Setting the Standard for Automation™

Facility P&ID Drawings
and why you need them!

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

ISA Hamilton Members Meeting
February 22, 2022 – Hamilton, Ontario, Canada

About the Speaker

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

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

- Secretary, ISA Hamilton Section
- Newsletter Editor, ISA Water/Wastewater Division
- 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

- Has published over 50 papers and articles on automation topics
- Received ISA "Standards Leader of the Year Award" in 2021
- Received University of Guelph "Mid Career Achievement Award" in 2014

- Contact: graham.nasby@guelph.ca

Presentation Outline

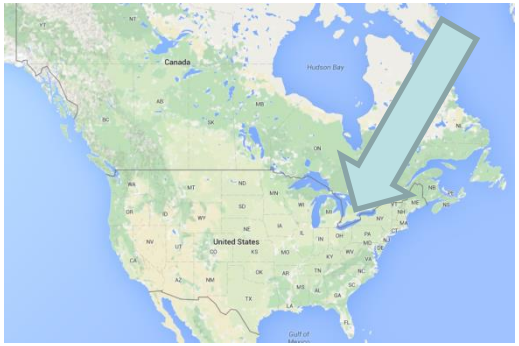
- About Guelph
- Typical Facility Documentation
- Project Drawings
- Problems with “as built” drawings

- Facility Drawings
- Guelph Water’s P&IDs & Layout Drawings
- Tour of a Facility P&ID

- How we use Drawings
- Drawing Update Workflows
- Maintenance Updates
- Guelph’s Drawing Templates

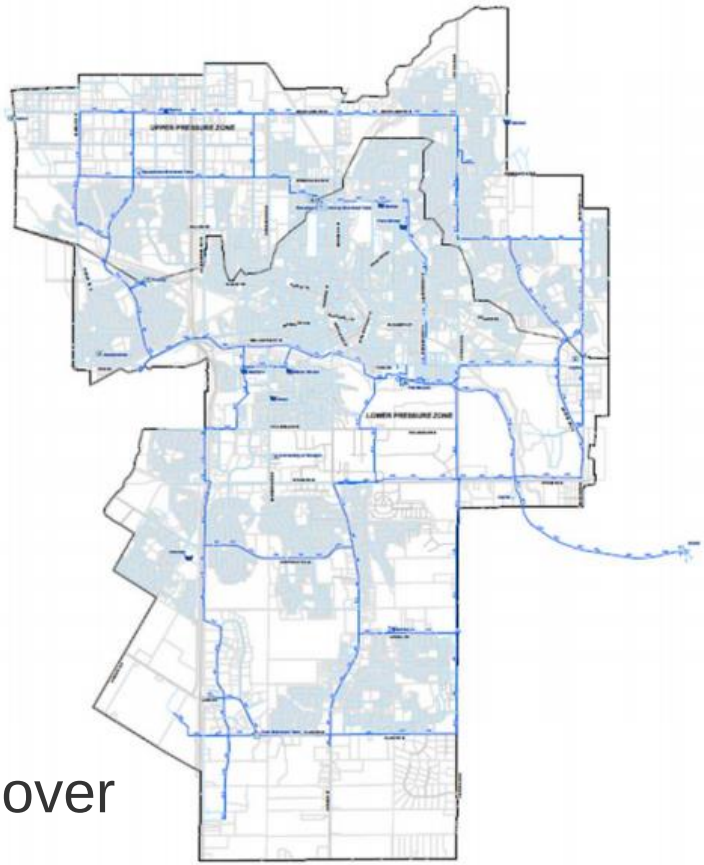
City of Guelph Water Services

- 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

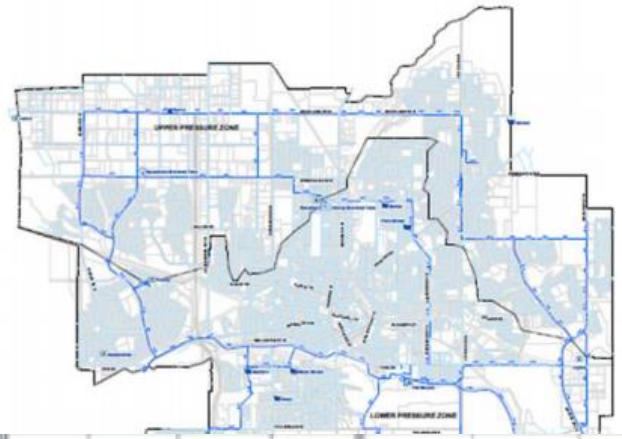


How do we document a facility?

- P&ID Drawings
- Layout Drawings

- Electrical Drawings
- PLC Panel drawings
- Loop Drawings / Connection Diagrams
- Network Drawings

- Architectural/Civil Drawings
- Structural Drawings
- Mechanical Drawings

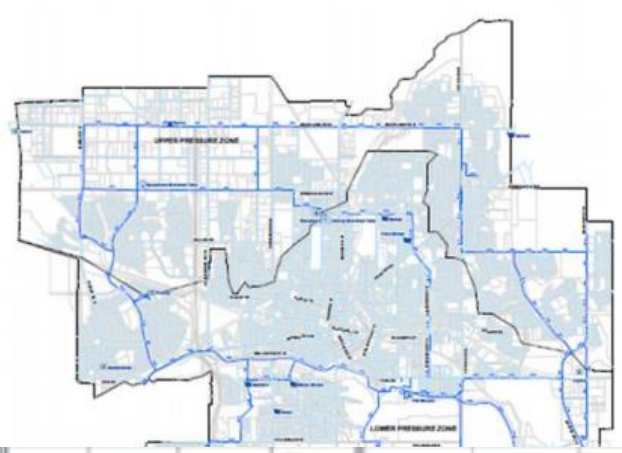


Other Documentation…

- Process Control Narratives (PCN)
- Master Alarm Database
- Instrument Database
- Standard Operating Procedures (SOP)
- Backup copies of software/code

- Asset Inventory
- Spare Parts Lists
- Maintenance Procedures
- Equipment Manuals & Documentation

- Disinfection Calculation Spreadsheets
- Test Plans / Test Records
- Critical Control Points Documentation
- Site Permits / Licences



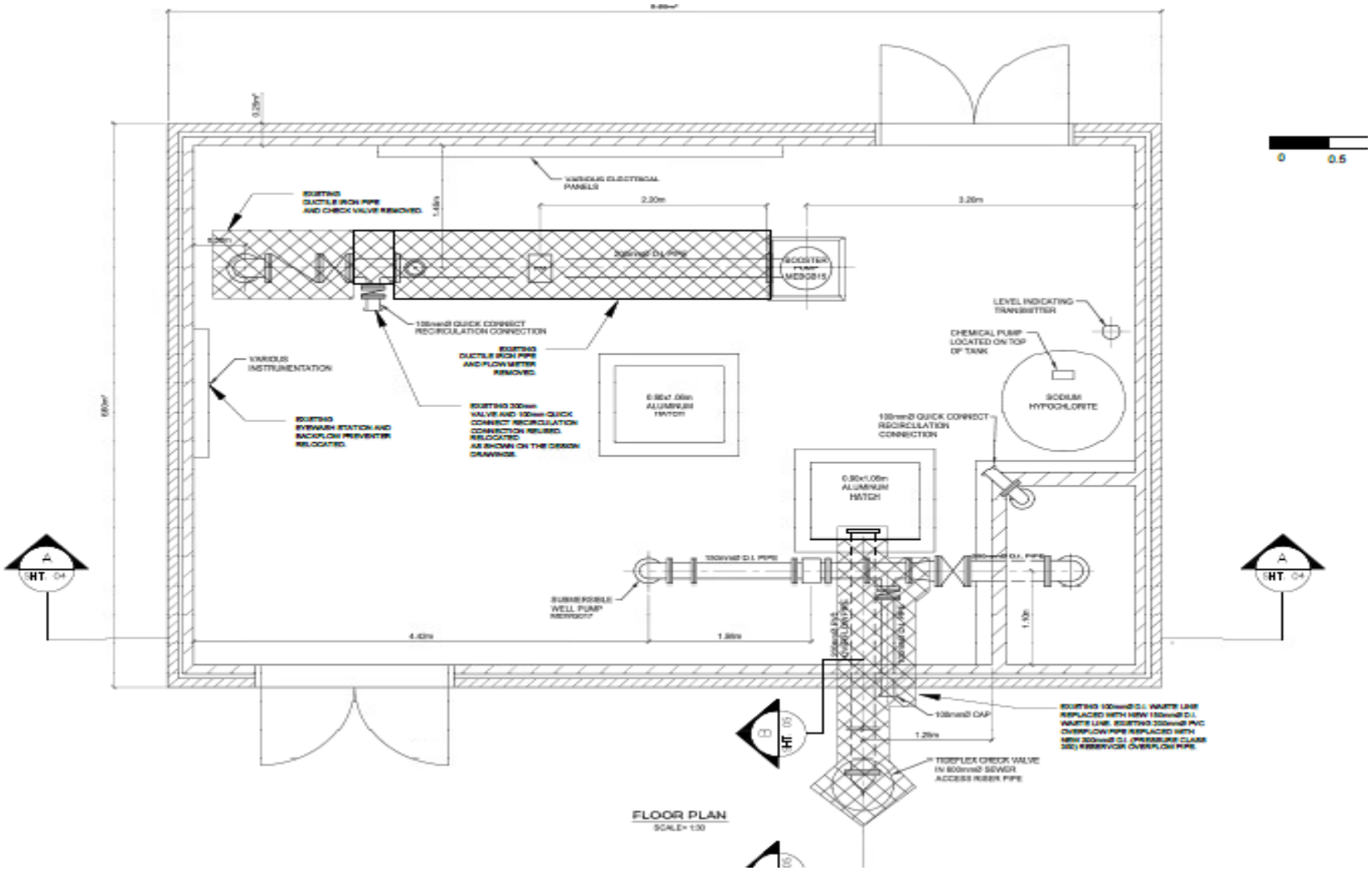
Project Drawings

"Project Drawings"

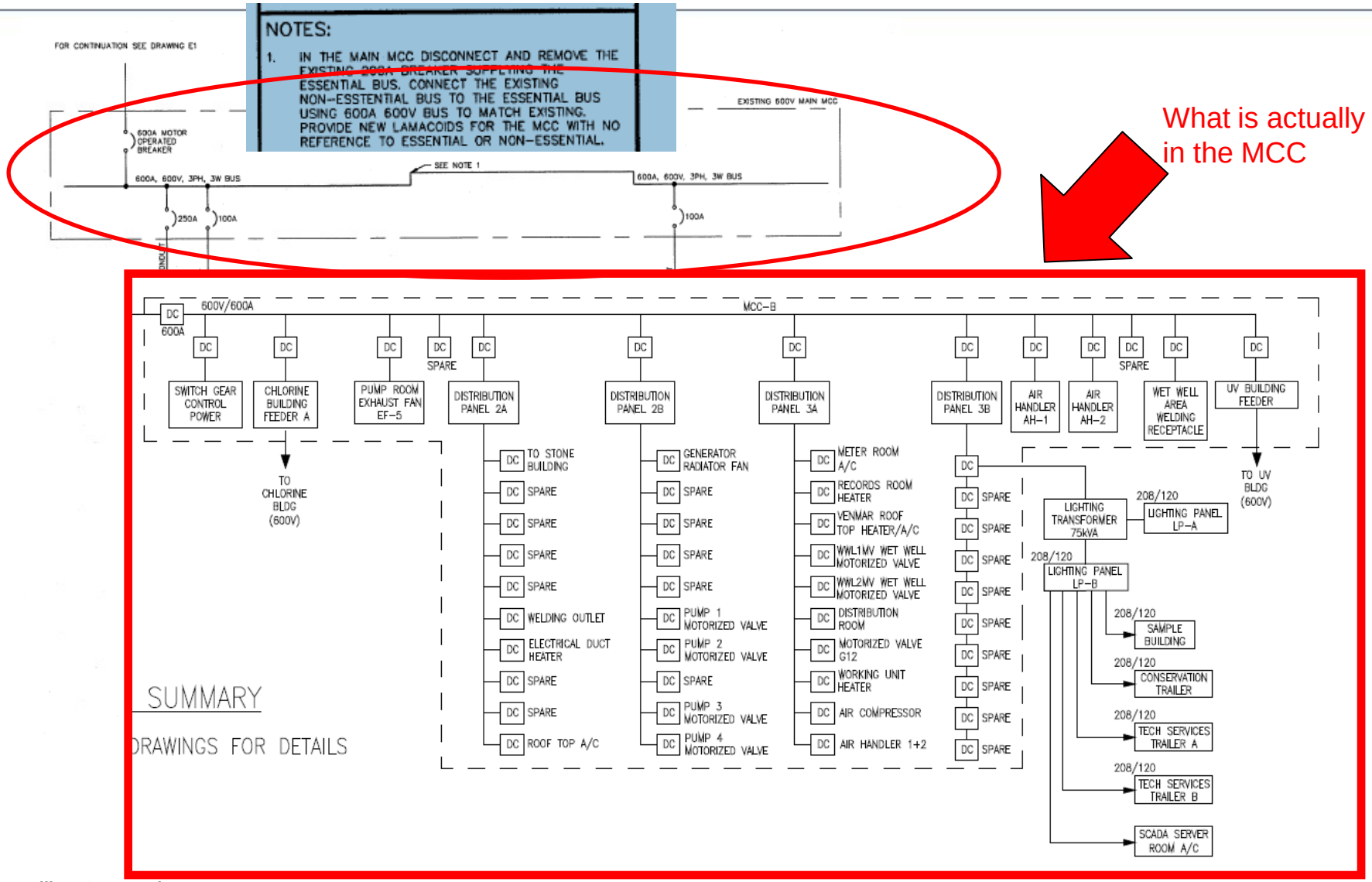
- Defines the scope of what the contractor is to do
- Used as a contractual tool
- Defines scope of work
- Defines when work is complete
- Only defines the contractor work

When work is complete, best practice is to issue "as-built" drawings to show what work the contractor actually did

Problems with As-Built Drawings



Problems with As-Built Drawings

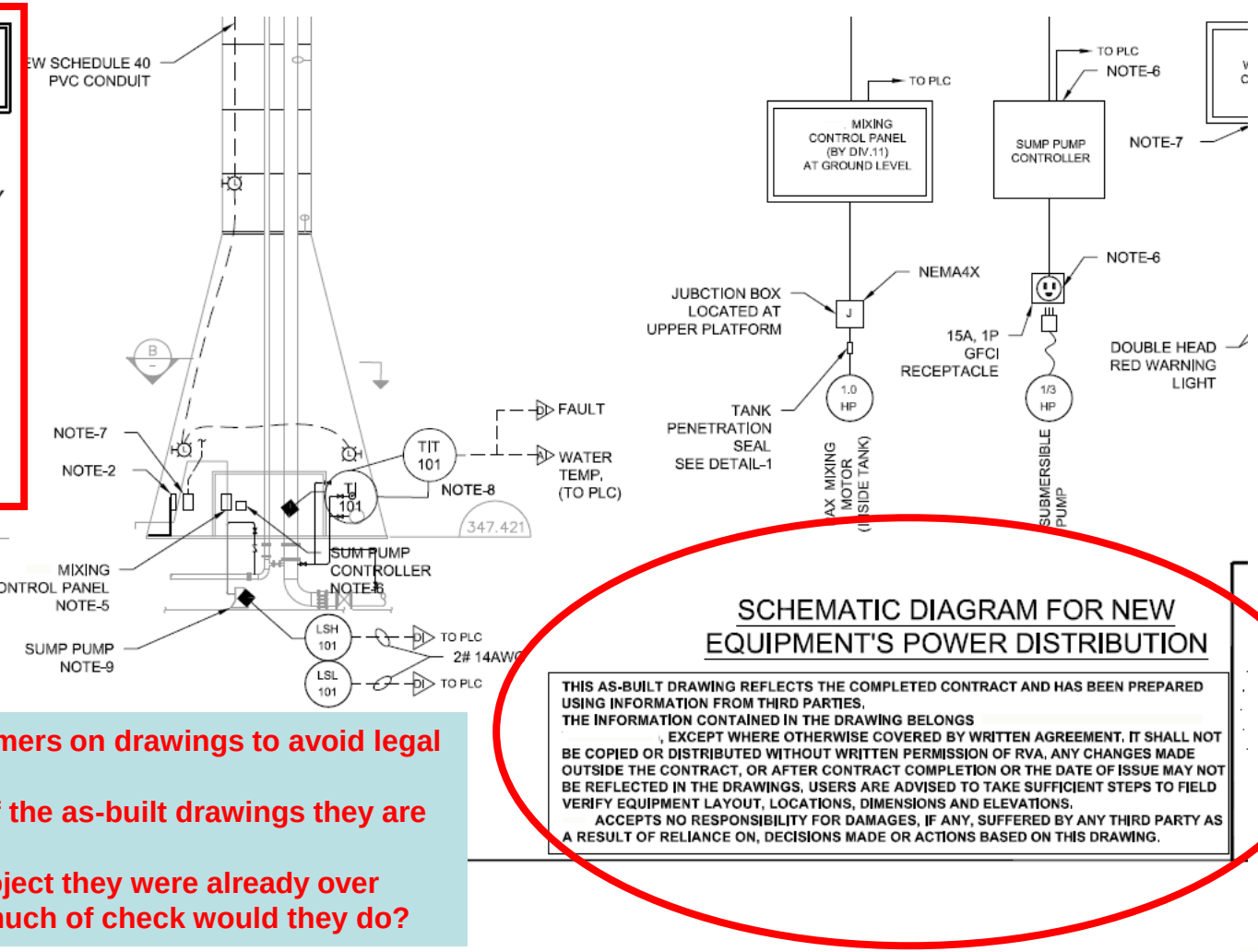


What is actually in the MCC

Problems with As-Built Drawings

AS-BUILT

THESE AS-BUILT DOCUMENTS HAVE BEEN PREPARED BASED ON INFORMATION PROVIDED BY OTHERS. THE DESIGN PROFESSIONAL HAS NOT VERIFIED THE ACCURACY AND/OR THE COMPLETENESS OF THIS INFORMATION AND SHALL NOT BE RESPONSIBLE FOR ANY ERRORS OR OMISSIONS WHICH MAY BE INCORPORATED HEREIN AS A RESULT.

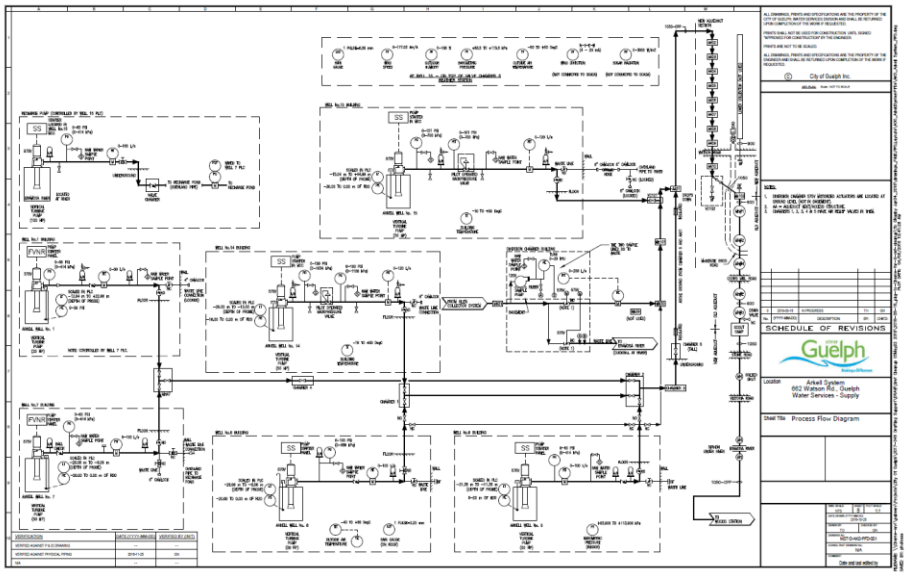


Consultants putting disclaimers on drawings to avoid legal liability is reasonable…
But did they bother check if the as-built drawings they are issuing match the site?
What if at the end of the project they were already over their hours budget? How much of check would they do?

Facility Drawings

- Maintained as “living documents” to document facilities
- Not associated with construction projects
- Small sub-set of drawings, realizing effort/resources to maintain
- Maintained “in-house”
- Satisfies regulatory requirement for “Up-to-date P&ID Drawings”

- Guelph Water uses:
  - PFDs
  - P&IDs
  - Site Layouts
  - Electrical & I/C Drawings



- Historical “as built” drawings & records from construction projects kept on file for reference

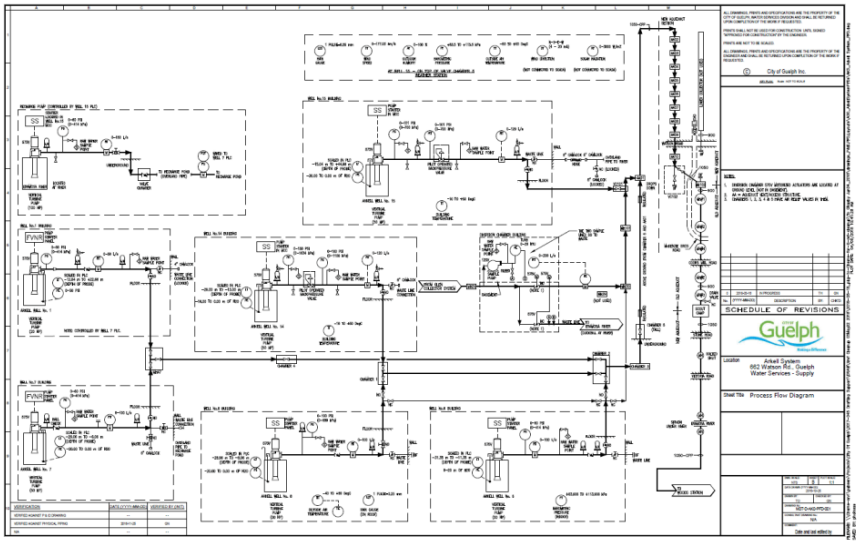
Facility Drawings

- Maintain a small number of drawings only
- Maintaining drawings takes staff-time/resources
- Do not use any x-refs (external references) in CAD files
- One CAD file per drawing (except for electrical drawings)
- Only use 11”x17” size (8.5x11 is too small, larger sizes hard to print)
- Keep it simple

- Drawings are stored/maintained in house. Standard templates used.

- Engineering firm on retainer for CAD support as needed

- Do not include as deliverable with construction projects
  (nice drawings are not the focus in a project)



Facility Drawings: PFDs

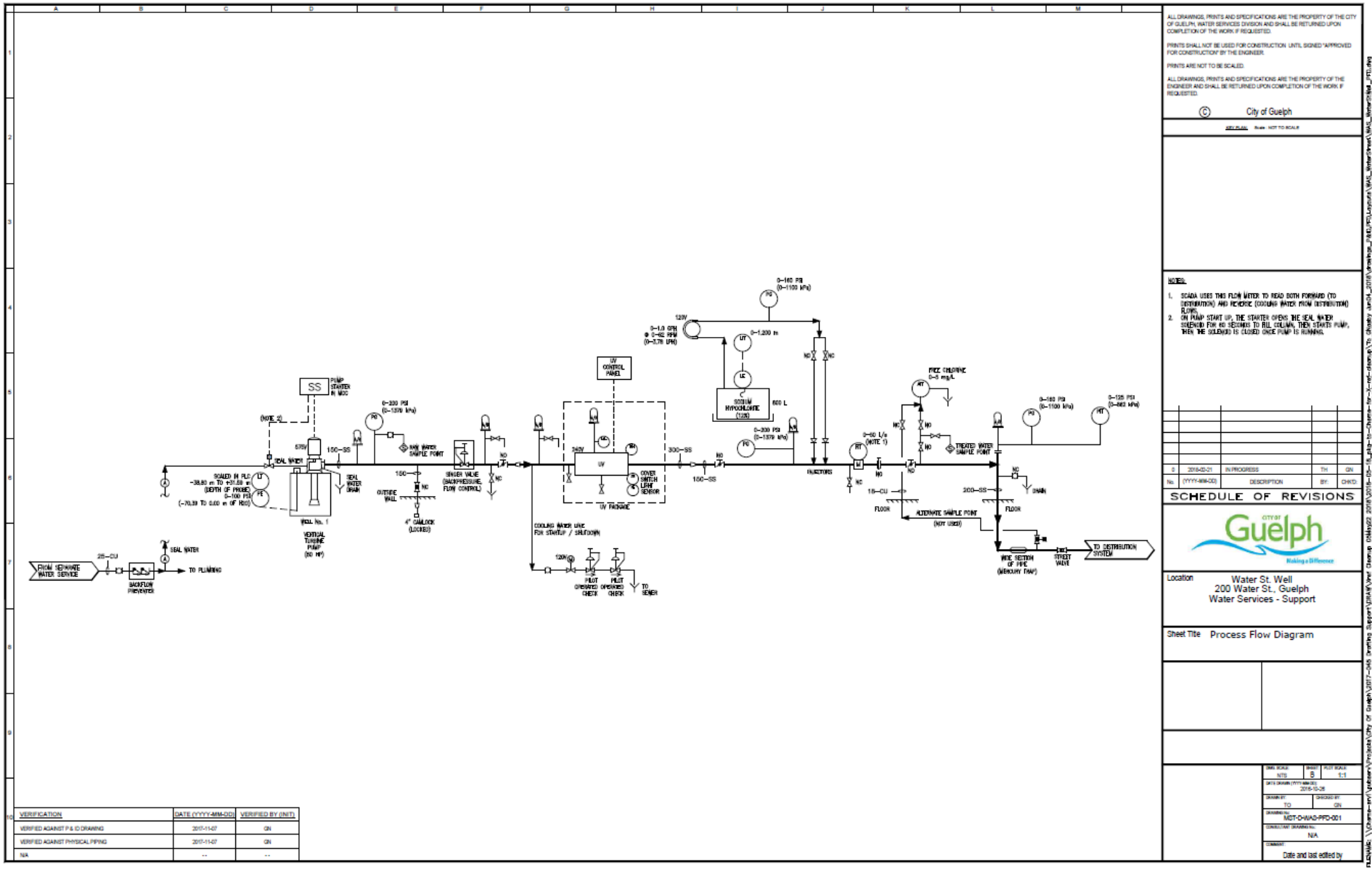
- PFDs – Process Flow Diagrams

Goals

- Show major piping only, summarize/omit secondary lines
- Show all main valves & instrumentation
- Do not include any SCADA I/O or tagging details
- Do not include unnecessary tagging details
- Do not use “layers” to show/hide information (layers get forgotten)
- Include key information such as instrumentation ranges & pump sizes

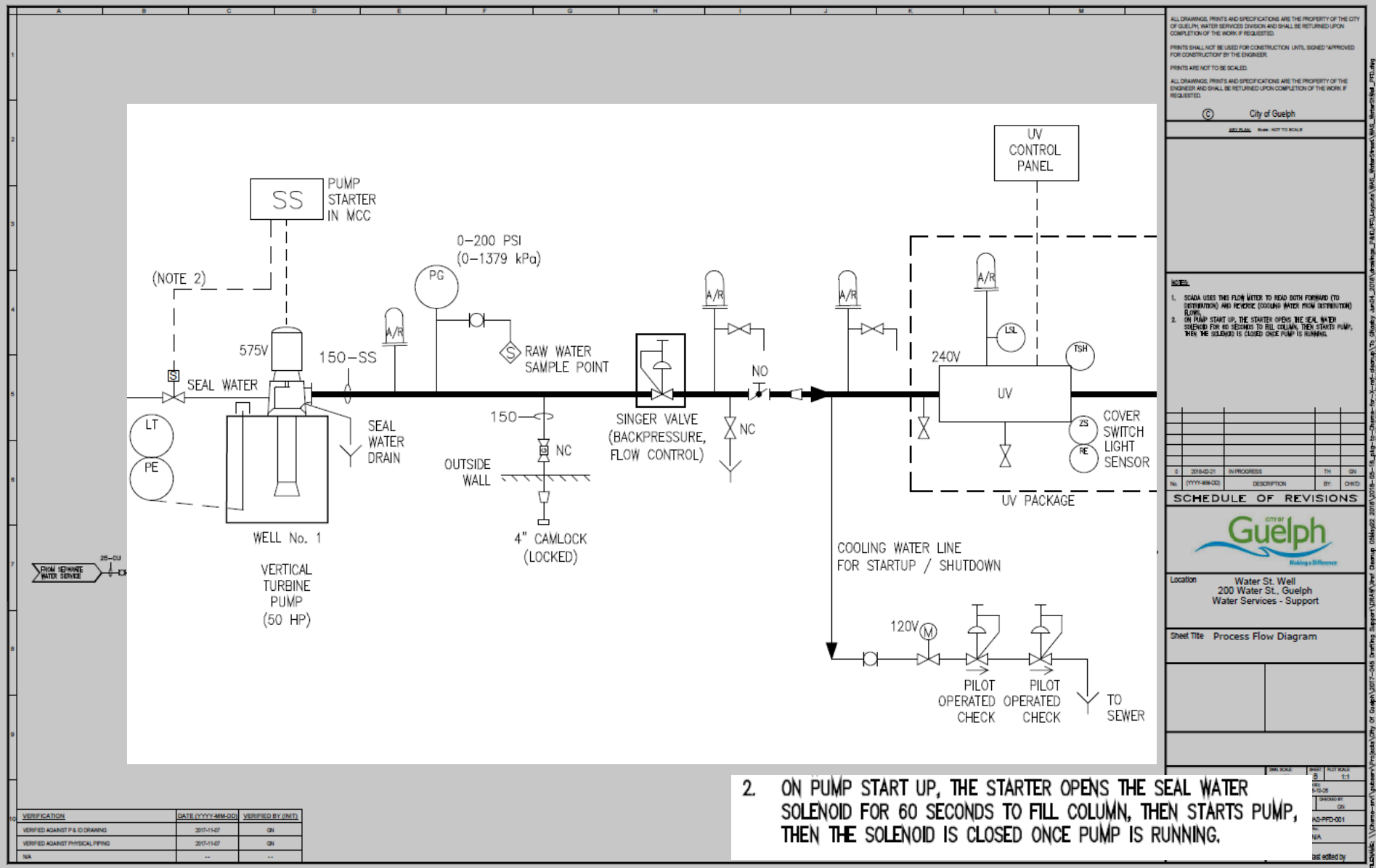
- Quickly summarizes the process
- Useful for regulatory submissions/permits, as well as SOP’s and training
- Easy to read drawing for Inspector visits
- One sheet per site

Facility Drawings: PFDs

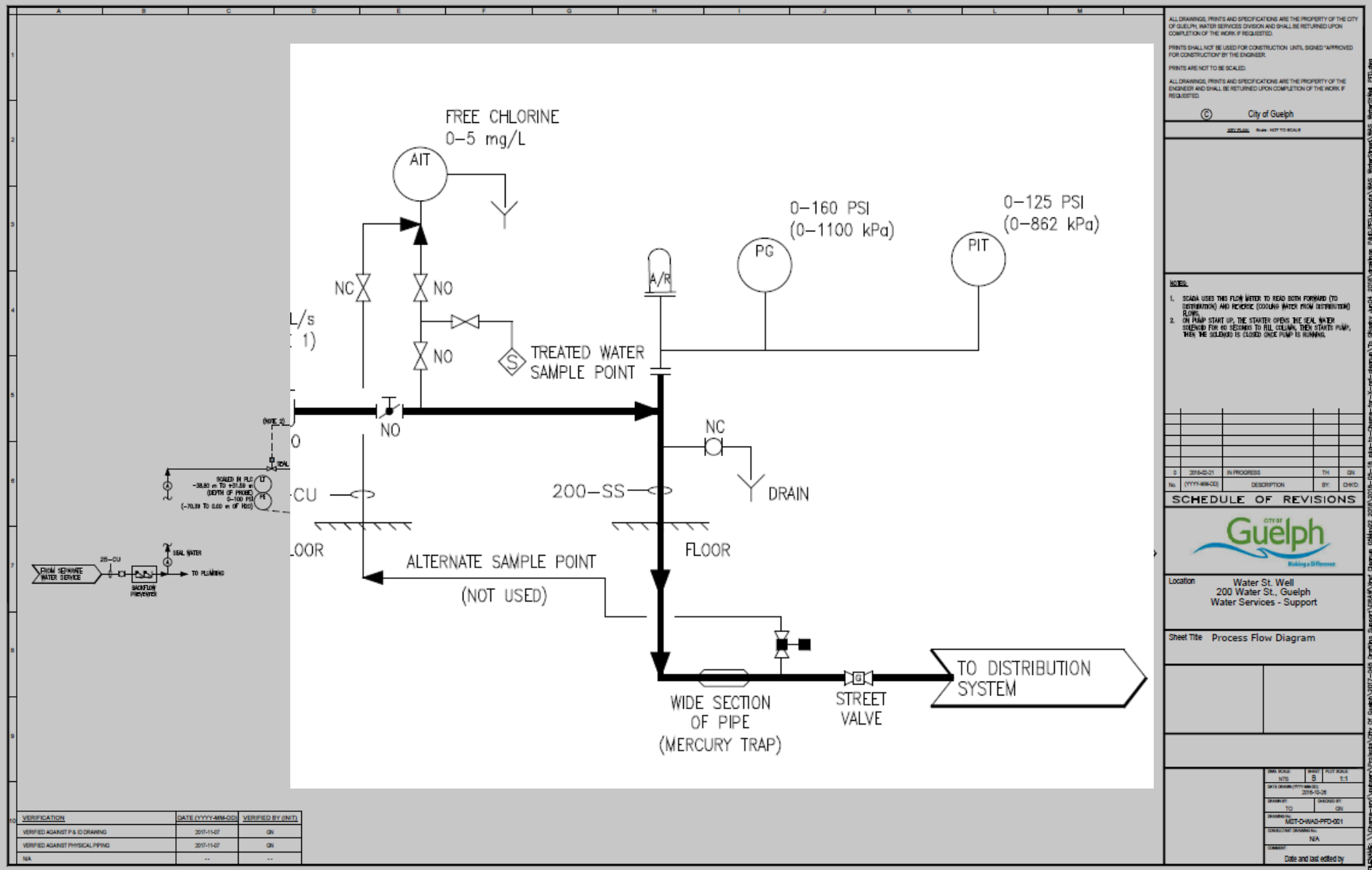


Facility P&ID Drawings
ISA Hamilton Members Meeting – Feb 22, 2022
Hamilton, Ontario, Canada

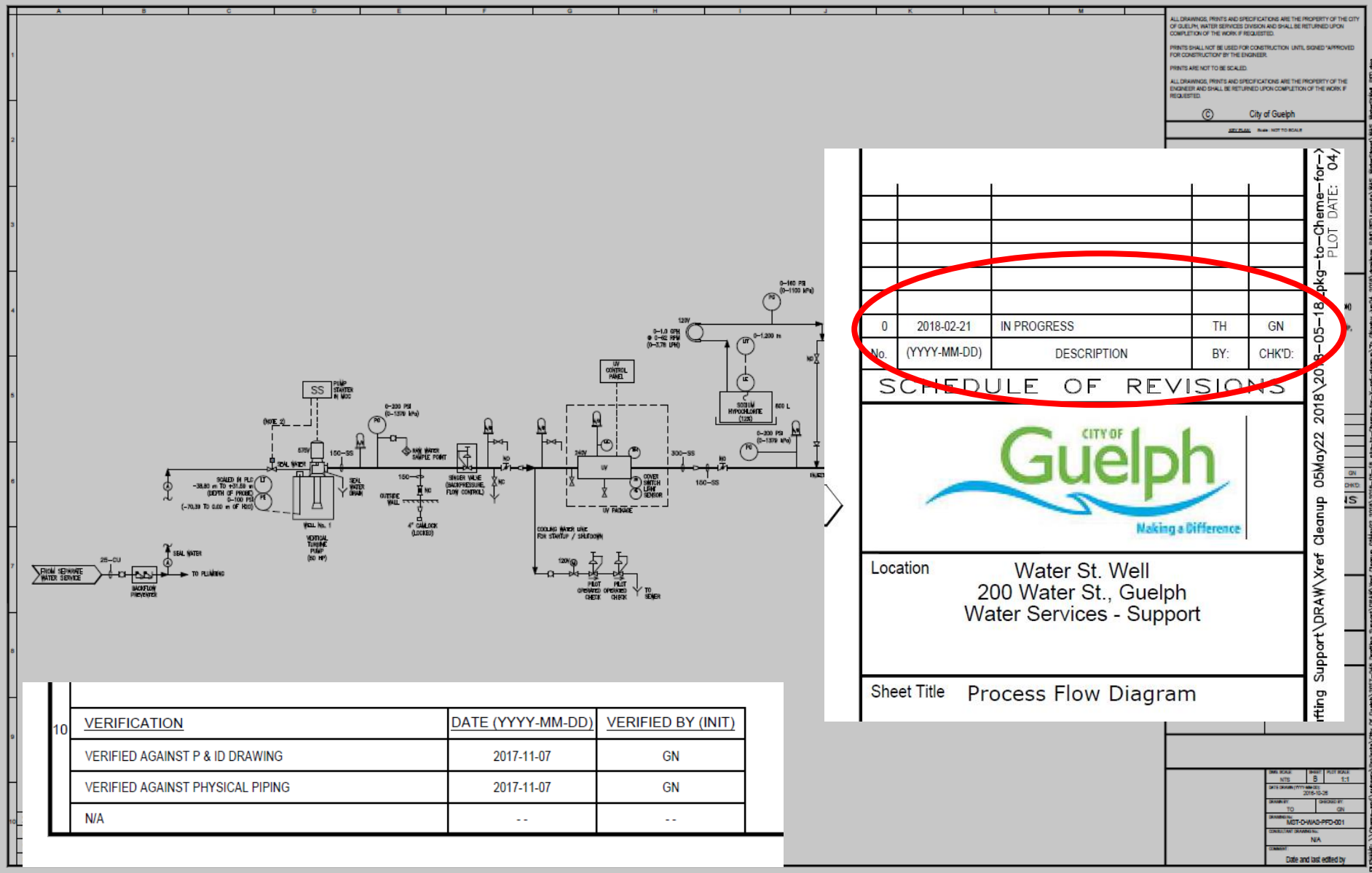
Facility Drawings: PFDs



Facility Drawings: PFDs



Facility Drawings: PFDs



No.	(YYYY-MM-DD)	DESCRIPTION	BY:	CHK'D:
0	2018-02-21	IN PROGRESS	TH	GN

SCHEDULE OF REVISIONS

CITY OF Guelph — Making a Difference

Location: Water St. Well
200 Water St., Guelph
Water Services - Support

Sheet Title: Process Flow Diagram

10 VERIFICATION	DATE (YYYY-MM-DD)	VERIFIED BY (INIT)
VERIFIED AGAINST P & ID DRAWING	2017-11-07	GN
VERIFIED AGAINST PHYSICAL PIPING	2017-11-07	GN
N/A	--	--

Facility Drawings: P&IDs

- P&IDs – Piping and Instrumentation Diagrams

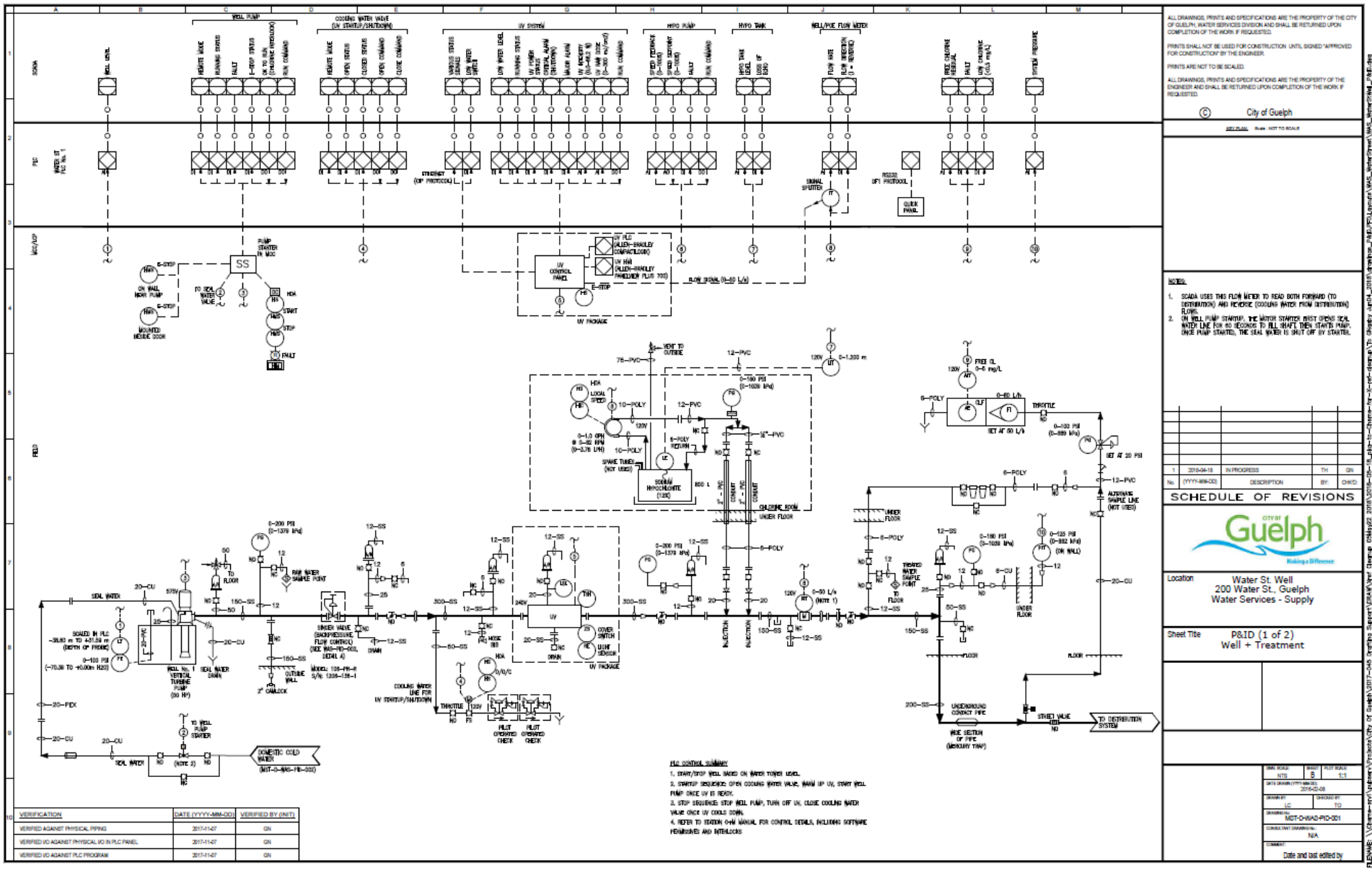
Goals

- Show all pipes with sizes and materials
- Show all valves, instrumentation, and pumps, including sizes
- Full SCADA I/O Details, and clearly show hard-wired controls
- Shows what I/O is from each device/instrument
- All instrumentation and signals have ranges clearly shown
- Both “native” and (in brackets) converted signal scaling is shown
- Summarize electrical details

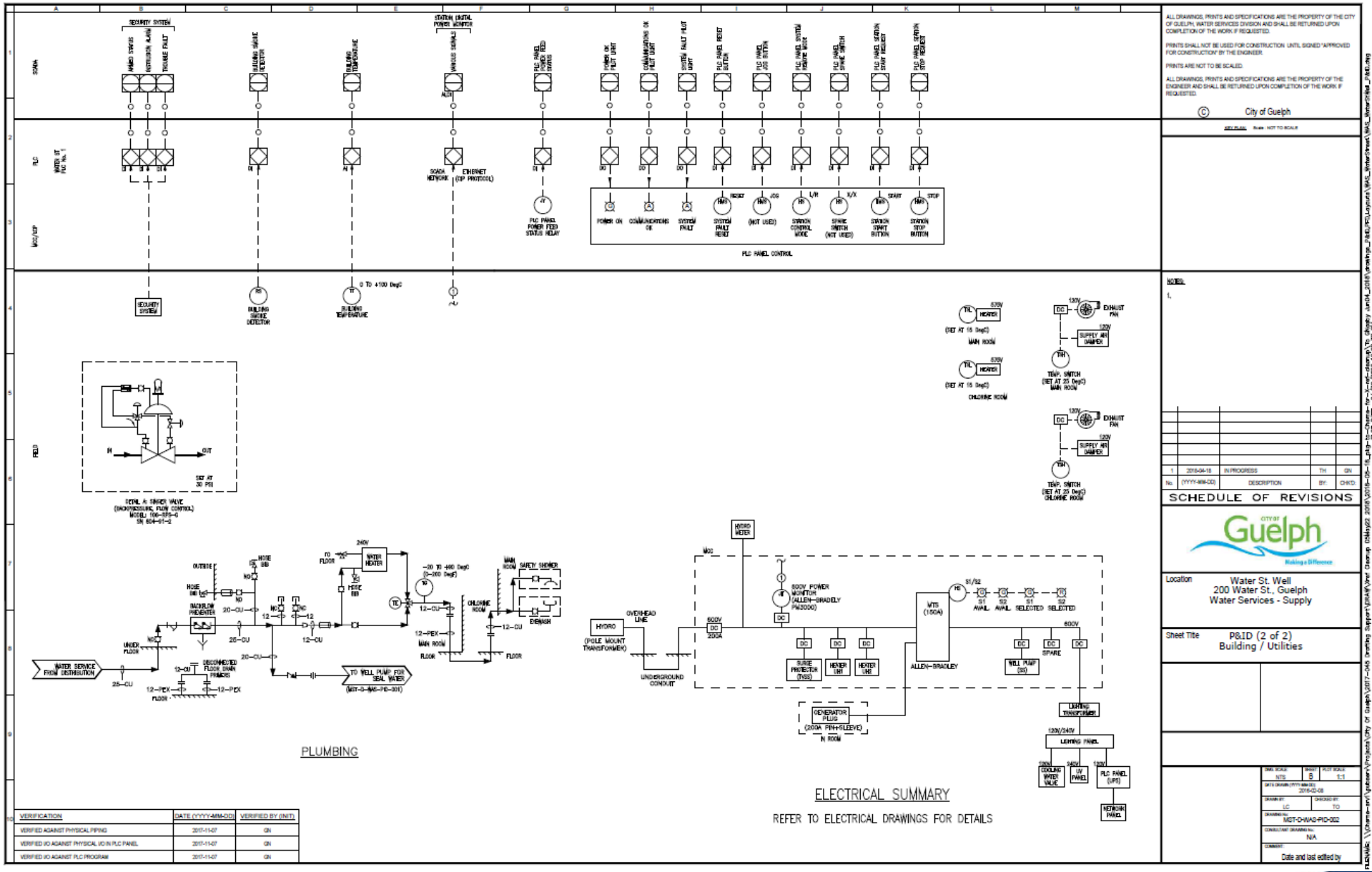
Avoid

- Cryptic SCADA tags for signal names – use plain language
- Specific PLC I/O addresses – these can be found in other drawings
- Software programming details – that information is in the PCN

Facility Drawings: P&IDs

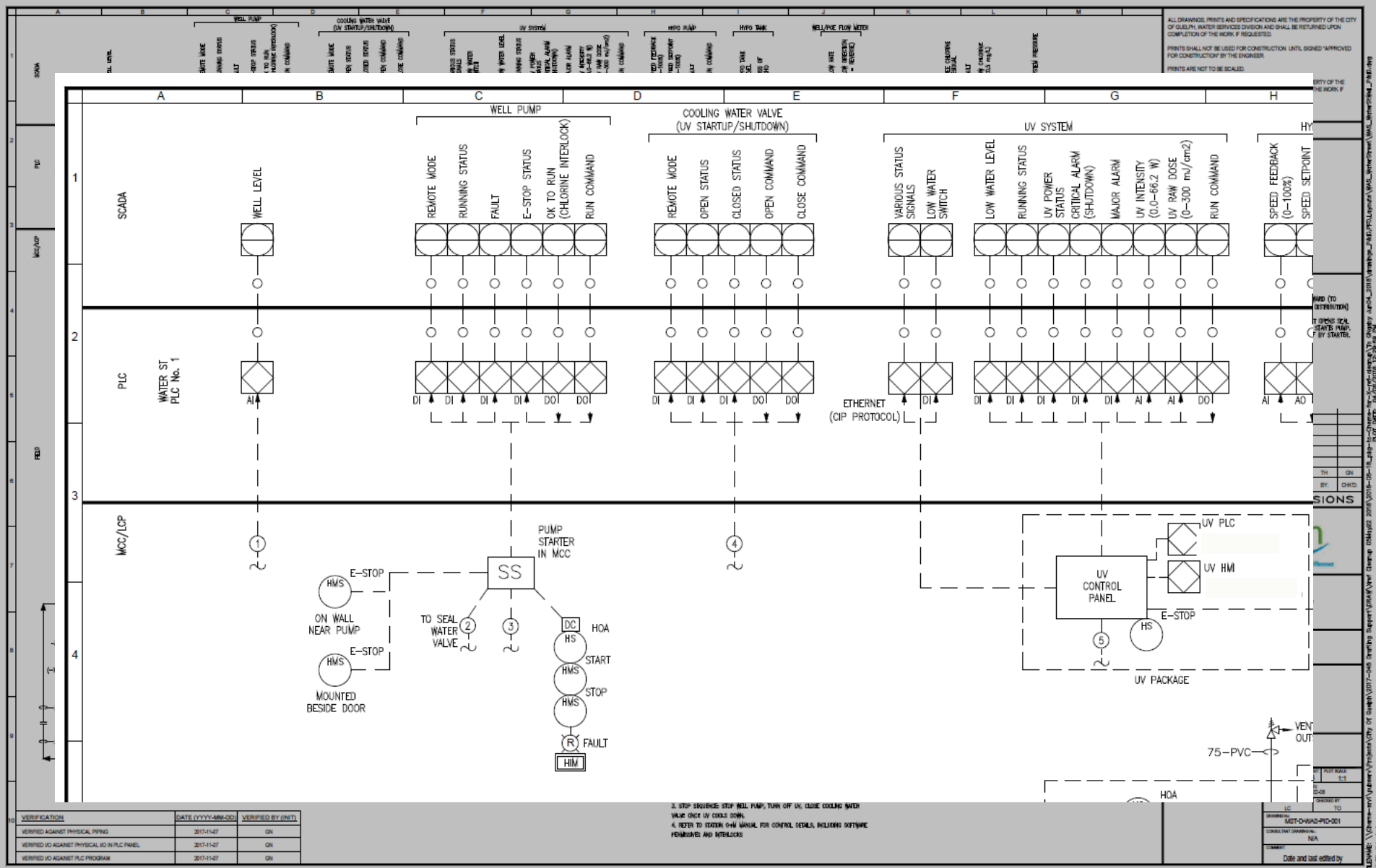


Facility Drawings: P&IDs



VERIFICATION	DATE (YYYY-MM-DD)	VERIFIED BY (INIT)
VERIFIED AGAINST PHYSICAL PIPING	2017-11-07	GN
VERIFIED I/O AGAINST PHYSICAL I/O IN PLC PANEL	2017-11-07	GN
VERIFIED I/O AGAINST PLC PROGRAM	2017-11-07	GN

Facility Drawings: P&IDs



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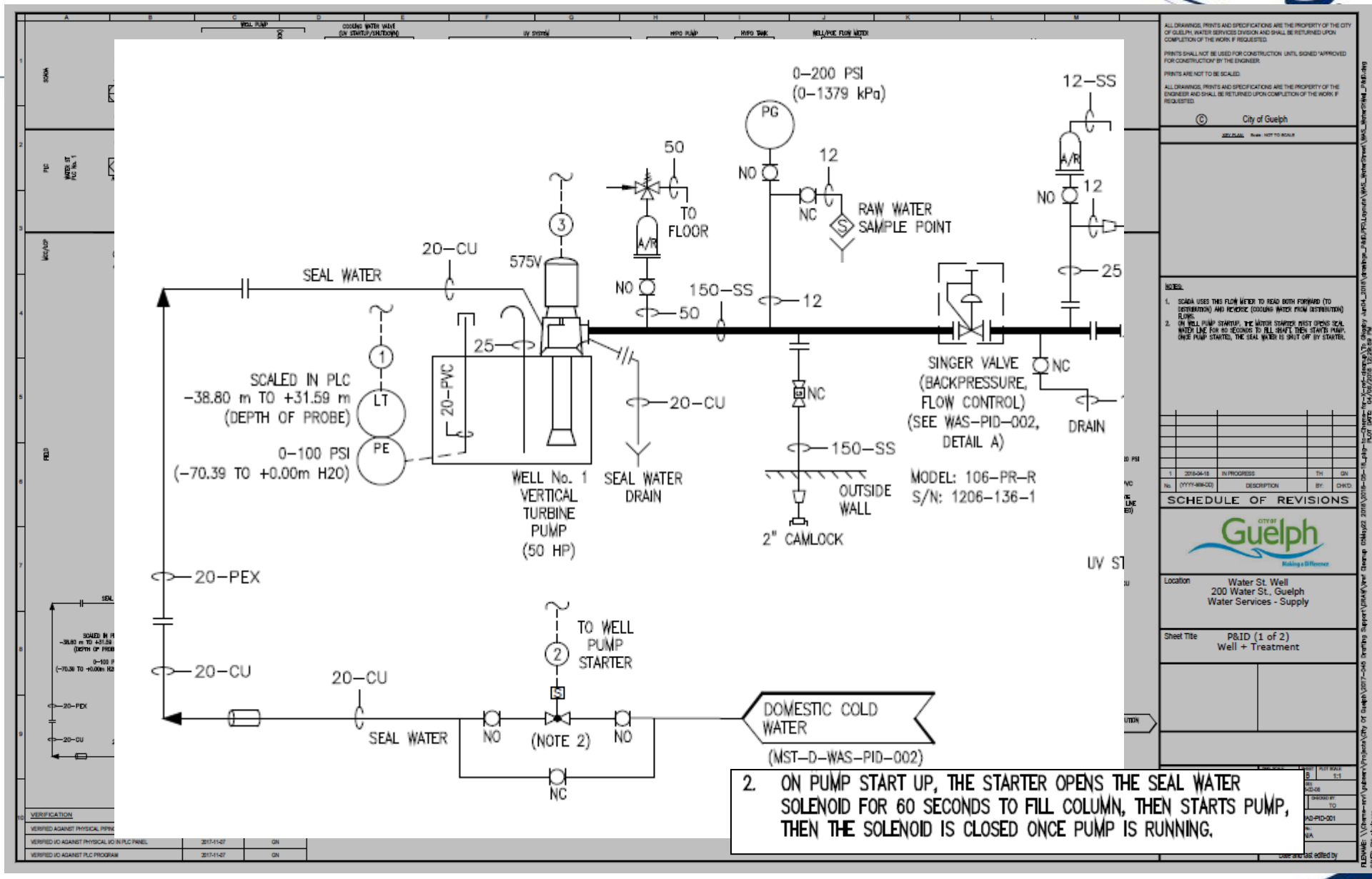
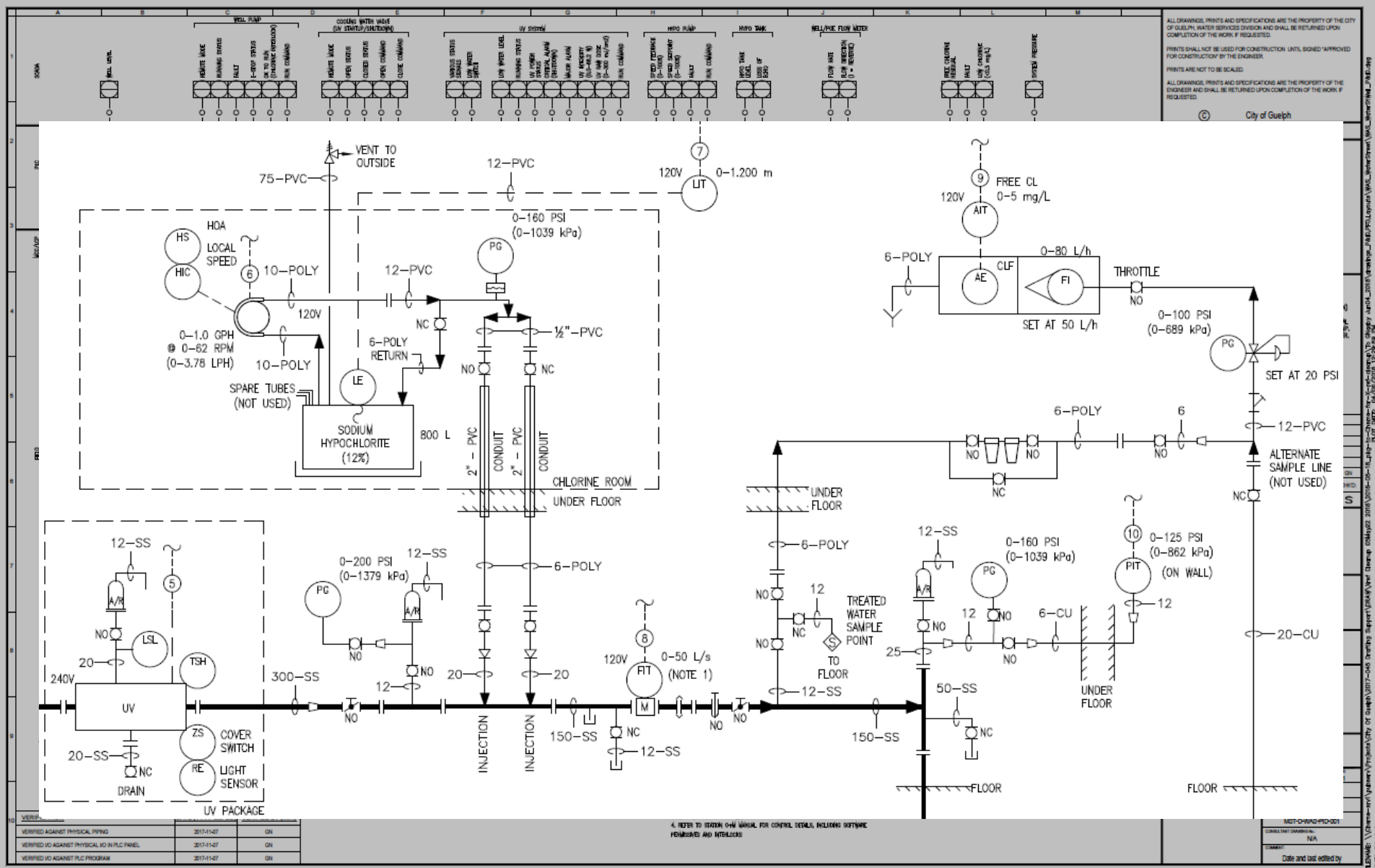


Facility Drawings: P&IDs



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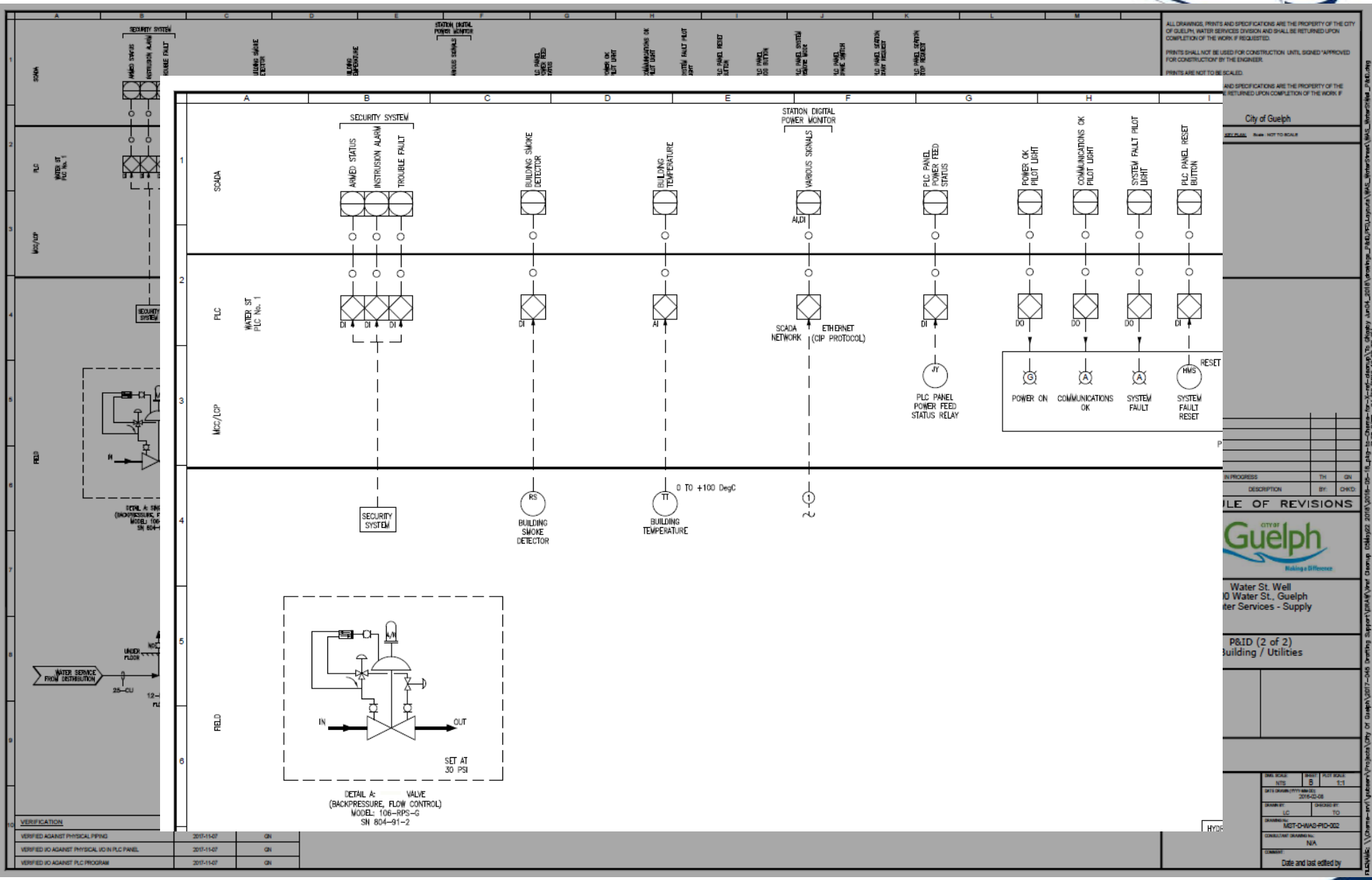
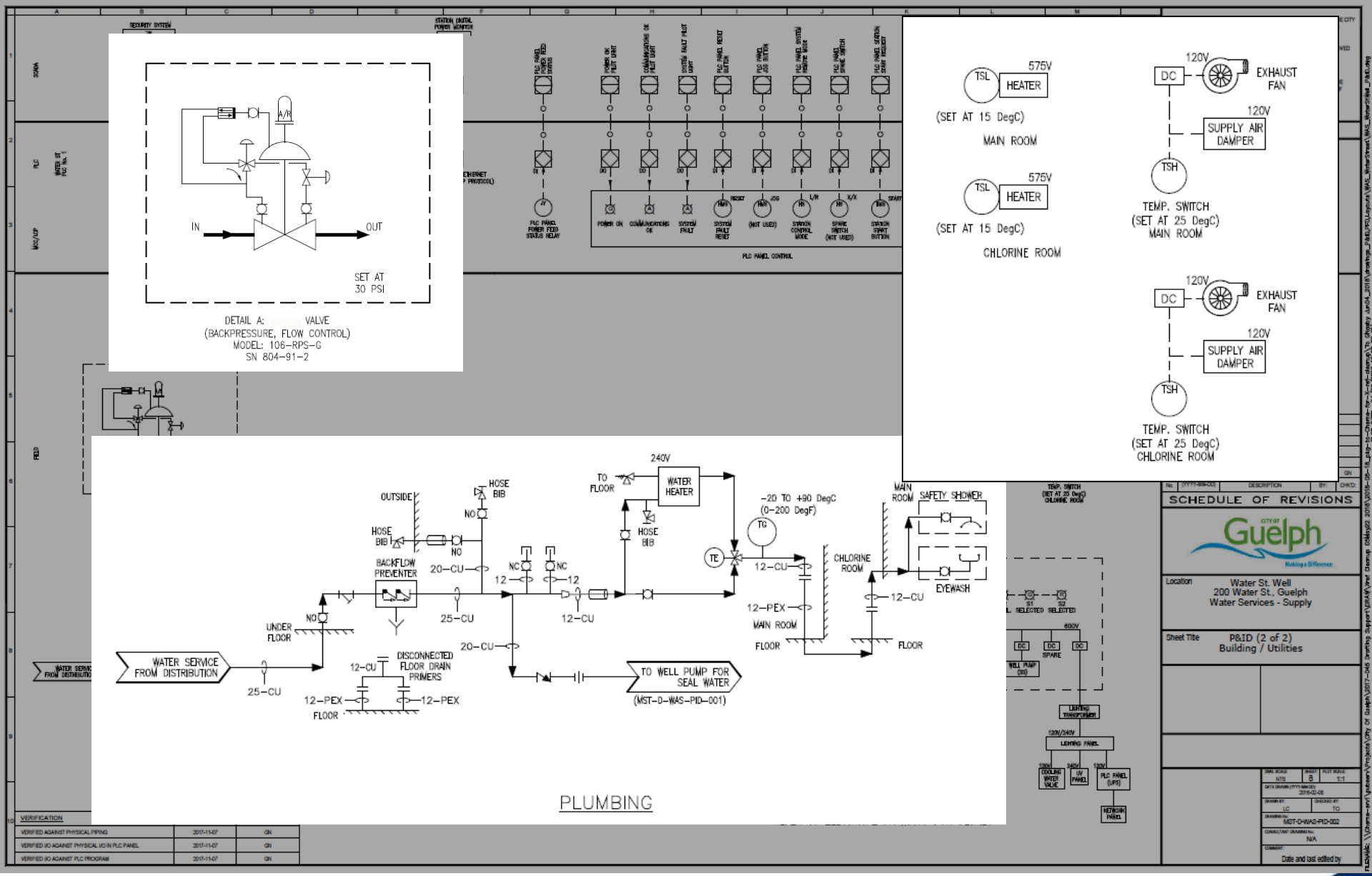
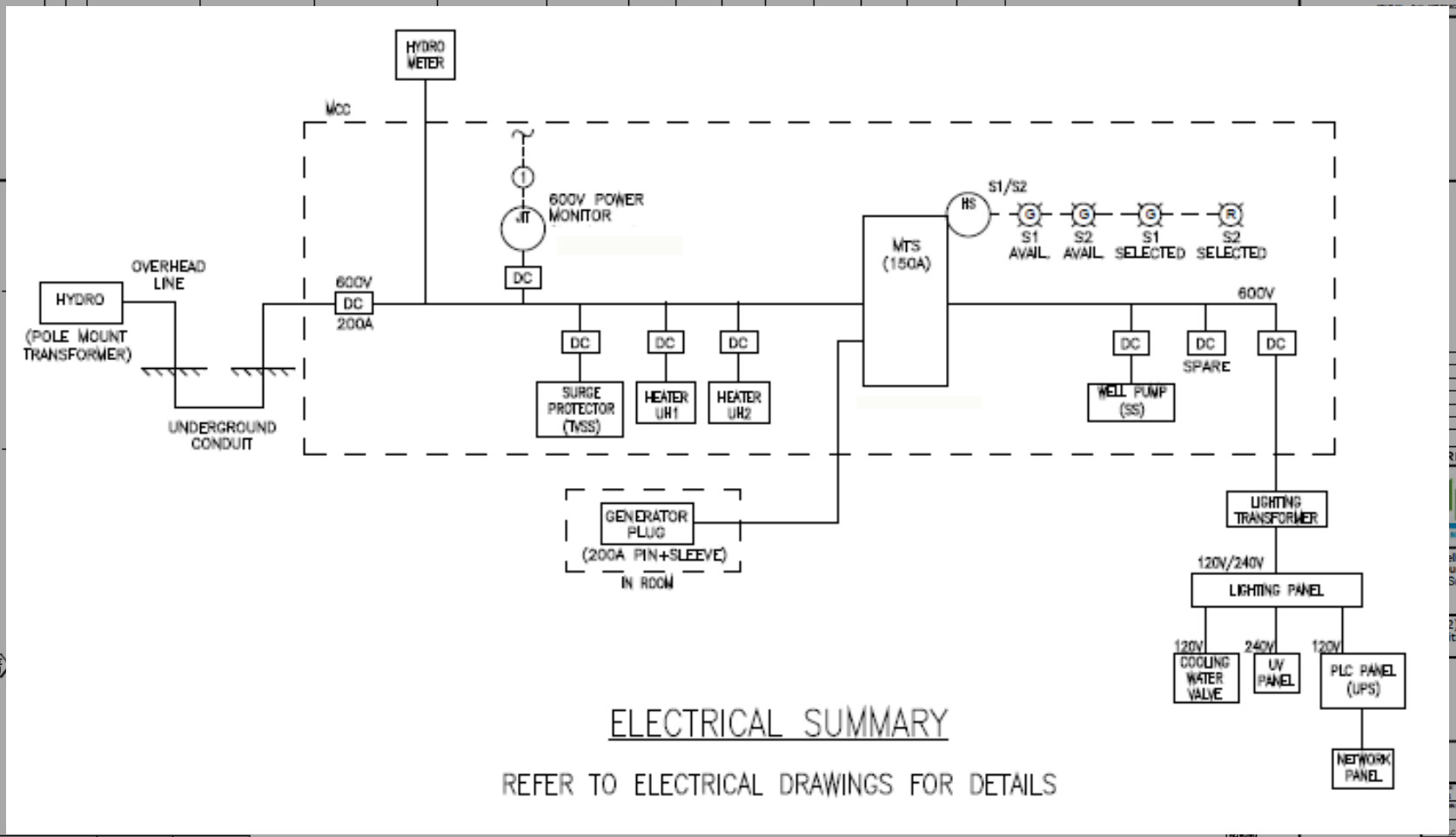


Facility Drawings: P&IDs



Facility Drawings: P&IDs



Facility Drawings: Site Layout Drawings

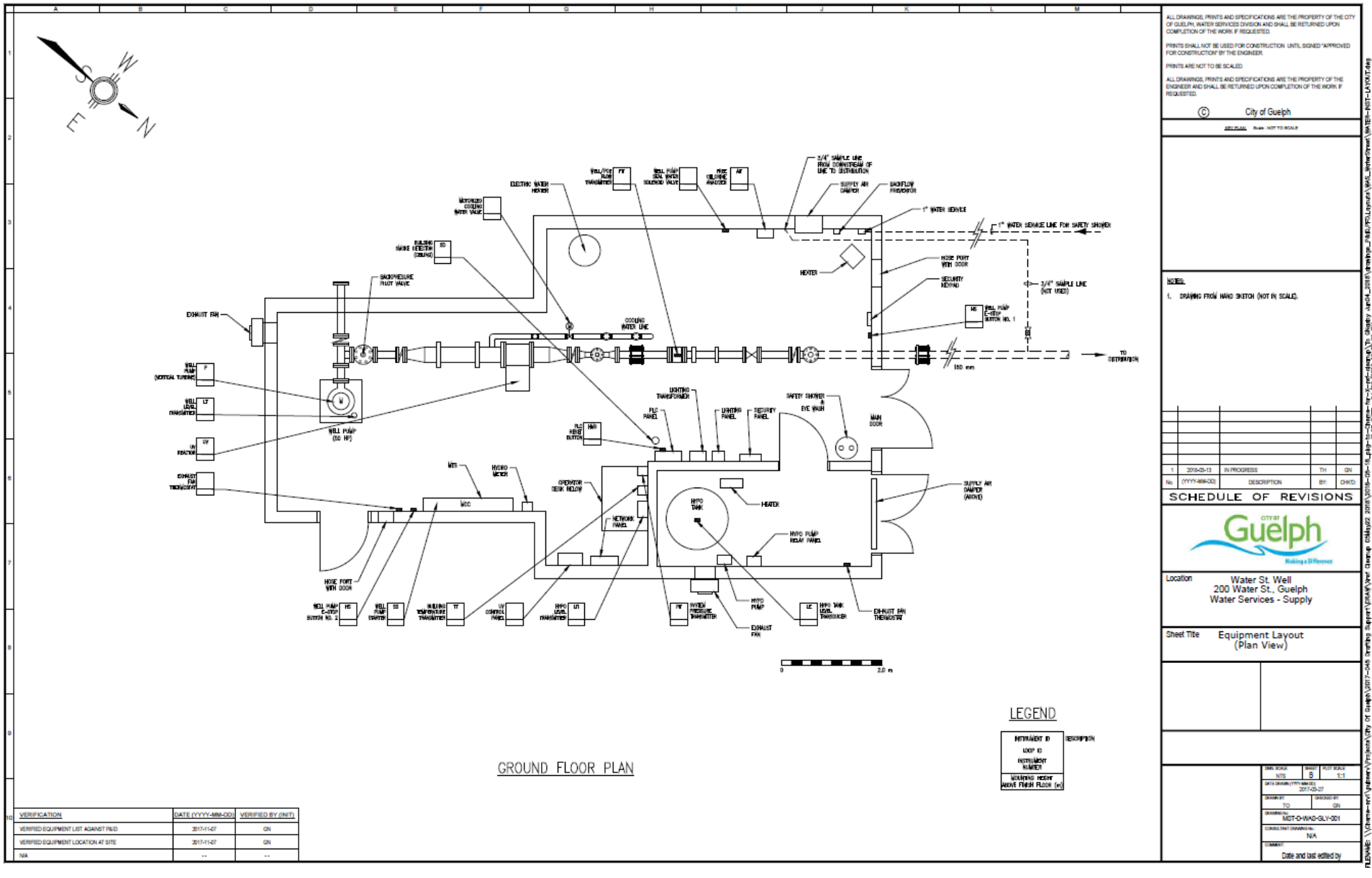
- Site Layout drawings

Goals

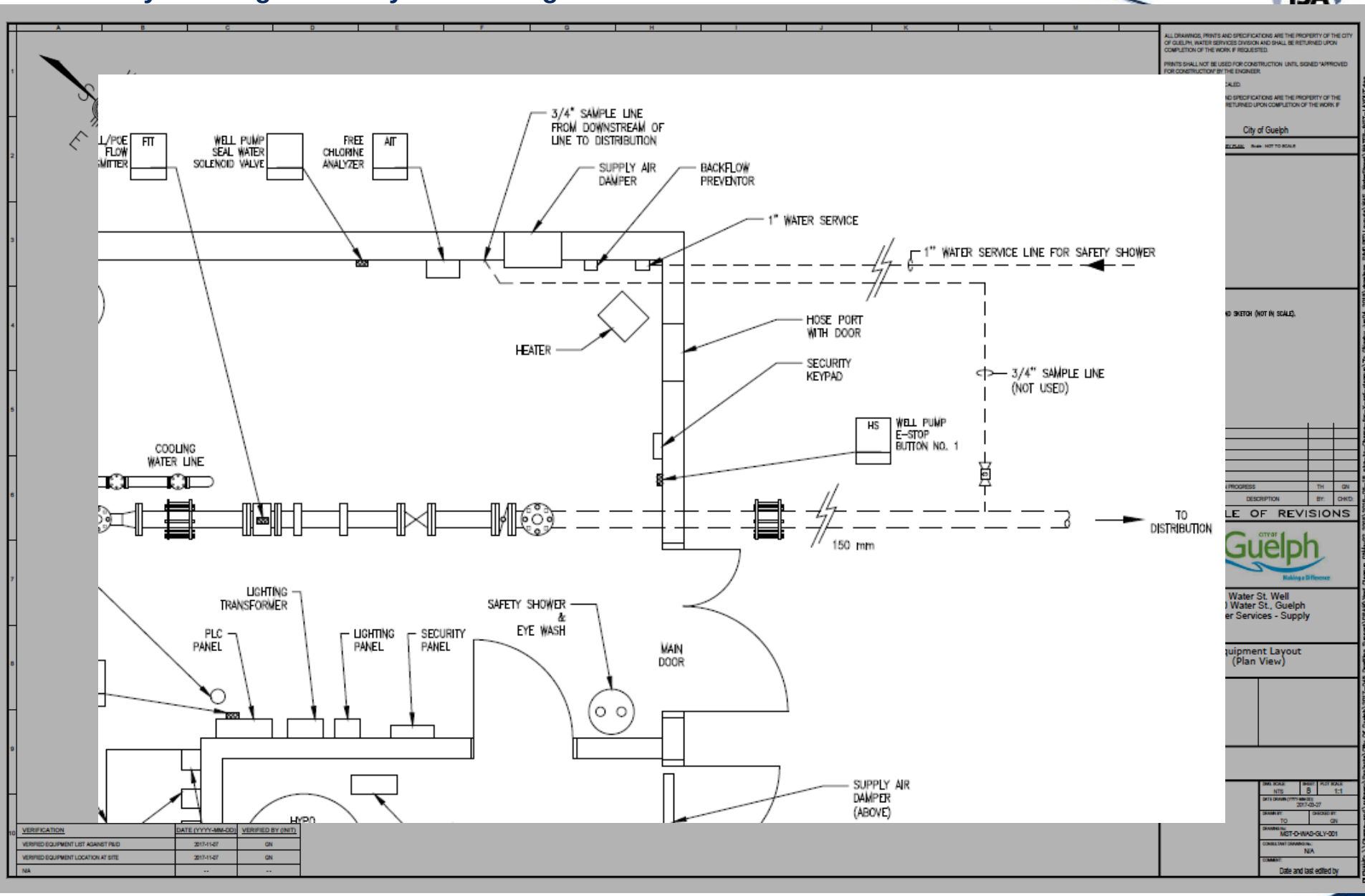
- Show locations of all devices and instrumentation at a facility
- Avoid unnecessary architectural details
- Only plan view is used
- Both tags and plain language descriptions are used for equipment
- Mounting height of equipment is shown
- Approximate scale on drawing

- Quickly summarizes locations of all devices/instrumentation
- Useful to orient staff with location of equipment at the site
- Useful tool for defining scopes of work for contractors/staff
- One layout drawing per site

Facility Drawings: Site Layout Drawings



Facility Drawings: Site Layout Drawings



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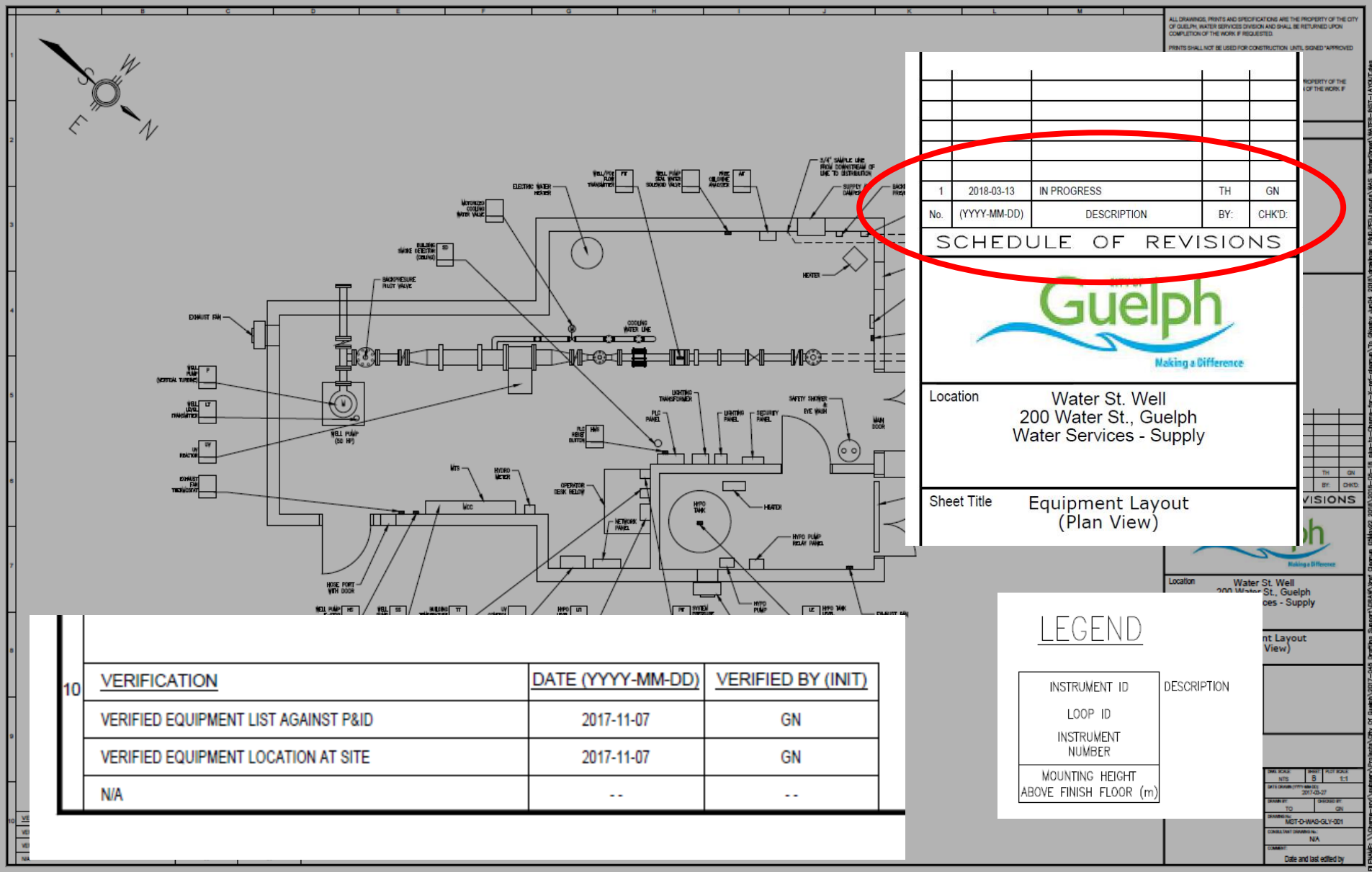


Facility Drawings: Electrical & I/C Drawings

- Electrical & I/C Drawings

Goals

- Most frequently used drawings for trouble-shooting
- Treated as a “set” of drawings
- Standard order/format
- Only updated when changes are made

- Electrical Layout
- MCC & Lighting Panels
- Electrical Starters: Loop/Connection Diagrams
- PLC Panel Drawings
- Instrumentation Loop/Connection Diagrams
- Network Drawings

Facility Drawings: Electrical & I/C Drawings

SHEET	DWG.#	DESCRIPTION
1	MST-D-WAS-EID-001	DRAWING INDEX
2	MST-D-WAS-ELY-001	ELECTRICAL EQUIPMENT LAYOUT (PLAN VIEW)
3	MST-D-WAS-ELY-002	ELECTRICAL MAJOR CONDUITS/JUNCTION BOXES
4	MST-D-WAS-ELY-003	LIGHTING LAYOUT (WITH SWITCHES & RECEPTACLES)
5	MST-D-WAS-E00-001	ELECTRICAL SINGLE LINE
6	MST-D-WAS-E00-002	ELECTRICAL MCC ELEVATION
7	MST-D-WAS-E00-003	ELECTRICAL LIGHTING PANEL SCHEDULE
8	MST-D-WAS-ELP-001	ELECTRICAL STARTER/LOOP DRAWING #1 DIGITAL POWER MONITOR
9	MST-D-WAS-ELP-002	ELECTRICAL STARTER/LOOP DRAWING #2 WELL PUMP STARTER
10	MST-D-WAS-ELP-002A	ELECTRICAL STARTER/LOOP DRAWING #2A WELL PUMP STARTER SCHEMATIC WIRING DIAGRAM
11	MST-D-WAS-ELP-003	ELECTRICAL STARTER/LOOP DRAWING #3 UV UNIT
12	MST-D-WAS-ELP-004	ELECTRICAL STARTER/LOOP DRAWING #4 UV COOLING WATER VALVE
13	MST-D-WAS-ELP-004A	ELECTRICAL STARTER/LOOP DRAWING #4A UV COOLING WATER VALVE DEVICE TERMINALS
14	MST-D-WAS-IND-001	SCADA NETWORK DIAGRAM
15	MST-D-WAS-ICPI-001	PLC PANEL LAYOUT
16	MST-D-WAS-ICPI-002	PLC PANEL TERMINAL BLOCK LAYOUT & BOM
17	MST-D-WAS-ICPI-003	PLC PANEL POWER DISTRIBUTION
18	MST-D-WAS-ICPI-004	PLC PANEL PLC RACK LAYOUT
19	MST-D-WAS-ICPI-005	PLC PANEL POWER SUPPLY & SLOT 0
20	MST-D-WAS-ICPI-006	PLC SLOT NO. 1 & 2
21	MST-D-WAS-ICPI-007	PLC SLOT NO. 3 & 4
22	MST-D-WAS-ICPI-008	PLC SLOT NO. 5 & 6
23	MST-D-WAS-ICPI-009	PLC SLOT NO. 7
24	MST-D-WAS-ICPI-010	PLC SLOT NO. 8
25	MST-D-WAS-ICPI-011	PLC SLOT NO. 9
26	MST-D-WAS-ILP-001	LOOP DRAWING #1 HYPO PUMP
27	MST-D-WAS-ILP-002	LOOP DRAWING #2 HYPO TANK LEVEL
28	MST-D-WAS-ILP-003	LOOP DRAWING #3 POE CHLORINE ANALYZER
29	MST-D-WAS-ILP-004	LOOP DRAWING #4 WELL POE/FLOWMETER
30	MST-D-WAS-ILP-005	LOOP DRAWING #5 POE SYSTEM PRESSURE
31	MST-D-WAS-ILP-006	LOOP DRAWING #6 BUILDING AMBIENT TEMPERATURE
32	MST-D-WAS-ILP-007	LOOP DRAWING #7 SECURITY SYSTEM
33	MST-D-WAS-ILP-008	LOOP DRAWING #8 SMOKE DETECTOR
34	MST-D-WAS-ILP-009	LOOP DRAWING #9 WELL LEVEL PROBE

KEY PLAN Scale - NOT TO SCALE

NOTES:

No.	(YYYY-MM-DD)	DESCRIPTION	BY:	CHK'D:
1	2016-07-06	AS FOUND	LM	TB

SCHEDULE OF REVISIONS

Location: Water Street Well
200 Water st, Guelph
Water Services - Supply

Sheet Title: DRAWING INDEX
ELECTRICAL, I&C, PLC PANEL

DWG. SCALE	SHEET	PLOT SCALE
NTS		1:1

DATE DRAWN (YYYY-MM-DD): 2016-07-06

DRAWN BY: LM | CHECKED BY: CHKBY

DRAWING No.: MST-D-WAS-EID-001

CONSULTANT DRAWING No.: 17249

COMMENT:

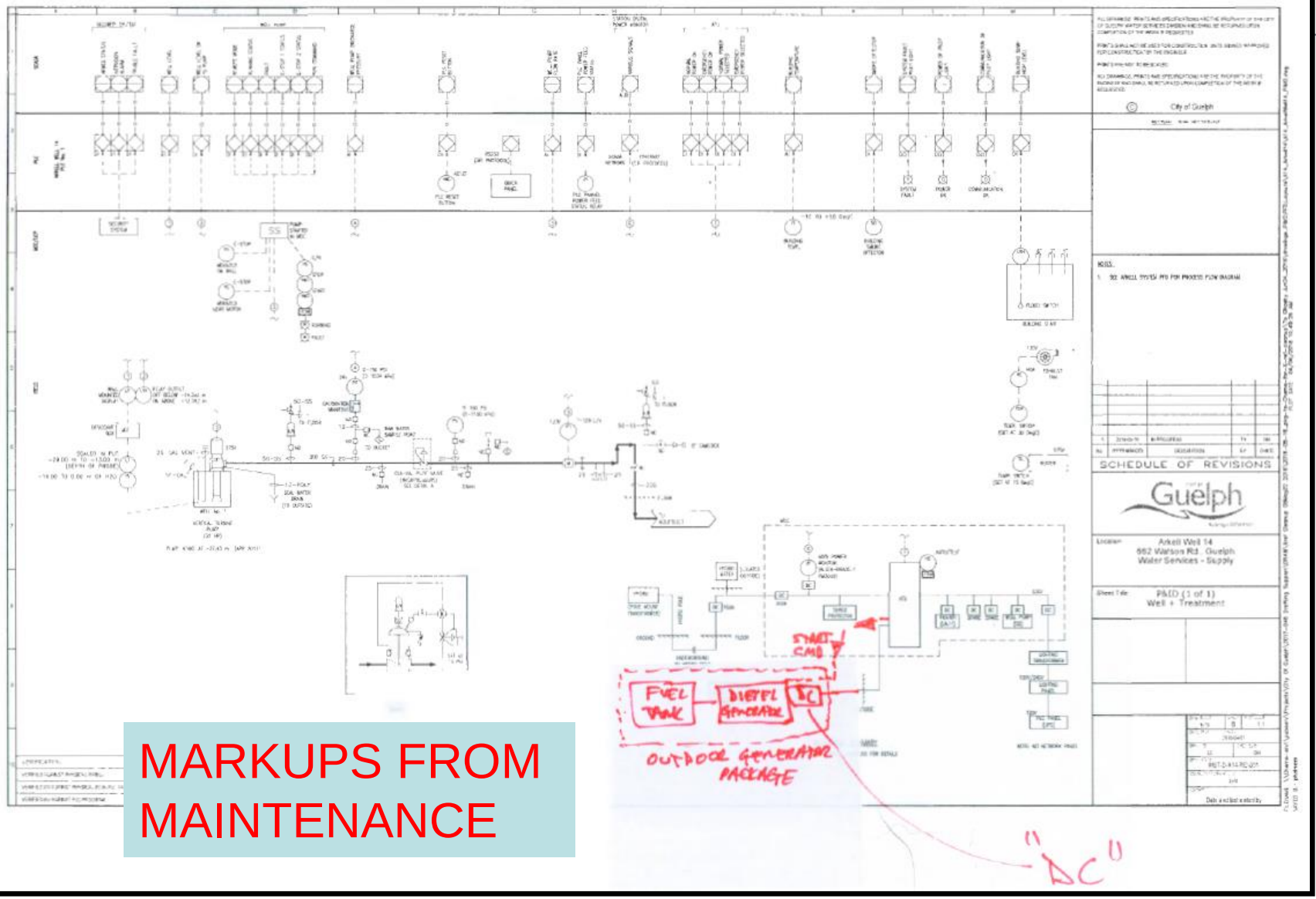
Keeping Facility Drawings Up to Date

- Drawings updated once per year
  - PDF copies are stored in a Document Management System
  - AutoCAD files are maintained by SCADA Department (GIT revision control)
  - Updated PDFs are generated once per year

- Storage
  - “Official PDF copy” is in the Document Management System
  - Paper print out at each facility in O&M binder, updated once per year

- Maintenance Work Flow
  - When maintenance works on a system, they print out the PDF drawing and mark it up with a red pen – paper markups given to SCADA Department
  - For major updates, new PDF copies are issued
  - For minor updates, wait until annual update or as time permits

Keeping Facility Drawings Up to Date



Keeping Facility Drawings Up to Date

- Annual Verifications
  - Each Year 20% of the P&IDs, PFDs and Layouts are Yellow-lined on site
  - For remaining 80% of drawings, a quick desk-based verification is done
  - Edits made as needed, and new PDF drawings issued with an updated ate

- Yellow-lining
  - Print out drawing and use a yellow highlighter to trace over lines as they are verified
  - Observed changes are marked up in red-pen
  - The AutoCAD drawing is then updated
    - Update “Verifications” schedule & “Revisions” schedule on drawing
    - Revision comment stays as “AS FOUND”

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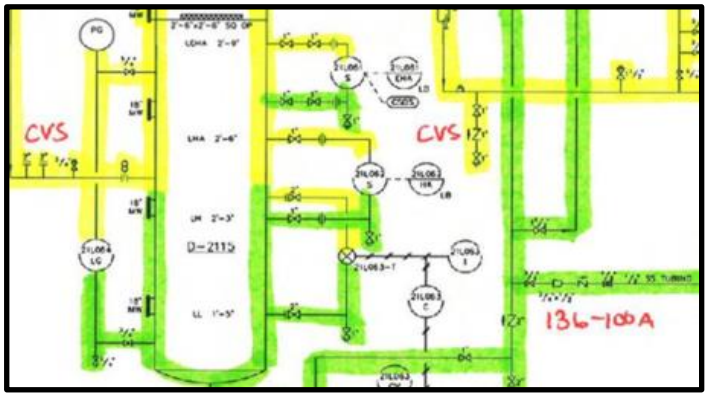
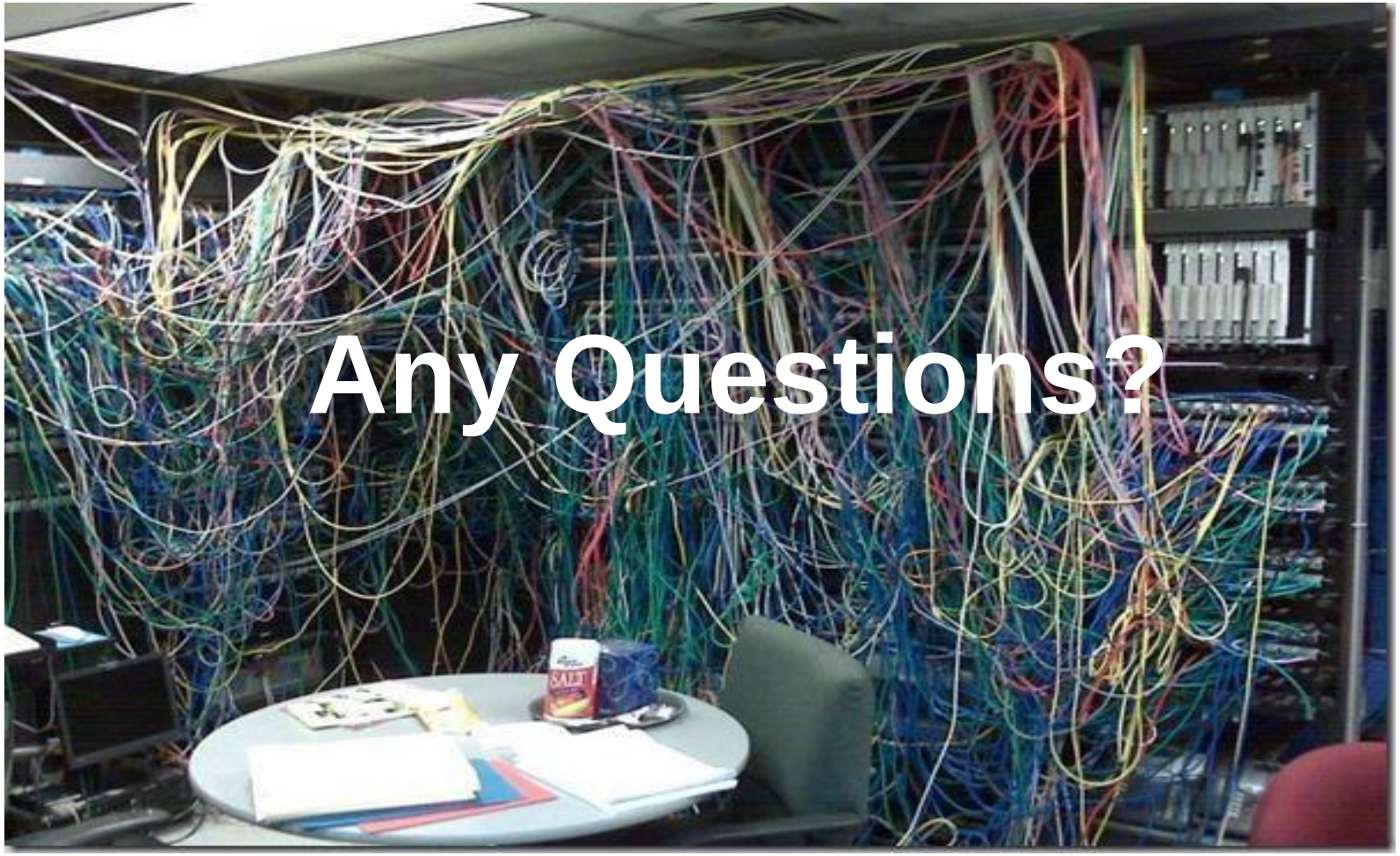
	VERIFIED AGAINST PHYSICAL PIPING	2017-11-07	GN
	VERIFIED I/O AGAINST PHYSICAL I/O IN PLC PANEL	2017-11-07	GN
	VERIFIED I/O AGAINST PLC PROGRAM	2017-11-07	GN



Wrap-Up



* No facility drawings for this system (yet)