Setting the Standard for Automation™

Where your Drinking Water Comes from…

(and how it all relies on industrial automation systems)

Graham Nasby
City of Guelph Water Services
Guelph, Ontario, Canada

ISA Toronto – Annual General Meeting (AGM)
May 30, 2019 – Toronto, Ontario, Canada

About the Speaker

Graham Nasby, P.Eng., PMP, CAP
Water SCADA & Security Specialist
City of Guelph Water Services

- 10 years in the consulting sector
- Joined Guelph Water Services in 2015

- Vice-President of Industries & Sciences in ISA
- Co-chair of ISA112 SCADA Systems standards committee
- Voting member of ISA101 HMI Design and ISA18 Alarm Management standards committees
- Named Canadian Expert on IEC/SCC-TC65 with Standards Council of Canada
- Active member of American Water Works Association and Water Environment Federation
- WebMaster for ISA Hamilton Section

- Has published over 40 papers and articles on automation topics
- Received University of Guelph “Mid Career Achievement Award” in 2014
- Named ISA’s technical division leader of the year award in 2013.

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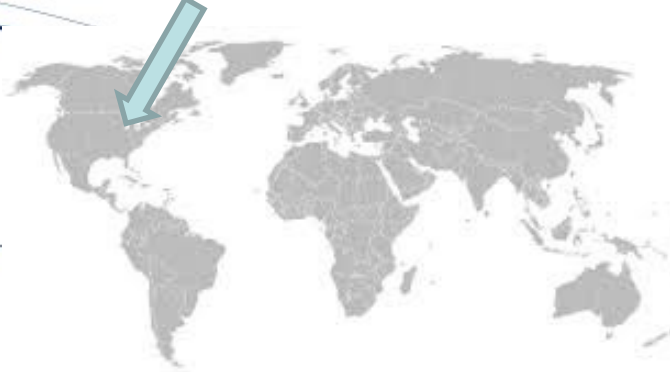
Presentation Outline

- About Guelph Water Services
- Components of a Municipal Water System
- Operational Framework
- Managing a Drinking Water System

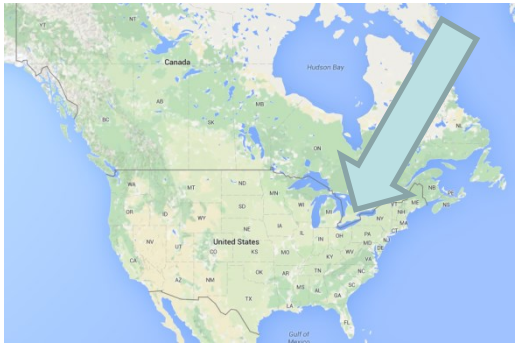
- Water Sources
- Water Treatment
- Water Distribution

- Municipal Water SCADA Systems
- Components of a typical SCADA System

City of Guelph Water Services

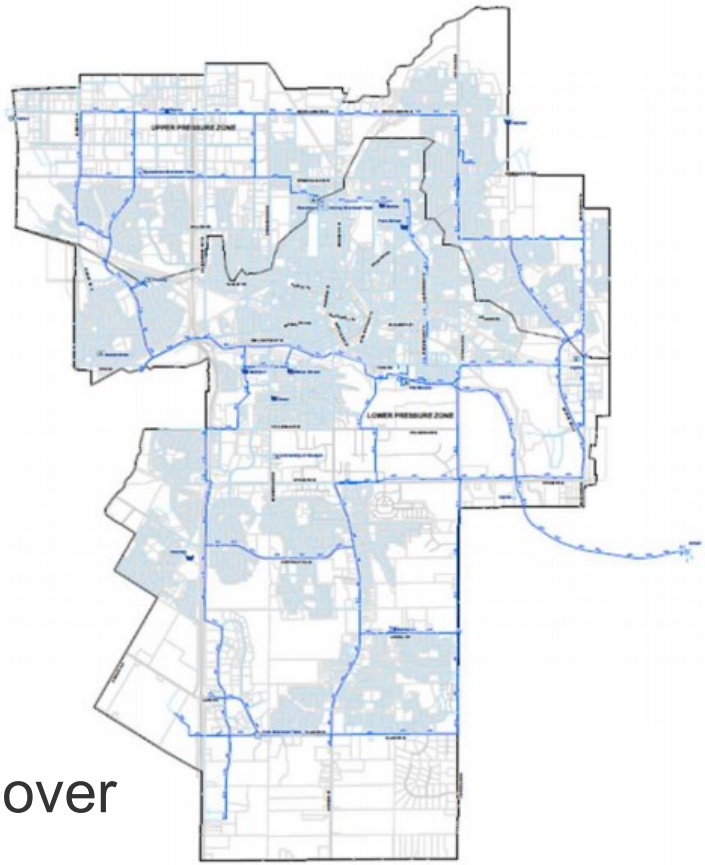


- Guelph, Ontario, Canada
- 140,000 residents
- 21 groundwater wells
- 3 water towers
- 549 km of water mains
- 49,000 service connections
- 2,750 fire hydrants
- 46,000 m^3/day [12 MGD]



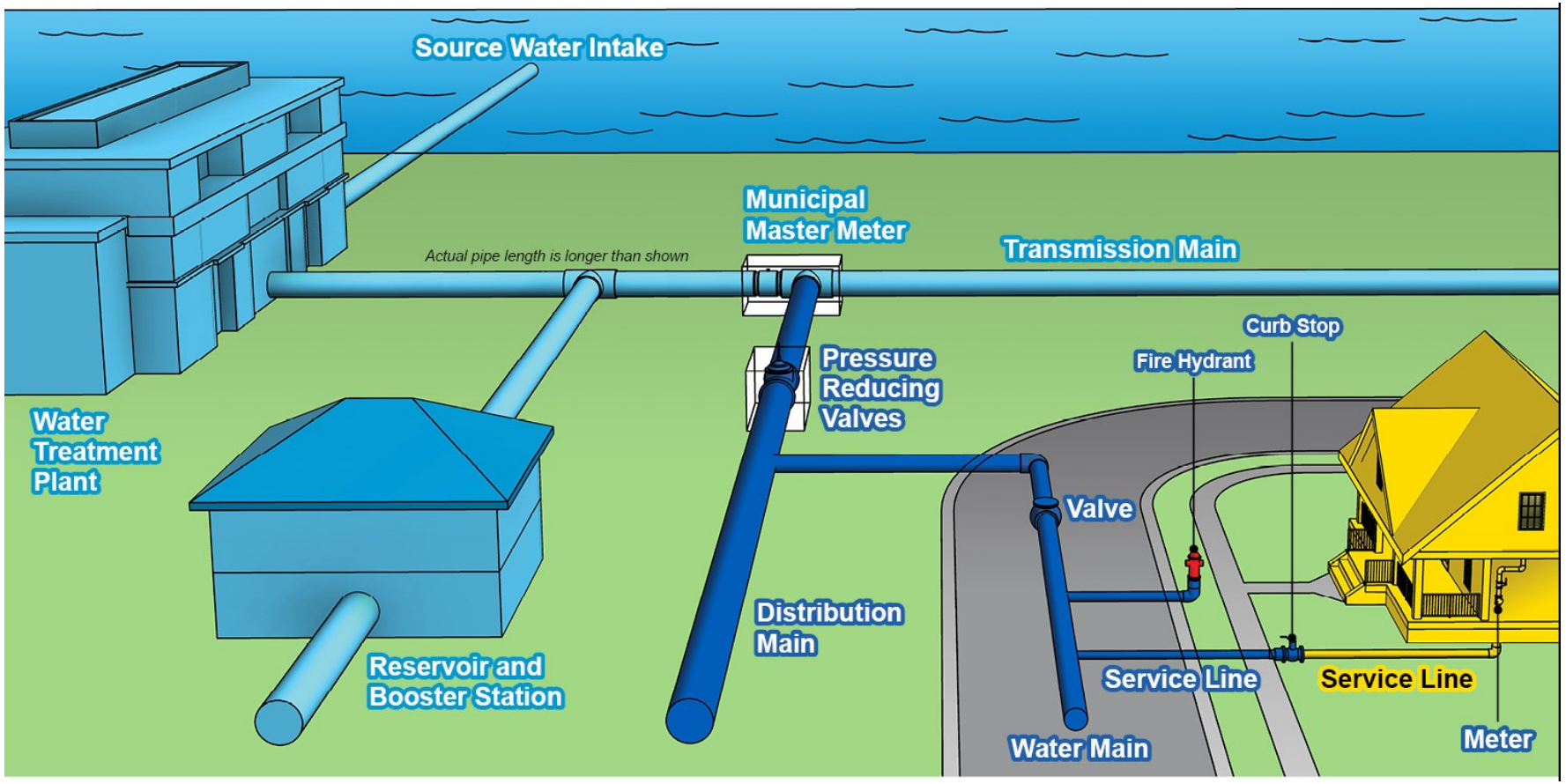
Guelph Water Facilities

- Approx. 15km x 15km (10mi x 10mi)
- 35 Facilities
  - 4 booster stations
  - 21 wells
  - 2 valve chambers
  - 3 water towers
  - 5 monitoring sites
- High availability SCADA network
  - Primary: private fibre optic
  - Secondary: private wireless, auto-failover
- 40 PLCs plus 2 data centers

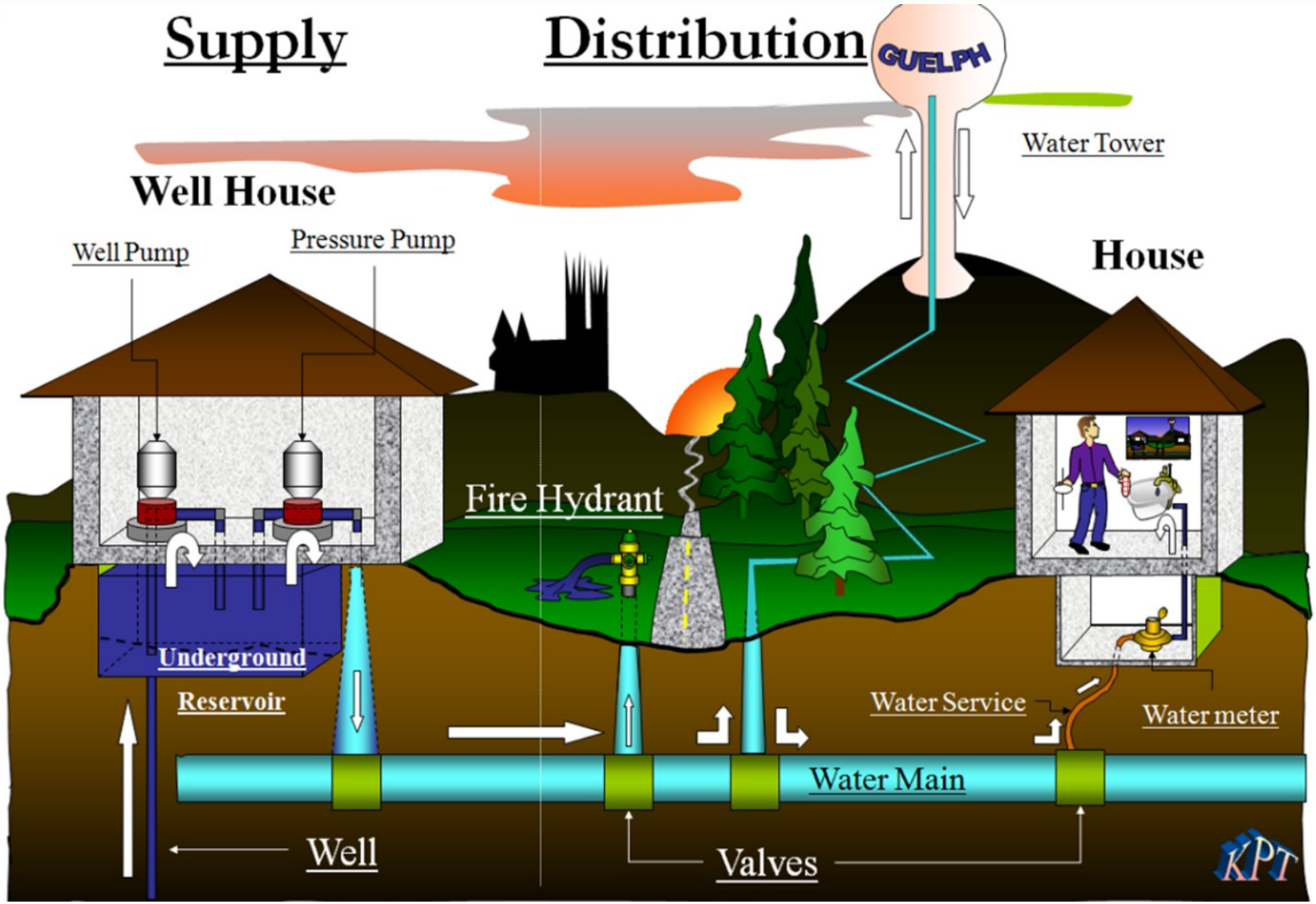


Introduction

Typical Surface Water System

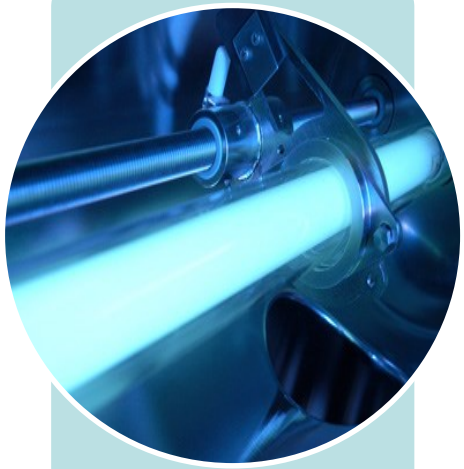


Typical Groundwater System



Components of a Drinking Water System

Supply & Source Protection

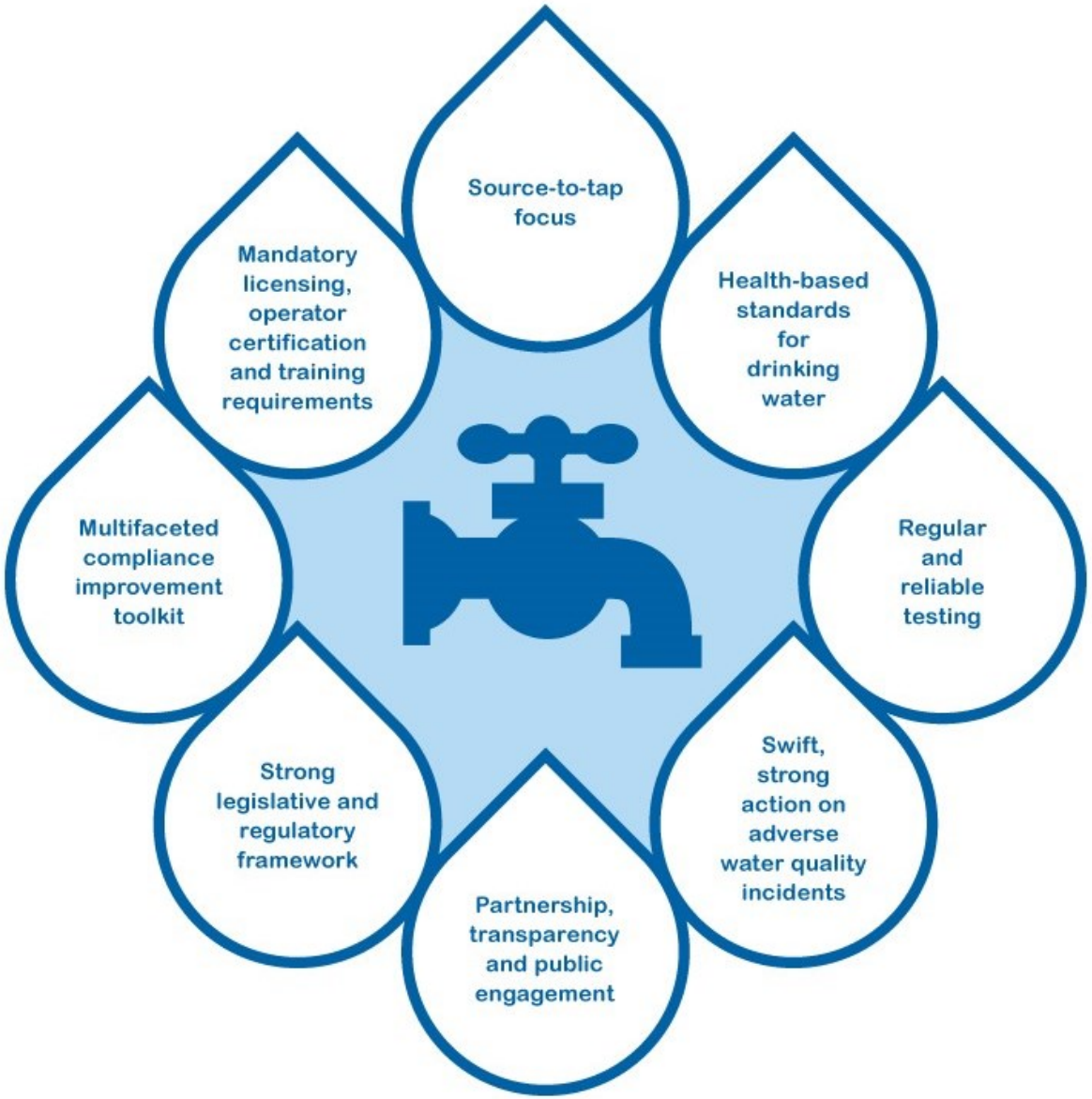


Treatment

Distribution

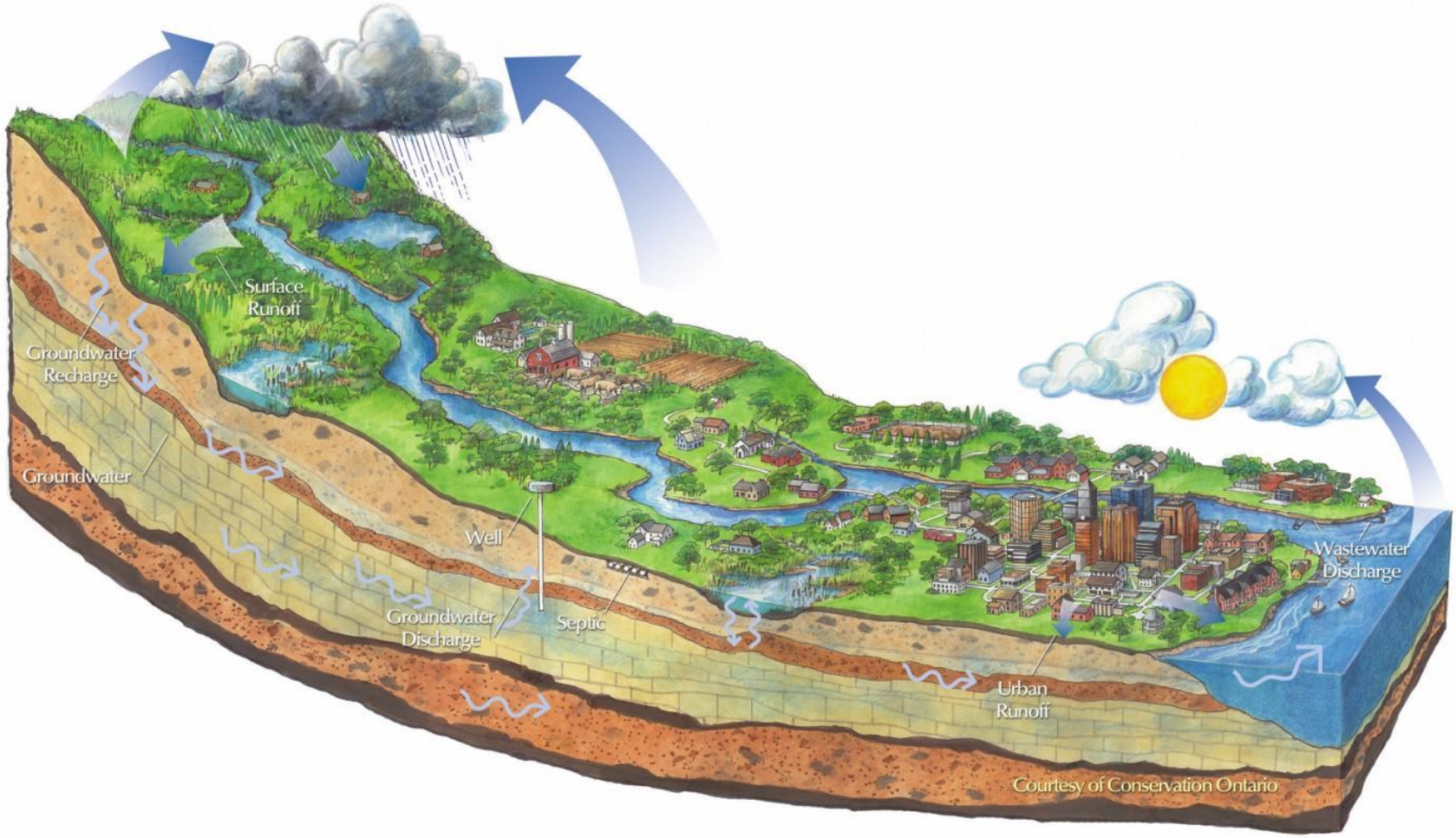
Water Use & Conservation

Operational Framework



Source Water

Water Cycle


Surface Runoff
Groundwater Recharge
Groundwater
Well
Groundwater Discharge
Septic
Urban Runoff
Wastewater Discharge
Courtesy of Conservation Ontario

Source Water
Surface Water – A Typical Watershed

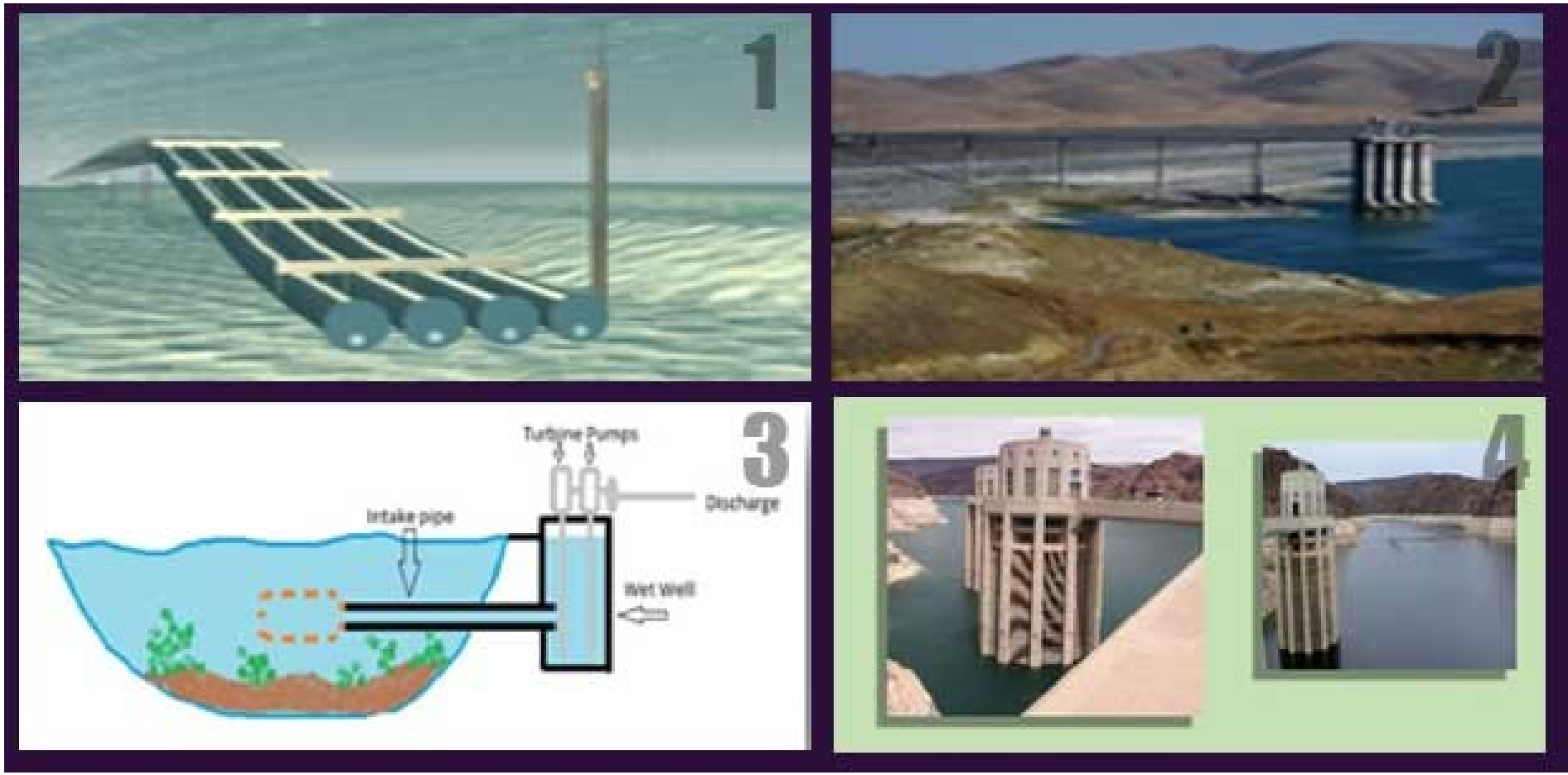
Surface Water
River Source

Surface Water
River Source

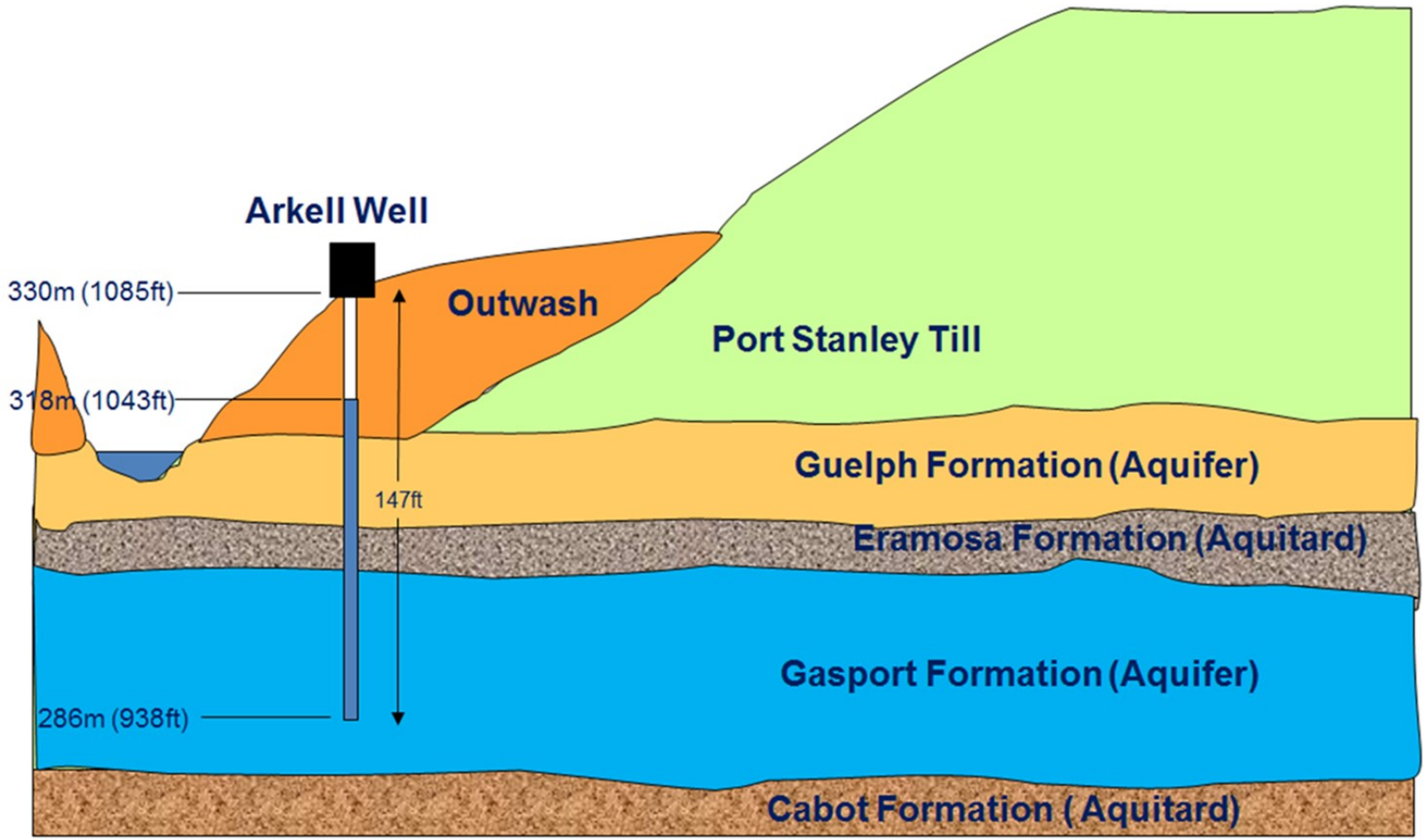
Surface Water
Lake Source

Surface Water
Lake Source

Intake Structures for a Surface Water Source



Ground Water Source Example

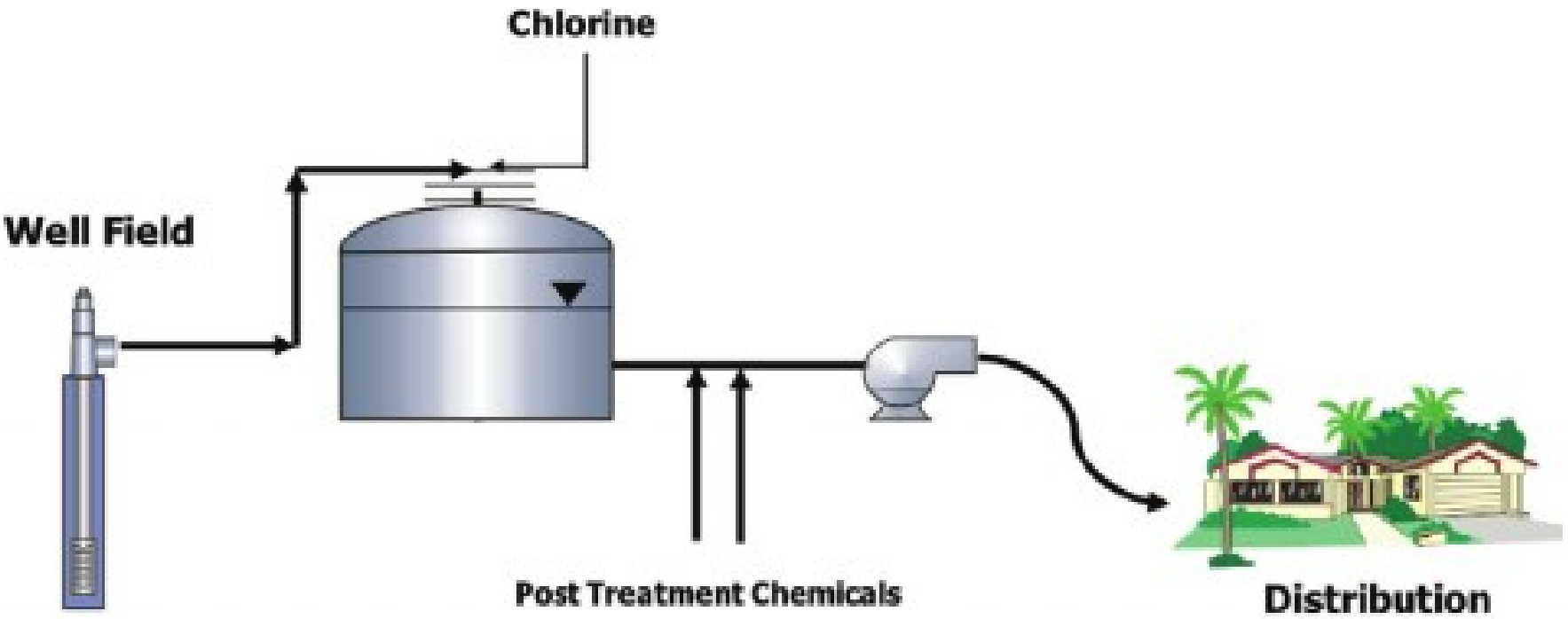


Groundwater – Typical Well Pumps

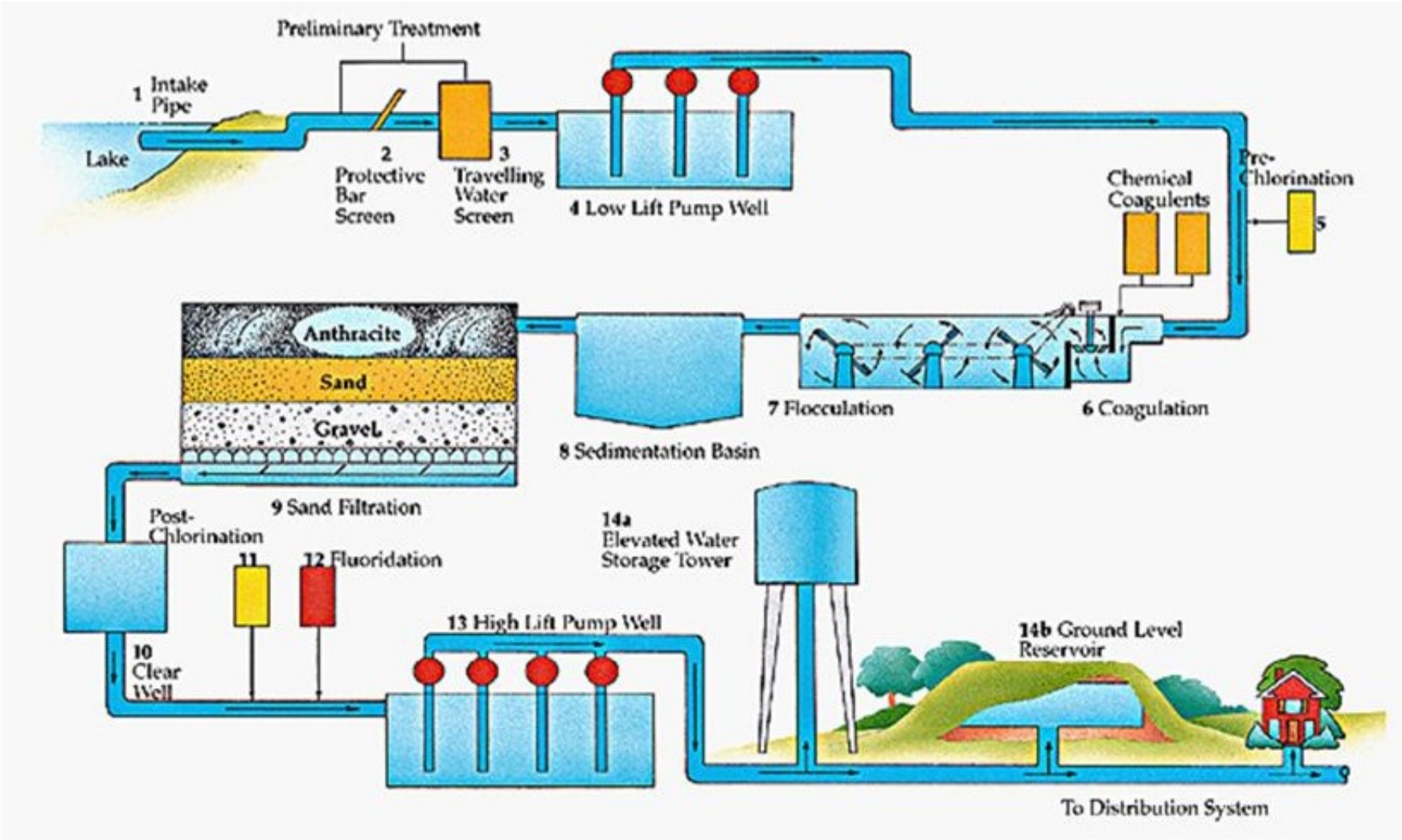
Groundwater Recharge System

Water Treatment

Ground Water Treatment

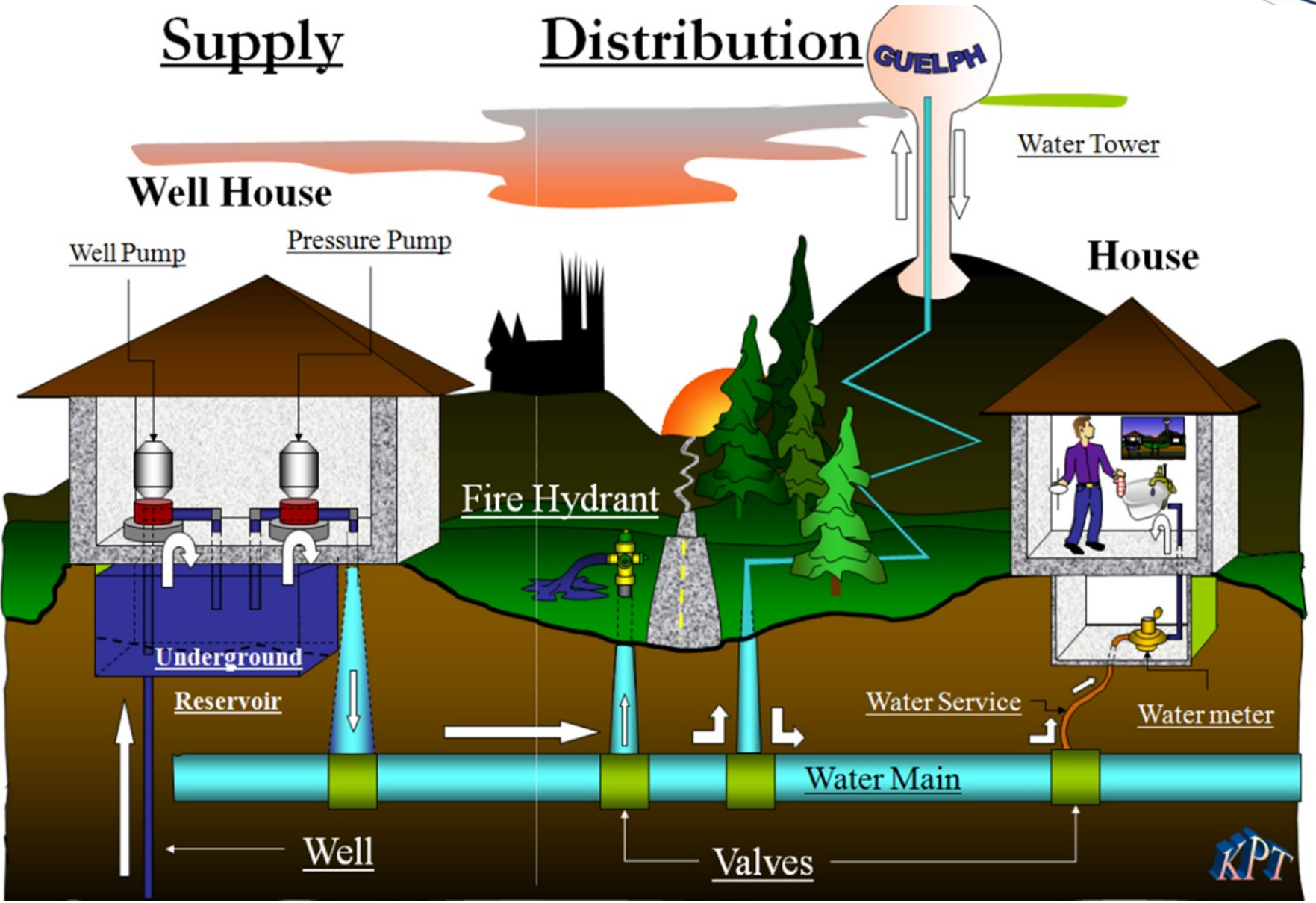


Surface Water Treatment (Conventional Filter Plant)

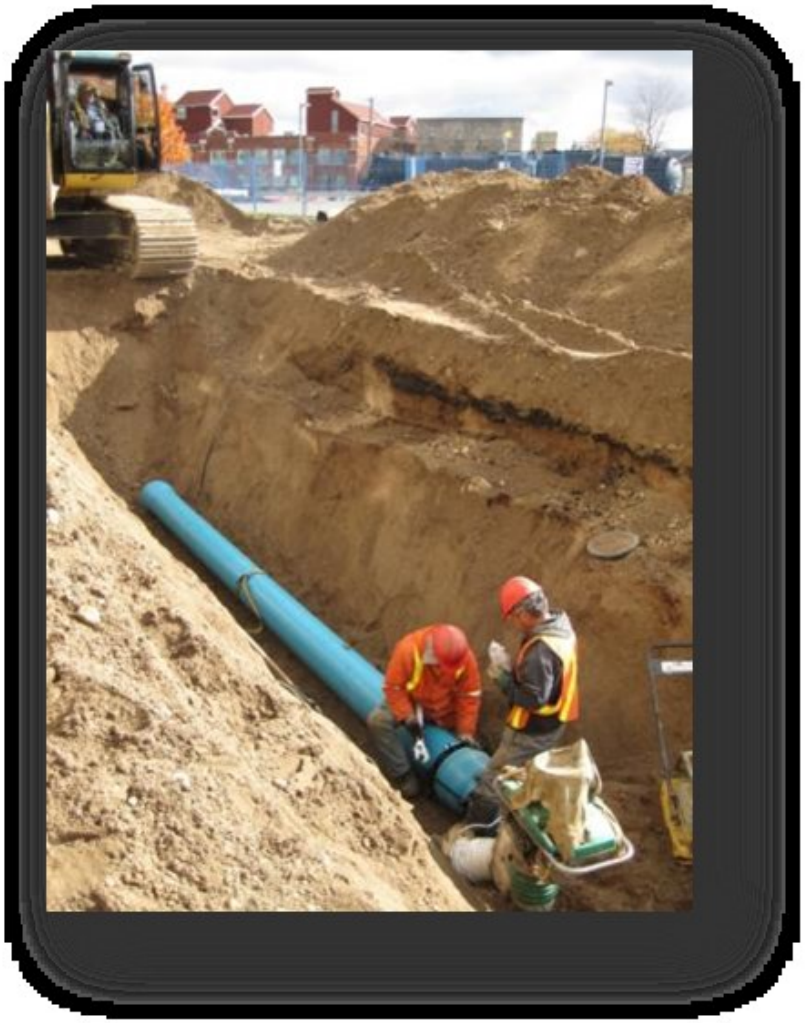


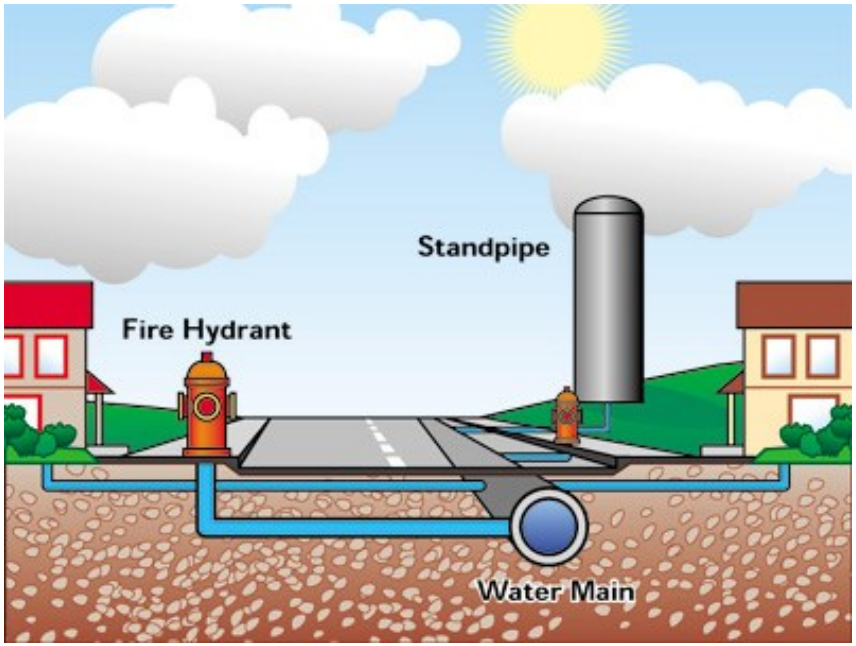
Water Distribution

Water Distribution Systems



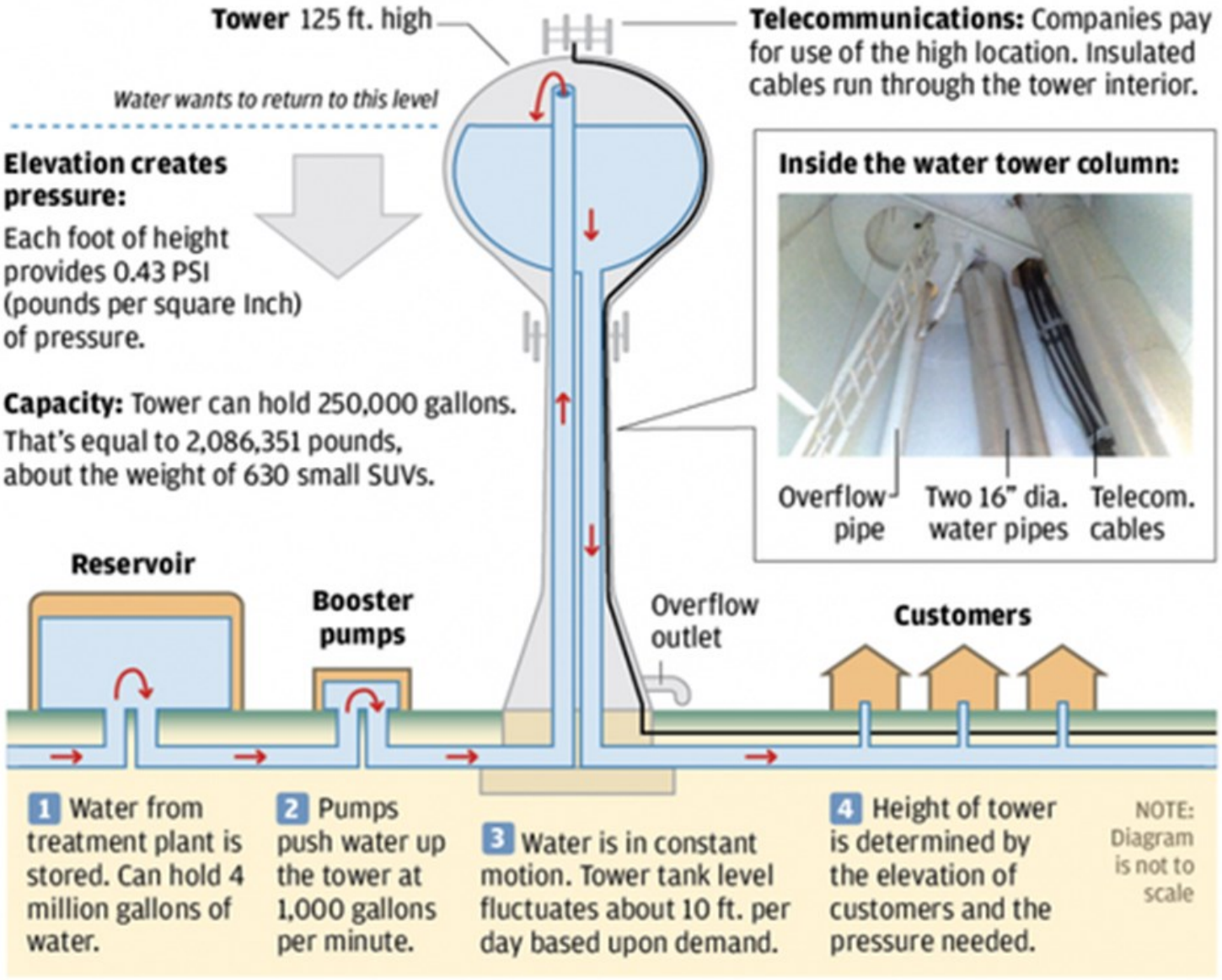
Water Distribution





Water Towers

HOW A WATER TOWER WORKS



Watermain Repairs

Automated Control Systems at Water Facilities

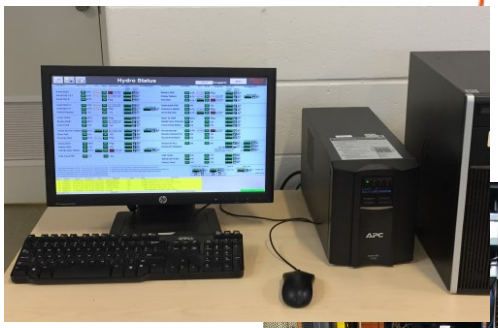
Called “SCADA” in the Water sector
(SCADA = Supervisory Control and Data Acquisition)

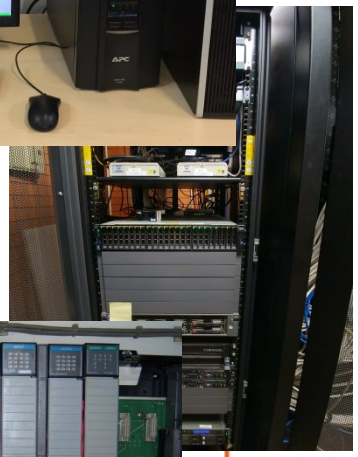
What is SCADA?

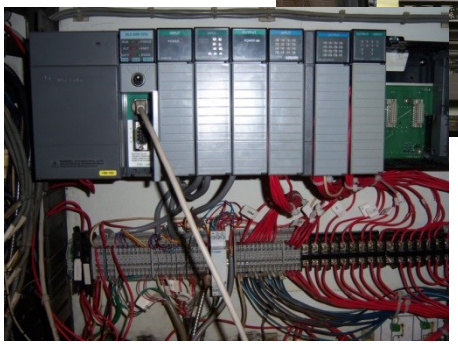
SCADA = Supervisory Control and Data Acquisition

Not SCADA

Typical SCADA Architecture







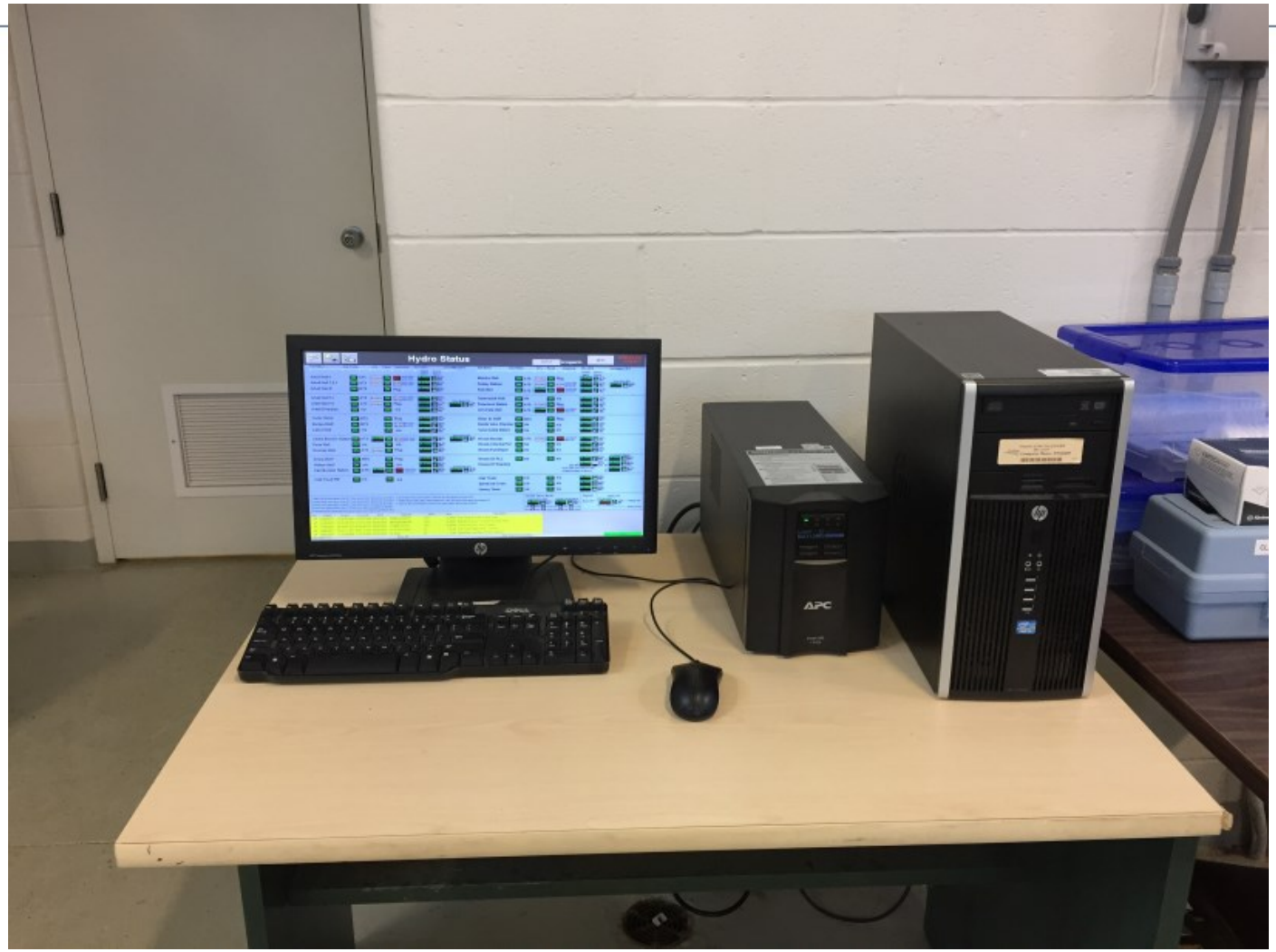
SCADA View Terminals
SCADA View Terminals
SCADA network
SCADA Servers
SCADA Reporting Servers
SCADA Servers
SCADA network
SCADA Control Panels
SCADA Control Panels
Field Wiring
Motor Control Centres (MCCs)
Pumps
Blowers
Control Devices
Flow
Analyzer
Level
Instruments
Valves
Packaged Equipment
Control Devices
Field Devices

Why we have SCADA systems

- Unattended automatic control of water facilities
- Logging of critical control parameters
  - Chlorine Residuals (e.g., every 5 minutes)
  - Turbidity
  - Well Flow Rates & Daily Flow Totals
  - POE Flow Rates & Daily flow Totals
  - Tower Levels & Pressure

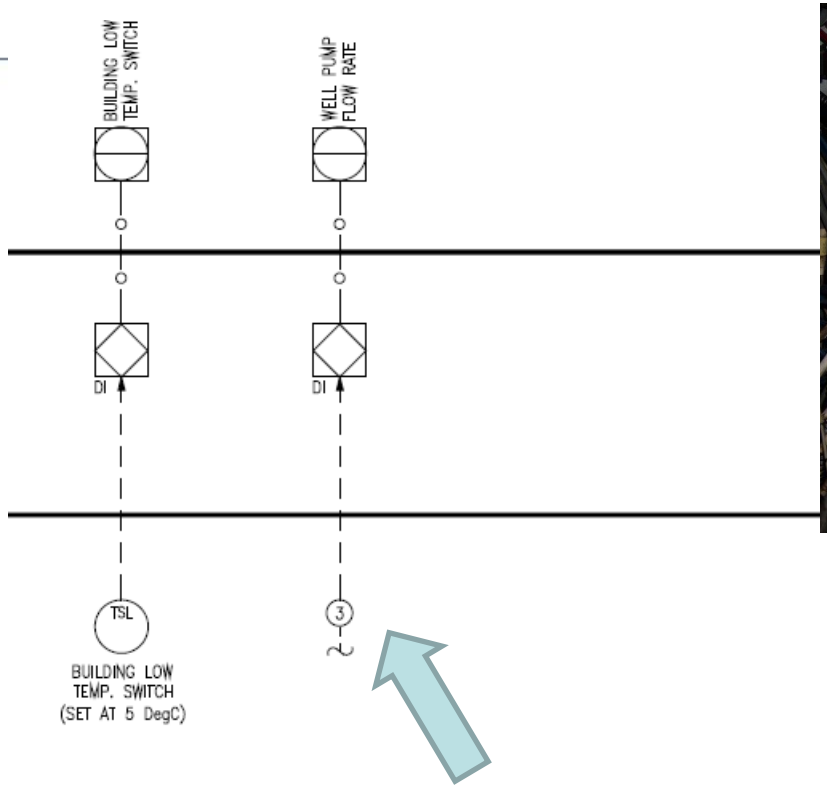
- Provides “visualization” of water facilities to Operators
- Enables remote monitoring and control by Operators
- Triggering and Annunciation of Alarms
- Automated responses (increase chlorine dose, shutdown, etc.)
- Reporting based on logged process data

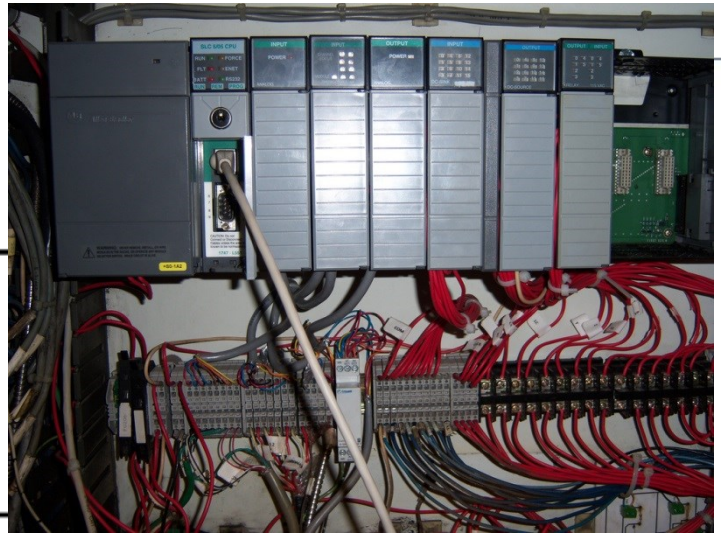
SCADA View Terminal

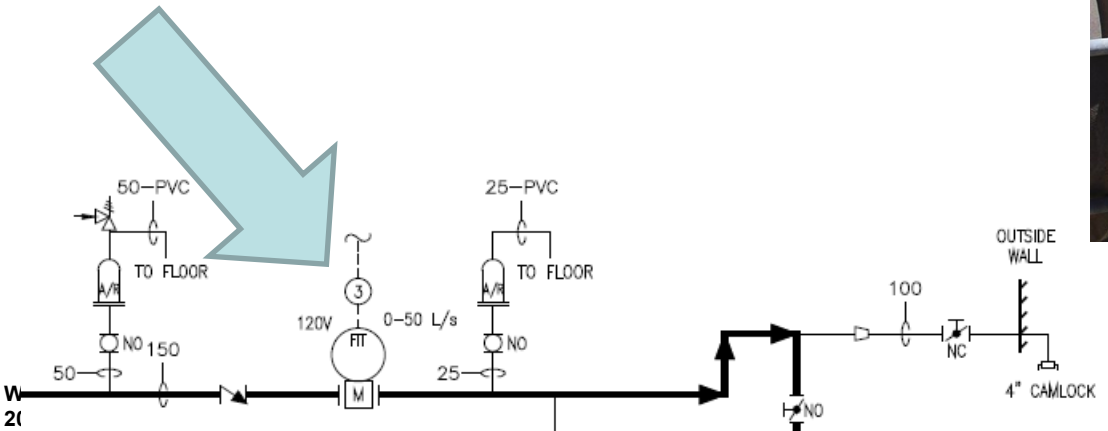


More Heavily Used SCADA View Terminals

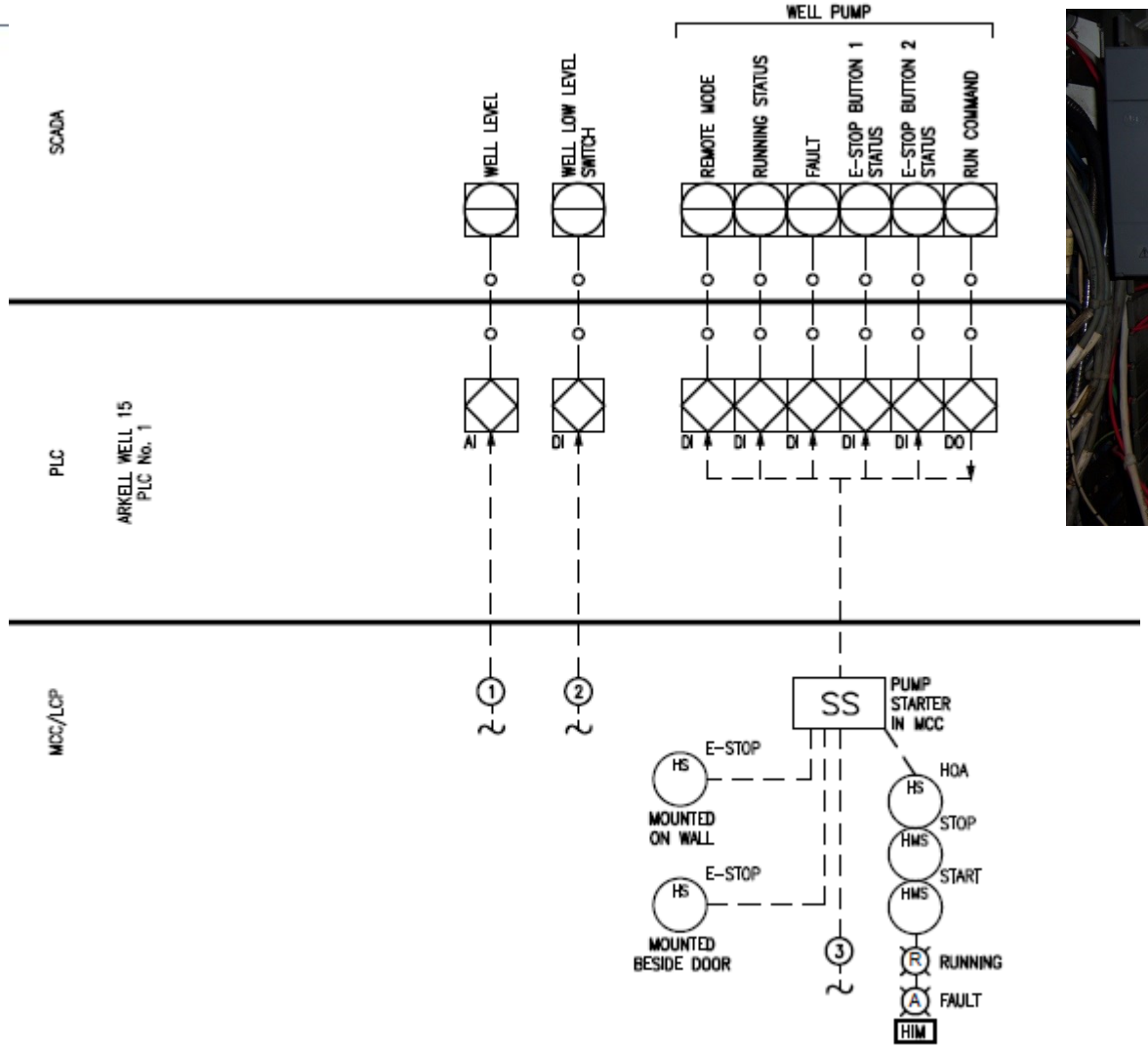
I/O Level - Instrumentation

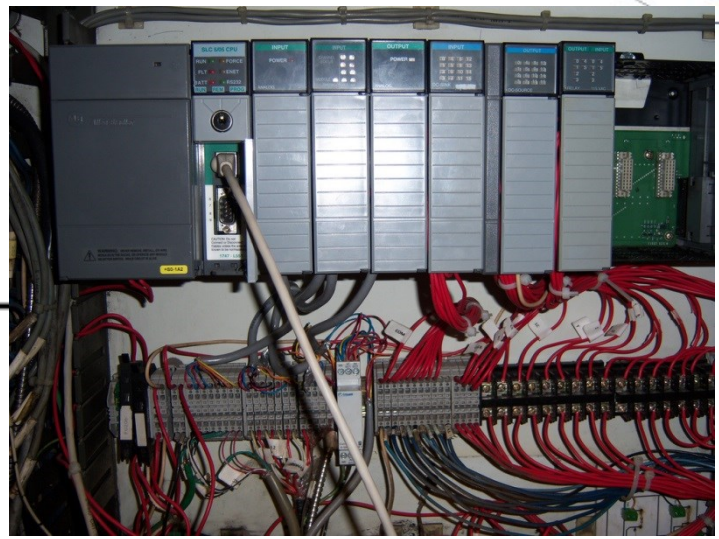




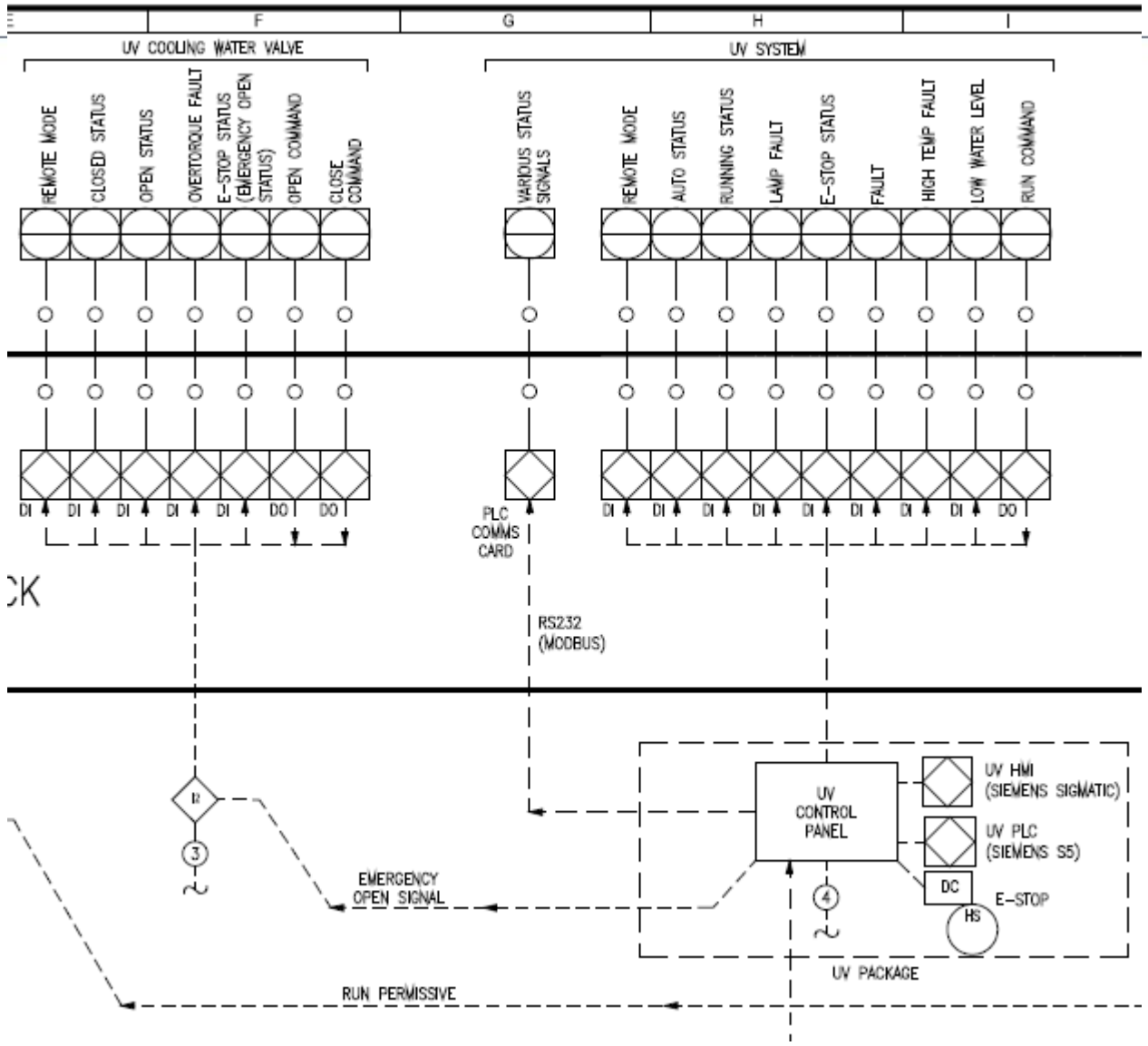


I/O Level - Pumps



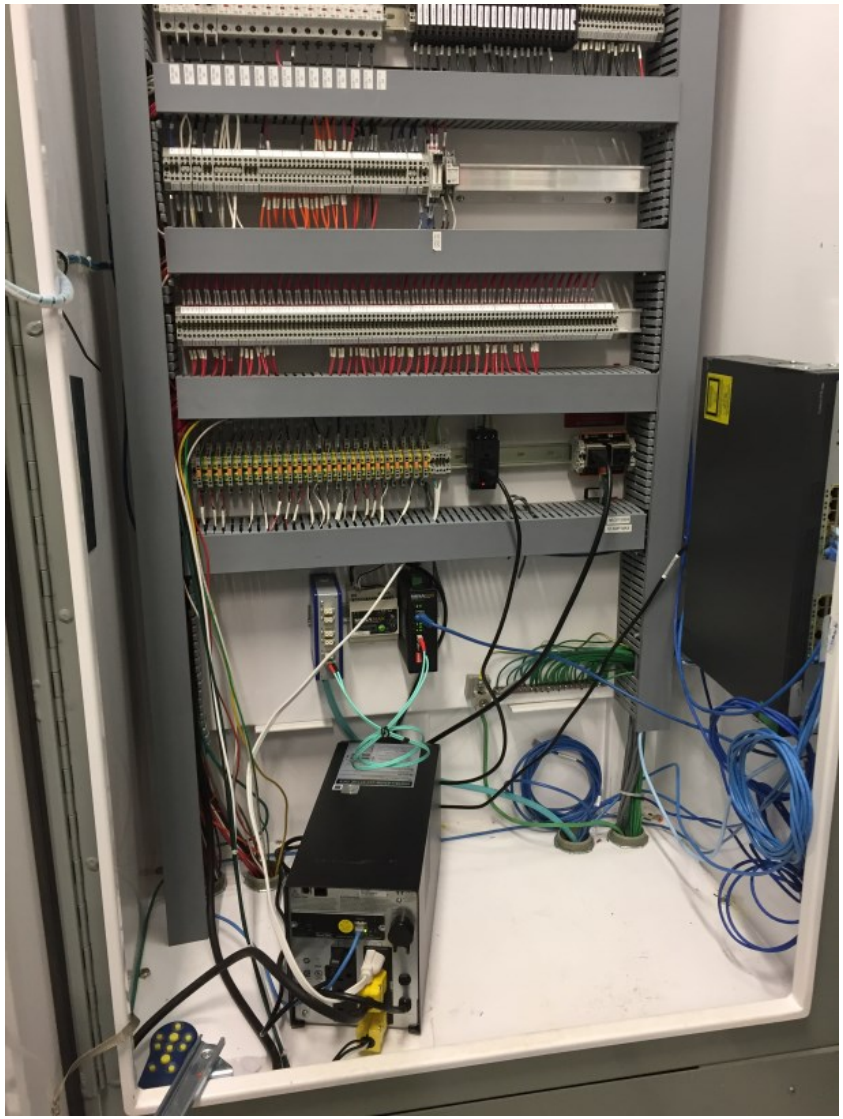


I/O Level – a more complicated example

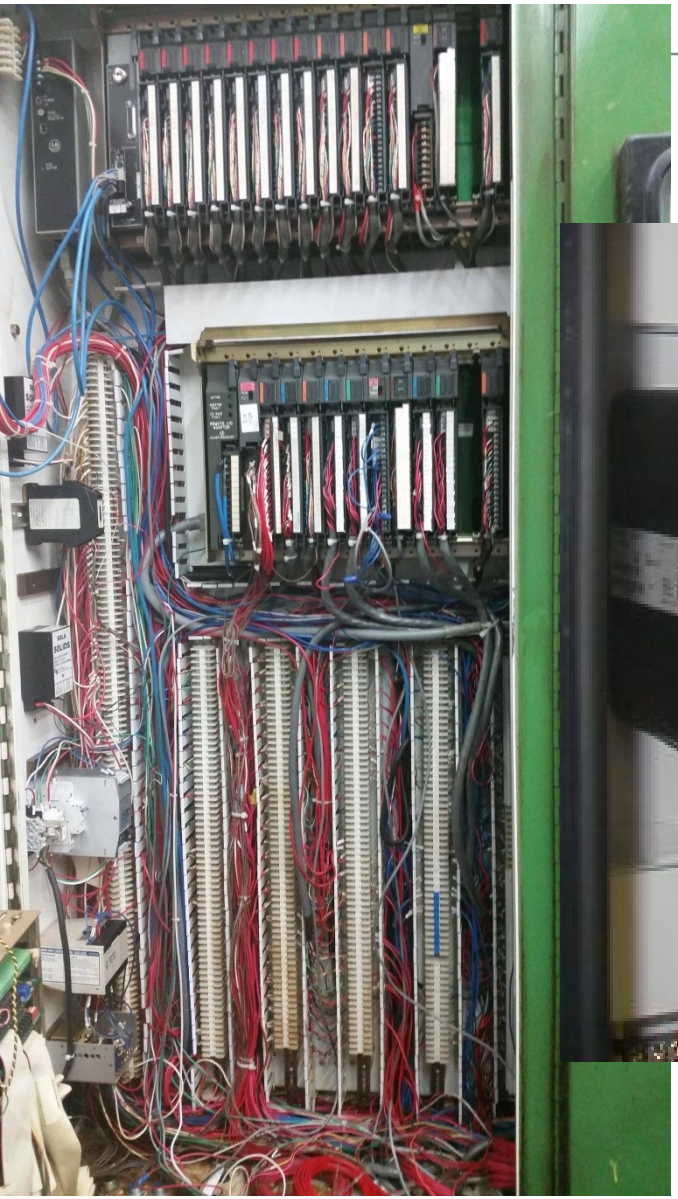


UV Reactor

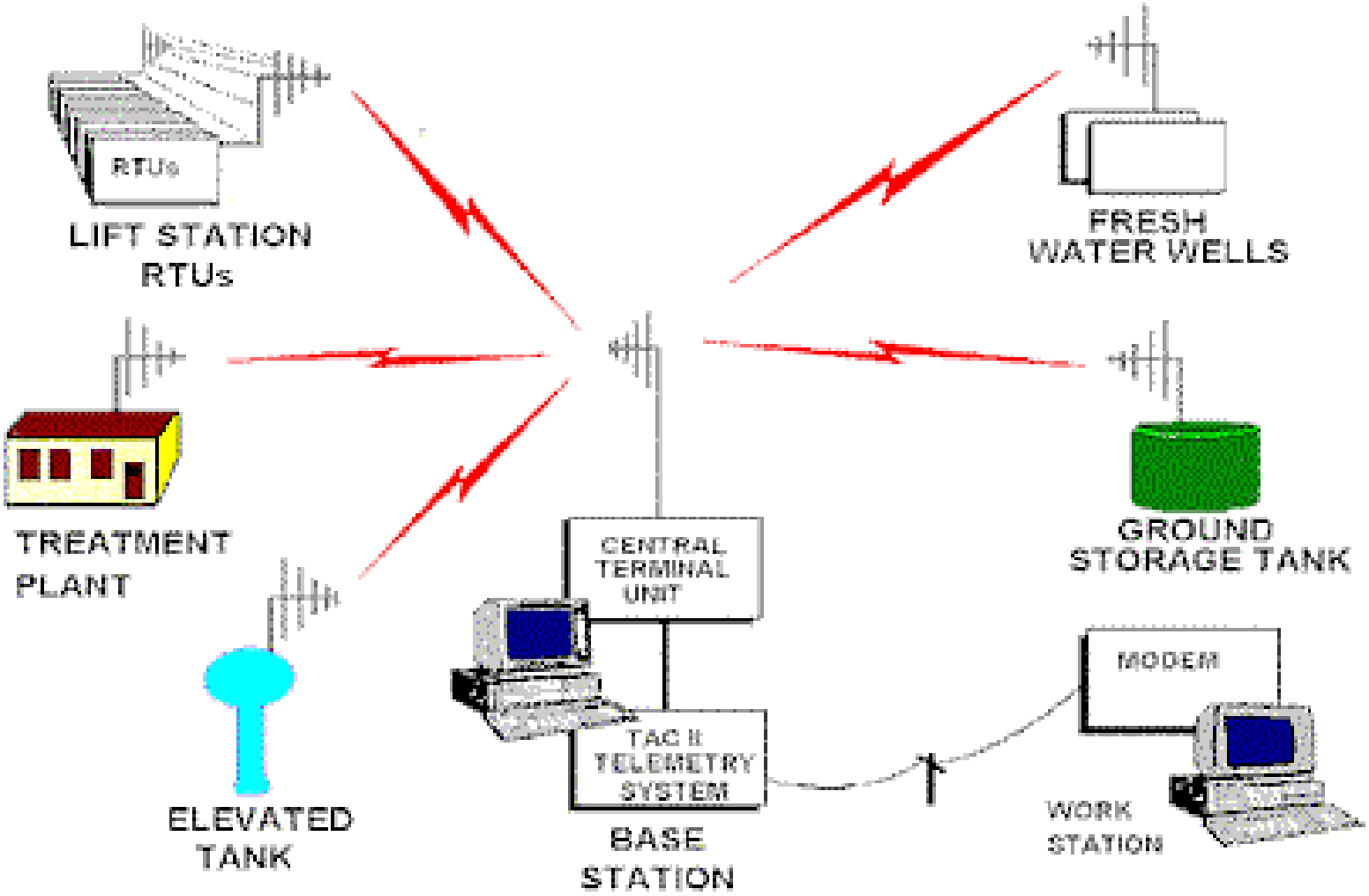
PLC Control Panels



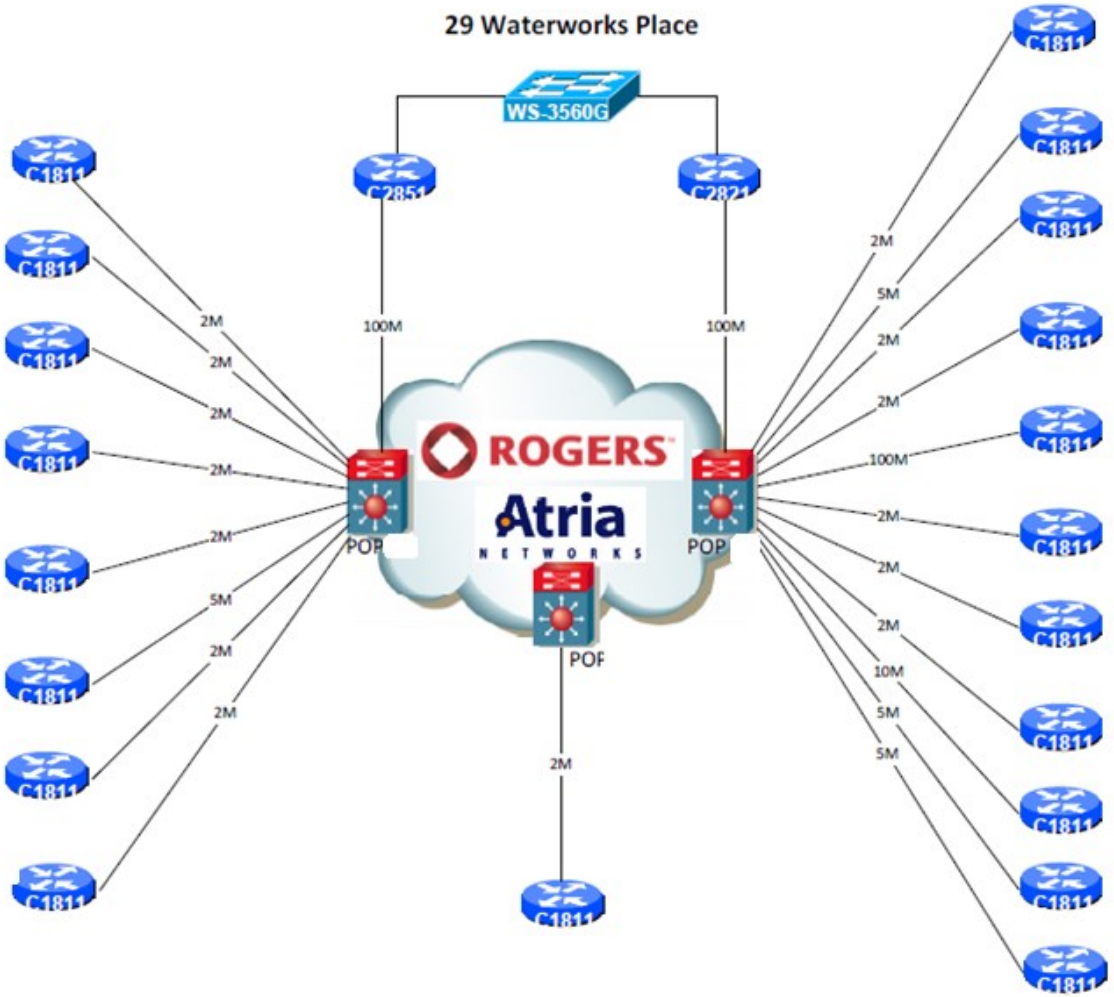
PLCs – Old and New Technology



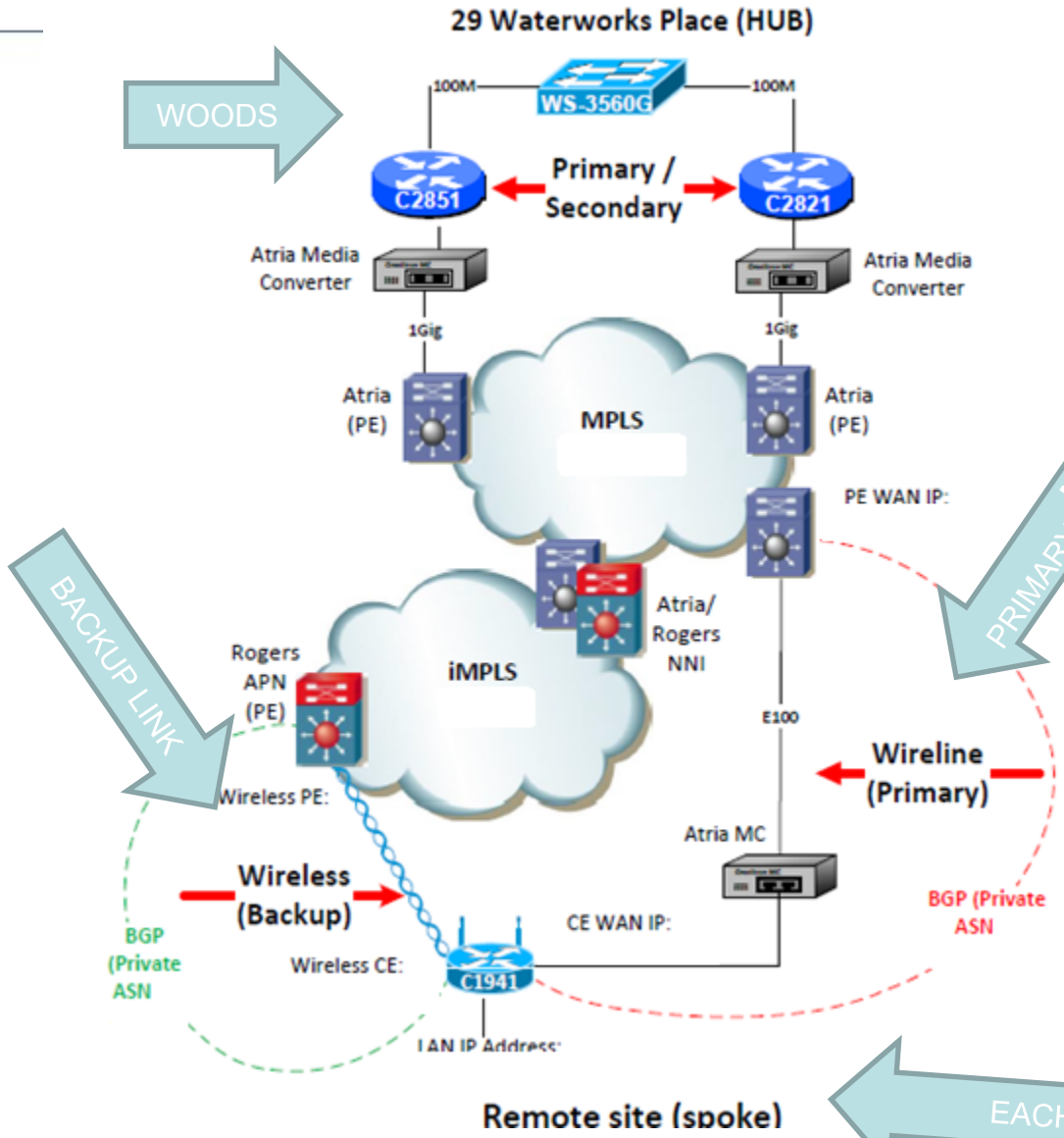
SCADA Network



SCADA Network (Fibre optic example)



Example: Guelph Water SCADA Network
Fibre-topic network with automatic fail-over to Wireless backup



Main site objectives:

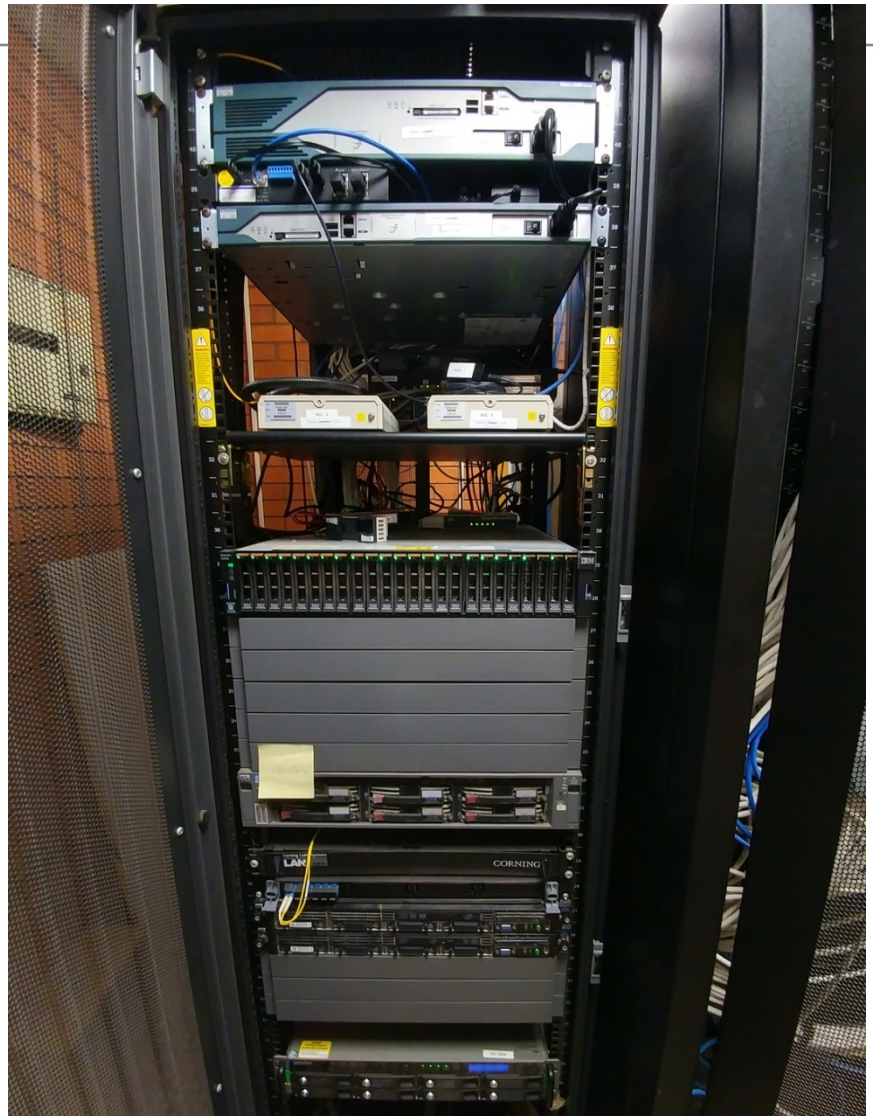
- Maintain status quo with existing Primary / Secondary (standby) routers (no config. changes)
- Both Primary and Secondary routers will continue to handle traffic via existing Atria MPLS network
- Rogers will extend a connection from Atria network to Rogers EON network via a new inter-as bridge specific to the customer's VRF
- Both Primary / Secondary routers will communicate to new Wireless backup accesses over this bridge via the existing Atria MPLS network over BGP

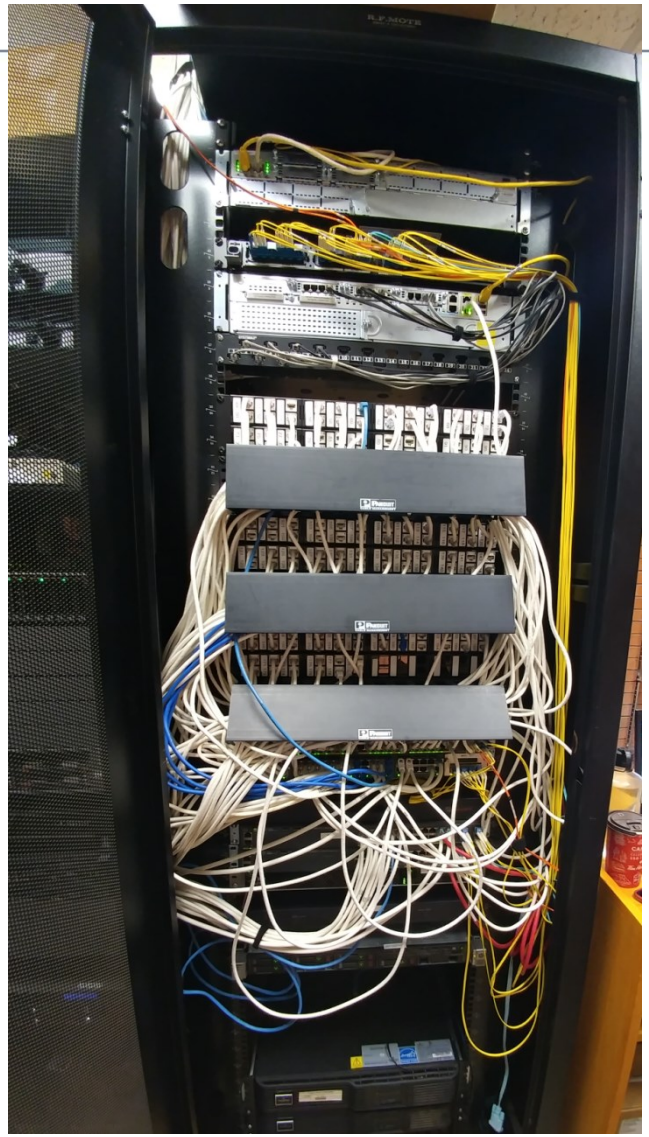
Remote sites objectives:

- Maintain current Atria access via Fiber/MC
- Replace current Atria Router with a Rogers Managed Cisco 1941 router w/HSPA+ wireless backup module & antenna
- Rogers will build a new MPLS customer VRF on the EON platform and inter-connect this with the Atria MPLS customer VRF
- Wireless backup will be via Rogers EON network back to Atria MPLS via inter-as bridge
- Wireline primary access will be direct from 1941 to Atria MPLS core via BGP
- Wireless will use AS Prepend inbound and local pref outbound for Wireline
- Assumptions:

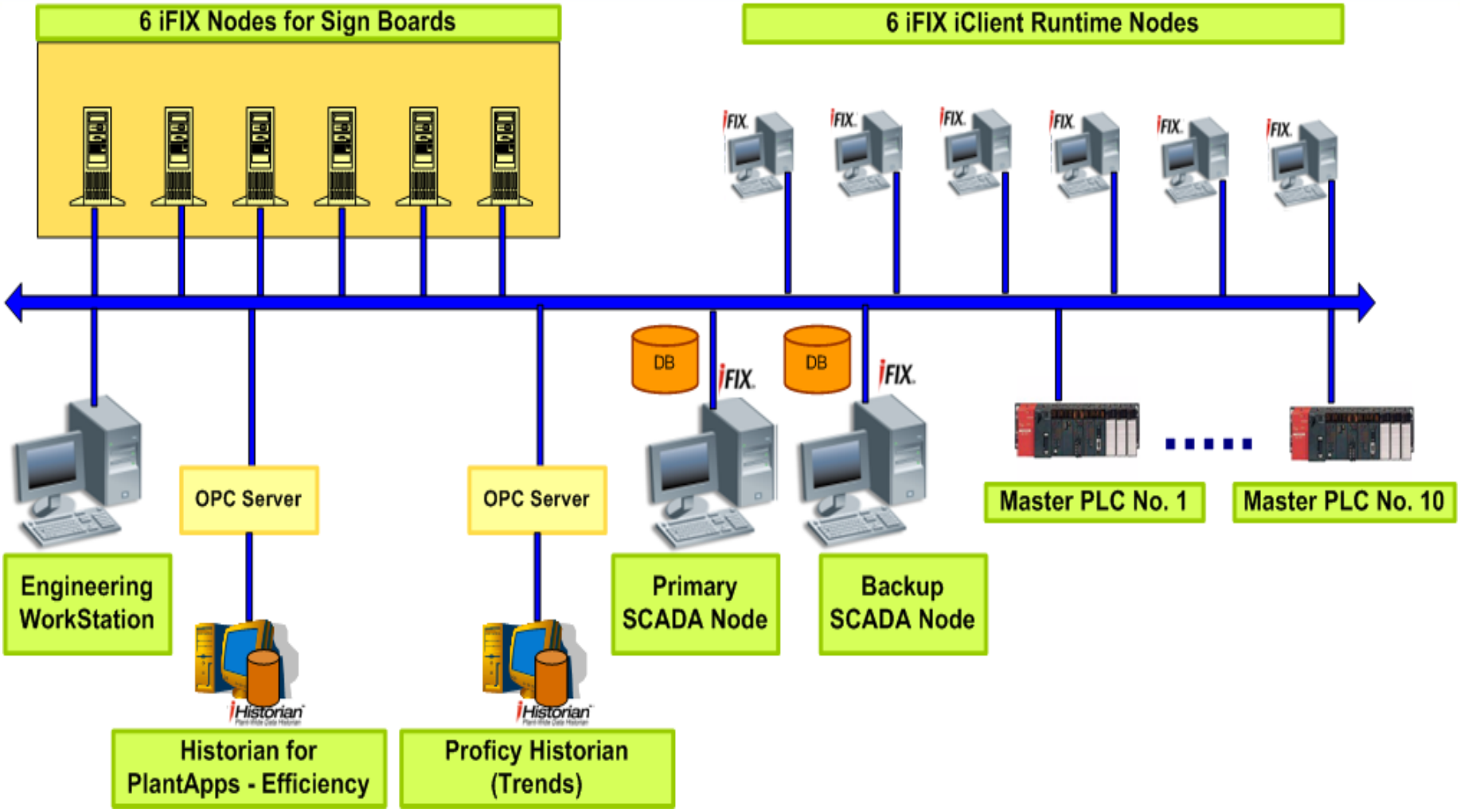
1. Private AS different from Host AS (no AS-Override Required)
2. Hub and Spoke will be maintained and each spoke will re-use the same Private-As (not

SCADA Servers

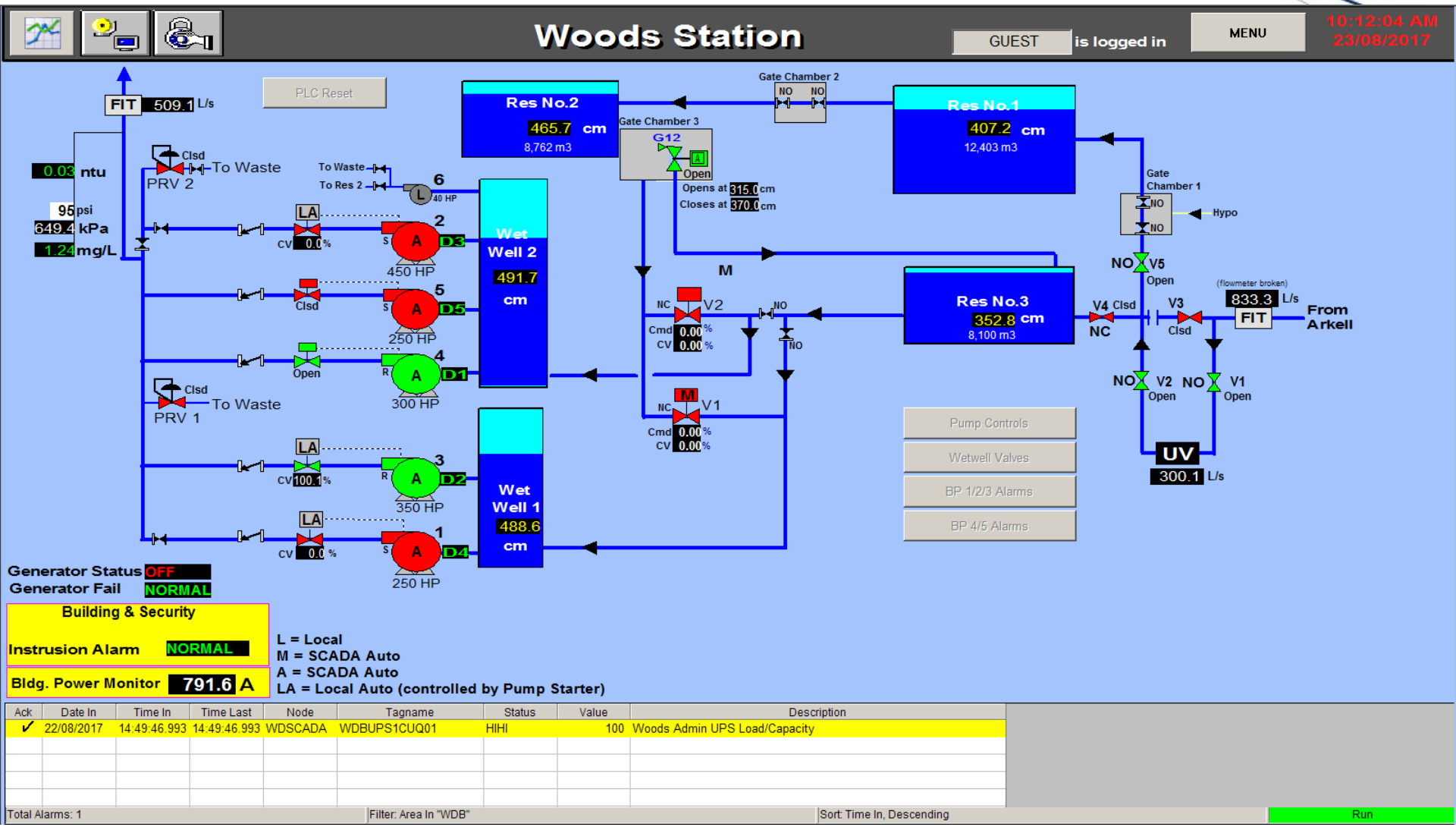




SCADA Servers - Example

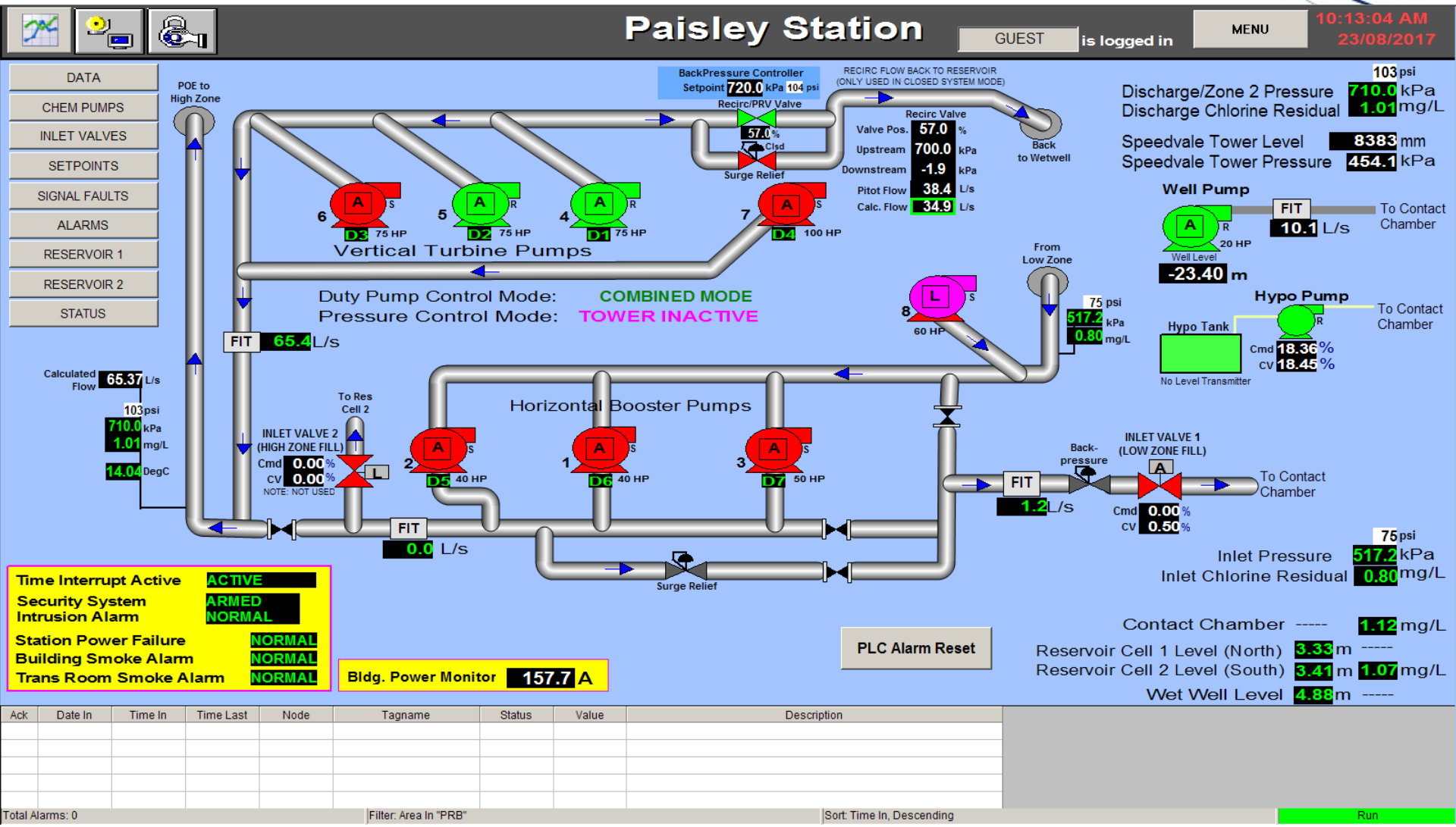


SCADA Screens



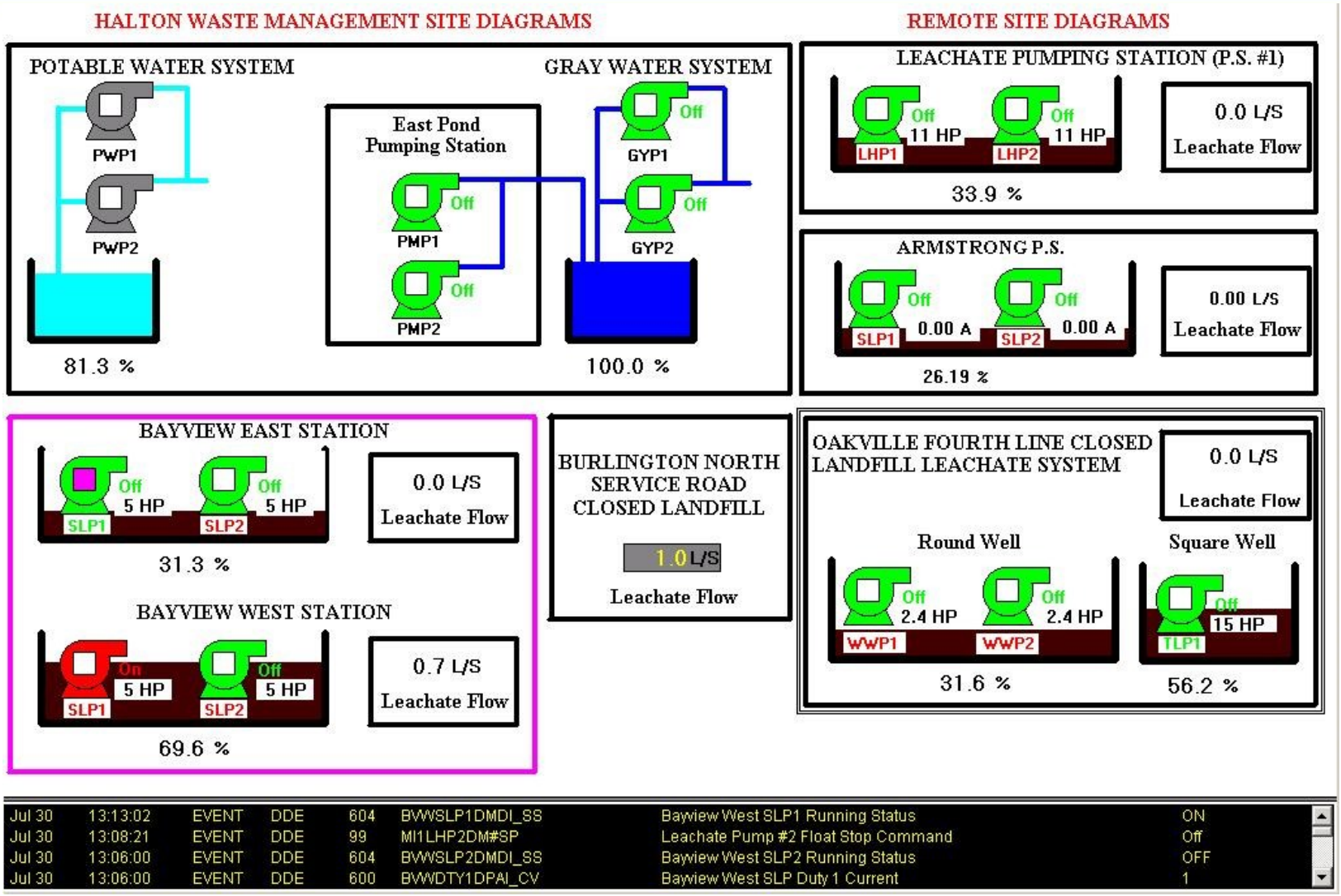
HMI = Human Machine Interface

SCADA Screens

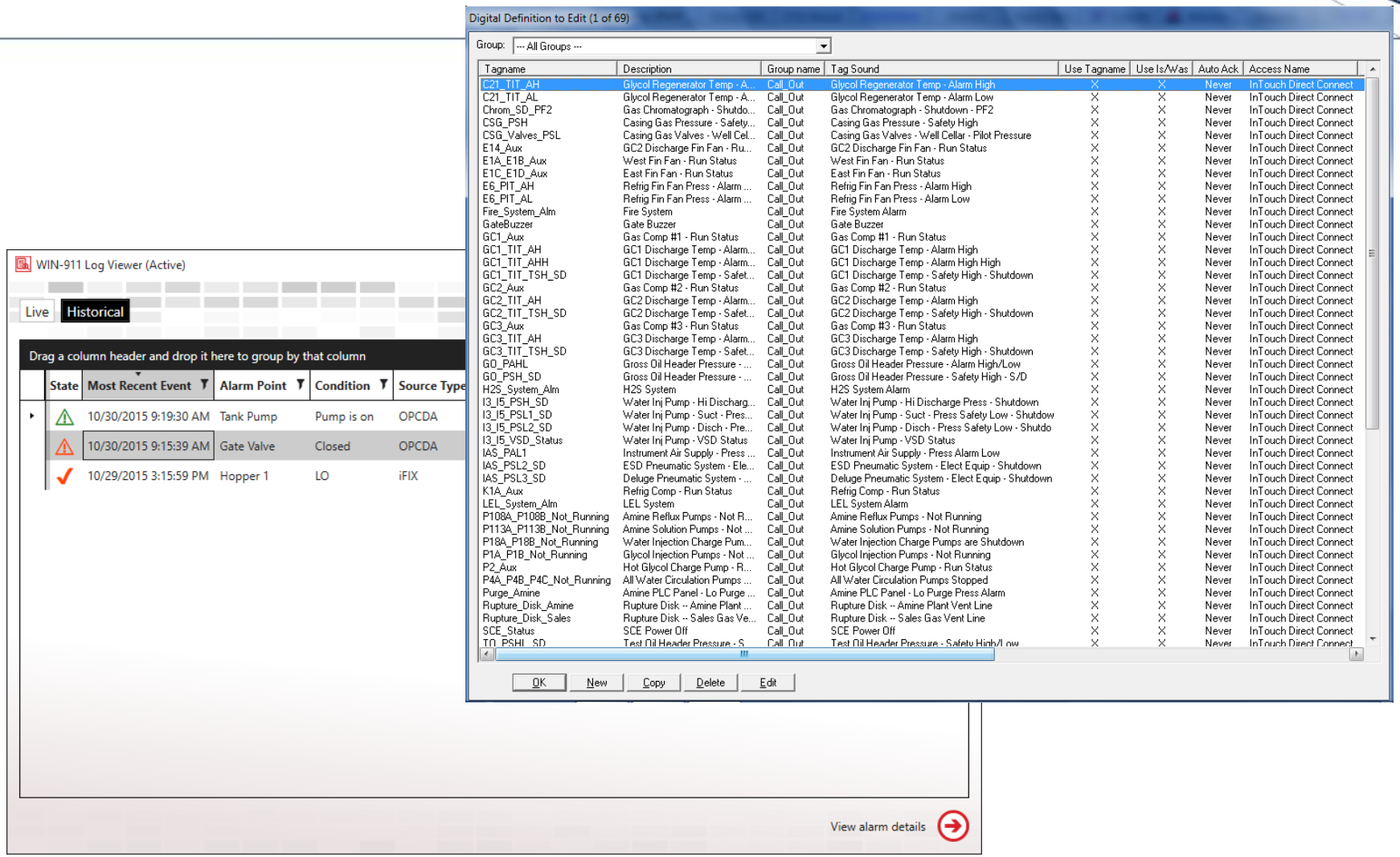


HMI = Human Machine Interface

Screens – another example

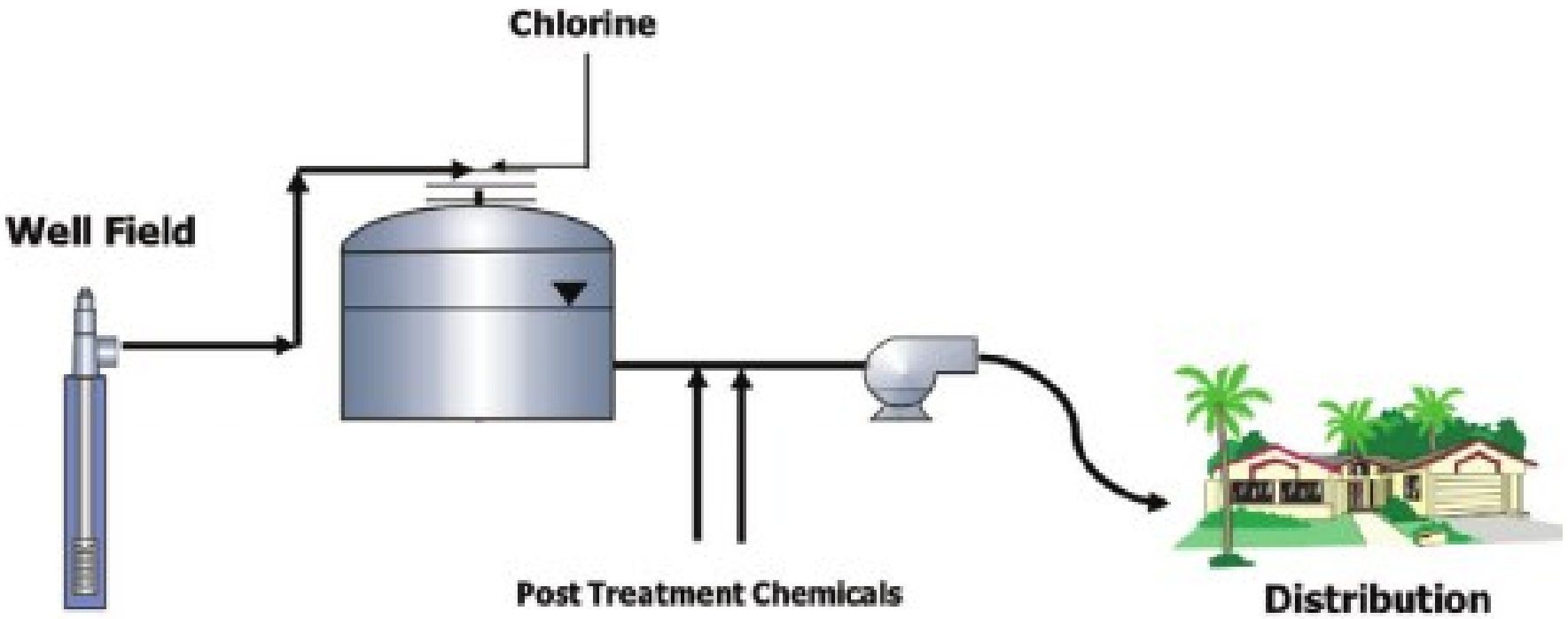


Alarm System & Call Out Alarms

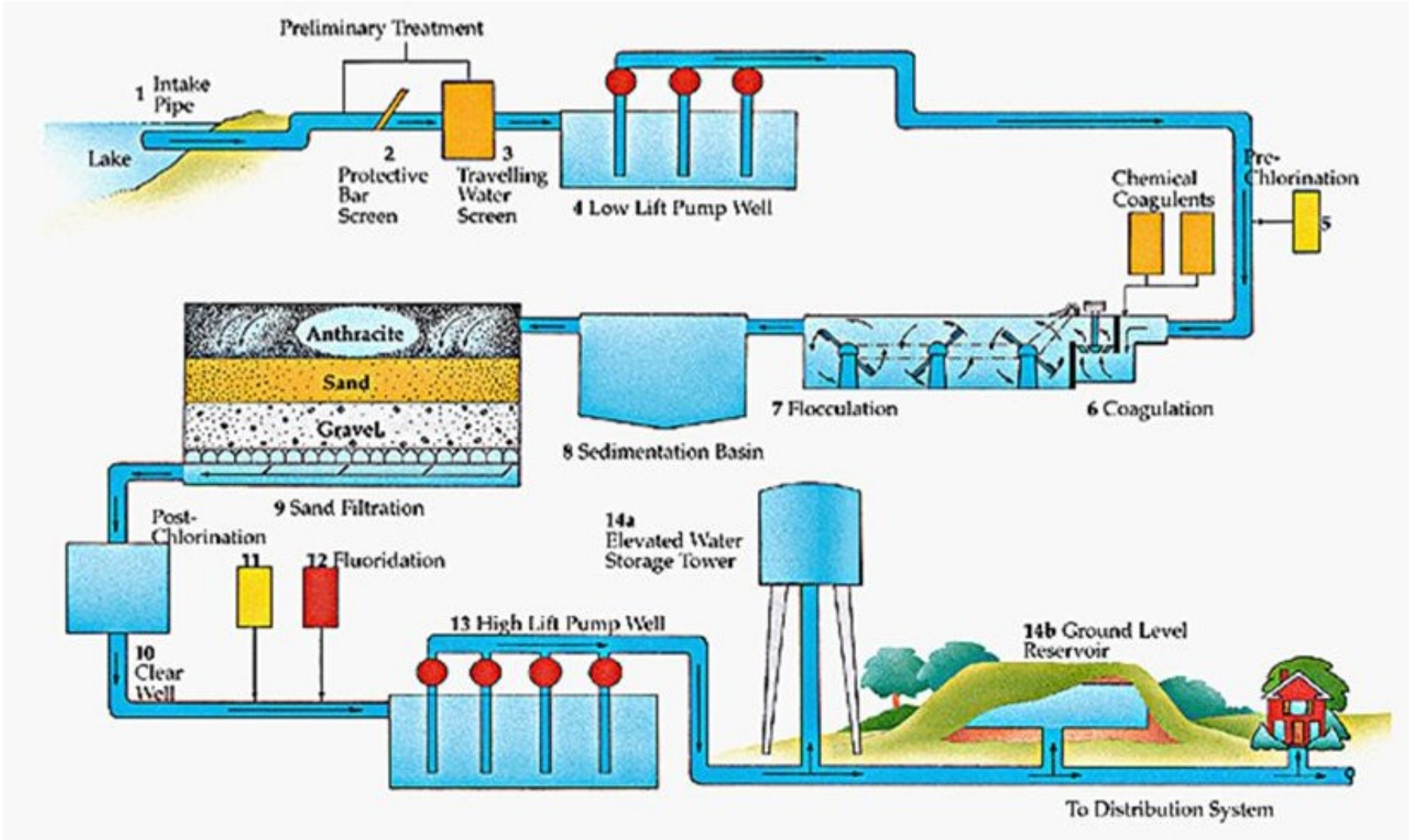


Typical SCADA Control Techniques

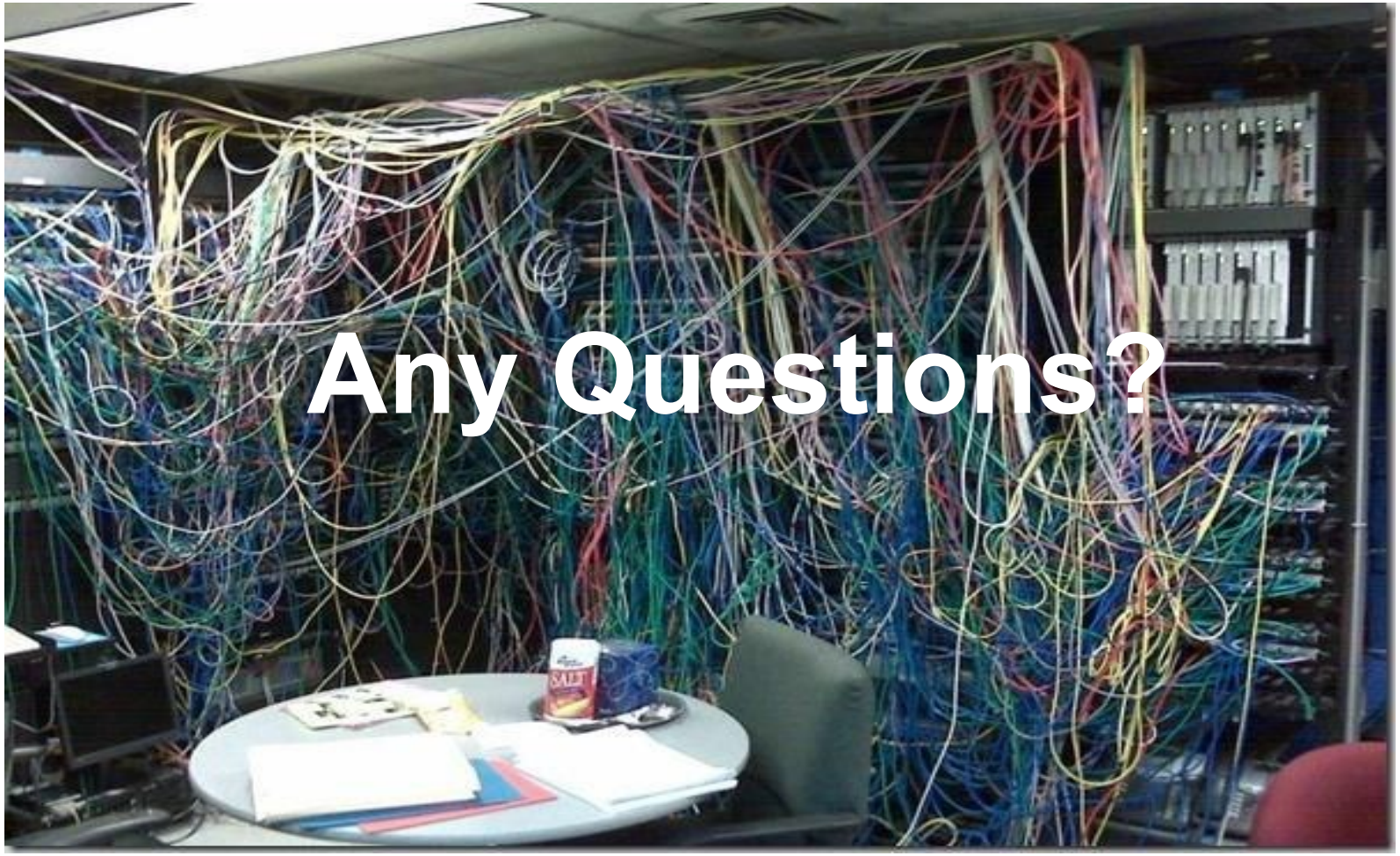
Ground Water Treatment



Surface Water Treatment (Conventional Filter Plant)



Wrap-Up



* Not a high performance SCADA System