent Sewers: RT-DSS Optimization Case Study: South Bend, Indiana

Population:	100,886
Established:	1865
Treatment Plants:	1 (75 MGD)
Outfalls:	36
CSO Overflow:	1.5
Abatement Plan:	$700,000,000

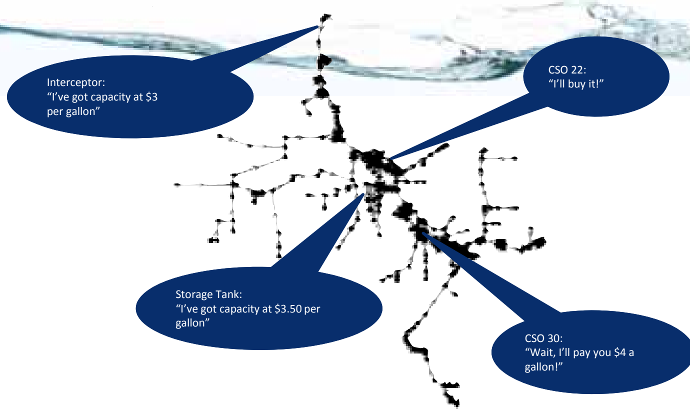
Turn on the Lights



Problem Characteristics



WEF Water Environment Federation · LIFT · WE&RF

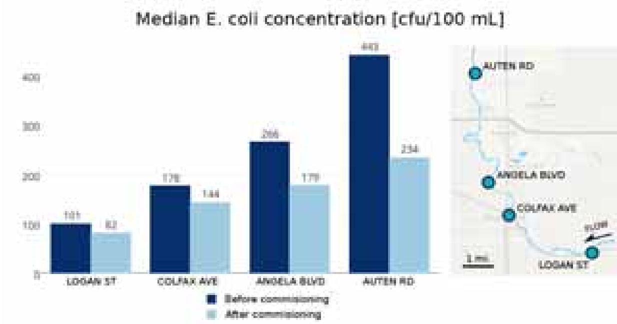


Agent Based Optimization

Agent-based computing generates rules to achieve global optimization of storage, conveyance, and energy consumption.

WEF Water Environment Federation · LIFT · WE&RF

Achieve Results



55% reduction in E. Coli contribution

South Bend RT-DSS Outcomes

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Opti

emnet

Optimatics
PLAN SMARTER

Primodal
Earth Essential Technologies
www.primodal.com

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Outcomes of the August Knowledge Development Forum

Ryan Nagel, PE
Asset and Utility Management Practice Leader
Hazen and Sawyer

Hazen

Ryan Nagel – Hazen and Sawyer's Asset and Utility Management Practice Leader

- Knowledge Development Forum Outcomes:
  - Perspectives – Trends; Drivers; Motivations
  - Readiness – Maturity; Challenges; Obstacles
  - Definitions – Terminology
- Recommendations for KDF Continuance
- Sustaining KDF Outputs/Communication

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Intelligent Water Systems (IWS) KDF Participants represented all segments of our industry:

- Utilities
- Research Foundations
- Suppliers
- Vendors
- Consultants
- Engineering Firms
- Software Companies
- Academic Institutions

Perspectives: Trends; Drivers; Motivations

Roundtable Discussion

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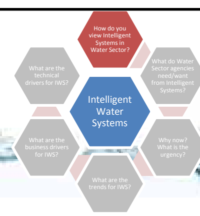
Roundtable Discussion



1. **How do you view Intelligent Systems in Water Sector?**
   - IWS will allow utilities to collect historical and real-time data from numerous sources and effectively utilize analytical tools to process data.
   - IWS delivers the integration of information required for high-performance Operations.
   - IWS technologies enable and enhance the use of data by utility personnel.
   - IWS enables elevated Levels of Service.
   - IWS takes advantage of the Internet of Things.

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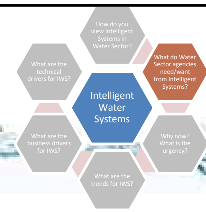
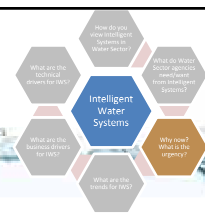
Roundtable Discussion



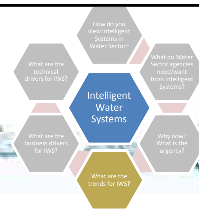
2. **What do Water Sector agencies need/want from Intelligent Systems?**
   – Support decision making, such as determining what to invest in next so as to make the best use of scarce funds.

Roundtable Discussion



3. **Why now? What is the urgency?**
   – The Internet of Things is dramatically increasing the velocity and volume of data.
   – Utilities are being asked to do more with less money and fewer resources.
   – Customers are demanding more information. Customers want transparency from the utility service providers.
   – Water Sector agencies need better decision support systems.
   – Water Sector agencies are under pressure to improve the efficiency and effectiveness of Operations.
   – IWS can improve the efficiency of regulatory compliance.
   – IWS is needed to capture institutional knowledge before it departs.

Roundtable Discussion



4. **What are the trends for IWS?**
   - IWS technology vendors are delivering better, cheaper, and more secure cloud-based solutions.
     - Cloud-based solutions are becoming more acceptable to our Sector.
     - Sensors will continue to become cheaper and more powerful.
     - IWS will become increasingly valuable for regulatory compliance, if not essential.
     - The data access and sharing expectations of younger workforce are growing.
     - IWS can help address the need for utilities to be more transparent to customers, communities, and stakeholders.
     - Customer expectations are growing, and customer service is becoming increasingly complex.
     - IWS enables utilities to stay ahead, or at least even with, citizens/scientists who are increasingly aware of how the utility performs.

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Roundtable Discussion

5. **What are the business drivers for IWS?**
   - IWS can help to develop business cases for least-cost alternatives.
   - IWS technologies are greener, less costly, and more sustainable than the current, prevailing technologies being deployed by Water Sector.
   - IWS enables managers to run their utility smarter.

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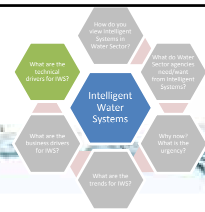
Roundtable Discussion



6. **What are the technical drivers for IWS?**
   - Water Sector utilities need to attract and retain younger generation hires who are technologically savvy.
   - The technology groundwork is already in place – it’s happening now, and it works!
   - Total integrated solutions – from data capture to analytics – are better/cheaper than just a few years ago.
   - IWS enables proper QA/QC of maintenance efforts.
   - Big Data (i.e., data with high volume, velocity, and complexity) requires IWS technologies for analytics.

Readiness:
Maturity; Challenges; Obstacles

Roundtable Discussion - Readiness

Organizational Culture

- Challenges exist for both big and small utilities - "one size fits all" will not work
- Public Sector is generally risk averse
- Unwillingness to change
- Concerns of personnel regarding job security
- Politically-driven decisions
- Impact of policies on culture (i.e., data ownership, access, etc.)

Roundtable Discussion - Readiness

Needs

- Build technical infrastructure to minimize barriers
- Multi-disciplinary solutions (solving problems today requires consideration of all perspectives)
- Customer understanding and support
- Academia can help address the gaps (an IWS curriculum?)

Roundtable Discussion - Readiness

Deployment

- Must be adaptive / innovative
- Strong need for continuity of leadership as IWS is deployed, including investment and training
- People need to be brought along and "champions" identified
- Dedicated pool of cross-functional staff
- Data governance is critical foundation for data strategy, data policies, data definitions, data accuracy, and data reliability
- Outreach is critical

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Roundtable Discussion - Readiness

Risks

- Someone has to want to use the data
- Lack of expertise within Water Sector utilities
- Security of data

Definitions: Terminology

Intelligent Water Systems Definitions:

To make our economy sustainable and to manage our most precious resource, we need to create an integrated, **INTELLIGENT WATER SYSTEM**. A smart network that monitors its own health, remotely senses damage, assesses water availability and predicts demand. A system that helps manage end-to-end distribution, from reservoirs to pumping stations to smart pipes to holding tanks to intelligent metering at the user site.

"Smarter Planet, Smarter Water" – Shalome Doran

INTELLIGENT WATER grids have the potential to revolutionize the interaction between hydrologic systems, and man-made infrastructure. Through advances in sensing, computation and control it is possible to couple the flow of water, with the flow of information, permitting modern water infrastructure to make automated decisions based on an intimate knowledge of its overall state.

"Intelligent Systems" – Univ. of Michigan Civil and Environmental Engineering

BIG DATA consist of datasets whose "size" is beyond the ability of typical/traditional database software tools to capture, store, manage, and analyze. Key differentiators that characterize Big Data include: **Volume** (size of the dataset); **Variety** (data from multiple repositories, domains, or types); **Velocity** (rate of data flow); and **Variability** (the change in other characteristics)

National Institute of Standards and Technology (NIST)

Intelligent Water Systems Components:

- Data capture
- Data validation
- Data curation (storage, query, transfer)
- Data integration
- Data Analytics
- Business intelligence/decision support
- Knowledge sharing
- Performance reporting & visualization

Descriptive – What happened?	HINDSIGHT
Diagnostic – Why did it happen?	INSIGHT
Predictive – What will happen?	
Prescriptive – How can we make it happen?	FORESIGHT

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Intelligent Water Systems - EXAMPLES

- Tracking flows system-wide to better predict where overflows may occur and take action to prevent or minimize overflows
- Advanced metering infrastructure (AMI) allowing utilities to monitor water use in real time and providing ratepayers access to usage statistics
- Water demand forecasting
- Energy demand forecasting
- Assisting with monitoring of chemical usage/dosage
- Optimizing purchasing/procurement
- Enhancing environmental monitoring and analytics to allow for more precise control of treatment systems
- Real-time asset management to bring different assets into and out of service and better predict asset failure in order to take proactive, corrective measures

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KDF Recommendations

Recommendations for KDF Continuance

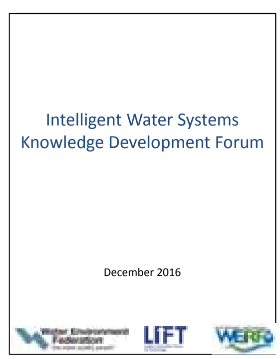
- The KDF has certainly discussed the Automation of Decisions. But, the KDF should also focus on the Automation of Workflows. That is, we need to operationalize Analytics and Information Management (not just Data Management).
- Definitions here at the KDF have focused on Technology, but what about Definitions associated with Business/Organization/People?
- Need to integrate a Data-Analytics-Information-Decision Support infrastructure throughout the entire organization
- Metering has been mentioned often during the KDF, but what about engaging the customer? If utilities want to achieve more transparency, don't we need to know what customers want with regard to Analytics/Information?
- What is real-time? Real-time means something different to managers in different functional roles within a utility. Perhaps, it is better to emphasize sampling time and having data collected when needed.

Recommendations for KDF Continuance

- Some IWS components that the KDF needs to more urgently address:
  - Data Governance – the foundation of sound data asset management
  - Data Validation – confidence in the numbers before they are stored in data repositories; build "Data Trust"
  - Platforms and Infrastructure associated with data management
  - Automated response (i.e., beyond Predictive Analytics): Envision a future in which more data is passed from one machine to another to automated decisions and responses
- Need a standard nomenclature regarding types of utility operations requirements for Analytics / Information / Modeling and Simulation / Decision Support

KDF White Paper Outline

- Background
- Participants
- KDF – The Process and Targeted Outcomes
- The August-2016 KDF – Presentations; Discussions; Outcomes
- Sustaining the KDF Outputs/Communications going forward


Intelligent Water Systems
Knowledge Development Forum

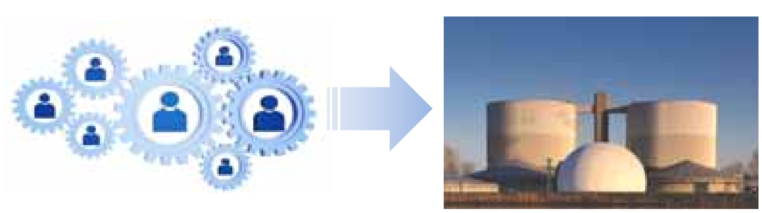
December 2016

LIFT Program

Fidan Karimova
Water Technology Collaboration Manager
Water Environment & Reuse Foundation

LIFT

LIFT is a WEF/WE&RF initiative to encourage and support innovation in water



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Utility Technology Focus Groups

1. Shortcut Nitrogen Removal
2. P-Recovery
3. Digestion Enhancements
4. Biosolids to Energy
5. Energy from Wastewater
6. Collection Systems
7. Green Infrastructure
8. Small Facilities
9. Odor Control
10. Disinfection
11. Water Reuse
12. Intelligent Water Systems

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Leaders Innovation Forum for Technology

74 Technologies
70 Companies

LIFT

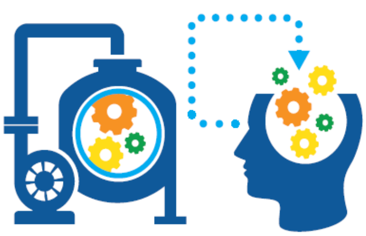
LIFT Link

LIFT Link
Discover. Connect. Collaborate.

- Discover new technologies
- Connect with others with similar needs, technology interests, and desired expertise
- Collaborate on research and technology ideas, proposals, projects, demonstrations, and implementation

LIFTLINK.WERF.ORG

LIFT SEE IT

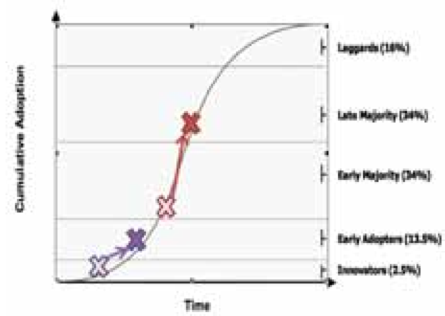


- Scholarship Exchange Experience for Innovation and Technology Program (SEE IT) in partnership with WEF, NACWA, WE&RF
- Visit technologies of interest at implementing utilities
- To apply go to: http://bit.ly/liftseeit
- Applications due: **December 1, 2016**

Technology Survey

http://www.surveygizmo.com/s3/2952785/LIFT-Water-Tech-Survey-2016

Understand the industry priorities and connect interested parties



Water Environment Federation

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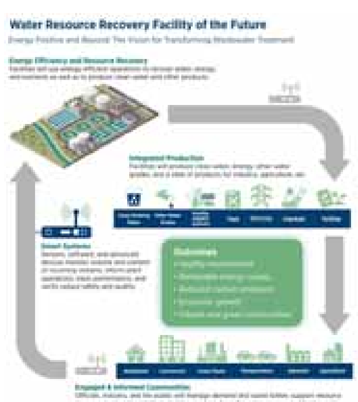
WE&RF

WRRF of the Future



WRRF of the Future- vision of the facilities that are expected to recover water and other resources by 2035 or before

- Energy Efficiency and Resource Recovery
- Smart Systems
- Integrated Production
- Engaged and Informed Communities

Water Environment Federation

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WE&RF

THANK YOU!

Any Questions?

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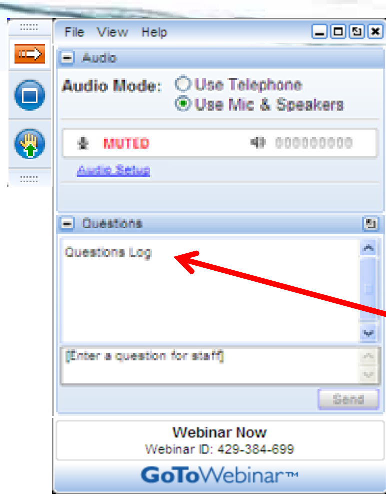

- **Audio Modes**
  - Listen using Mic & Speakers
  - Or, select "Use Telephone" and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**

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