Improving Business Processes through Operational Intelligence in the Water Quality Industry

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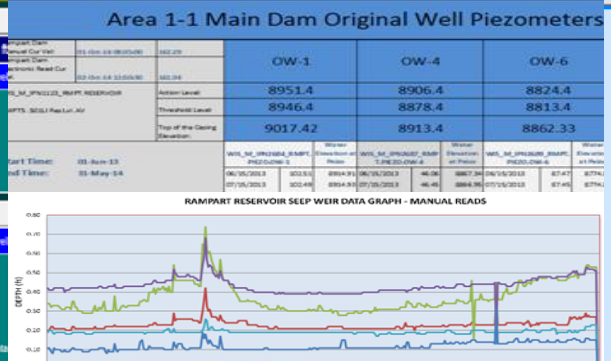
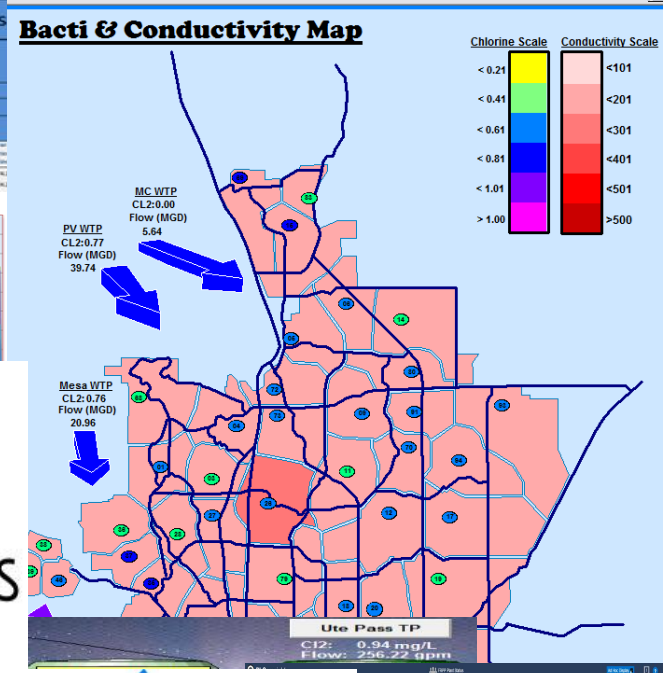
Colorado Springs Utilities
It's how we're all connected





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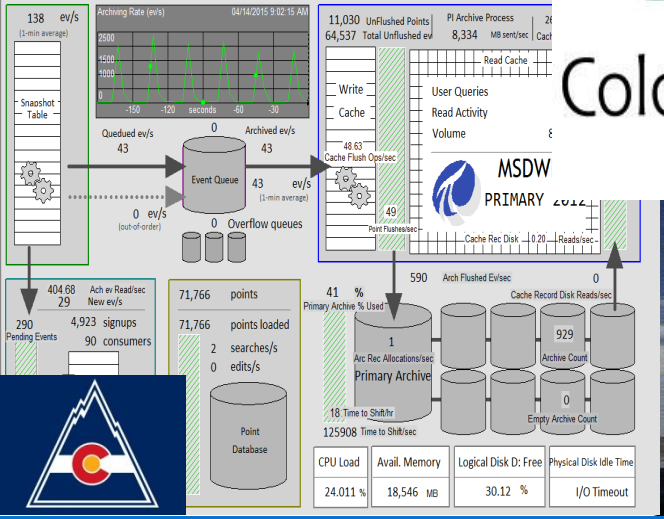
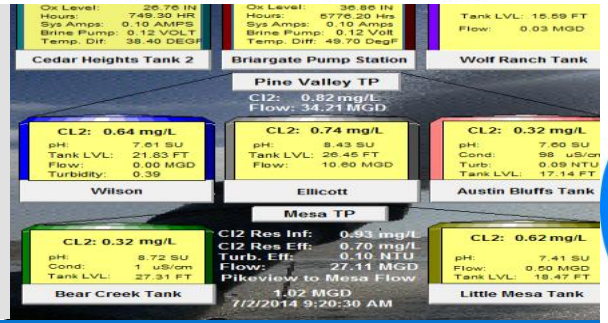
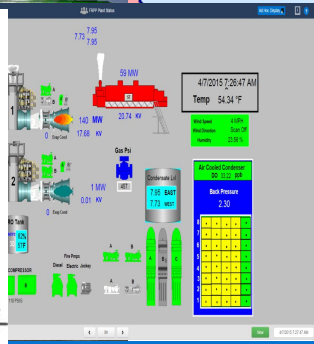


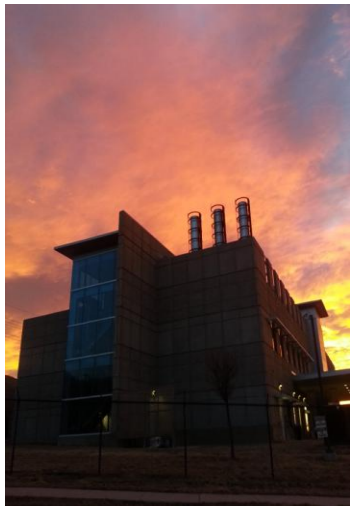


WATER QUALITY ASSURANCE



Laboratory Services' Water Quality Assurance

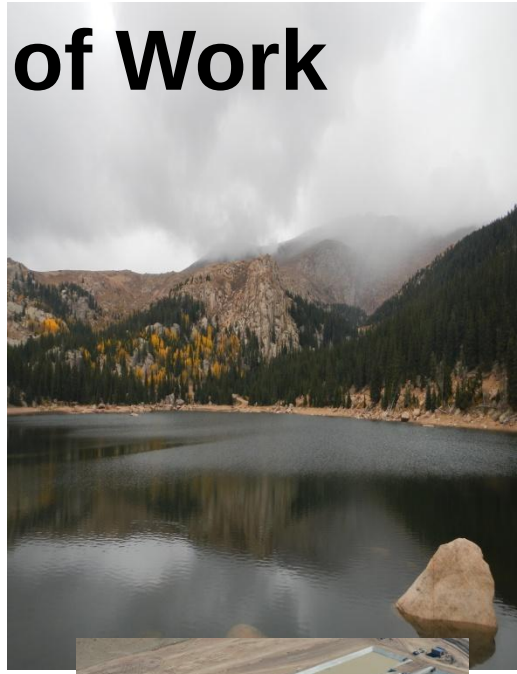
- Laboratory Services provides technical, scientific & regulatory support
  - State certified Laboratory
  - Analysis over 14,000 samples annually with over 80,000 analytes
- Water Quality Assurance Group Responsibilities
  - Technical and scientific guidance for water quality disciplines
    - Source water to tap and back to environment
    - Compliance and process control sampling
    - Water quality management authority
    - Customer service outreach
  - PI System Super-users



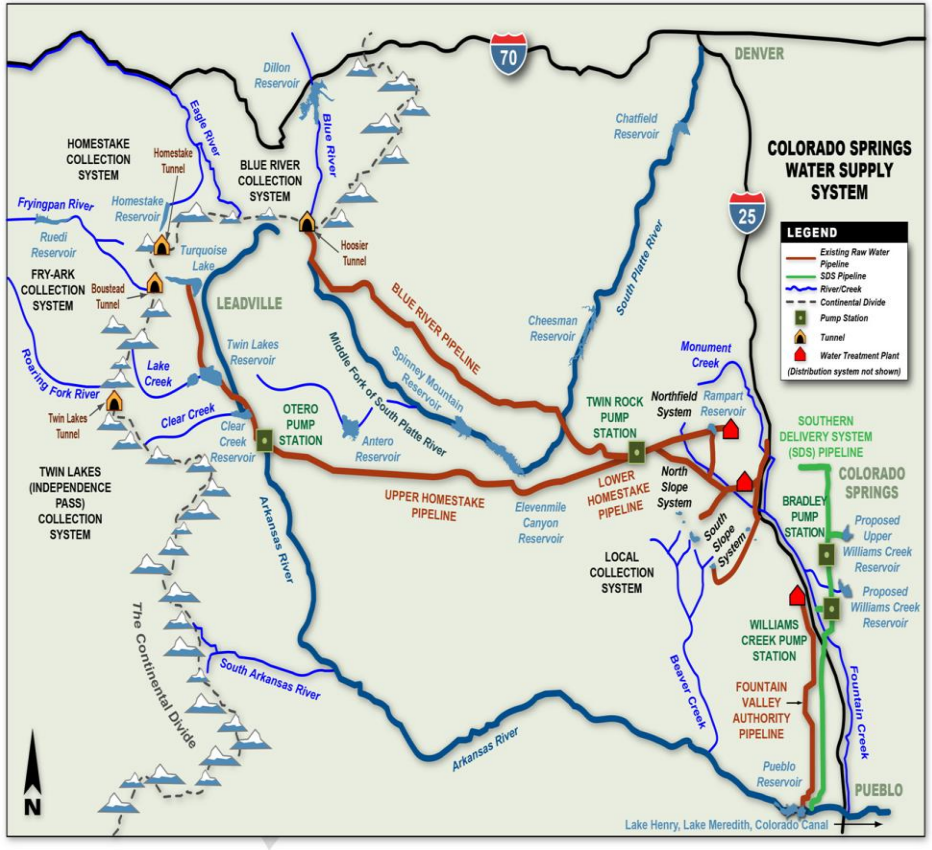
Water Quality Assurance Scope of Work

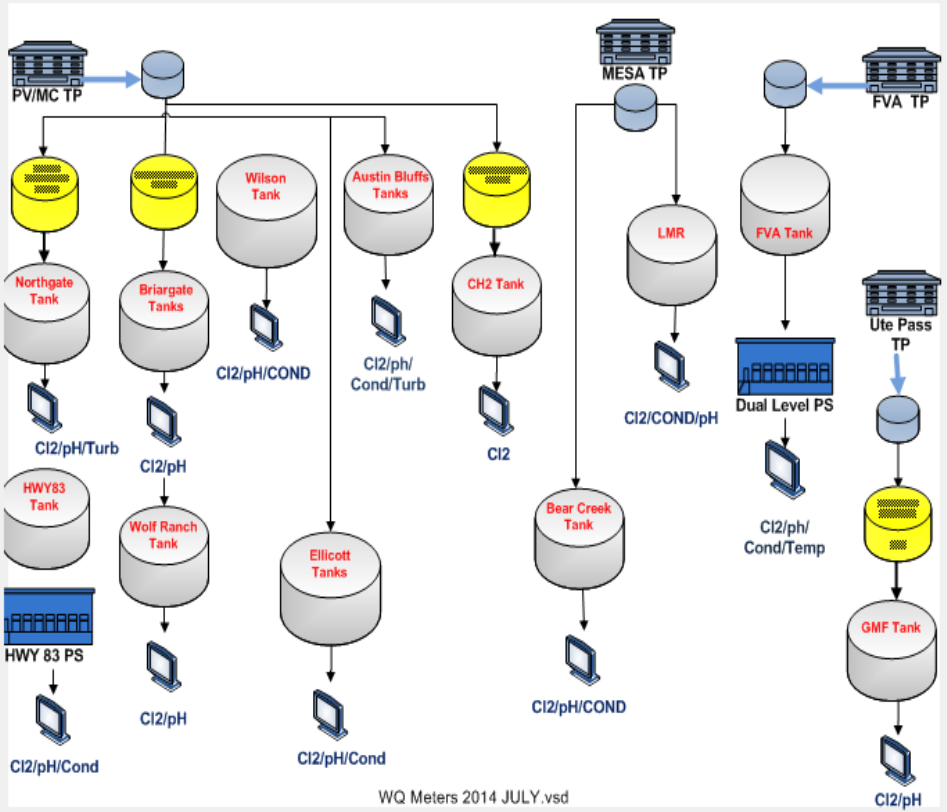
Providing Water Quality Management Support

- 8 Watersheds
- 7 Finished Water Treatment Facilities
  - 286 MGD peak and 215 MGD sustained
  - 38 Finished Water Reservoirs
- 4 Post-Chlorination Stations
- 2700 miles of potable water distribution mains
- Serving 449,260 Customers
- 2 Wastewater Treatment facilities
  - Permitted for 85 MGD
  - Solids Handling Facility



Colorado Springs Utilities Critical Water Infrastructure





Business Challenges

- Multiple Enterprise Interfaces and Dissimilar Systems
  - Users required to learn many systems
  - Enterprise integration issues
    - Data redundancy and disconnected technologies
- Dependent upon other departments for information
  - SCADA Operators tasked to monitor Water Quality Assets
- Business Drivers
  - Expanding Infrastructure with limited resources
  - Environmental and Compliance Regulatory Drivers
- Obsolete Systems
  - Hard Coded Static Reports (SQR)
    - 3 week turnaround time

Sustainable WQ Management Program

We needed to identify who we are

- Why are we here?
- What value can we bring?
- How can we leverage the data and show it's value?

We needed to focus on Business Process Improvements

- Leveraging technologies
- Create a environment of data sharing
  - Create a just-in-time informed process
- Create a Dynamic Reporting System
  - Improve compliance and process control data timeliness
- Capture institutional knowledge
  - Optimize on training and development opportunities
- Transforming users with actionable information

LASTLY… BUILDING VALUE NOW & BUILDING VALUE OVER TIME

What is this PI Thang?

Can the PI System been utilized and to what extent?

- *How can we implement the system?*
- *How can we leverage this technology?*
- *Can we improve efficiency using real-time data?*
- *Can we visualize the value of data?*
- *Can we justify the expenditure of the system?*

Convergence with IT and OT

- *Establishing strategic plan of implementation*
- *Leveraging enterprise business applications*
- *Provide team value and usability*

PI System implementation

Key business processes and programs

- Total Coliform Rule Monitoring Program
  - 60 monitoring location collected weekly with over 10 analytes per site
- Post-Chlorination and Water Quality Monitoring Stations
  - Continuous monitoring of critical water quality assets
- Compliance and Process Control Sampling Program
  - Potable Water Treatment Plants
  - Water Resource Recovery Facility
  - Watershed and Source Water Management

Hone in on the Data Target

We created a Centralized Data Platform

- Which enables us the ability to
  - Interface with multiple enterprise data sou
  - Leverage all related enterprise systems
  - Access Real-Time data
  - Capture sensor-based data
  - Operate independently
- Which Leads to
  - Maximize Real-time Data Intelligence
  - Improved decision quality
  - End-User Ownership and Empowerment
  - Data Sharing across the organization

SUSTAINABLE OPERATIONAL FUTURE

To Manage you must be able to Measure

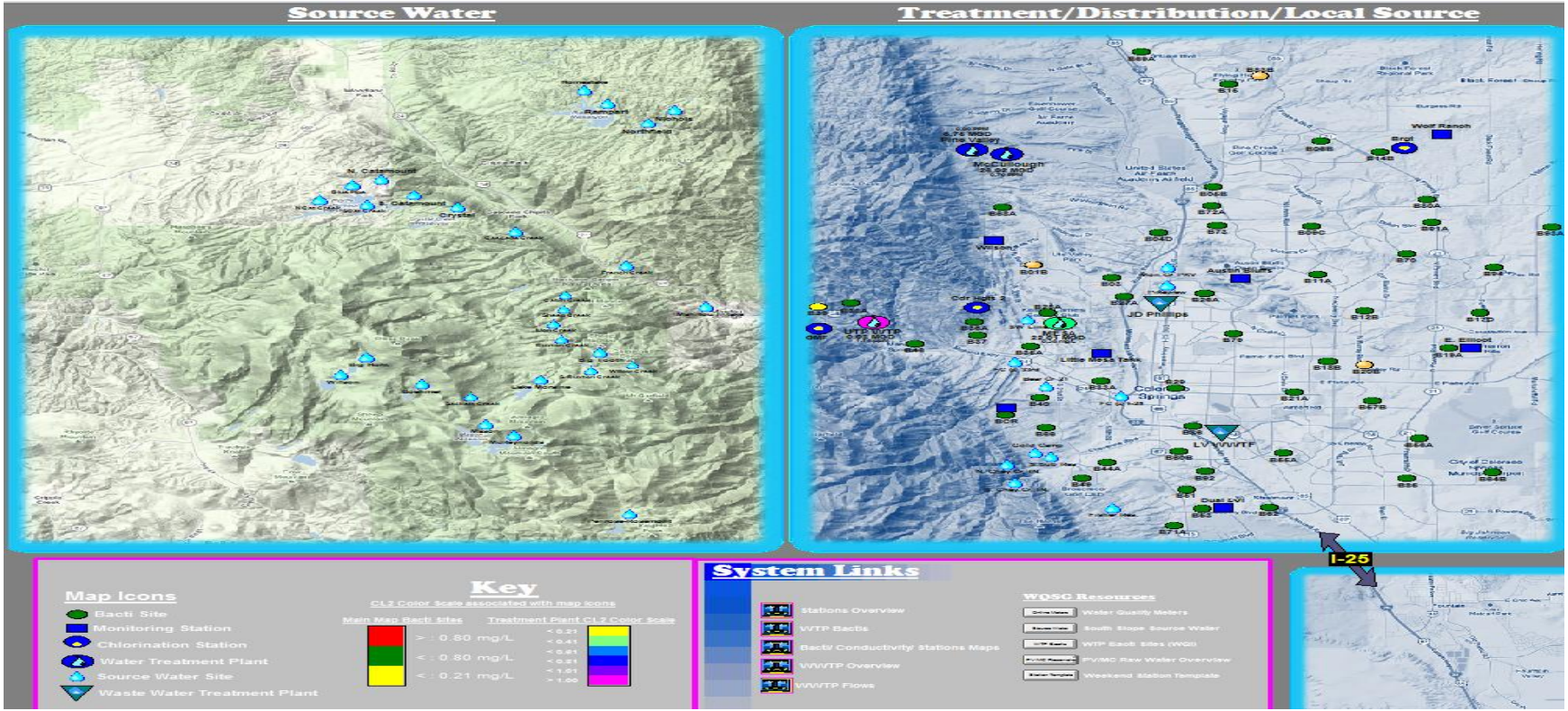
To manage performance effectively all enterprise data sources must be evaluated

Communicate effectively and provide visibility

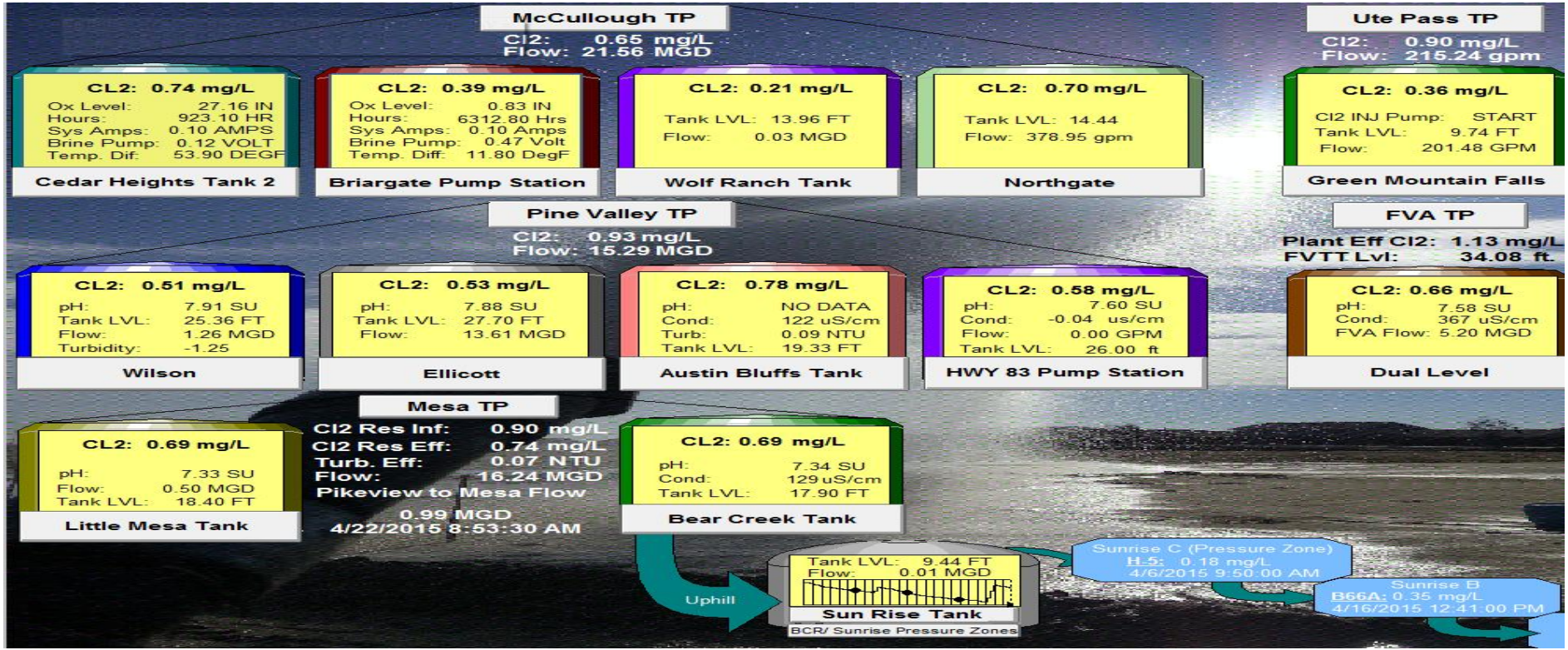
- Monitoring system health and make operational changes
- Identify and correct problems early
- Provides the ability to Manage Risk
- Make key water system trade-offs
- Defend and justify decisions based on facts
- Creates training opportunity
- Plan and optimize system performance

DYNAMIC REAL-TIME DATA PROVIDES VALUE BEYOND EXPECTATIONS

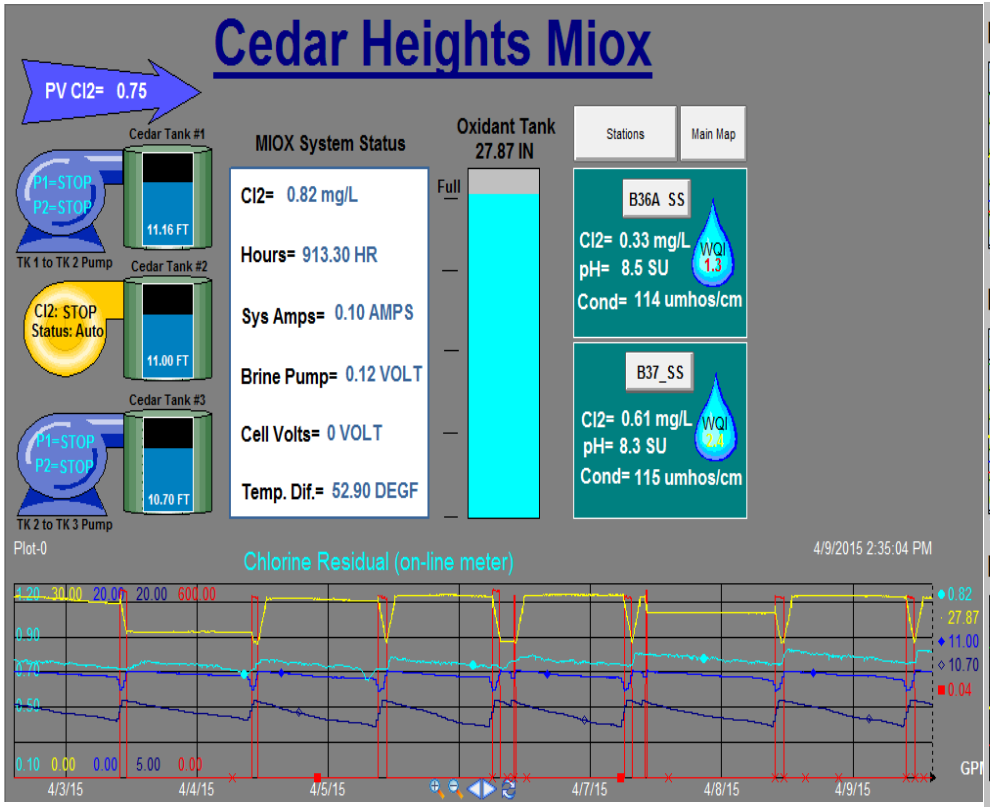
Holistic View of Water Quality Assets

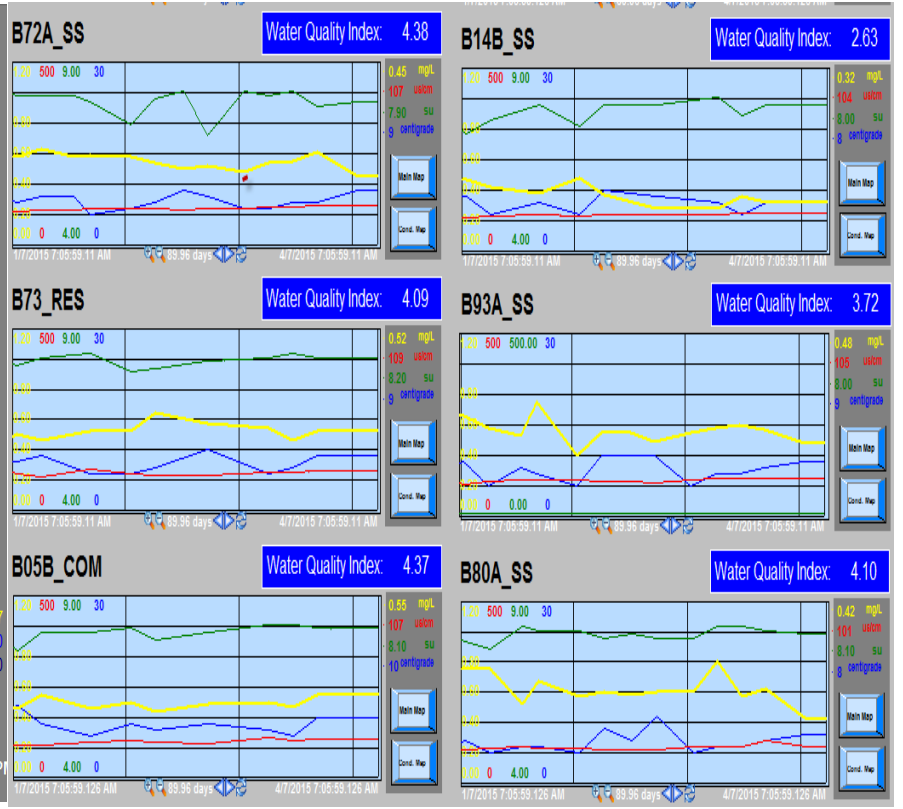


Water Quality Monitoring Dashboard



Post-Chlorination Station Dashboard





Then the analytics began…

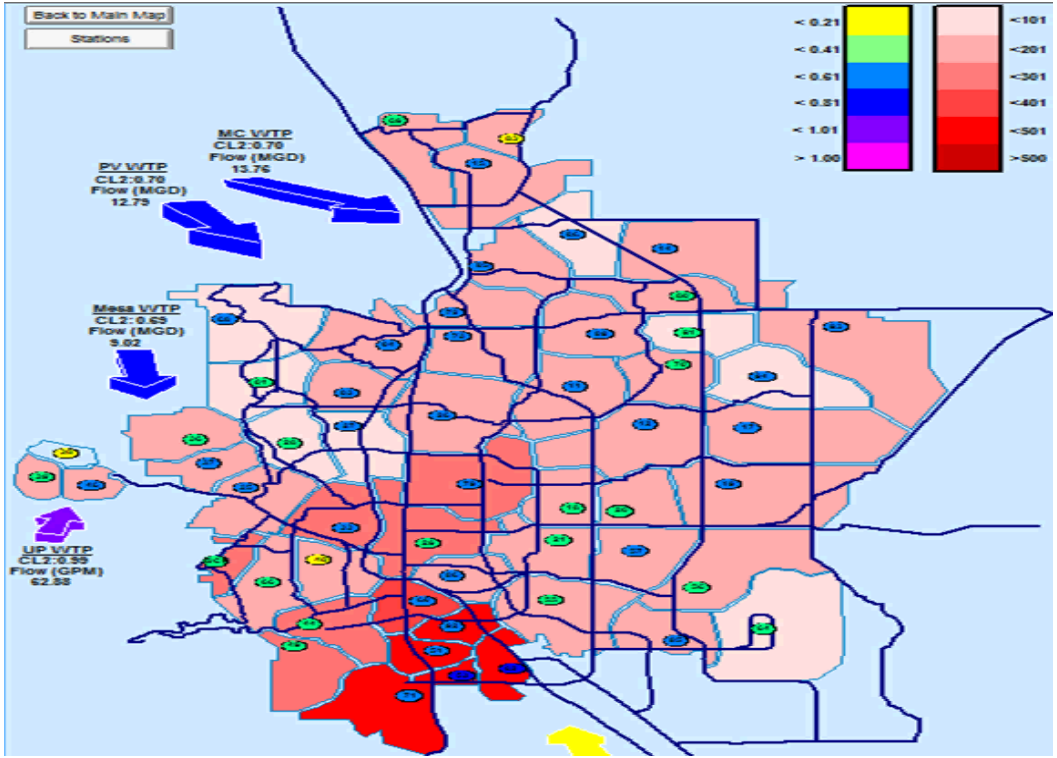
- Accessibility to the real-time data
  - Created a environment of data accessibility
  - Empowered team members and customers
- Perform Advanced Water Quality Analytics
  - Development a Algorithm for Water Quality Index
    - Leveraging PI System AF
  - Enhance Water Quality Station Performance KPI's
  - Visualization of Chlorine Residual in the Water Distribution System
  - Treatment Plant Zone of Influence with Conductivity Source Trace
  - Water Distribution System Optimization
- Provides situational awareness,

GETTING DEEP INTO THE DATA NOW THAT IT'S ACCESSIBLE AND DYNAMIC

Source Trace Dynamic Mapping

Utilizing PI Process Book

- Distribution system awareness
- Centralized data source
- Visualization Data
- Leverage Data Sources
- Storyboard
  - Tell the data story:
    - Understand
    - Predict
    - Mitigate

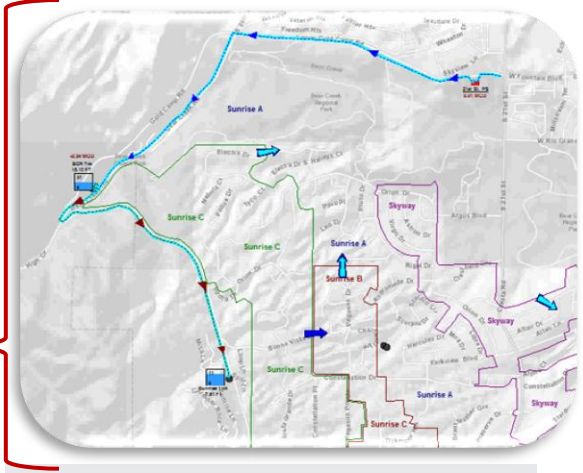


THE ABILITY TO PERFORM EVENT ANALYSIS BY REWINDING THE DATA

Leveraging PI System tools

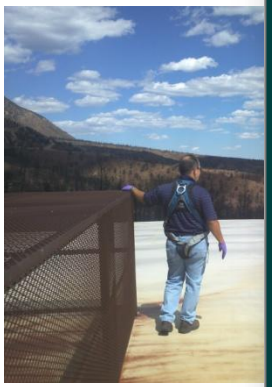
Bear Creek & Sunrise Pressure Zone Water Quality issues

- Real-time PI System data makes a big difference
- A powerful tool that not only provides data that helps us identify problems but provides the ability to perform data analytics that enables us the insight into solving them



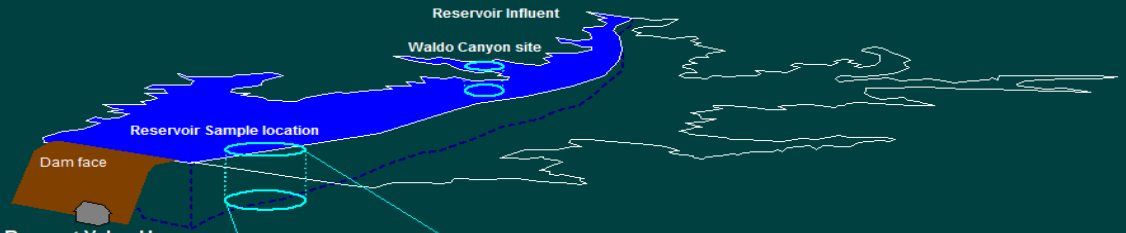
CHALLENGES	SOLUTION	RESULTS
Persistent low chlorine water in large area of town	Reactive approach *Poor allocation of resources*	Problem mitigated through optimum conveyance of water using real-time data
Potential safety concerns with low chlorine residual	Spill reservoir as needed *Not sustainable*	Mechanical solution has led to chlorine residual managed
Low water turnover lead to higher water age and lower Chlorine residual	Manually add Chlorine to Reservoir *Temporary solution*	Water System Awareness- Informed and educated team
	Capital investment of post chlorination system *Costly*	

Reservoir Water Quality Display



Rampart Reservoir

Waldo Canyon Fire Study



Rampart Reservoir Burn Area

Sample Date: 10/14/2014 9:20:00 AM

	Top	Middle	Bottom
Chlorophyll	0	2	2 ug/L
Conductivity	68	68	68 umhos/cm
DO	6.4	6.5	6.3 mg/L
pH	7.2	7.3	7.3 SU
Temperature	12	12	12 degree C
Secchi Depth	22	NA	NA Ft

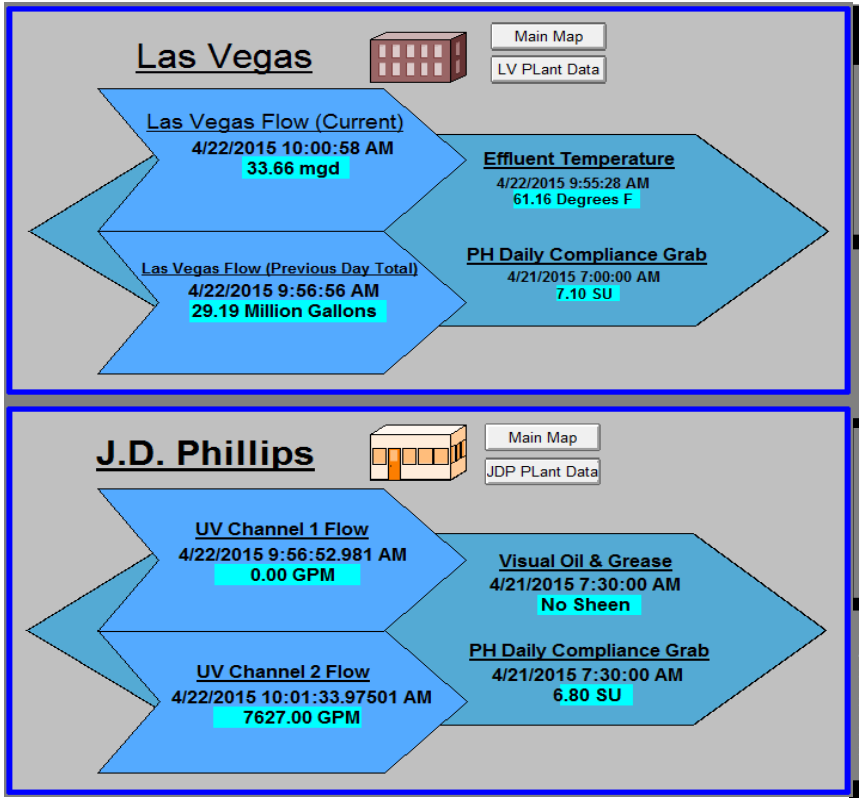
Reservoir Effluent

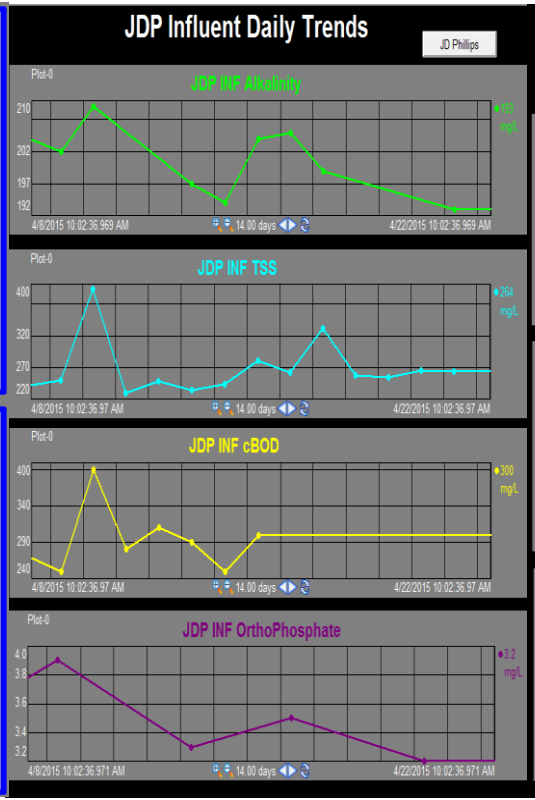
Sample Date	3/10/2015 8:45:00 AM
Aluminum	0 mg/L
Chlorophyll	2 ug/L
Conductivity	72 umhos/cm
E. coli	0 MPN/100mL
Fluoride	0.16 mg/L
Hardness	28.1 mg/L
Iron	62.9 ug/L
Magnesium	1500 ug/L
Manganese	44.7 ug/L
Nitrate	0 mg/L
TOC	1.86 ug/L
pH	7.3 SU
Phosphate	0 ug/L
Temp	5 degree C
Coliform	1 CFU/100mL
Organisms	30 P/ml
Turbidity	0.65 NTU

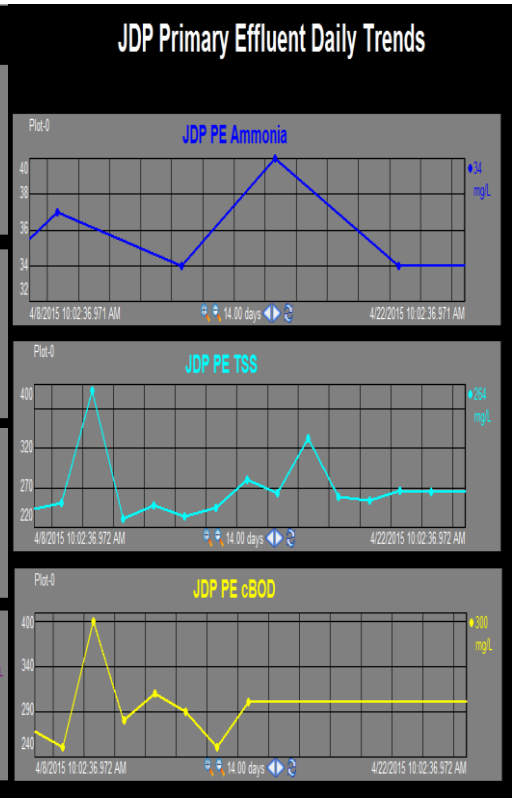
Reservoir Level: 172 FT

	pH	Temp	Turbidity	Conductivity	Alkalinity	DO	Chlorophyll	TOC	Ammonia	Fluoride	Nitrate	Nitrite	Iron	Magnesium	Manganese
TOP Secchi Depth: 22 FT	6.8	12	0.35	68	15	6.3	0	1.67	0	0.15	0	0	0	1440	0
MIDDLE	7.1	12	0.4	67	15	4.9	1	1.79	0	0.14	0	0	0	1440	0
BOTTOM	7.1	12	0.4	68	15	5.5	1	1.76	0	0.14	0	0	20.8	1450	7.82

Operation Awareness for Wastewater

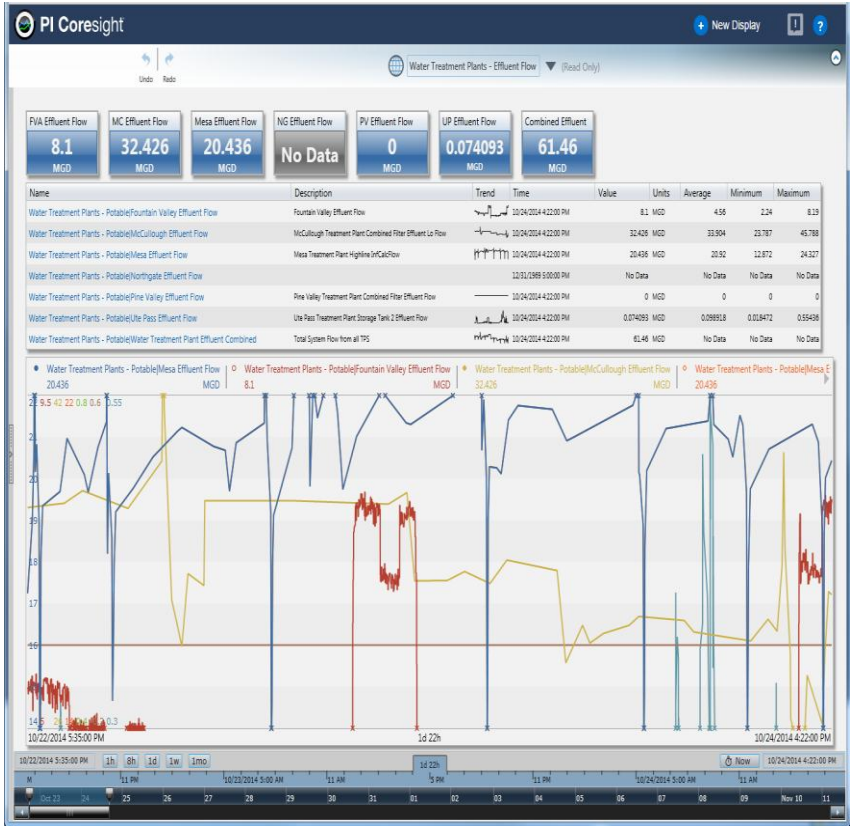






Ad-Hoc Trending using PI Coresight

- Empowering end-users
  - Increased ownership of the data and autonomy
  - It is an intuitive and interactive tool
- Creates a platform for users to have the ability to access real-time data
  - Custom views that can be designed to meet specific business needs
- Web-based client allows users to analyze enterprise data
  - Mobile accessibility and device agnostic
- Data analytical in the field improves decision quality
  - Reduces operational costs



Utilization PI System Real-Time Data

- **Leads to new discoveries**
  - Proactively identify treatment plant zone of influence and system disruptions
  - Optimize system control by decreasing water age at the fringes of the distribution system
  - Reduce treatment plant effluent chlorination set points
  - Anticipate customer service impact
- **Lead to Improved operational efficiencies**
  - Improved internal and external customers service
  - Meet our ability to sustain operational needs

MAINTAINING OPERATIONAL EFFICIENCY AS WE EXPERIENCE GROWING INFRASTRUCTURE WITHOUT INCREASING STAFFING LEVELS

Gains Realized with PI System Utilization

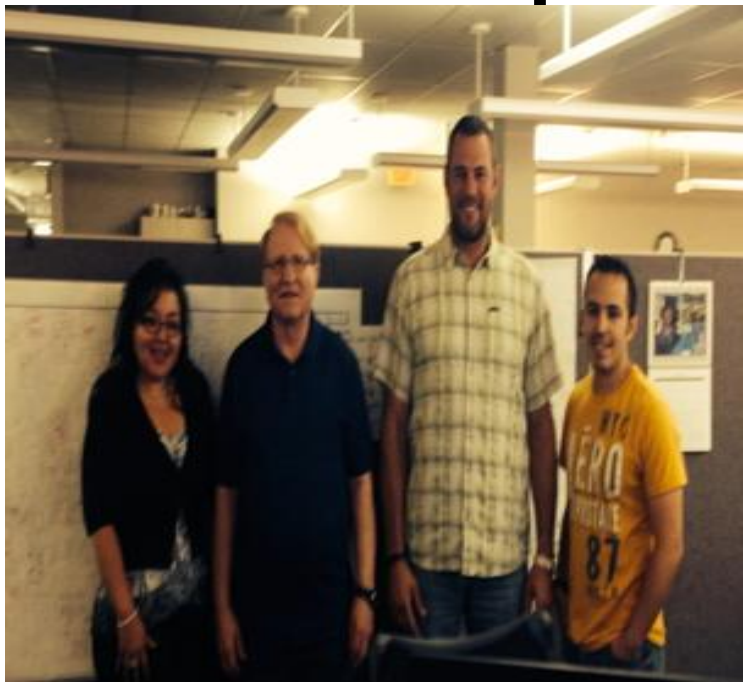
- **Significant O&M Reduction Realized**
  - 29% Reduction in resource allocation for online Instrumentation Inspections
  - 30% Reduction in Vehicle Usage Annually
  - 58% Reduction in Overtime
- **Saving has helped with reallocation of O&M dollars**
  - To expand our Water Quality Instrumentation Program
    - Pre PI System utilization we had only 6 operating WQ systems
    - Compared to 18 installed and operational by end of year 2015

Realized Benefits and the Power of Data

- Transformed from a static and reactionary team to a **SOLUTIONS** based team
- Eliminate the need for assistance from other operating areas
- Identify System disruptions
  - Flexibility in resource allocation
  - Improved decision process
- Disaster Recovery and Event Analysis
  - Replay events and perform analysis
  - Troubleshooting and training
- Centralized data accessibility
- Increased ownership of the data, its values and the processes around WQ
- Allowing internal customers access and visualize data in real-time
- Quick accessibility to the data within 15 minutes of LIMS authorization

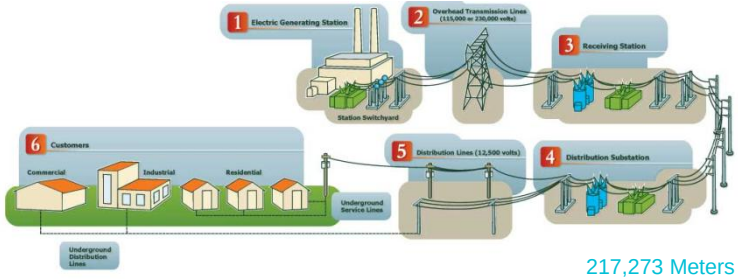
LEVERAGING DATA HAS TRULY REVOLUTIONIZE OUR TEAM DYNAMICS AND OUR IMPACT TO THE ORGANIZATION

What does it take to Empower the Water Quality Assurance Group?



COLLABORATION, TEAMWORK AND INFRASTRUCTURE

Colorado Springs Utilities – 4 Service Utility



ELECTRIC

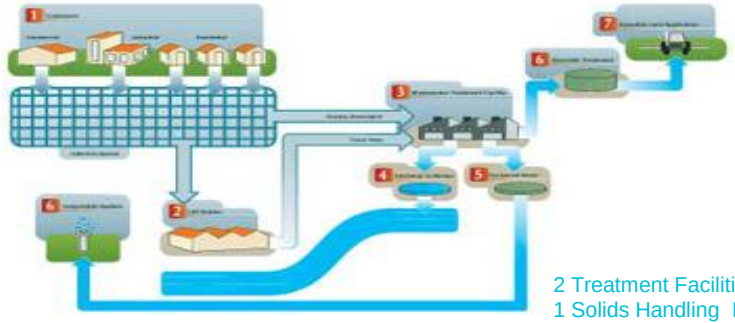
217,273 Meters
4 Hydro Electric Plants
2 Gas Plants
2 Coal Plants
Contracted Solar
Generating Capacity 1164MW's

WATER

137,619 Meters
7 Water Plants
Treatment Capacity 286 MGD's

GAS

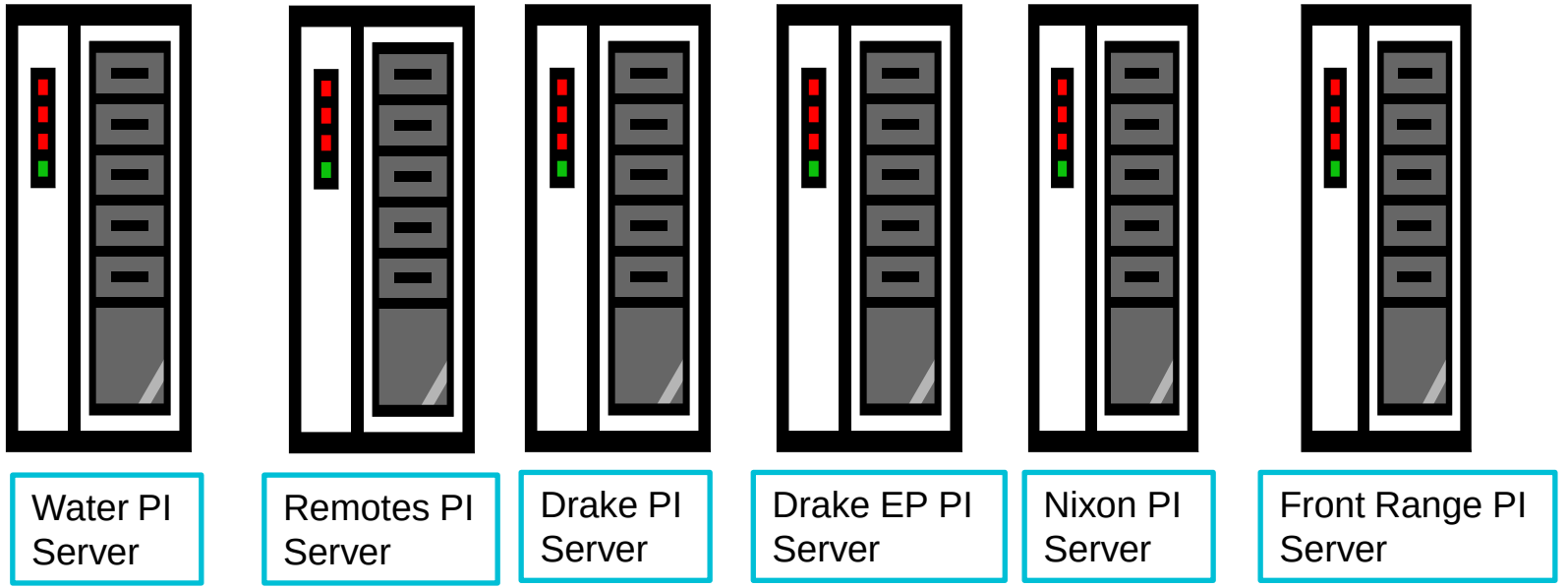
192,872 Meters
7 Gate Stations
Net Volume Throughput 269.8 MCF's



WASTEWATER

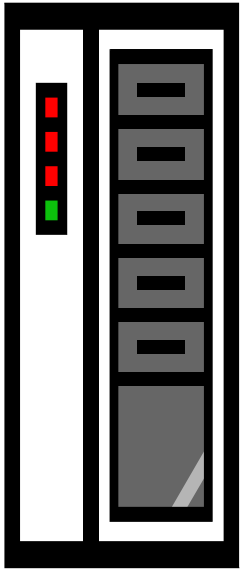
2 Treatment Facilities
1 Solids Handling Facility
19 Lift Stations
Treatment Capacity 38 MGD's

Source PI Servers

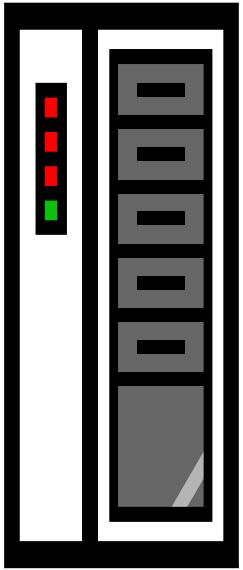


Enterprise PI Infrastructure

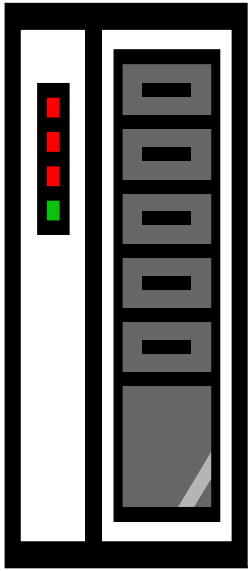
CSU PI Collective



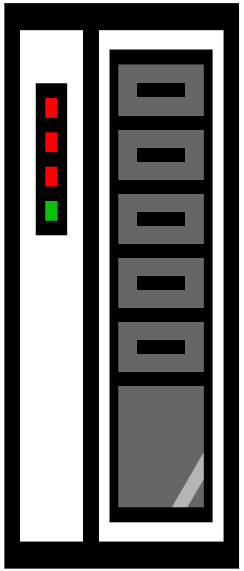
Primary PI Server



Secondary PI Server

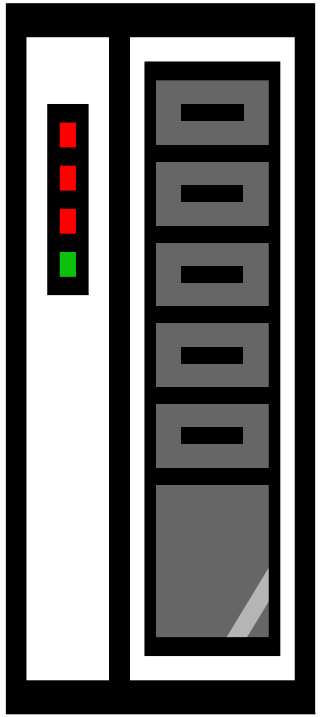


PI Asset Framework
PI Notifications
PI Analyses



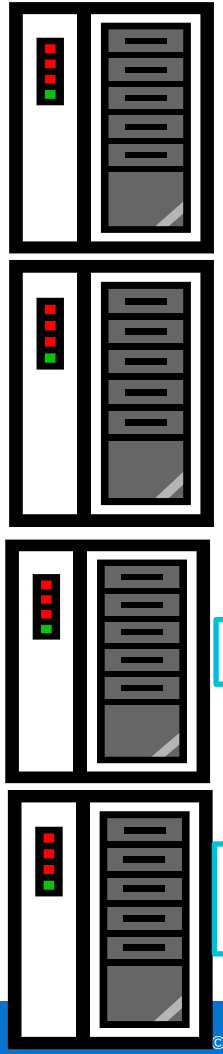
PI WebServer
PI Coresight
PI Manual Logger

PI to PI



Water PI Server

PI Collective



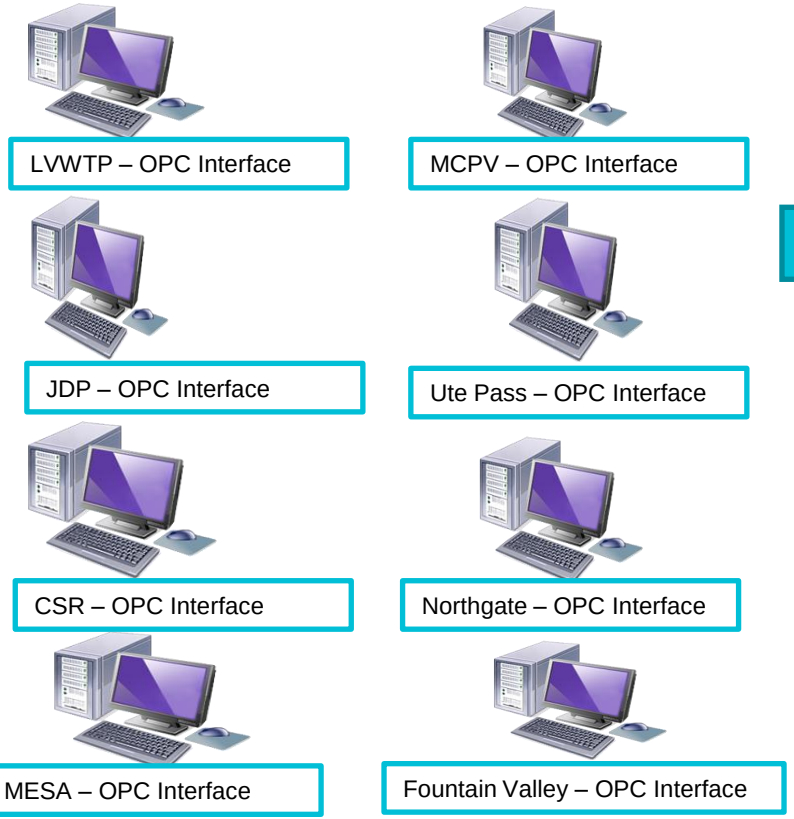
Primary PI

Secondary PI

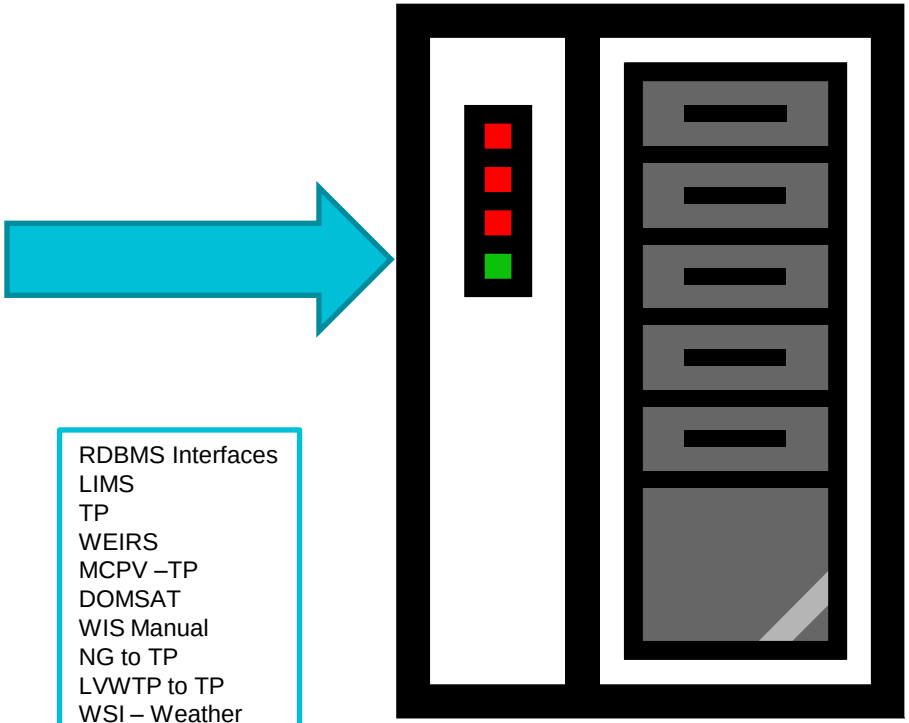
PI AF & PI Notifications

PI Web Server –
PI Coresight

H2O PI Server & 17 Interfaces



RDBMS Interfaces
LIMS
TP
WEIRS
MCPV –TP
DOMSAT
WIS Manual
NG to TP
LVWTP to TP
WSI – Weather



Water PI Server

Data Flow from SCADA to the Collective

SCADA Interfaces

Electric Backup 1-2

SCADA Interfaces

Electric 1-2

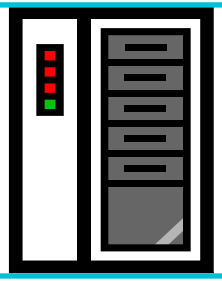
Gas Backup 1-2

Gas 1-2

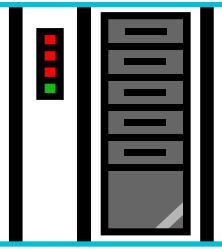
Water Backup1-2

Water 1-2

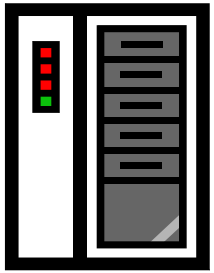
PI Collective



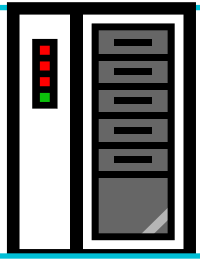
Primary PI Server



Secondary PI Server

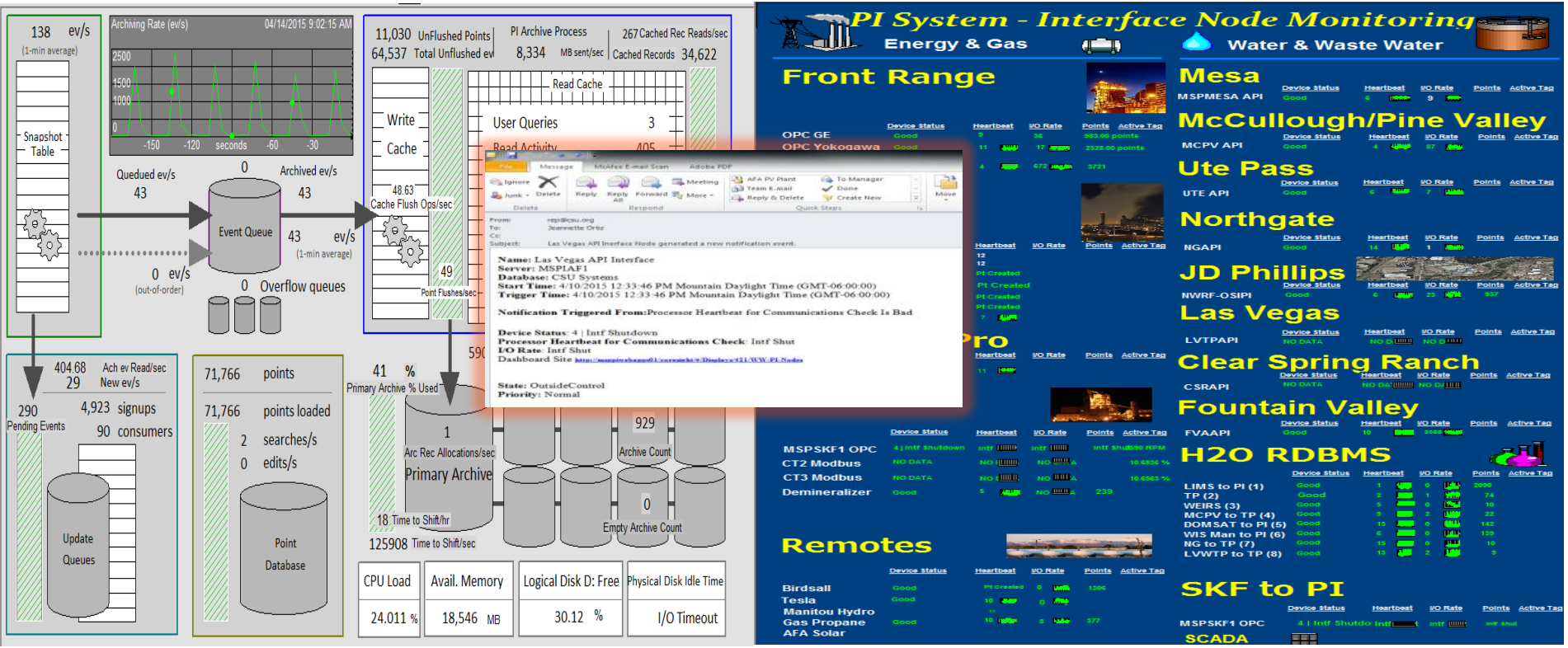


PI AF

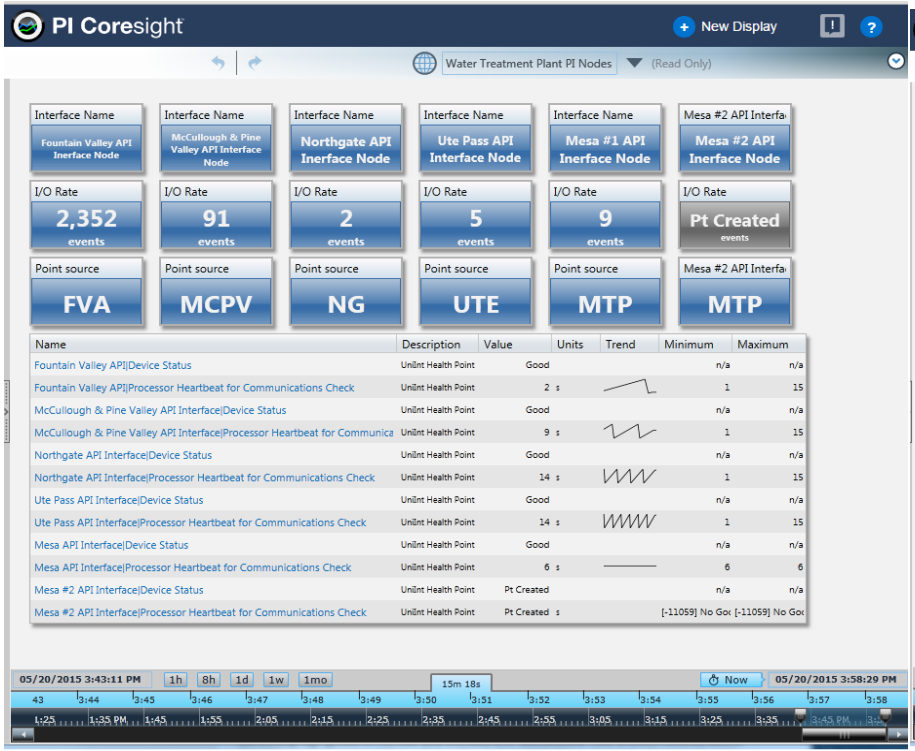


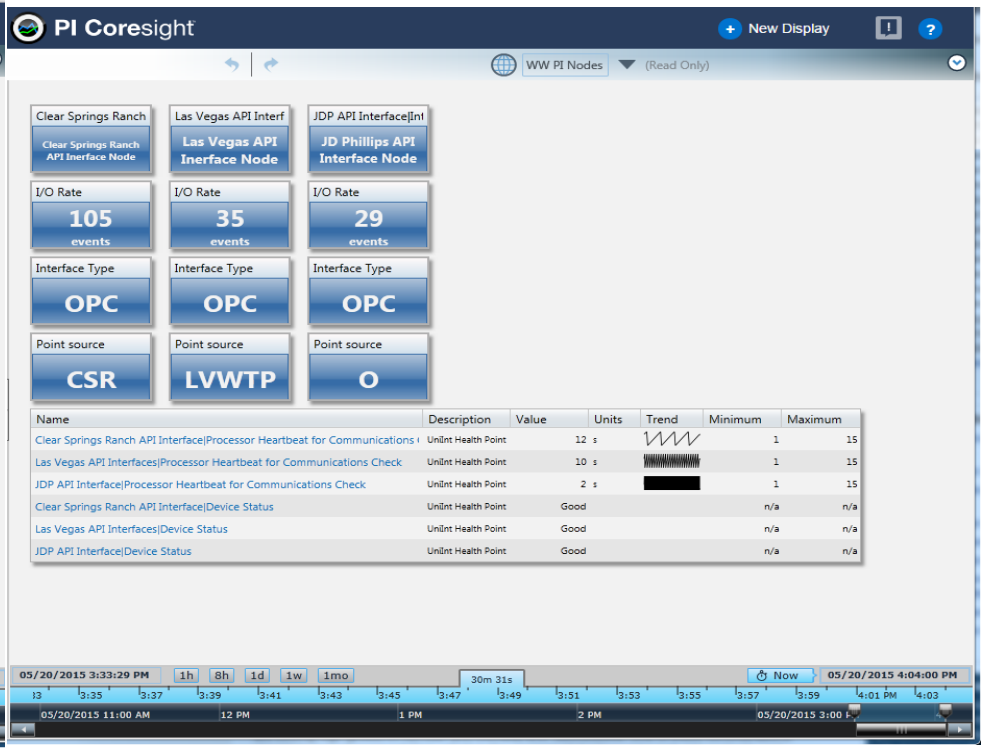
PI Web Server - PI Coresight

PI to Monitor PI

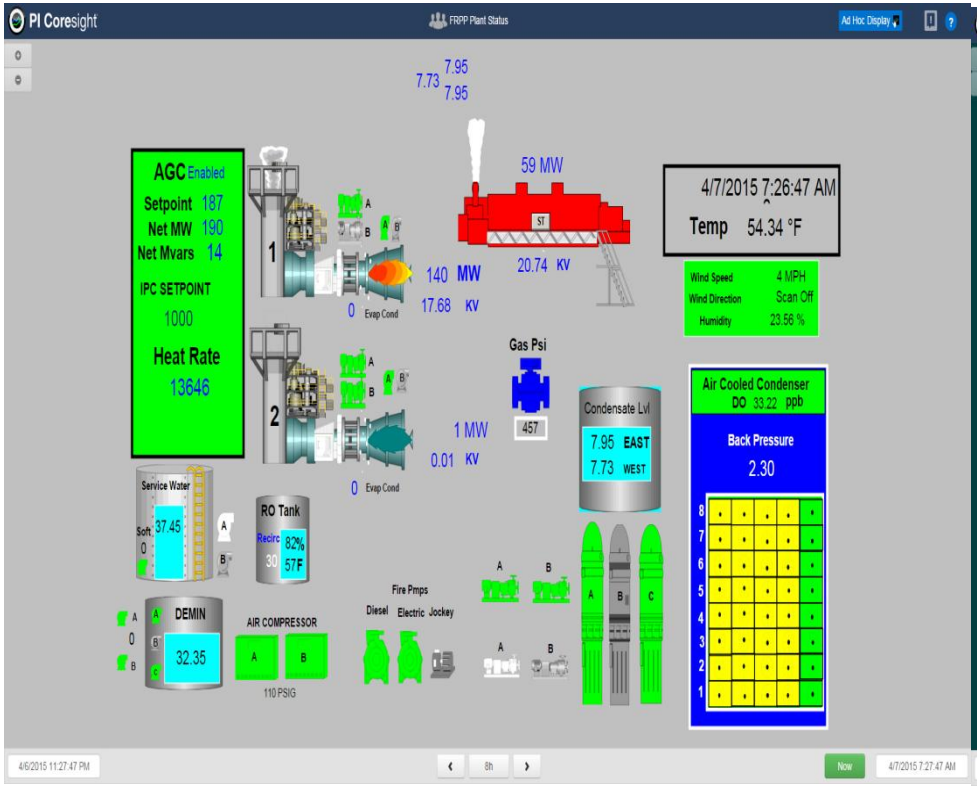


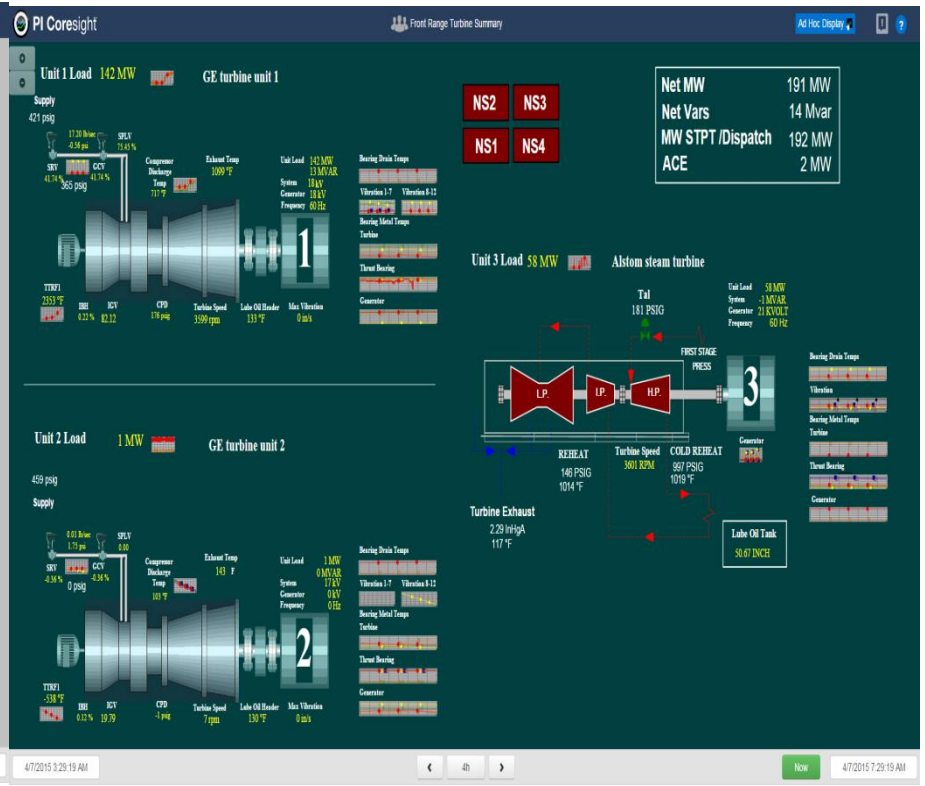
Water & Wastewater PI OPC Interface Node Monitoring



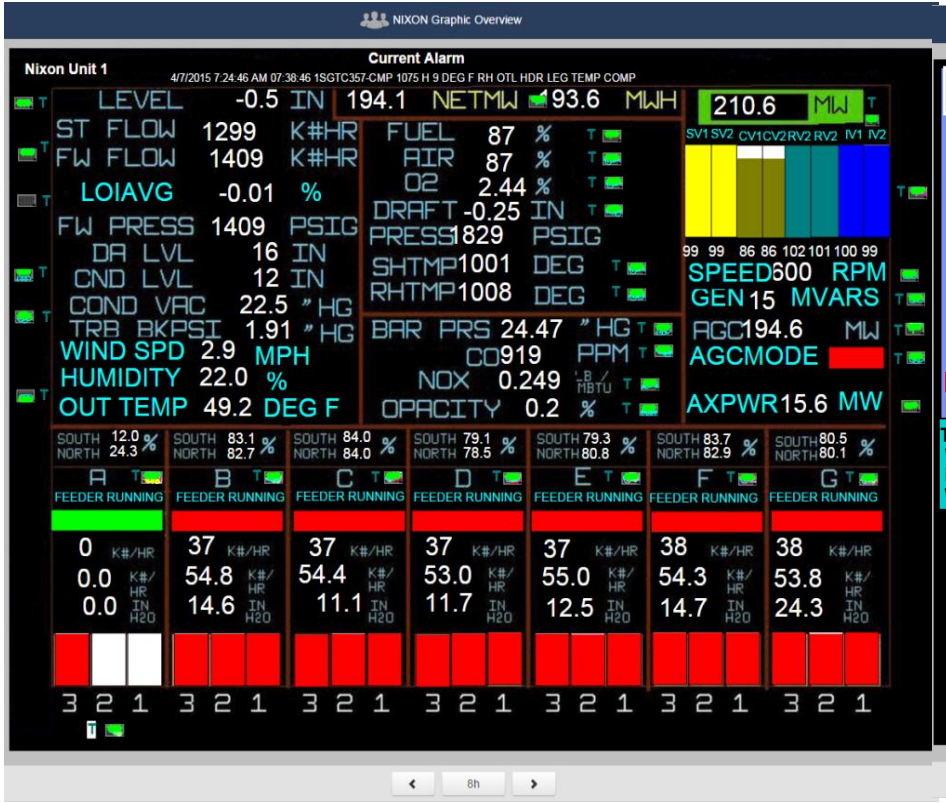


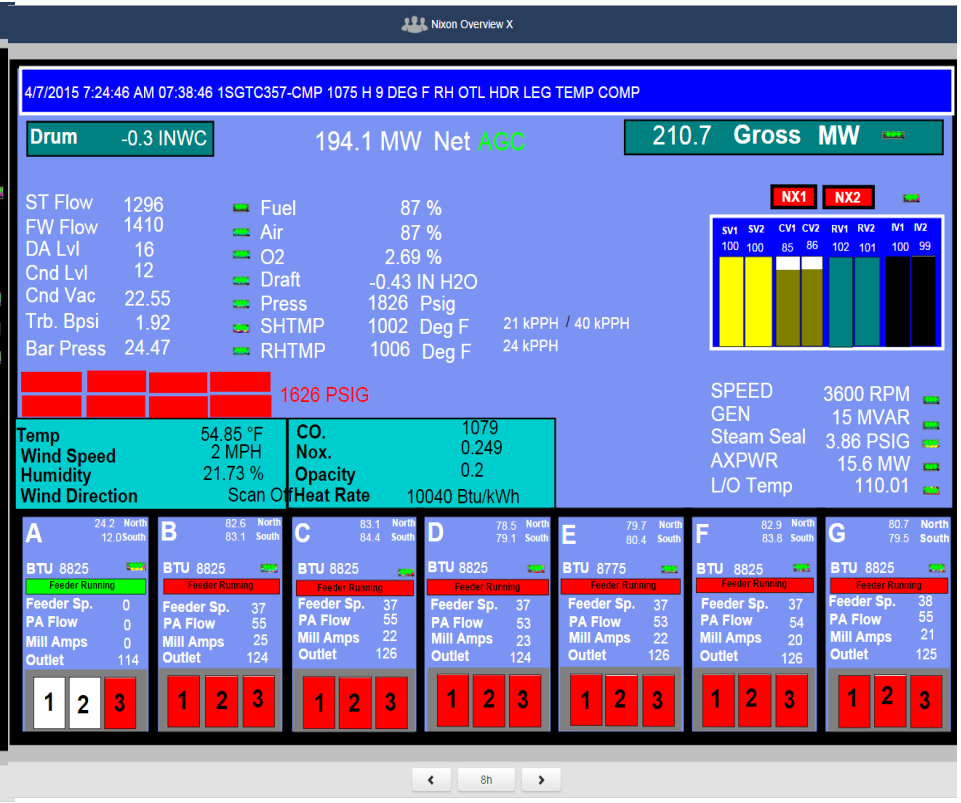
Operational Intelligence for Electric Generation



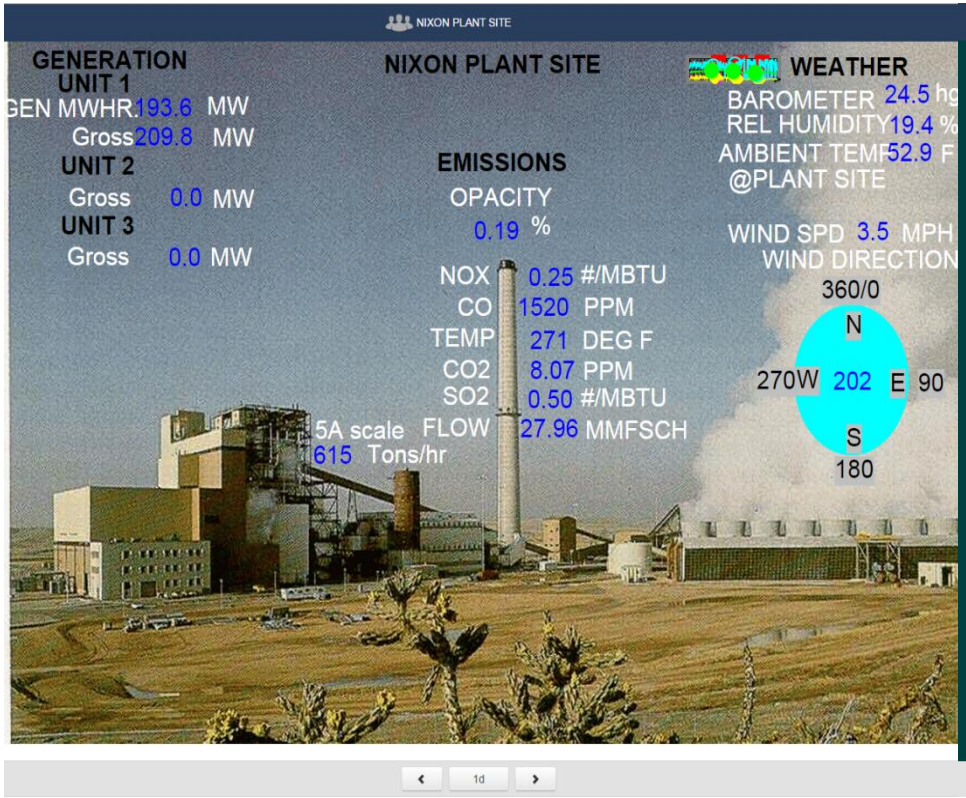


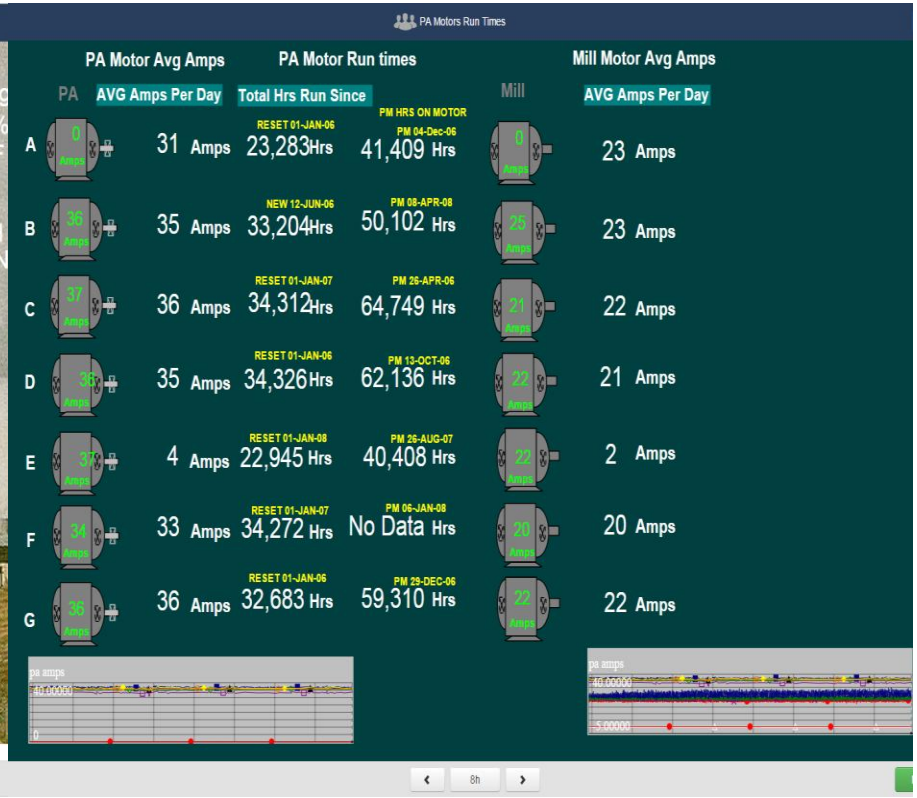
Operational Intelligence for Electric Generation



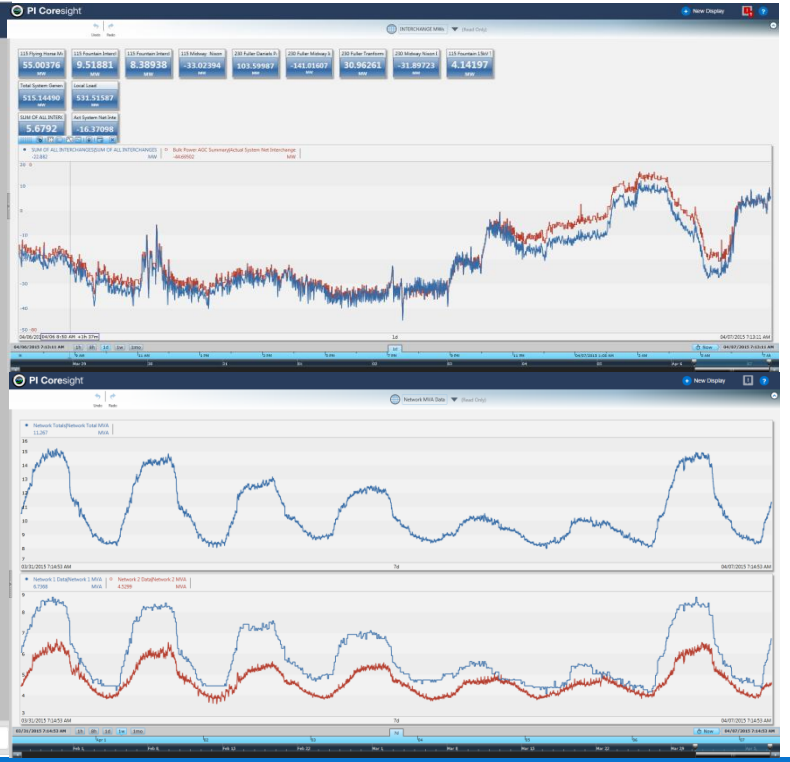


Operational Intelligence for Electric Generation

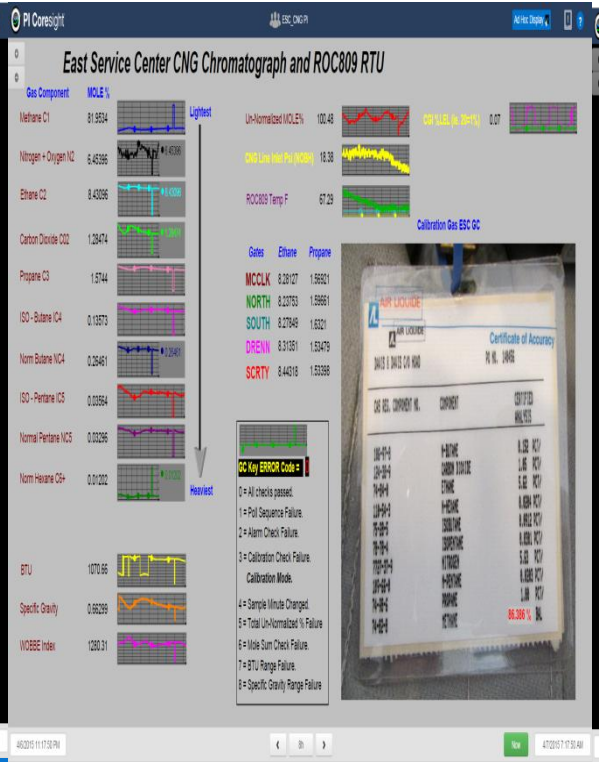


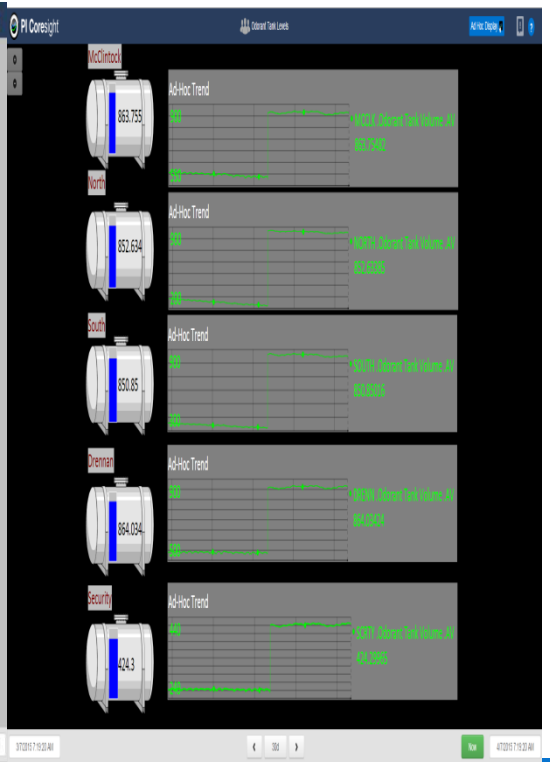


Operational Intelligence for Electric T&D

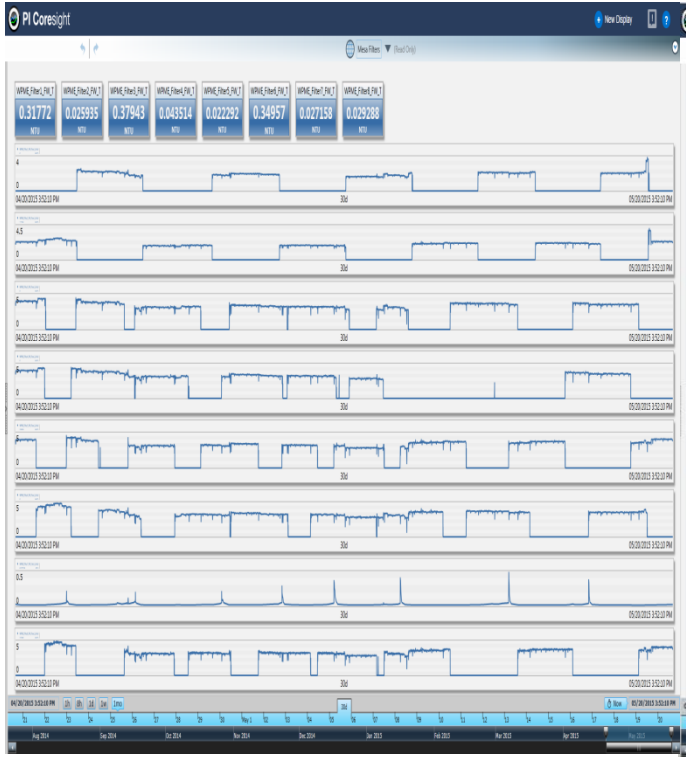


Improving Business Processes through Operational Intelligence for Natural Gas

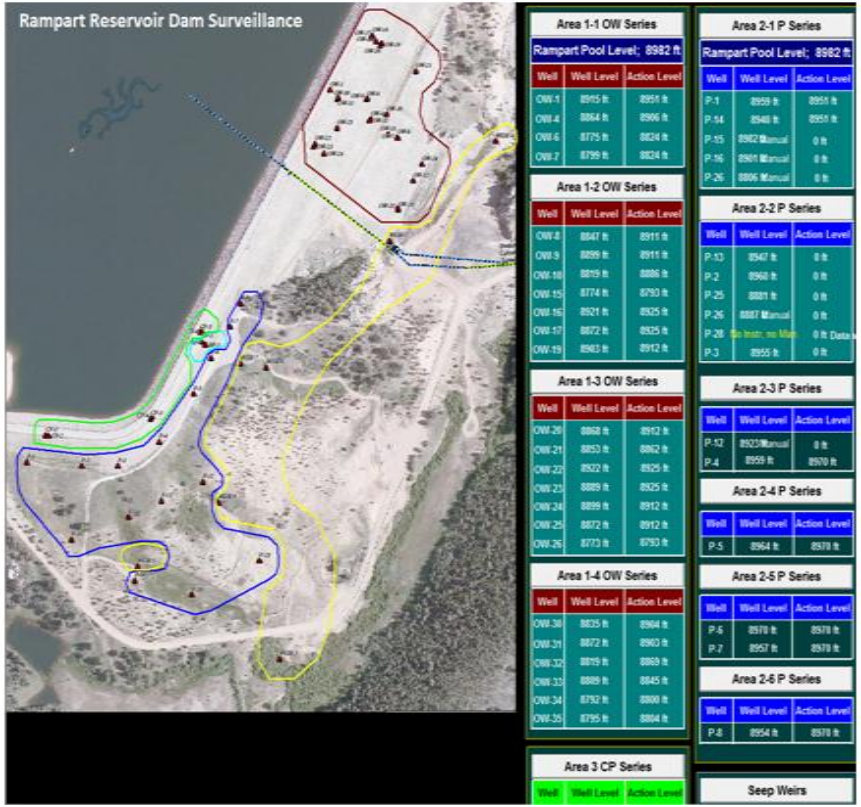




Water & Wastewater Plant Process Monitoring



Dam Monitoring and FERC Reporting



Area 1-1 OW Series — Rampart Pool Level: 8982 ft

Well	Well Level	Action Level
OW-1	8915 ft	8951 ft
OW-4	8864 ft	8906 ft
OW-6	8775 ft	8824 ft
OW-7	8799 ft	8824 ft

Area 1-2 OW Series

Well	Well Level	Action Level
OW-8	8847 ft	8911 ft
OW-9	8899 ft	8911 ft
OW-10	8819 ft	8886 ft
OW-15	8774 ft	8793 ft
OW-16	8921 ft	8925 ft
OW-17	8872 ft	8925 ft
OW-19	8903 ft	8912 ft

Area 1-3 OW Series

Well	Well Level	Action Level
OW-20	8868 ft	8912 ft
OW-21	8853 ft	8862 ft
OW-22	8922 ft	8925 ft
OW-23	8889 ft	8925 ft
OW-24	8899 ft	8912 ft
OW-25	8872 ft	8912 ft
OW-26	8773 ft	8793 ft

Area 1-4 OW Series

Well	Well Level	Action Level
OW-30	8825 ft	8964 ft
OW-31	8872 ft	8903 ft
OW-32	8819 ft	8869 ft
OW-33	8889 ft	8845 ft
OW-34	8792 ft	8800 ft
OW-35	8795 ft	8804 ft

Area 2-1 P Series — Rampart Pool Level: 8982 ft

Well	Well Level	Action Level
P-1	8959 ft	8951 ft
P-14	8948 ft	8951 ft
P-15	8982 Manual	0 ft
P-16	8981 Manual	0 ft
P-26	8806 Manual	0 ft

Area 2-2 P Series

Well	Well Level	Action Level
P-13	8947 ft	0 ft
P-2	8968 ft	0 ft
P-25	8881 ft	0 ft
P-26	8887 Manual	0 ft
P-28	No Instr. no Man	0 ft Data
P-3	8955 ft	0 ft

Area 2-3 P Series

Well	Well Level	Action Level
P-12	8923 Manual	0 ft
P-4	8959 ft	8970 ft

Area 2-4 P Series

Well	Well Level	Action Level
P-5	8964 ft	8970 ft

Area 2-5 P Series

Well	Well Level	Action Level
P-6	8970 ft	8970 ft
P-7	8957 ft	8970 ft

Area 2-6 P Series

Well	Well Level	Action Level
P-8	8954 ft	8970 ft

Area 3 CP Series

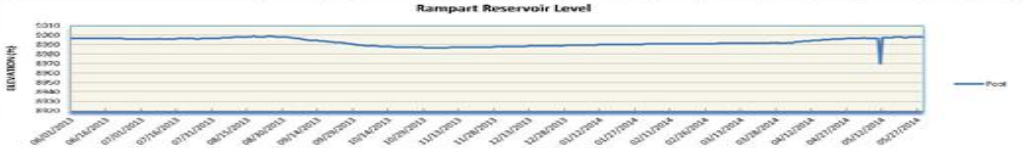
Well	Well Level	Action Level

Seep Weirs

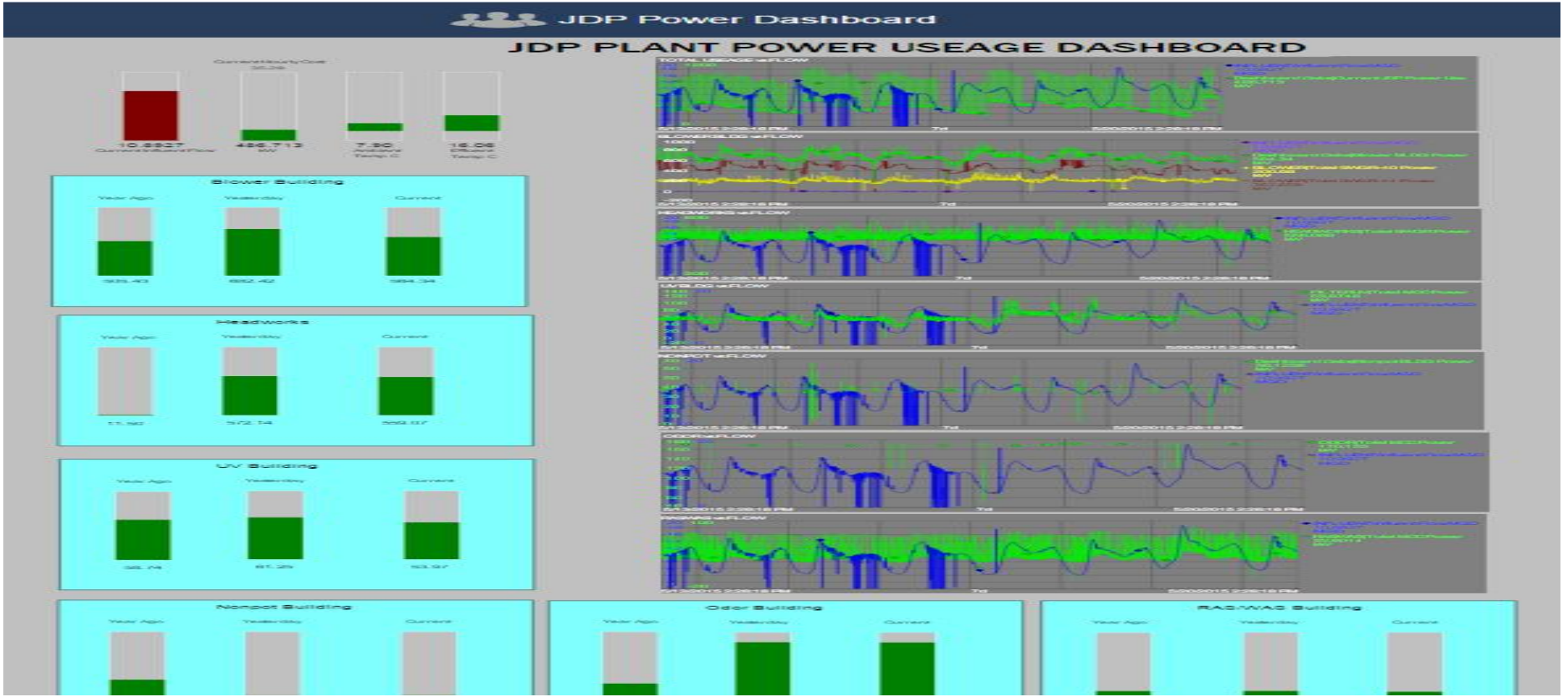
Area 1-1 Main Dam Original Well Piezometers - Manual Reads

	OW-1	OW-4	OW-6	OW-7	Rampart Pool Level
	8951.4	8906.4	8824.4	8824.4	
	8946.4	8878.4	8813.4	8813.4	
	9017.42	8913.4	8862.33	8861.64	

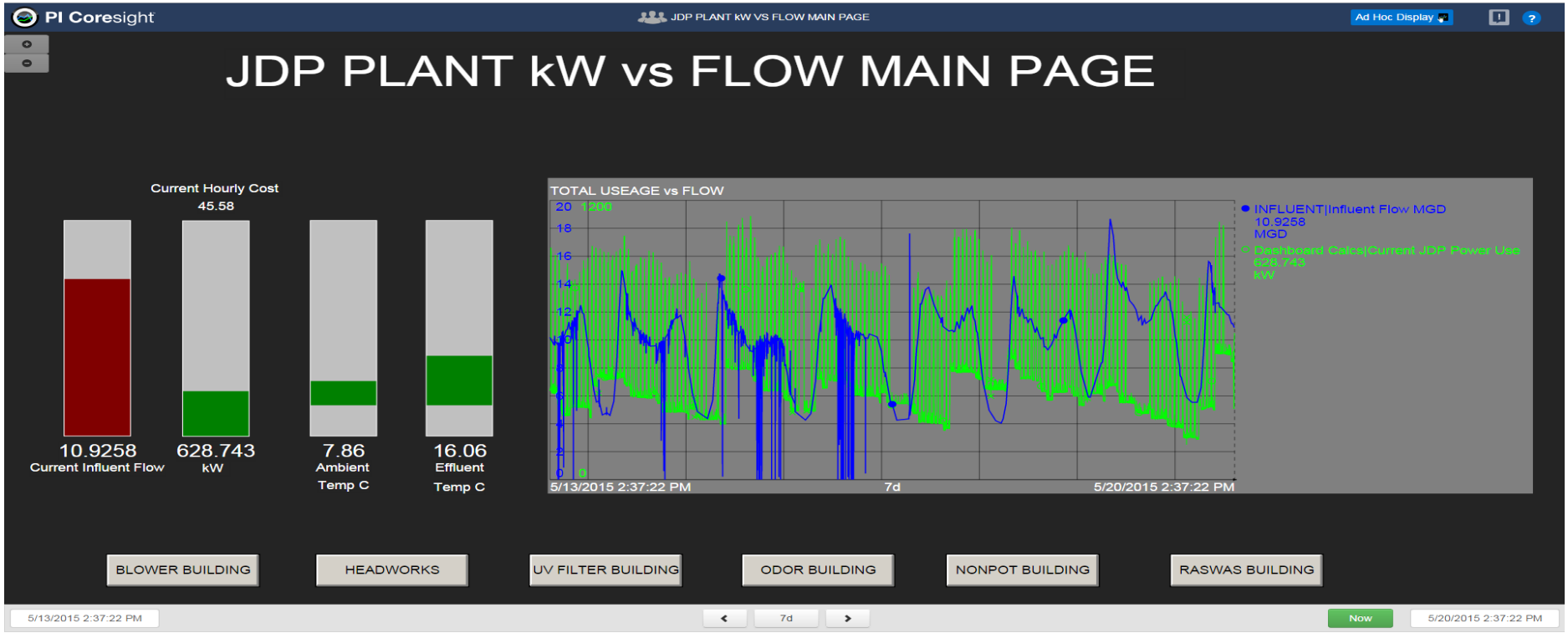
Start Time: 03-Nov-13
End Time: 31-May-14



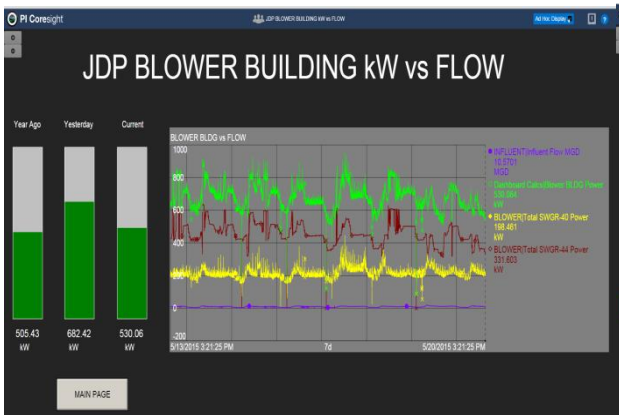
Wastewater Plant Power Usage Monitoring

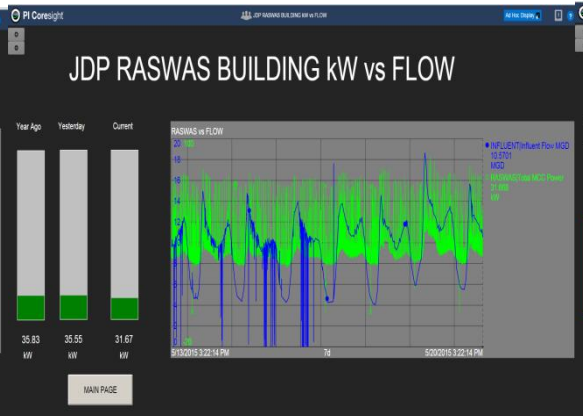


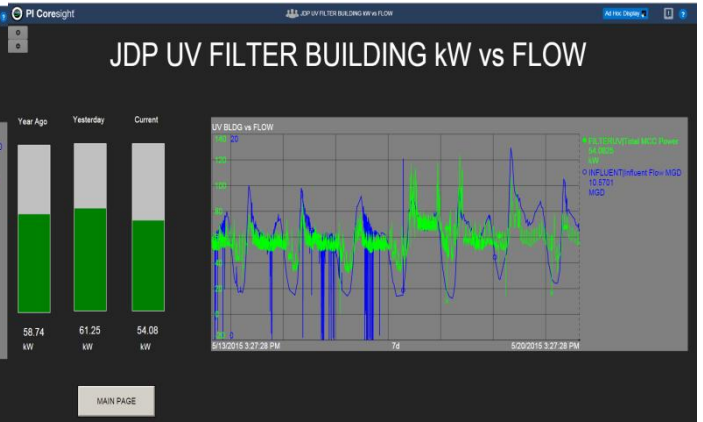
Energy Management & Monitoring

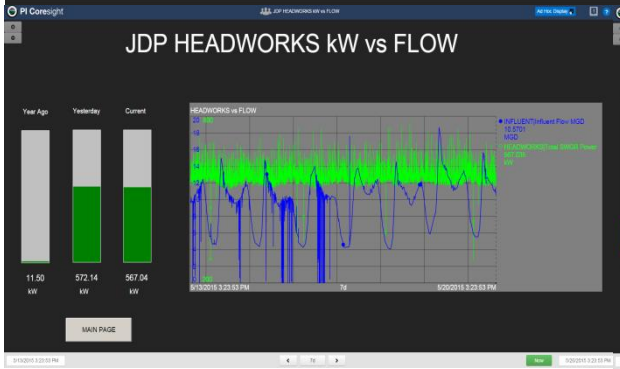


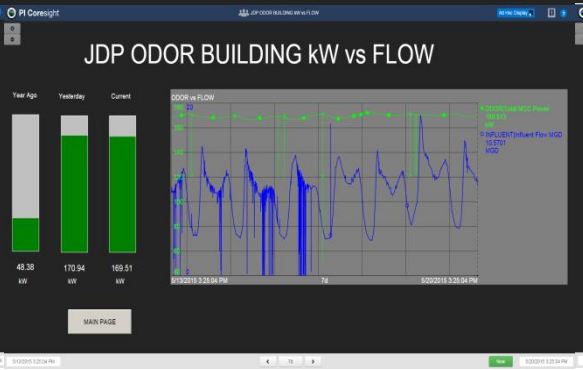
Energy Management & Monitoring by Process Area

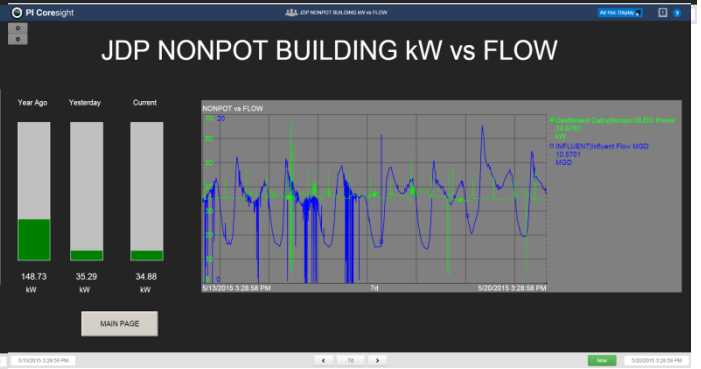




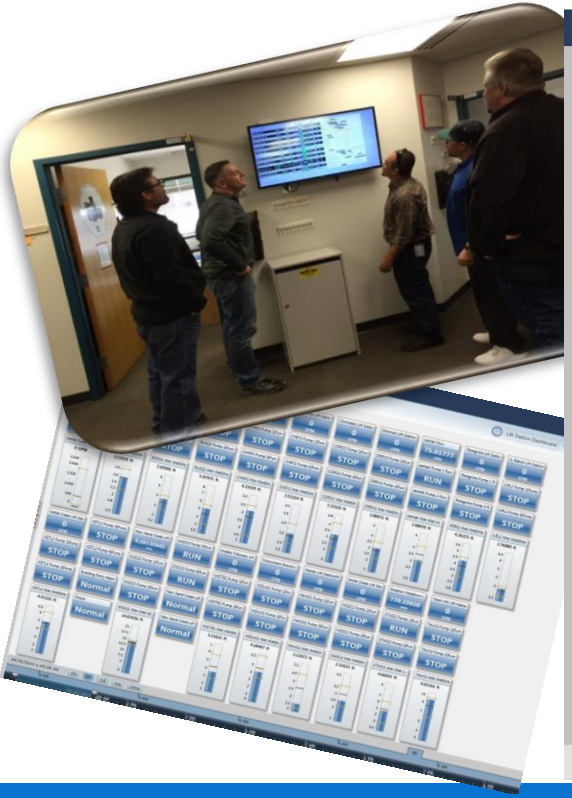


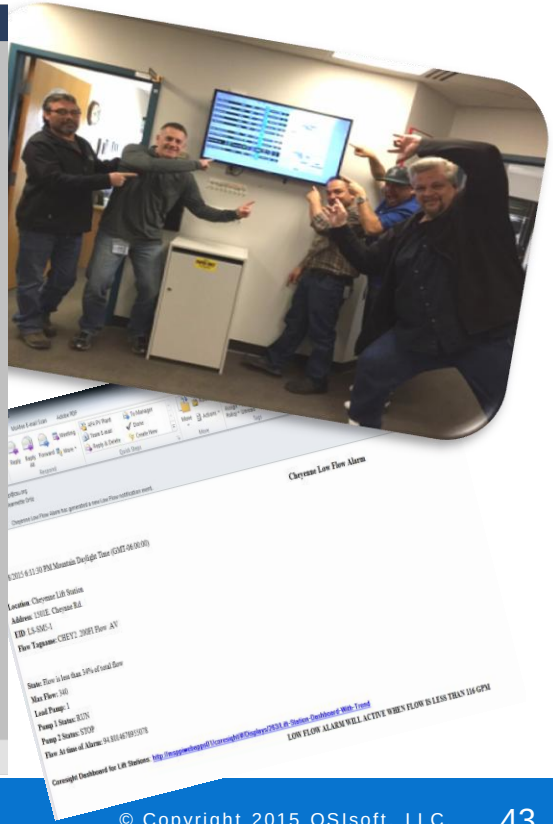






Improving Business Processes through Operational Intelligence for Wastewater Lift Stations





Operational Gains Realized throughout CSU with the Utilization of the PI System

- Reduction in O&M costs
- Continued growth experienced for management and monitoring of critical systems
- Leverage Integration Opportunities
- Single platform for data access PI client tools

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COLLABORATION, TEAMWORK AND INFRASTRUCTURE

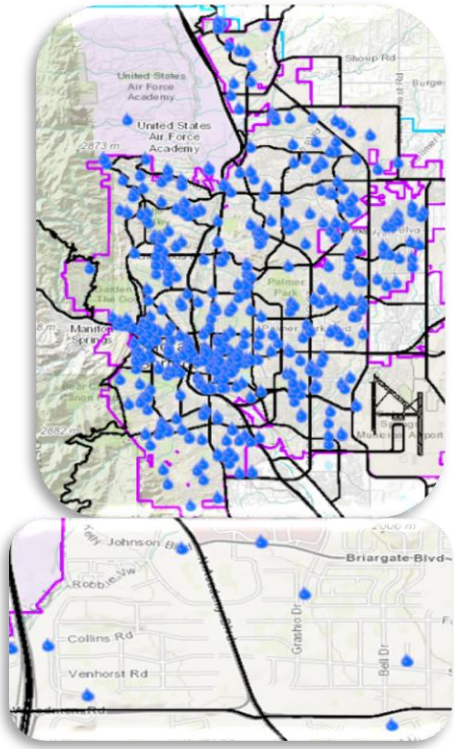
Lessons Learned

- Demonstrating the value and potential of the PI system was a challenge at first;

  However, once the benefits were realized support has been plentiful
  - We realized improved efficiencies which has led to operational cost saving
  - Can be training tool to evaluation of real-time data rather than traditional hypothetical approach
- Develop a Road Map and start with process that can easily be converted and move to more complex and labor intensive
- Maintain Momentum and continue to build upon successes
- Lastly, it is essential to foster team collaboration
  - End-users should be involved and encouraged throughout the entire process of development
  - Leverage SME's and their institutional knowledge provides a vision backed by facts and expertise

Water Quality Assurance Future Plans

- Leveraging our KPI's and improving our operational efficiencies
  - Continuous Calibration of Baselines and Benchmarks
- Discontinued Antiquated Reporting Systems
  - Improve Compliance and Process Control Reporting
  - Continued to expand data sharing opportunities
- Integrate with Esri ArcGIS
  - Visualization and spatial analytics
    - Customer service inquires and system disruptions
- Integration with Maximo
  - Asset management and Expanding PI Notifications



Special Thanks

QUESTIONS?

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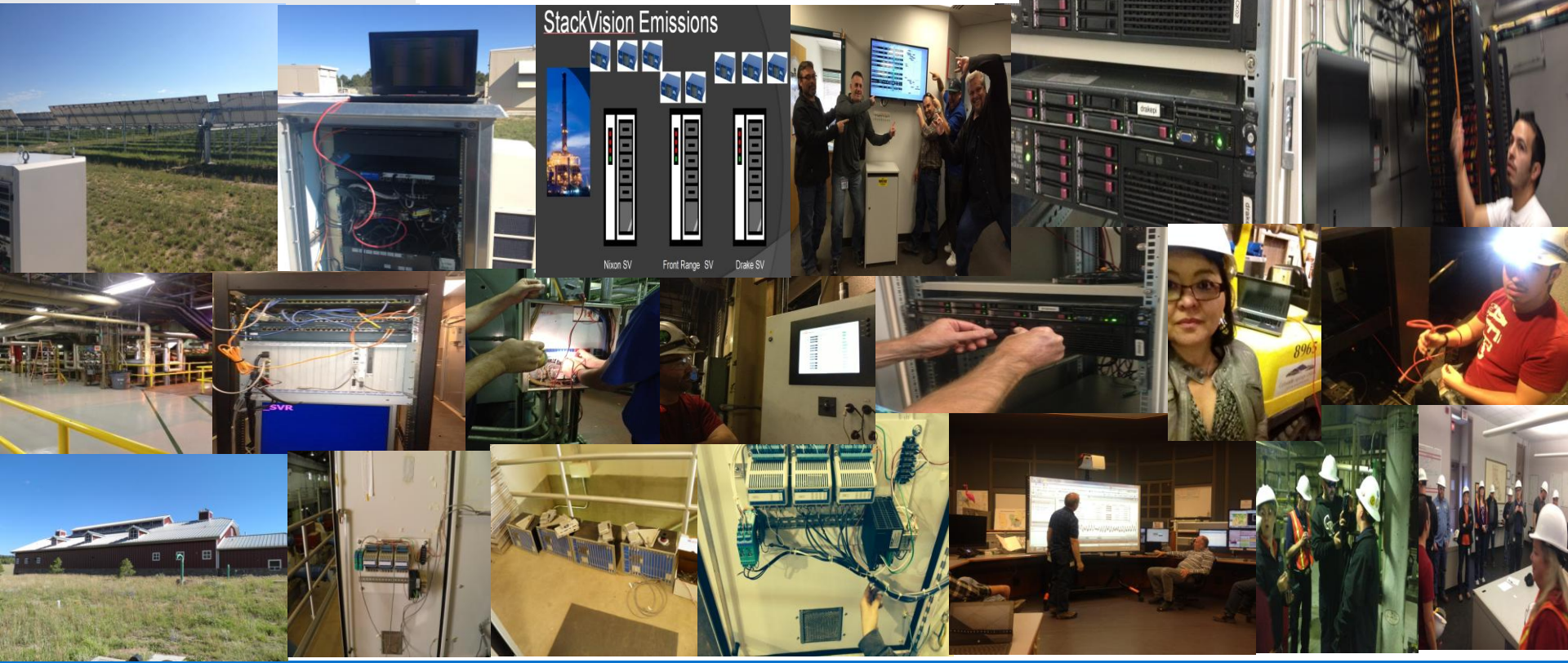

Contact Information

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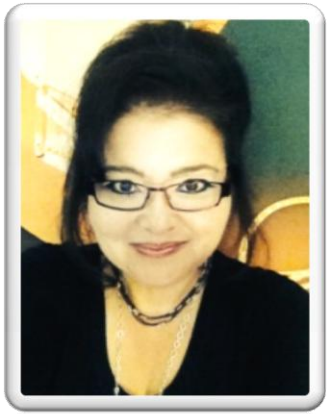

COLLABORATION, TEAMWORK AND INFRASTRUCTURE

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THANK YOU

IT IS A NOT ONLY A PI THANG BUT ALSO A TEAM THANG!