THE VILLAGE OF WELLINGTON

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Technical Memorandum

Date:	September 6, 2018
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Subject:	Water Reclamation Facility PLC Replacement Study

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1.0 EXECUTIVE SUMMARY

1.1 Presently, the Village's process automation at the Water Reclamation Facility is comprised of obsolete and near end-of-life PLC (Programmable Logic Controller) hardware that will soon be unsupported by the manufacturer. This study was commissioned to examine the feasibility, costs and impacts realized by replacing the automation platform with modern hardware. There are fourteen (14) PLC locations (and associated software programming) within the facility, each of which are evaluated against four (4) hardware replacement alternative strategies in this technical memorandum. Process controllers are located in the following process areas:

A. Headworks (PLC-1) – Allen-Bradley SLC 5/05
B. Blower Facilities (Alka-Pro PLC) - Allen-Bradley PLC/5
C. MCC Room Main Building (CP-1) - Allen-Bradley PLC/5
D. Aeration Basin No. 3 (CP-2000) - Allen-Bradley SLC 5/05
E. Sludge Dryer Facility (CP9005-2) - Allen-Bradley SLC 5/05
F. Generator Building (MCP-2) – Replaced Under Renewal & Replacement Project
G. Filter Dosing Building (PLC-5000) - Allen-Bradley SLC 5/05
H. Gravity Filter Main Control Panel - Allen-Bradley SLC 5/05
I. Sludge Dewatering PLC - Allen-Bradley SLC 5/05
J. Solids Stabilization Control Panel (Lime) - Replaced Under Renewal & Replacement Project
K. Seepex Control Panel (Cake Pumps) - Allen-Bradley SLC 5/05

1.2 Communication from PLC/5 to remote input/output racks (RIO) is over Data Highway Plus (DH+) communications protocol. Otherwise communications for all other main PLC's is over Ethernet/IP protocol.

1.3 The four hardware replacement alternatives are:

A. <u>Alternative 1 - Conversion Kits (PLC/5 Platform):</u> Rockwell has developed a system for replacing existing PLC/5 hardware with Control Logix hardware, in place, without disconnecting, or removing, field wiring from a PLC/RIO input/output card. The conversion kit consists of a conversion mounting assembly, cables and conversion modules.
B. <u>Alternative 2 - Remove and Replace in Situ (SLC 5/05):</u> New Control Logix hardware is required and rewiring of the existing SLC5/05 input/output modules to the new Control Logix modules is required. The existing PLC is removed and the new unit installed directly in its place. This approach requires significant down time to perform.
C. <u>Alternative 3 – Temporarily Support and Relocate (SLC 5/05):</u> The existing process controller will be relocated onto a temporary support adjacent to/in front of the existing enclosure while a new controller is installed its place in the existing enclosure. Both controllers will operate simultaneously while signals are transferred, one-by-one, from the old PLC to the new PLC.
D. <u>Alternative 4 – New PLC Panel (Any existing platform):</u> a new PLC panel is provided in an new location and signals transferred from one panel to the other. The existing PLC panel would become a terminal junction box (or marshalling panel) to the new process controller panel with new wire and raceway routed from the existing PLC panel to the new PLC panel.

1.4 The analysis performed herein yields recommended approaches that prioritize minimal impact to plant operations with additional consideration for physical and practical limitations observed at each location. New PLC and SCADA programming will be required due to incompatibility of the existing software with the updated hardware.

1.5 It is recommended to replace existing PLC's identified in the study with equivalent Control Logix platforms and rewrite the existing PLC programming for each PLC replaced.

1.6 Software Considerations:

A. The existing control system is comprised of different PLC programs that provide varying degrees of automation and monitoring throughout the treatment facility. Each PLC controls a section of the plant. All existing programs are written in ladder logic program files with RS Logix 5 programming software. The existing program files are not compatible with the proposed Control Logix PLC hardware and cannot be loaded onto the new process controllers. Replacement of the existing PLC hardware requires rewriting of the ladder logic in RS Studio 5000 (Studio 5000) programming software. Legacy programs are written in language that uses physical register addresses in the ladder logic, where the new PLC platform program is written in language that is register tag based that uses a user-defined string of text to point to the memory location. To migrating from a register address based program to a string text memory address, a complete re-write of the program is required. There are conversion tools available; however, experience has proven that use of these tools does not result in a complete, error free, conversion and significant effort is usually required to trouble shoot and correct conversion errors. Often the program does not function efficiently after conversion. Industry practice is to re-write the program in the new platform software for a conversion of this type and magnitude.

B. To quantify the level of effort required to convert the control logic from address based programming to tag based programming, the number of rungs in each legacy program are determined and the required memory, in bytes, for all rungs in the program file are determined. The number of rungs can be representative of the level of effort required since a programmer will need to study the existing control logic rung by rung. Since rungs can contain a variable number of instructions, the required memory can be representative of the average complexity of each rung. The following table provides, by process controller discussed in Section 4.0, the number of rungs and required memory for the facility's existing PLC's.

PLC Name	Rungs	Bytes	Bytes/Rung	Effort
PLC-1 (Headworks)	58	2246	38.72	Low
Alka-Pro PLC (Blowers)	906	6691	7.39	High
CP-2000 (Basin 3)	644	46508	72.22	Moderate
MCP-2 (Generator Bldg)	N/A	N/A	N/A	N/A
PLC-5000 (Filter Dosing)	418	28657	68.56	Moderate
Main Control Panel (Filters)	367	13495	36.77	N/A
CP9005-2 (Dryer)	578	20220	34.98	Moderate
Belt Filter Press PLC	591	18509	31.32	Moderate
Cake PLC	67	2536	37.85	Low
Lime PLC	N/A	N/A	N/A	N/A

C. Local HMI Considerations: conversion of the PLC logic will break all links to the existing local HMI objects and animations due to the change in program file structure (address-based versus tag-based). It is required to reconfigure each local HMI to remap the old address-based pointer to a tag-based pointer. It is difficult to measure the level of effort required to perform this task because it depends on how each object and animation is configured and how many objects there are. The best measure is the PLC program. It can be assumed that more complex PLC programs, such as the Dryer facility will require additional effort when compared to simpler programs, such as the Cake Pump PLC.

D. Any replacement HMI will require that old configuration files be converted for compatibility with the newest software because old configurations cannot be loaded onto a new terminal. Consideration is given to replacement of existing HMI's with industrial computers operating either a Runtime or Slim license of VT SCADA. A Slim license would allow the computer to access the displays from the SCADA server, but would not function if communications were lost. A Runtime license will remain operational in the event of a communications lost.

1.7 Conclusions:

A. The PLCs investigated have either reached their end of useful life or support by the manufacturer is in process of being sunset. Migrating to an updated PLC platform will mitigate the increasing costs of procuring hardware for replacement and expansion of the existing PLC system.

B. Replacement of the PLC hardware and software will disrupt plant operations; however, the approaches analyzed and recommended minimize these disruptions by completing as much work as practicable prior to switching from the old platform to the new. Entire process shutdowns can be avoided with careful planning and clear constraints imposed by the design.

C. The existing PLC hardware is programmed with legacy PLC programming software. This creates two problems. First, all new programming furnished on the old platform will require rewriting in the future. Second, all SCADA HMI and Local HMI programming will require remapping when converting from the old to new software platform.

D. The Village can optimize local control by implementing industrial computers in place of existing local HMIs. Doing so will provide the ability to mirror existing SCADA HMI screens for this project, and in the future. Purchase of Runtime licenses will be required if redundancy is desired. Otherwise, a Slim client, already included in the Village's existing VT SCADA license will suffice.

1.8 Recommendations

A. Replace existing SLC 5/05 and PLC/5 PLC platforms with equivalent Control Logix platform as follows:

Headworks (PLC-1)	Temporary Relocate & Replace
Alka-Pro Panel (New RIO)	Conversion Kit (Covert to RIO)
MCC-Room Main Building (CP-1)	New PLC Panel
Aeration Basin #3 (CP-2000)	New PLC Panel
Generator Building (MCP-2) - Addressed in Expansion	Not Required
Sludge Dryer Facility (CP-9005-2)	New PLC Panel
Filter Dosing Building (PLC-5000)	Temporary PLC and

	Replace
Gravity Filter Building (Main Control Panel) – Recommend to Address in Expansion	Not Required
Belt Press Building (Sludge Dewatering PLC)	Temporary PLC and Replace
Solids Stabilization Control Panel (Lime PLC) - Addressed in Expansion	Not Required
Belt Press Building (Cake Pump PLC)	Remove and Replace

B. Coordinate PLC software and firmware with ongoing waste water plant expansions/improvements.

C. Encumber funding for the contractor to field verify wiring systems and programming to determine what has been rendered obsolete by changes and upgrades performed

1.9 The Opinion of Probable Construction Cost is **$955,900**.

2.0 PURPOSE

2.1 The Village of Wellington Utilities (Village) operates a 6.5 MGD Water Reclamation Facility (plant) that is controlled, monitored and operated through a programmable logic controller (PLC) based Supervisory Control and Data Acquisition (SCADA) control system. Currently, there are fourteen (14) programmable logic controllers (PLC's) and remote input/output racks (RIO's) that comprise SCADA interface with the treatment process components and systems that provide varying degrees of automation throughout the plant. The PLC's and RIO racks are networked together, through a multimedia switch, to the SCADA workstations in the control room. The existing PLC'S and RIO'S are Rockwell Automation Allen-Bradley SLC5/05 series, and Allen-Bradley PLC 5 series, which are a legacy controller platforms that have been sunset (no longer manufactured or supported) by Rockwell Automation. The Village has identified the need to replace the legacy PLC hardware platforms with state-of-the-art equipment to modernize the process level automation platform, including software programming, to enhance reliability of treatment operations and mitigate risk resulting from reliance on hardware that is obsolete. The purpose of this study is to evaluate the options, and associated costs, to replace the fourteen (14) programmable logic controllers (PLC's) and remote input/output racks (RIO's) with state-of-the-art Rockwell Automation Control Logix platform while maintaining plant operations. This technical memorandum will:

1. Generate an updated control system block diagram depicting the current SCADA system configuration including process controllers, SCADA workstations and networking communications interconnecting the control system components.
2. Analyze the feasibility to implement new Rockwell Automation Control Logix platform controllers, including physical characteristics of the existing PLC panel enclosures, at each existing process controller location.
3. Determine the most reasonable approach (balancing cost, complexity, down time and treatment process impact) to upgrade/convert each process controller to the Control Logix Platform, including any physical constraints of the existing installation. Implementation of possible temporary PLCS while modifications are made for permanent units will be considered if practicable.

4. Review the various process controller software programs to understand complexity and level of effort required for conversion to Control Logix platform. This includes impacts to Plant SCADA and local HMI's.
5. Determine the scope of work, and conceptual level costs, to design and implement the hardware and software conversion for each existing process controller location.
6. Identify challenges related to hardware upgrades while maintaining plant operations and provides recommendations for implementation of both software and hardware.

2.2 This technical memorandum was developed based on site inspections, review of available plans and specifications and discussions with plant personnel and equipment suppliers.

2.3 This technical memorandum does not evaluate, or make recommendations, related to the SCADA workstations, software, or means of communications or related protocol. It is observed that the current method of interconnection of the various process controllers exposes the control system to single point failures as many of the process controllers are in a single branch (star) type configuration from the SCADA multimedia switch in the control room. For example, a failure of the fiber optic cable, or connections, to the belt press building also interrupts SCADA from monitoring and controlling the Lime Building, Dryer Facility, MCC/Generator Building, Effluent Filters and Aeration Basin No.3 with no redundant path for the control and monitoring signals.

3.0 BACKGROUND

3.1 The existing plant SCADA system is a distributed process controller (PLC) based system that communicates over a combination of copper and fiber optic Ethernet to the main control room in the Administration Building. Process controllers are located in the following process areas:

1. Headworks (PLC-1)
2. Blower Facilities (Alka-Pro PLC)
3. MCC Room Main Building (CP-1)
4. Aeration Basin No. 3 (CP-2000)
5. Sludge Dryer Facility (CP9005-2)
6. Generator Building (MCP-2)
7. Filter Dosing Building (PLC-5000)
8. Gravity Filter Main Control Panel
9. Sludge Dewatering PLC
10. Solids Stabilization Control Panel (Lime)
11. Seepex Control Panel (Cake Pumps)

3.2 The PLC replacement candidates generally consist eleven (11) of Rockwell Automation SLC 500 processor platforms with three (3) Rockwell Automation PLC/5 platform racks. Communication from PLC/5 to remote input/output racks (RIO) is over Data Highway Plus (DH+) communications protocol. Otherwise communications for all other main PLC's is over Ethernet/IP protocol.

3.3 The PLC/5 platform is "discontinued" according to Rockwell Automation. The SLC 500 platform is primarily "active mature" according to Rockwell Automation, however many components are "discontinued" or "end of life". The recommended replacement product is Rockwell Automation Control Logix platform for PLC/5 and Compact Logix for SLC 500, however Control Logix may also be considered. The product life cycle terms are described as follows:

1. Active mature: the product is fully supported, but a newer product or platform exists and there is value gained by migrating.
2. End of life: a product discontinued date has been announced by the manufacturer and completing migrations to a current platform is recommended. Components are generally orderable until the discontinued date, however outages on specific items may occur earlier.
3. Discontinued: the product is no longer manufactured or procured. Limited replacement stock may be available regionally. The recommended replacement product is Rockwell Automation Control Logix platform.

3.4 The costs of replacement parts for both the PLC/5 and SLC 500 platforms have been steadily increasing because decreased availability (PLC/5) and the manufacturer increasing cost to encourage customers to migrate (SLC 500) to newer platforms. Parts are generally available through third party suppliers but in limited quantity.

3.4 The Operations Building has control servers and workstations running Schneider Electric Wonderware graphical user interface software talking to the PLC's over Ethernet communications protocol. The Village is currently in the process of converting the existing system to a Trihedral VTScada platform. This SCADA HMI conversion is anticipated to be completed prior to the beginning phase of design for the PLC replacement.

3.5 Each process controller location was investigated to generate an up-to-date control system block diagram depicting the control system and communications architecture of the SCADA system including major components of each panel and their relative interconnections. A control system block diagram depicting the current system configuration is provided in Appendix A.

3.6 There is a plant expansion, currently in design, that will construct a new control room in a renovated Operations Building and will modify existing PLC's, replace existing PLC's, and install new PLC's. This technical memorandum excludes considerations for the following areas impacted under that project:

1. Existing Operators Building (Modify PLC)
2. Existing Lime Building (New PLC)
3. Existing Generator Building (New PLC in existing enclosure)
4. Reuse Building (Relocate PLC)
5. Blower Building (New PLC)

4.0 HARDWARE REPLACEMENT ALTERNATIVES

4.1 This section discusses possible alternatives to process controller PLC/RIO replacement. Section 4.0 discusses each process controller panel and applies the most appropriate, and reasonable, of the replacement alternatives discussed below on a case-by-case basis.

4.2 Alternative 1 - Conversion Kits (PLC/5 Platform)

A. Transferring the existing wiring to the new system is the most time consuming and error prone portion of a PLC hardware replacement. Rockwell has developed a system for replacing existing PLC/5 hardware with Control Logix hardware without disconnecting, or removing, field wiring from a PLC/RIO input/output card. The conversion kit consists of a conversion mounting assembly, cables and conversion modules. The conversion mounting assembly is selected by determining the existing PLC/5 rack size. The cables and conversion modules are selected by determining the PLC/5 card that is being replaced and the Control Logix replacement card. Refer to Appendix B for vendor data on the PLC 5 to Control Logix conversion kit. The existing PLC/5 input/output card swing arm (the module which physically plugs into the I/O module) plugs into the conversion modules directly and is connected to the new input or output module with a pre-wired cable. Appendix C contains vendor data on the associated pre-wired conversion cable. This approach significantly reduces the amount of time required to convert from the PLC/5 platform to the Control Logix platform and minimizes the risk of wiring errors and downtime alike.

B. Rockwell Automation indicates that the conversion kit increases the depth of the PLC rack assembly to 10.25 inches (with the programming key inserted into the controller). A minimum enclosure depth of 12 inches is recommended by Rockwell Automation to apply the conversion kit. No ventilation space is required in front of the PLC; however, there must be adequate ventilation around (top, bottom, sides) the new Control Logix hardware in the enclosure to prevent overheating.

C. The existing PLC software program cannot be directly loaded into the new Control Logix processor as there are significant changes in the complexity of the programming language between platforms. There is a translator offered by Rockwell Automation; however, the end product of the translation generally results in mixed success with regards to programming performance. A general re-write and testing of the software is recommended by Rockwell Automation before performing the conversion to streamline the process.

D. After the hardware has been replaced, the re-written PLC program is then loaded into the new PLC and tested in conjunction with the SCADA HMI. Refer to Section 5 for software considerations.

E. This approach is practical for PLC/5 installations only. No conversion kit is available for SLC 5/05 hardware. The processes must be operated manually for a short period, conservatively 12 hours, to provide time to verify control strategies and links with plant SCADA HMI.

4.3 Alternative 2 - Remove and Replace in Situ (SLC 5/05)

A. Rockwell Automation does not offer a conversion kit for the SLC5/05 rack, input/output module and power supply to the equivalent Control Logix equipment. New Control Logix hardware is required and rewiring of the existing SLC5/05 input/output modules to the new Control Logix modules is required.

B. There must be adequate slack in the existing wiring harness for reuse. The harness is the bundle of wires that plug into each input/output module. Where the length is inadequate, new wiring internal to the panel must be installed from the new input/output module to the nearest termination point. Rewiring will be the most time consuming portion of the shutdown.

C. Once all internal wiring has been terminated on the new hardware, the system must be loop checked to ensure no wiring errors were made. Any errors must be corrected prior to attempting start up.

D. As with Alternative 1, the existing PLC software program cannot be directly loaded into the new Control Logix processor as there are significant changes in the complexity of the programming language between platforms. A general re-write and testing of the software is recommended before performing the conversion to streamline the process.

E. After loop checks are verified, the revised PLC program is then loaded into the new PLC processor and tested in conjunction with the SCADA HMI. Refer to Section 5 for software considerations.

F. This approach is practical for processes which can be operated and monitored manually for extended periods, conservatively 4 weeks, depending on the number of points which must be rewired. This time period provides time to rewire, loop check, functional test and prove links with plant SCADA HMI. Where processes cannot be operated and monitored manually for extended time period, an alternative which requires less downtime must be considered.

4.4 Alternative 3 – Temporarily Support and Relocate (SLC 5/05)

A. The existing process controller will be relocated onto a temporary support adjacent to/in front of the existing enclosure while a new controller is installed its place in the existing enclosure. Both controllers will operate simultaneously while signals are transferred, one-by-one, from the old PLC to the new PLC. As each signal is migrated, it must be loop checked to ensure no wiring errors were made. After all signals are migrated, the old hardware may be eliminated.

B. To accomplish this approach, there must be adequate slack in the existing wiring harnesses to relocate the existing hardware to a temporary support. The harness is the bundle of wires that plug into each input/output module. Where the length is inadequate, new wiring internal to the panel must be installed from the new input/output module to the nearest termination point. Rewiring, if any, will be the most time consuming portion of the work.

C. Similarly, a new process controller could be installed onto a temporary support adjacent to/in front of the existing enclosure while signals are transferred from the old PLC to the new PLC one at a time. Similarly, the controllers will operate simultaneously during the swap. All internal wiring from the existing PLC to interfaces (interposing relays, surge protectors, etc) would be replaced with new wiring to the new PLC. After all signals are transferred, the new process controller would be mounted onto the backplane in place of the existing. The suitability of this slightly modified approach can be considered on a case by case basis.

D. As with Alternative 1, the existing PLC software program cannot be directly loaded into the new Control Logix processor as there are significant changes in the complexity of the programming language between platforms. A general re-write and testing of the software is recommended before performing the conversion to streamline the process.

E. After loop checks are verified, the revised PLC program can be loaded and tested in conjunction with the SCADA HMI. Refer to Section 5 for software considerations.

F. This approach is practical for process areas where two conditions are true: (1) those which cannot be reasonably operated and monitored manually for extended periods of time and (2) where there is not physical space in the existing PLC panel to accommodate the new Control Logix equipment without removal of the existing PLC. The temporary support must be located so the hardware is protected from environmental conditions that would pose a hazard to the equipment. Downtimes for pieces of equipment are anticipated; however the intent is for signals to be switched from the old PLC to the new PLC one at a time, minimizing risk.

4.5 Alternative 4 – New PLC Panel (Any existing platform)

A. Where Alternatives 1, 2 or 3 are not feasible, a new PLC panel must be provided in an alternate location and signals transferred from one panel to the other. The existing PLC panel would become a terminal junction box (or marshalling panel) to the new process controller panel with new wire and raceway routed from the existing PLC panel to the new PLC panel. The advantage of this approach is the amount of interruption to the process is limited to individual signals, or small groups of signals, that are manageable by operations in maintaining the treatment process. The disadvantage is that additional conditioned floor space is required and additional wire and raceway is required. Termination of the wiring in both panels is time consuming and the total amount of time to make the transition is likely the longest.

B. The new PLC, wiring and raceway could be installed and signals transferred one at a time to minimize disruptions, and risk, to plant operations. The two PLC systems would operate in parallel temporarily, until all signaling and control is transferred, after which the legacy PLC platform will be removed.

C. With a new panel, new software programming is required to operate both systems in parallel. After loop checks are verified, the new PLC program is loaded and tested in conjunction with the SCADA HMI. Refer to Section 5 for software considerations.

D. Replacement PLC panels would need to supply to power any instruments currently powered from the existing panels. This must be considered during detailed design.

E. This approach is practical for processes which cannot be reasonably operated and monitored manually for extended periods or if there is physically not sufficient space in the existing PLC panel to accommodate the new Control Logix equipment. Inn this approach, minimal downtimes for operation of process equipment is anticipated.

4.6 Constraints, Limitations and Other Considerations

A. PLC replacements, regardless of whether they utilize conversion kits, require extensive planning and attention to detail to be executed effectively. All required hardware, cables, wiring, labels, and programming (PLC and HMI) must be on-site, tested to the greatest extent and ready to install. This is intended to minimize disruptions to plant operations.

B. A switchover plan should be developed, reviewed and approved for each PLC system. The plan must identify which process areas and specific equipment will be impacted, the length of time anticipated for the work, and the specific procedures to transfer wiring and verify control strategies quickly and accurately. Coordination with and input from operations is important for planning of operating modes during transition.

C. Plant staff must be prepared to operate the affected equipment manually for a period of time and will depend on the number of, and method of, replacement points being transferred; the amount of wiring made obsolete; the complexity of automatic control; and any unforeseen circumstances that may arise.

D. In all cases, for each PLC modified, an input and output schedule will be provided during detailed design. The schedule will be a tool for transferring existing wiring to the new PLC platform.

E. Hardware loop checks will be required for all signal migrations except for PLC-5 conversion kits since no wiring will be transferred. Software loop checks and functional checks are required in all cases.

F. All wiring rendered obsolete should be removed to clean up the appearance of the panels and simplify troubleshooting.

G. The replacements will include updated layout drawings and schematics reflecting the as-built condition of the modified panels.

H. Additional considerations will be made during design to accommodate plant operations where necessary, including loop controllers, temporary control panels and rerouting signals temporarily if required for regulatory reporting. Constraints will be placed on the contractor to ensure that safety and maintenance of plant operations will be a critical consideration for all work.

4.7 General PLC Panel Design Criteria

A. Control panels located outdoors and containing digital equipment will be specified with NEMA 4X, 316 stainless steel equipment enclosures with sunshields and powder coat white paint. Internal heat management will be specified as required. Panel fronts will be oriented north, where practical.

B. Panels located indoors will be specified with NEMA 12 (indoor, conditioned) or NEMA 4X, 316 stainless steel (corrosive locations) equipment enclosures.

C. All control panels containing digital equipment will be equipped with uninterruptable power supply (UPS) units to serve as power conditioners and maintain power to digital equipment during a power outage.

D. New PLC panels will include all ancillary devices necessary for a complete control system including, but not limited to circuit breakers, surge protection, PLC’s, switches, UPS, patch panels, power supplies, fuses, grounding, terminals and interposing relays.

E. All outdoor analog 4-20ma signals will have surge protective devices (SPD’S), at both ends, where the instrument is located outdoors.

F. All outdoor discrete signals will have SPD'S on the signal loop to reduce the effects of lightning.

G. Communications links will match existing, to the greatest extent, with the old control panel serving as a termination or patch point to extend existing infrastructure. Where the existing protocol cannot be matched, new links will be designed.

5.0 PLC CONTROL PANELS

5.1 The facility is currently equipped with the following process controllers which are candidates for upgrade from legacy PLC/5, or SLC-5/05, platforms to the Control Logix Platform:

1. Headworks (PLC-1)
2. Blower Facilities (Alka-Pro PLC)
3. MCC Room Main Building (CP-1)
4. Aeration Basin No. 3 (CP-2000)
5. Generator Building (MCP-2)
6. Sludge Dryer Facility (CP9005-2)
7. Filter Dosing Building (PLC-5000)
8. Gravity Filter Main Control Panel
9. Sludge Dewatering PLC
10. Solids Stabilization Control Panel (Lime)
11. Seepex Control Panel (Cake Pumps)

Appendix D contains a table depicting detailed breakdowns of physical properties including locations, names, enclosure dimensions, communication protocols, existing I/O cards and presence of local HMI (Panelview) terminal for each of the candidate process controllers.

5.2 The sections that follow identify for each PLC location constraints, and hardware related challenges, to convert the existing PLC platform to the new PLC platform.

5.3 Headworks (PLC-1)

A. PLC-1 performs monitoring functions related to headworks process equipment in addition to control of a motorized emergency bypass gate. The existing process controller is an Allen-Bradley SLC 5/05 with no additional remote I/O chassis. A photograph the panel is provided below.

PLC-1 Enclosure

B. The panel has adequate space and wire length to temporarily relocate the existing rack to make space for a new PLC rack in the same location. The process would require manual operation for a short (2 hours) time period to relocate the existing rack onto a temporary support. The wiring would be transferred to the new PLC one signal at a time.

C. Although PLC-1 is located in the headworks, the process is presently monitored and controlled by Alka-Pro PLC via RIO CP-1 located in the operations building. Screens and compactors operate in tandem and are activated locally with float switches with PLC-1 only performing monitoring functions. The grit system time sequence is automated by the PLC. Coordination will be required during the replacement of CP-1, Alka-Pro PLC and PLC-1 process controllers.

D. The headworks and grit collection system will need to be monitored manually during the replacement and loop checks.

E. It is recommended to utilize Alternative 3 (temporary PLC and replace) for this location.

5.4 Alka-Pro Control Panel (Blower Room)

A. The existing process controller is an Allen-Bradley PLC/5. A photograph the panel is provided below.

Alka-Pro PLC Enclosure

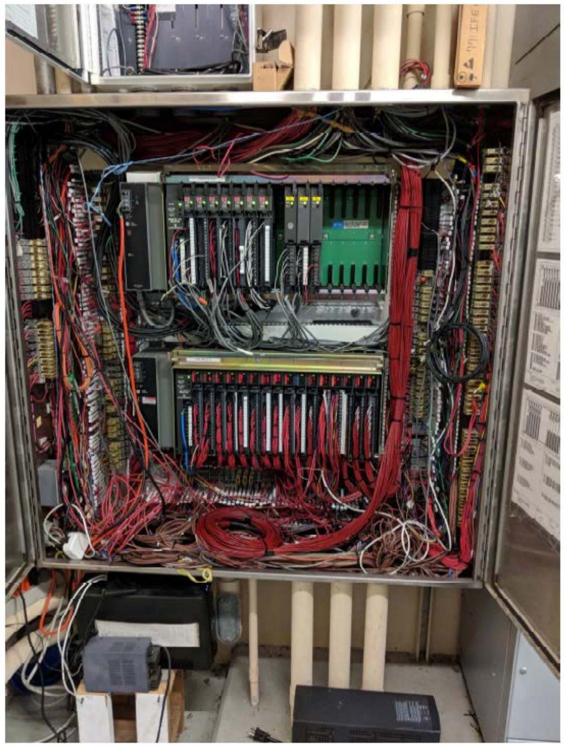
B. The existing blowers are being relocated from the control building to a new blower building in the expansion project. It is assumed that IO related to the blowers will be relocated to the proposed PLC in the new blower building. There will be a minimal amount of I/O remaining after the conversion.

C. Panel CP-1, described below, is a Remote IO rack for this controller. Replacement of each will need to be carefully coordinated to minimize impact to plant operations.

D. Due to the small number of remaining signals after the blowers are relocated, it is recommended to utilize Alternative 1 (conversion kit) for this location. However, the panel is recommended to be converted into a RIO for PLC panel CP-1.

5.5 MCC Room Operator’s Building (CP-1)

A. A large portion of the plant is controlled through CP-1 including the headworks, RAS pumps, WAS pumps, clarifiers and aerators. Extended shutdown of the process controller is not practical. The existing process controller is an Allen-Bradley PLC/5. A photograph the panel is provided below.



CP-1 Enclosure

B. The expansion project will convert the existing transformer vault into a MCC room and mechanical room. There will be adequate space in the proposed MCC room to install a new RIO control panel. An approximate floor plan is provided in Appendix E. As of the writing of this technical memorandum, the expansion project design is not complete; therefore it may be necessary to consider an alternate location if relocation to the MCC room is not practical.

C. There are existing RTU panels which may pose as obstructions to new raceway. The RTU panels are formerly Data Flow enclosures that have been reduced to terminal blocks with a handful of devices. Relocation of the enclosures and associated devices may be considered to provide clearance for new raceway. A photograph showing the relative locations is provided in Appendix F.

D. Space in the existing panel is limited and the addition of the conversion kit hardware will further reduce the available space, making maintenance difficult. In addition, there is no lightning surge suppression in the panel, which is recommended for signal wiring (analog or digital) which connects to field devices not within the operations building.

E. Consideration is given to relocating the process controller from the Alka-Pro PLC to this panel, and converting the Alka-Pro to an RIO, since there are fewer processes dependent on the Alka-Pro panel. This approach will be refined during detail design.

F. Although a conversion kit is available and will fit within the available space, it is recommended to utilize Alternative 4 (new PLC panel) for this location. Considering the number of areas the host PLC controls, there is value in complete upgrade of the control panel, including adding lightning surge suppression and providing clear space to improve maintenance and troubleshooting activities. It is recommended to utilize Alternative 4 (new PLC panel) for this location.

5.6 Aeration Basin No. 3 (CP-2000)

A. This process will be cumbersome to monitor and control manually and extended shutdown is not practical. The existing process controller is an Allen-Bradley SLC 5/05 with no additional remote I/O chassis. A photograph the panel is provided below.

CP-2000 Enclosure

B. It is not advised to erect temporary support on which to install a new PLC platform exposed to direct sunlight and/or weather.

C. There is adequate space install a new PLC control panel at grade, below the existing panel. The existing panel would be converted to a terminal junction box with signals and communications passing through. The new panel, approximately the same size as the existing, would be installed on an equipment stand with the front facing north. Raceway and wire from the old panel to new would run down the west side of the structure. The proposed location improves maintenance access to the panel and mitigates exposure to direct sunlight.

D. The existing HMI is non-functional. It is recommended to install an industrial computer loaded with VT SCADA Slim or Runtime Client. The Village will need to provide the configuration file during construction, so that it may be configured to operate with the replacement PLC and new HMI.

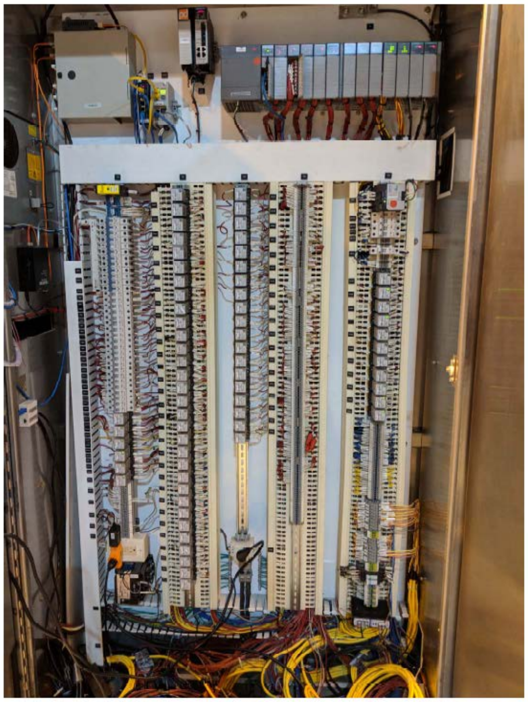
E. It is recommended to utilize Alternative 4 (new PLC panel) for this location.

5.7 Generator Building (MCP-2)

A. The PLC is replaced under the WWTP Expansion project. No work is proposed for this location.

5.8 Sludge Dryer Facility (CP-9005-2)

A. This process will be cumbersome to monitor and control manually and extended shutdown of the process is not practical. The existing process controller is an Allen-Bradley SLC 5/05 with no additional remote I/O chassis. A photograph the panel is provided below.



CP-9005-2 Enclosure

B. A new PLC will be constructed and wired on temporary supports outside of the panel. The wiring would be transferred to the new PLC one signal at a time. The process would require manual operation for a short (8 hours) time period to relocate the new rack from the temporary support to the panel.

C. The existing HMI is functional. It is recommended to replace the HMI with an industrial computer loaded with VT SCADA Slim or Runtime Client. The Village will need to provide the configuration file during construction, so that it may be configured to operate with the replacement PLC program.

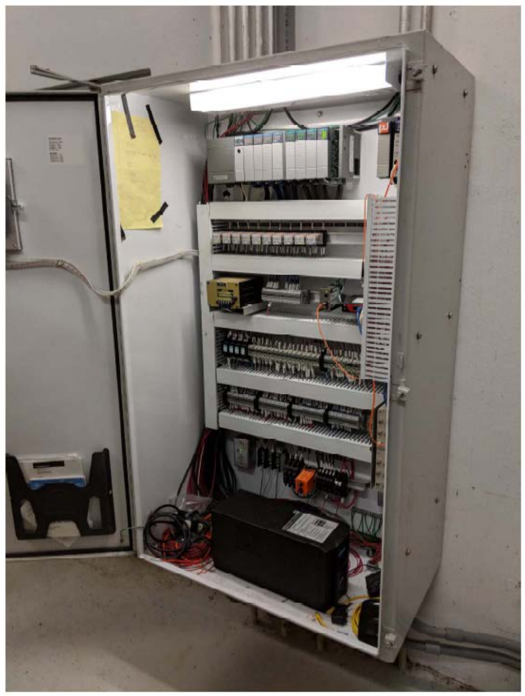
D. Operation of the dryer is not continuous. Swap activities may be coordinated during times where solids processing are not required. In addition, the belt press, Seepex (Cake) pump and sludge dryer operate in tandem. PLC change out of each must be closely coordinated to ensure system operation in maintained.

E. Alternatively, replacement of the PLC in the sludge dryer could be delayed until the process is upgraded in the future. Spare parts (I/O Cards) can be utilized from other upgraded PLC's with specialty I/O (RTD, Counters, etc.) purchased before they become unavailable to ensure maintainability. Plant O&M staff indicates that there are currently no plans to upgrade the existing dryer facility as it was installed 7 years ago and has operated trouble free since.

F. It is recommended to utilize Alternative 3 (temporary PLC and replace) for this location.

5.9 Filter Dosing Building (PLC-5000)

A. This process will be cumbersome to monitor and control manually and extended shutdown of the process is not practical. The existing process controller is an Allen-Bradley SLC 5/05 with no additional remote I/O chassis. A photograph the panel is provided below.



PLC-5000 Enclosure

B. A new PLC will be constructed and wired on temporary supports outside of the panel. The wiring would be transferred to the new PLC one signal at a time. The process would require manual operation for a short (4 hours) time period to relocate the new rack from the temporary support to the panel.

C. The existing HMI is functional. However, it is recommended to replace the HMI with an industrial computer loaded with VT SCADA Slim or Runtime Client. The Village will need to provide the configuration file during construction, so that it may be configured to operate with the replacement PLC program.

D. It is recommended to utilize Alternative 3 (temporary PLC and replace) for this location.

5.10 Gravity Filter Main Control Panel

A. This process will be cumbersome to monitor and control manually and extended shutdown of the process is not practical. The existing process controller is an Allen-Bradley SLC 5/05 with no additional remote I/O chassis. A photograph the panel is provided below.

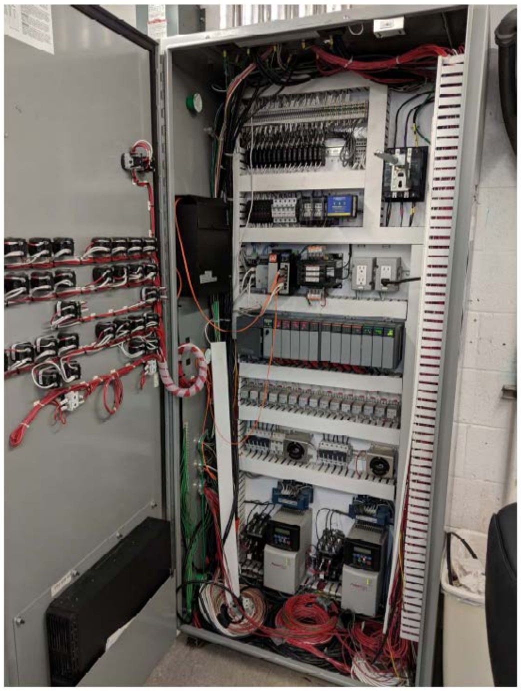
Gravity Filter MCP Enclosure

B. The Gravity Filter PLC is being relocated to a new building in the expansion project and modified to accommodate the 4th effluent filter. It is recommended that the PLC be replaced as part of the expansion project.

C. There is an existing HMI that appears to be functional. It may be relocated onto the new PLC panel. However, the current communications interface is RS-232 serial, which is not compatible with the Control Logix Platform. A new industrial computer with Ethernet communications is recommended. It is recommended that this be replaced as part of the expansion project.

5.11 Sludge Dewatering PLC

A. This process controller monitors and controls both belt filter presses. This process will be cumbersome to monitor and control manually and extended shutdown of the process is not practical. The existing process controller is an Allen-Bradley SLC 5/05 with no additional remote I/O chassis. A photograph the panel is provided below.



Sludge Dewatering PLC Panel

B. A new PLC will be constructed and wired on temporary supports outside of the panel. The wiring would be transferred to the new PLC one signal at a time. The process would require manual operation for a short (4 hours) time period to relocate the new rack from the temporary support to the panel.

C. Similar to the dryer, operation of the belt press is not continuous. Swap activities likely will occur during times where operation of solid processing is not required. In addition, the belt press, Seepex (Cake) pump and sludge dryer operate in tandem and the PLC change out of each must be closely coordinated to ensure operation in maintained.

D. It is recommended to utilize Alternative 3 (temporary PLC and replace) for this location.

5.12 Solids Stabilization Control Panel (Lime)

A. The PLC is removed under the WWTP Expansion project. No work is proposed for this location.

5.13 Seepex Control Panel (Cake Pumps)

A. This process controller monitors and controls the Seepex pump which transfers pressed sludge to the dryer facility. This equipment will be cumbersome to monitor and control manually. However, the expansion project is scheduled to add a second cake pump, which can then be utilized to maintain operations during the PLC change out. The change out is anticipated to take up to 3 weeks. The existing process controller is an Allen-Bradley SLC 5/05 with no additional remote I/O chassis. A photograph the panel is provided below.

Seepex Control Panel PLC (Cake Pump)

B. Similar to the dryer and belt presses, operation of the Seepex pump is not continuous. PLC swap activities will be accomplished during times when processing of solids is not required. In addition, the belt press, Seepex (Cake) pump and sludge dryer operate in tandem and PLC change out of each must be closely coordinated to ensure operation is maintained.

C. The cake pump will need to be controlled and monitored manually during the replacement and loop checks. Migration can be performed while operating the second cake pump, planned under the upcoming expansion, or during off hours. A temporary control panel can be considered during design to perform timing and protection functions for the pump.

D. It is recommended to utilize Alternative 2 (remove and replace) for this location.

6.0 SOFTWARE CONSIDERATIONS

6.1 Software Conversion

The existing control system is comprised of twelve (12) PLC programs that provide varying degrees of automation and monitoring throughout the treatment facility. Each PLC controls a section of the plant. All existing programs are written in ladder logic program files with RS Logix 5 programming software. The existing program files are not compatible with the proposed Control Logix PLC hardware and cannot be loaded onto the new process controllers. Replacement of the existing PLC hardware requires rewriting of the ladder logic in RS Studio 5000 (Studio 5000) programming software.

6.2 Legacy Control Logic and Coordination Meetings

Instructions available to SLC 5/05 and PLC/5 processors are more limited than those in the newer Control Logix platform. For example, what might have required a complicated selection matrix in the RS Logix 5 program to automatically select a lead pump would only require a single instruction with the new RS Studio 5000 software. Furthermore, Plant O&M staff indicates that there is a significant amount of logic and signals that are not being used any longer that can be removed.

With this in mind, it is recommended that the software programmer be required to study the existing control logic and coordinate with Village personnel for each PLC program converted. The coordination requires a series of technically involved meetings that will ensure the Village has a forum to address concerns, or make specific requests. These meetings will also ensure the programmer understands how the Village operates each process to help develop appropriate control logic.

This is an important task that will require substantial time and effort from the programmer, but will help facilitate a clean start-up and minimized downtime. This process should take place in parallel with shop drawings and equipment fabrication to prevent long durations of time where no work is being performed on site.

6.3 PLC Addressing

PLC programs make use of address-based or tag-based file structure to describe information such as a blower running, or influent flow as examples. PLC/5 and SLC 5/05 programs are address-based. Control Logix programs are tag-based. Address-based directly addresses the memory location of the information. Tag-based uses a user-defined string of text that points to the memory location. As an example, the “Blower 1 Running Status” address in a PLC/5 program could be described by address *B14:20/1*. Normally, the address would have a description associated, so a maintenance technician can quickly identify the signal. Without quality address descriptions, the logic can difficult to read and time consuming to troubleshoot. To address this problem, tag-based file structure was made possible within the Studio 5000 programming platform. This allows the software programmer to qualitatively identify an address without a description. To continue the example, the equivalent tag-based identifier would be *WRF_Blower_1_Running*. The readability extends through to the SCADA HMI database. This difference (address vs tag based) is what triggers a complete re-write of the control logic when changing platforms. Taking advantage of this capability will improve readability of the PLC programs and reduce maintenance and development time required to troubleshoot and implement control logic functions.

It is recommended that, as part of the software conversion, the programmer be required to convert all migrated and new addresses/tags to utilize a standard recipe to be coordinated with the Village during design. Legacy descriptions such as *B14:20/1* should not be acceptable to Village staff. The recipe can be formulated to include process area, equipment name, number and signal name. For example, the tag *WRF_HW_SCREEN_1_RUNNING* describes clearly where and what is running. This will facilitate standard syntax across the updated programs. This will require additional programming effort from the contractor.

6.4 Firmware Considerations

It was indicated by Village personnel that PLC programming software is being purchased in the Water Treatment Plant improvement project. PLC and programming firmware must be coordinated with the Village during design and construction to ensure compatibility with the

VT SCADA system. It is recommended that all PLC processors replaced are loaded with the same firmware version, to the greatest extent practicable. This will ensure the Village is not required to purchase additional software licenses to maintain the PLC programs at both plants.

6.5 Message Instructions

Rockwell Automation PLC's accomplish peer-to-peer communications of signals by the use of message instructions (MSG). The message instruction fetches or sends data from a remote device, usually another PLC, via communication protocol configured in the instruction. A MSG is comprised of the local memory location to store the data, the length of the message, and the source/destination.

The software programmer will need to study the existing messages and ensure all active links between PLC's are restored and unused ones are deleted.

6.6 Control Logix Complexity

In an attempt to quantify the level of effort required to convert the control logic from address based programming to tag based programming, the number of rungs in each legacy program are determined and the required memory, in bytes, for all rungs in the program file are determined. The number of rungs can be representative of the level of effort required since a programmer will need to study the existing control logic rung by rung. Since rungs can contain a variable number of instructions, the required memory can be representative of the average complexity of each rung. The following table provides, by process controller discussed in Section 4.0, the number of rungs and required memory for the facility's existing PLC's.

PLC Name	**Rungs**	**Bytes**	**Bytes/Rung**	**Effort**
PLC-1 (Headworks)	58	2246	38.72	Low
Alka-Pro PLC (Blowers)	906	6691	7.39	High
CP-2000 (Basin 3)	644	46508	72.22	Moderate
MCP-2 (Generator Bldg)	N/A	N/A	N/A	N/A
PLC-5000 (Filter Dosing)	418	28657	68.56	Moderate
Main Control Panel (Filters)	367	13495	36.77	N/A
CP9005-2 (Dryer)	578	20220	34.98	Moderate
Belt Filter Press PLC	591	18509	31.32	Moderate
Cake PLC	67	2536	37.85	Low
Lime PLC	N/A	N/A	N/A	N/A

A simple PLC program will contain about one-hundred rungs while more involved programs can include thousands. In addition, the "bytes per rung" is a loose measurement of the average complexity of each rung within the respective PLC program. Any value over 50 represents more complicated control logic.

The level of effort required to convert the programming is described in the table above, with additional consideration for the number of rungs and sensitivity of disruption to the respective processes controlled.

6.7 Local HMI Considerations

Conversion of the PLC logic will break all links to the existing local HMI objects and animations due to the change in program file structure (address-based versus tag-based) described in Section 5.2. It is required to reconfigure each local HMI to remap the old address-based pointer to a tag-based pointer. It is difficult to measure the level of effort required to perform this task because it depends on how each object and animation is configured and how many objects there are. The best measure is the PLC program. It can be assumed that more complex PLC programs, such as the Dryer facility will require additional effort when compared to simpler programs, such as the Cake Pump PLC.

Any replacement HMI will require that old configuration files be converted for compatibility with the newest software because old configurations cannot be loaded onto a new terminal. Consideration is given to replacement of existing HMI's with industrial computers operating either a Runtime or Slim license of VT SCADA. A Slim license would allow the computer to access the displays from the SCADA server, but would not function if communications were lost. A Runtime license will remain operational in the event of a communications lost. All historian data would be preserved and automatically synchronized with communications is restored. Industrial computers will provide several benefits:

1. Allow the existing VT SCADA HMI displays to be accessed. Operators will be more comfortable working with the same displays they interface with in the control room on a daily basis.

2. Provide savings associated with redevelopment of the existing HMI's configuration files since the existing VT SCADA displays would be already be hosted by the VT SCADA servers. Simple configuration would be required, which could be accomplished by a SCADA programmer in less than a day. The Village's existing VT SCADA license allows for unlimited Slim licenses (remote Ethernet access to SCADA). Savings will be offset by additional software licenses if Runtime licenses are preferred. For Runtime versions, tag counts per process area (PLC) would need to be coordinated with the license purchased.

3. Reduce development cost for local HMI's in the future. Instead of paying for both SCADA HMI and local HMI development, in addition to coordination activities required for the two interfaces to operate together, the Village will only need to pay for SCADA HMI development.

In either case, it is recommended that the Village supply the contractor with the existing HMI configuration files (PanelView or VT SCADA). Reconfiguration of the local HMI's can be complete off site and installed/verified during the switchover/start-up process. It is also recommended to replace the existing panel views with industrial computers loaded with VTSCADA Runtime Clients for maximum reliability.

6.8 SCADA HMI Considerations

Each PLC is connected to the VT SCADA HMI system via communications drivers. There is one driver for each PLC. Each driver contains a database which maps PLC addresses to HMI objects, animations, trends, etc. Conversion of the PLC logic will break all links to the SCADA HMI due to the change in program file structure (address-based versus tag-based) described in Section 5.2. It is required that the programmer reconfigure the SCADA HMI databases to remap the old address-based pointers to new tag-based pointers.

The relative level of effort to remap the SCADA HMI to new PLC programs can be measured by determining the number of points currently mapped. As of the writing of this TM, there are currently approximately 2750 data points in the database. It is assumed in this analysis that the entire database will require remapping. There is a moderate amount of effort required to "reconnect" plant SCADA to the new process controllers. The process of remapping points is straightforward, but time consuming.

Reconfiguration of the SCADA HMI database can be completed and tested off site and installed/verified during the switchover/start-up process for each process area. SCADA HMI loops checks from the field device to the HMI display are recommended.

6.9 Other Considerations

Village O&M staff indicates that portions of PLC programming software are no longer required since treatment processes controlled or monitored by the control logic have either been abandoned or modified, rendering the logic useless. Therefore, conversion of that control logic is unnecessary. Process areas no longer in use, or have been significantly modified, and do not require programming conversion are:

1. Majority of the Lime System, excluding conveyors
2. Majority of the Gravity Filter system
3. Existing Blowers to be relocated to new building
4. Alka-Pro system

It is difficult to quantify the level of effort required to identify obsolete programming and wiring systems. Existing I/O that has been rendered obsolete must be field verified if it is to be removed. The process of tracing programming and wiring is consuming and must be done one signal at a time. It will ultimately be the responsibility of the software programmer to determine exactly what logic is obsolete and coordinate their findings with field conditions. It is recommended that funds be available for this effort, for each process controller replaced. The effort to coordinate the software and field conditions is proportional to the quantity of I/O present in any given panel and the ability of the Village to provide as built schematics of the PLC panel.

7.0 CONCLUSIONS/RECOMMENDATIONS

7.1 Conclusions

A. The PLCs investigated have either reached their end of useful life or support by the manufacturer is in process of being sunset. Migrating to an updated PLC platform will mitigate the increasing costs of procuring hardware for replacement and expansion of the existing PLC system.

B. Replacement of the PLC hardware and software will disrupt plant operations; however, the approaches analyzed and recommended minimize these disruptions by completing as much work as practicable prior to switching from the old platform to the new. Entire process shutdowns can be avoided with careful planning and clear constraints imposed by the design.

C. The existing PLC hardware is programmed with legacy PLC programming software. This creates two problems. First, all new programming furnished on the old platform will require rewriting in the future. Second, all SCADA HMI and Local HMI programming will require remapping when converting from the old to new software platform. The Village will effectively be paying twice for the same result.

D. The Village can optimize local control by implementing industrial computers in place of existing local HMIs. Doing so will provide the ability to mirror existing SCADA HMI screens for this project, and in the future. Purchase of Runtime licenses will be required if redundancy is desired. Otherwise, a Slim client, already included in the Village's existing VT SCADA license will suffice.

7.2 Recommendations

A. Replace existing SLC 5/05 and PLC/5 PLC platforms with equivalent Control Logix platform as follows:

Headworks (PLC-1)	Temporary Relocate & Replace
Alka-Pro Panel (New RIO)	Conversion Kit (Covert to RIO)
MCC-Room Main Building (CP-1)	New PLC Panel
Aeration Basin #3 (CP-2000)	New PLC Panel
Generator Building (MCP-2) - Addressed in Expansion	Not Required
Sludge Dryer Facility (CP-9005-2)	New PLC Panel
Filter Dosing Building (PLC-5000)	Temporary PLC and Replace
Gravity Filter Building (Main Control Panel) – Recommend to Address in Expansion	Not Required
Belt Press Building (Sludge Dewatering PLC)	Temporary PLC and Replace
Solids Stabilization Control Panel (Lime PLC) - Addressed in Expansion	Not Required
Belt Press Building (Cake Pump PLC)	Remove and Replace

B. Coordinate PLC software and firmware with water and waste water plant expansions.

C. Identify, during design, what is acceptable with respect to equipment downtime and/or process shutdowns for each process area. Consider which processes can be reasonably operated and monitored manually for long periods (2-4 weeks). This will help optimize approaches that suit the goals to maintain plant operations with the number of Village personnel available to operate a process and modernize the existing PLC platform.

D. Where practical, consider separate communications card in each PLC rack to create a subnet for all device level (RIO, VFD, etc) communications. This is an effective substitute for managed switches, which require technical knowledge to maintain and replace. Not necessary if no device level communications are anticipated.

E. Encumber funding for the contractor to field verify wiring systems and programming to determine what has been rendered obsolete by changes and upgrades performed throughout the years. This will provide the information necessary to remove obsolete wiring with the goal of cleaning up the appearance and maintainability of the affected panels.

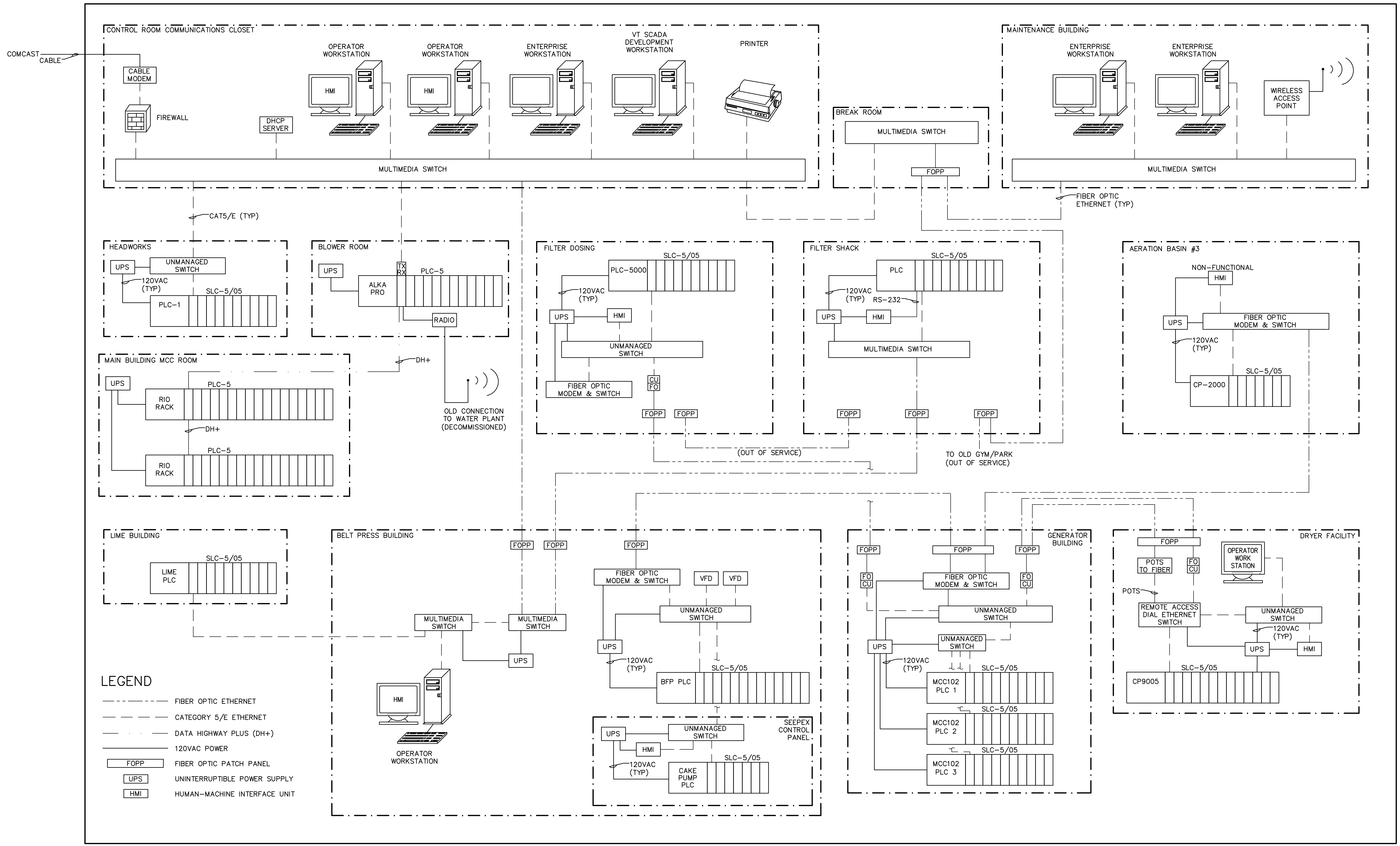
F. Encumber funding for two additional Studio 5000 Logix PLC programming software for maintenance of the new PLC hardware.

8.0 OPINION OF PROBABLE CONSTRUCTION COST

Description	Approach	Hardware Cost	Software Cost
Headworks (PLC-1)	Temporary Relocate & Replace	$37,000	$13,000
Alka-Pro Panel	Conversion Kit (Covert to RIO)	$40,000	$77,000
MCC-Room Main Building (CP-1)	New PLC Panel	$187,000	$0
Aeration Basin #3 (CP-2000)	New PLC Panel	$84,000	$36,000
Generator Building (MCP-2) - Addressed in Expansion	Not Required	$0	$0
Filter Dosing Building (PLC-5000)	Temporary PLC and Replace	$39,000	$25,000
Gravity Filter Building (Main Control Panel) - Addressed in Expansion	Not Required	$0	$0
Sludge Dryer Facility (CP-9005-2)	New PLC Panel	$60,000	$43,000
Belt Press Building (Belt Filter Press PLC)	Temporary PLC and Replace	$43,000	$31,000
Belt Press Building (Cake Pump PLC)	Remove and Replace	$37,000	$12,000
Solids Stabilization Control Panel (Lime PLC) - Addressed in Expansion	Not Required	$0	$0
	Subtotal	$527,000	$237,000
	Field Verification Allowance	10.0%	$76,400
	Miscellaneous Electrical	12.5%	$95,500
	PLC Programming Software	2 Licenses	$20,000
	Grand Total		**$955,900**

Appendix A

Control System Block Diagram



DRAFT DOCUMENTS – NOT FOR CONSTRUCTION

PLOT DATE: 2018/05/11 6:46:48 PM BY: BHAAS
File: E:\PROJECTS\WL\WL08 WRF PLC REPLACEMENT STUDY\DRAWINGS\FIGURE 1-BLOCK DIAGRAM Saved By BHAAS Save Date: 2018/05/10 11:14 AM

NO.	DATE	BY	REVISION

HILLERS ELECTRICAL ENGINEERING, INC.
23257 STATE ROAD 7, SUITE 100
BOCA RATON, FL 33428
(561) 451-9165
(561) 451-4886 FAX
LICENSE NO: EB 0006877

THE VILLAGE OF WELLINGTON
UTILITIES DEPARTMENT
12300 FOREST HILL BLVD,
WELLINGTON, FL 33414
(561) 791-4000

VILLAGE OF WELLINGTON WATER RECLAMATION FACILITY
PLC REPLACEMENT STUDY
FIGURE 1 – EXISTING CONTROL SYSTEM BLOCK DIAGRAM

DATE: MAY 2018
HEE NO.: WL08
PROJECT NO.: ______
DRAWING:
SHEET ____ OF 1

Appendix B

PLC/5 to Control Logix Conversion Kit Details

1771 I/O to 1756 I/O Conversion Modules

I/O Conversion Modules provide a fast and efficient method for converting 1771 PLC-5 I/O to 1756 ControlLogix I/O. The I/O conversion is accomplished without removing any field wires from the existing swing arm, virtually removing the risk of wiring errors. The existing swing arms fit directly onto the edge connector of the conversion modules.

The cables are pre-wired and have a connector for the conversion module on one end and a removable terminal block (RTB) on the other end. The I/O signals are routed through the conversion module and the cable to the appropriate terminals on the I/O module.

The I/O Conversion System includes:

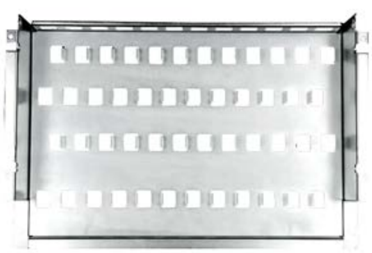
- Conversion Modules (Ex: Cat No: 1492-CM1771-LD001)
- Cables (Ex: Cat No: 1492-CONACAB005X)
- Conversion Mounting Assembly (Ex: Cat No: 1492-MUA4-A13-A17)

Conversion Modules, Cables, and Mounting Assemblies

Conversion Modules

Pre-wired Cables, 25-pin

Pre-wired Cables, 37-pin



Base Plate

The Conversion Modules are housed in a Conversion Mounting Assembly Base Plate. This base plate has the same footprint and mounting holes as the 1771 chassis. There is no need to drill and tap new mounting holes in the control cabinet.

Cover Plate

The Conversion Mounting Assembly Cover Plate covers and helps protect the Conversion Modules while providing a place to mount the new 1756 chassis. The Cover Plate has pre-drilled and tapped mounting holes allowing the new 1756 chassis to be mounted in several locations – centered, right-justified or left-justified. There is no need to drill and tap new mounting holes in the control cabinet.

Appendix C

PLC/5 to Control Logix Conversion Cable Details

Conversion Mounting Assembly Selection

Conversion Modules must be installed in a 1492 Conversion Mounting Assembly (see table below, a complete System Installation Manual is included with each assembly. Use the following steps to select the proper conversion mounting assembly:

1. Determine the quantity of each type of 1771 I/O modules used in the I/O chassis to be converted.
2. From the table below:
   a. Select the applicable 1492 conversion modules
   b. Review the Max Slots for I/O and Chassis Width data from the table below
   c. Select a 1756 I/O chassis which has enough I/O slots. Two I/O slots are required in the 1756 chassis for conversions where one 1771 I/O module converts to two 1756 I/O modules.
   d. Select the conversion mounting assembly which has enough conversion module slots.
   (2) conversion module slots are required in the conversion mounting assembly for conversions where (2) 1771 I/O modules convert to (1) 1756 I/O modules.

The combined depth of the conversion mounting assembly with the 1756 chassis mounted on top is 10.25 inches (controller w/key) or 10.0 inches (controller w/o key). Dimension drawings are included in the System Installation Manual that ships with the Assembly.

Chassis Dimensions and Max Slot Information

1771 Chassis				1756 Chassis			Conversion Mounting Assembly		
		Chassis Width[2] in (mm)							
Cat. No.	Max Slots for I/O	Without Power Supply	With Power Supply	Cat. No.	Max Slots for I/O	Chassis Width in (mm)	Cat. No.	Max Slots for Conversion Modules	Chassis Width in (mm)
1771-A1B	4	9.01 (229)	12.61 (320)	1756-A4	3	10.35 (263)	1492-MUA1B-A4-A7	4	9.01 (229)
				1756-A7	6	14.49 (368)			
1771-A2B	8	14.01 (356)	17.61 (447)	1756-A7	6	14.49 (368)	1492-MUA2B-A7-A10	8	14.01 (356)
				1756-A10	9	19.02 (483)			
1771-A3B1[1]	12	19.01 (483)		1756-A10	9	19.02 (483)	1492-MUA3B-A10-A13	12	19.01 (483)
				1756-A13	12	23.15 (588)			
1771-A4B	16	24.01 (610)		1756-A13	12	23.15 (588)	1492-MUA4-A13-A17	16	24.01 (610)
				1756-A17	16	29.06 (738)			

(1) 1771-A3B is not listed as it is used for 19 inch wide instrumentation panels.

(2) Notice that the 1756 Chassis Width sometimes exceeds the 1771 Chassis Width, with or without the Power Supply. The Cover-Plate of the 1492 Conversion Mounting Assembly allows the 1756 Chassis to be Left justified, Right justified or Centered. A complete System Installation Manual ships with the 1492 Conversion Mounting Assembly.

Digital Inputs

1. Column 1: find the Catalog Number of the **1771 Module** you are converting from.
2. Column 2: find the Catalog Number of the compatible **1756 Module** you are converting to. In some cases more than one module exists. Review the matrix carefully and review the I/O module Installation Manuals to determine full compatibility.
3. Column 3: find the **Conversion Module** catalog number and order quantity.
4. Column 4: find the **Conversion Cable** catalog number and order quantity.

1		2		3		4		5
Converting From 1771 Module(1)	Qty.	Converting to 1756 Module	Qty.	Conversion Module		Conversion Cable(3)		Wiring Diagram
				Cat. No.	Order	Cat. No.	Order	Page
1771-IA	2	1756-IA16	1	1492-CM1771-LD007	2	1492-C005005XE	1	19
1771-IA2	2	1756-IA16	1	1492-CM1771-LD007	2	1492-C005005XE	1	19
1771-IAD	1	1756-IA16	1	1492-CM1771-LD001	1	1492-CONCAB005X	1	20
1771-IAD	1	1756-IH16I	1	1492-CM1771-LD002	1	1492-CONCAB005Y	1	21
1771-IAN	1	1756-IA32	1	1492-CM1771-LD003	1	1492-CONCAB005Z	1	22
1771-IB	2	1756-IB16	1	1492-CM1771-LD007	2	1492-C005005XE	1	23
1771-IBD	1	1756-IB16	1	1492-CM1771-LD001	1	1492-CONCAB005X	1	24
1771-IBN	1	1756-IB32	1	1492-CM1771-LD003	1	1492-CONCAB005Z	1	25
1771-IC	2	1756-IC16	1	1492-CM1771-LD007	2	1492-C005005XE	1	26
1771-ICD	1	1756-IC16	1	1492-CM1771-LD001	1	1492-CONCAB005X	1	27
1771-ID	2	1756-IA16I	1	1492-CM1771-LD012	2	1492-C005005XL	1	28
1771-ID01	2	1756-IM16I	1	1492-CM1771-LD012	2	1492-C005005XL	1	29
1771-ID16	1	1756-IA16I	1	1492-CM1771-LD004	1	1492-CONCAB005Y	1	30
1771-ID16	1	1756-IH16I	1	1492-CM1771-LD004	1	1492-CONCAB005Y	1	31
1771-IG	2	1756-IG16	1	1492-CM1771-LA003(2)	2	1492-C005005XS	1	32
1771-IGD	1	1756-IG16	1	1492-CM1771-LD006	1	1492-CONCAB005X	1	33
1771-IH	2	1756-IC16	1	1492-CM1771-LD007	2	1492-C005005XE	1	34
1771-IM	2	1756-IM16I	1	1492-CM1771-LD007	2	1492-C005005XH	1	35
1771-IMD	1	1756-IM16I	1	1492-CM1771-LD002	1	1492-CONCAB005Y	1	36
1771-IN	2	1756-IN16	1	1492-CM1771-LD007	2	1492-C005005XE	1	37
1771-IND	1	1756-IN16	1	1492-CM1771-LD001	1	1492-CONCAB005X	1	38
1771-IND1	1	1756-IN16	1	1492-CM1771-LD001	1	1492-CONCAB005X	1	39
1771-IQ	2	1756-IB16I	1	1492-CM1771-LD007	2	1492-C005005XK	1	40
1771-IQ	2	1756-IB16I	1	1492-CM1771-LD014	2	1492-C005005XJ	1	41
1771-IQ16	1	1756-IB16I	1	1492-CM1771-LD004	1	1492-CONCAB005Y	1	42
1771-IT	2	1756-IB16	1	1492-CM1771-LD007	2	1492-C005005XE	1	43
1771-IV	2	1756-IV16	1	1492-CM1771-LD014	2	1492-C005005XG	1	44
1771-IVN	1	1756-IV32	1	1492-CM1771-LD005	1	1492-CONCAB005Z	1	45

(1) To understand any issues concerning I/O module compatibility refer to the conversion module wiring diagrams and the Installation Manuals for the specific I/O modules involved (with particular attention to the specification and wiring instructions).

(2) These 1771 Digital I/O Modules use a Swing Arm that only mounts to these Analog I/O Conversion Modules, which will therefore be used to provide for these 1771 Digital I/O conversions.

(3) The 005 in the Cat. No. indicates cable length of the 1492 cable. The recommended length of 0.5 M is listed, additional lengths are listed below.

1.0M Cable = 1492-CONCAB010__, 1.0M/1.0M Cable= 1492-C010010X__,0.5M/1.0M Cable = 1492-C005010X__,1.0M/0.5M Cable = 1492-C010005X__

Digital Outputs

1. Column 1: find the catalog number of the **1771Module** you are converting from.
2. Column 2: find the catalog number of the compatible **1756 Module** you are converting to.
   In some cases more than one module exists. Review the matrix carefully and review the I/O module Installation Manuals to determine full compatibility.
3. Column 3: find the catalog number of the **Conversion Module**.
4. Column 4: find the catalog number of the **Conversion Cable.**

1		2		3		4		5
Converting from 1771 Module(1)		Converting to 1756 Module		Conversion Module		Conversion Cable(4)		Wiring Diagram
Cat. No.	Qty.	Cat. No.	Qty.(2)	Cat. No. (3)	Order Qty.	Cat. No.	Order Qty.	Page
1771-OA	1	1756-OA8E	1	1492-CM1771-LD014	1	1492-CONCAB005U	1	47
1771-OAD	1	1756-OA16	1	1492-CM1771-LD006	1	1492-CONCAB005X	1	48
1771-OAN	1	1756-OA16	2	1492-CM1771-LD013	1	1492-CONCAB005S3	1	49
1771-OB	2	1756-OB16D	1	1492-CM1771-LD014	2	1492-C005005XF	1	50
1771-OBD	1	1756-OB16E	1	1492-CM1771-LD006	1	1492-CONCAB005X	1	51
1771-OBD	1	1756-OC8	2	1492-CM1771-LD008F	1	1492-CONCAB005S1	1	52
1771-OBDS	1	1756-OB16E	1	1492-CM1771-LD006	1	1492-CONCAB005X	1	53
1771-OBN	1	1756-OB32	1	1492-CM1771-LD009F	1	1492-CONCAB005Z	1	54
1771-OC	1	1756-OC8	1	1492-CM1771-LD014	1	1492-CONCAB005V	1	55
1771-OD	2	1756-OA16I	1	1492-CM1771-LD012	2	1492-C005005XM	1	56
1771-OD16	1	1756-OA16I	1	1492-CM1771-LD010F	1	1492-CONCAB005Y	1	57
1771-ODD	1	1756-OA16I	1	1492-CM1771-LD010F	1	1492-CONCAB005Y	1	58
1771-ODZ	2	1756-OA16I	1	1492-CM1771-LD012	2	1492-C005005XP	1	59
1771-OG	2	1756-OG16	2	1492-CM1771-LA003	2	1492-C005005XS	1	60
1771-OGD	1	1756-OG16	2	1492-CM1771-LD006	1	1492-CONCAB005X	1	61
1771-OM	2	1756-OA16	1	1492-CM1771-LD014	2	1492-C005005XG	1	62
1771-OMD	1	1756-OA16	1	1492-CM1771-LD006	1	1492-CONCAB005X	1	63
1771-ON	1	1756-ON8	1	1492-CM1771-LD014	1	1492-CONCAB005W	1	64
1771-OND	1	1756-ON8	2	1492-CM1771-LD006	1	1492-CONCAB005S2	1	65
1771-OQ	2	1756-OB16I	1	1492-CM1771-LA004	2	1492-C005005XT	1	66
1771-OQ16	1	1756-OB16I	1	1492-CM1771-LD010F	1	1492-CONCAB005Y	1	67
1771-OR	2	1756-OA16I	1	1492-CM1771-LD012	2	1492-C005005XR	1	68
1771-OVN	1	1756-OV16E	2	1492-CM1771-LD013	1	1492-CONCAB005S3	1	69
1771-OW	1	1756-OX8I	1	1492-CM1771-LD012	1	1492-CONCAB005Y	1	70
1771-OW16	1	1756-OW16I	1	1492-CM1771-LD011	1	1492-CONCAB005Y	1	71
1771-OWNA	1	1756-OW16I	2	1492-CM1771-LD013	1	1492-CONCAB005S4	1	72
1771-OY	1	1756-OX8I	1	1492-CM1771-LD012	1	1492-CONCAB005Y	1	73
1771-OYL	1	1756-OX8I	1	1492-CM1771-LD012	1	1492-CONCAB005Y	1	74
1771-OZ	1	1756-OX8I	1	1492-CM1771-LD012	1	1492-CONCAB005Y	1	75
1771-OZL	1	1756-OX8I	1	1492-CM1771-LD012	1	1492-CONCAB005Y	1	76

(1) To understand any issues concerning I/O module compatibility refer to the conversion module wiring diagrams and the Installation Manuals for the specific I/O modules involved (with particular attention to the specification and wiring instructions).

(2) Where two is indicated, these modules need to be located directly next to each other in the 1756 chassis.

(3) An "F" at the end of the 1756 catalog number indicates that it is fused to match the functionality of the 1771 module being replaced.

(4) The 005 in the Cat. No. indicates cable length of the 1492 cable. The recommended length of 0.5 M is listed, additional lengths are listed below.

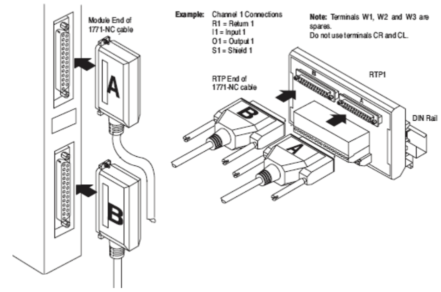
1.0M Cable = 1492-CONCAB010_, 1.0M/1.0M Cable= 1492-C010010X_0.5M/1.0M Cable = 1492-C005010X_, 1.0M/0.5M Cable = 1492-C010005X_

Analog Inputs and Outputs

1. Column 1: find the catalog number of the **1771Module** you are converting from.
2. Column 2: find the catalog number of the compatible **1756 Module** you are converting to.
   In some cases more than one module exists. Review the matrix carefully and review the I/O module Installation Manuals to determine full compatibility.
3. Column 3: find the catalog number of the **Conversion Module**.
4. Column 4: find the catalog number of the **Conversion Cable.**

1		2			3		4		5
Converting from 1771 Module		**Converting to 1756 Module**			**Conversion Module**		**Conversion Cable**		**Wiring Diagram**
Cat. No.	**Qty.**	**Cat. No.**	**Description**	**Qty.**	**Cat. No.**	**Order Qty.**	**Cat. No.**	**Order Qty.**	**Page**
1771-IFE	1	1756-IF16	Differential Current	1	1492-CM1771-LA002	1	1492-CONACAB005D	1	77
			Differential Voltage	1	1492-CM1771-LA002	1	1492-CONACAB005C	1	78
			Single End Current	1	1492-CM1771-LA001	1	1492-CONACAB005B	1	79
			Single End Voltage	1	1492-CM1771-LA001	1	1492-CONACAB005A	1	80
1771-IFF	1	1756-IF16	Differential Current	1	1492-CM1771-LA002	1	1492-CONACAB005D	1	81
			Differential Voltage	1	1492-CM1771-LA002	1	1492-CONACAB005C	1	82
			Single End Current	1	1492-CM1771-LA001	1	1492-CONACAB005B	1	83
			Single End Voltage	1	1492-CM1771-LA001	1	1492-CONACAB005A	1	84
1771-IL	1	1756-IF8I	Current	1	1492-CM1771-LA004	1	1492-CONACAB005K8	1	85
			Voltage	1	1492-CM1771-LA004	1	1492-CONACAB005L8	1	86
		1756-IF6I (6-ch)	Current	1	1492-CM1771-LA004	1	1492-CONACAB005K	1	87
			Voltage	1	1492-CM1771-LA004	1	1492-CONACAB005L	1	88
		1756-IF6I (2x 4-ch)	Current	2	1492-CM1771-LA004	1	1492-CONACAB005T1	1	89
			Voltage	2	1492-CM1771-LA004	1	1492-CONACAB005T2	1	90
1771-IR	1	1756-IRT8I	RTD	1	1492-CM1771-LA004	1	1492-CONACAB005F8	1	91
		1756-IR6I	RTD	1	1492-CM1771-LA004	1	1492-CONACAB005F	1	92
1771-IXE	1	1756-IT6I2	Thermocouple	1	1492-CM1771-LA005	1	1492-CONACAB005G	1	93
		1756-IRT8I	Thermocouple	1	1492-CM1771-LA005	1	1492-CONACAB005G8	1	94
1771-IXHR	1	1756-IT6I2	Thermocouple	1	1492-CM1771-LA005	1	1492-CONACAB005G	1	95
		1756-IRT8I	Thermocouple	1	1492-CM1771-LA005	1	1492-CONACAB005G8	1	96
1771-OFE1	1	1756-OF6VI	Voltage	1	1492-CM1771-LA003	1	1492-CONACAB005E	1	97
	1	1756-OF8I	Voltage	1	1492-CM1771-LA003	1	1492-CONACAB005E8V	1	98
	2	1756-OF8I	Voltage	1	1492-CM1771-LA003	2	1492-C005005E8V	1	99
1771-OFE2	1	1756-OF6CI	Current	1	1492-CM1771-LA003	1	1492-CONACAB005E	1	100
	1	1756-OF8I	Current	1	1492-CM1771-LA003	1	1492-CONACAB005E8C	1	101
	2	1756-OF8I	Current	1	1492-CM1771-LA003	2	1492-C005005E8C	1	102

1771-N High Resolution Isolated Analog I/O Modules



The 1771-N High Resolution Analog I/O modules are designed for use with 1771-RTPs (Remote Termination Panels) and connected by a 6 or 15 foot cable (Cat. No. 1771-NC6 or 1771-NC15). The conversion of the 1771-N Series I/O to a 1756 ControlLogix I/O can be accomplished without the removal of any field wires from the existing 1771-RTPs.

Simply replace the (2) existing 1771 cables with (2) of the following cables in the table below. Each of these cables has a connector on one end that attaches directly to the existing 1771-RTP and a 1756 RTB (Removable Terminal Block) on the other end for connection to the ControlLogix I/O module.

Use the following steps to select the proper conversion cables:

1. Column 2: find the catalog number of the 1771 Digital I/O module.
2. In column 3, find the catalog number of the compatible 1756 Digital I/O module. In some cases more than one module is required. Review the matrix and the I/O module installation manuals to determine full compatibility
3. In column 4, find the catalog numbers and descriptions of the appropriate cables.

1	2		3		4			5
I/O Description	Convert From:		Convert To:		Cable Description	Conversion Cable Catalog Number		Wiring Diagram Page
	1771 Module	Qty.	1756 Module	Qty.		Cable "A"	Cable "B"	
Standard 1771-N High Resolution I/O	1771-NOC	1	1756-OF8I	1	Current (8 Ch)	1492-CONACAB020N88		103
		1	1756-OF8	1	Current (8 CH)	1492-CONACAB020N8		104
		1	1756-OF6CI	2	Current (4/4 CH)	1492-CONACAB020N1	1492-CONACAB020N1	105
	1771-NIS	1	1756-IF8I	1	Current (8 CH)	1492-CONACAB020N38		106
		1	1756-IF6CIS	2	Current (4/4 CH)	1492-CONACAB020N2	1492-CONACAB020N2	107
	1771-NIV	1	1756-IF8I	1	Current (8 CH)	1492-CONACAB020N38		108
		1	1756-IF6I	2	Current (4/4 CH)	1492-CONACAB020N3	1492-CONACAB020N3	109
		1	1756-IF8I	1	Voltage (8 CH)	1492-CONACAB020N78		110
		1	1756-IF6I	2	Voltage (4/4 CH)	1492-CONACAB020N7	1492-CONACAB020N7	111
		1	1756-IF6I	2	Current (A - 4 CH) / Voltage (B - 4 CH)	1492-CONACAB020N3	1492-CONACAB020N7	112
		1	1756-IF6I	2	Voltage (A - 4 CH) / Current (B - 4 CH)	1492-CONACAB020N7	1492-CONACAB020N3	113
	1771-NR	1	1756-IRT8I	1	RTD (8 CH)	1492-CONACAB020N48		114
		1	1756-IR6I	2	RTD (4/4 CH)	1492-CONACAB020N4	1492-CONACAB020N4	115
	1771-NT1	1	1756-IRT8I	1	Thermocouple (8 CH)	1492-CONACAB020N68		116
		1	1756-IT6I	2	Thermocouple (4/4 CH)	1492-CONACAB020N5	1492-CONACAB020N5	117
	1771-NOV	1	1756-OF8I	1	Voltage (8 CH)	1492-CONACAB020N18		118
		1	1756-OF6VI	2	Voltage (4/4 CH)	1492-CONACAB020N5	1492-CONACAB020N1	119
	1771-NIV1	1	1756-IF8I	1	Voltage (8 CH)	1492-CONACAB020N78		120
		1	1756-IF6I	2	Voltage (4/4 CH)	1492-CONACAB020N7	1492-CONACAB020N7	121
	1771-NT2	1	1756-IRT8I	1	Thermocouple (8 CH)	1492-CONACAB020N68		122
		1	1756-IT6I2	2	Thermocouple (4/4 CH)	1492-CONACAB020N6	1492-CONACAB020N6	123

1	2		3		4			5
I/O Description	Convert From:		Convert To:		Cable Description	Conversion Cable Catalog Number		Wiring Diagram Page
	1771 Module	Qty.	1756 Module	Qty.		Cable "A"	Cable "B"	
Combination 1771-N High Resolution I/O	1771-NIVR	1	1756-IRT8I	1	RTD (4 CH)	-	1492-CONACAB020N44	124
			1756-IF8I		Voltage (4 CH)	1492-CONACAB020N74	-	
			1756-IR6I		RTD (4 CH)	-	1492-CONACAB020N4	125
			1756-IF6I		Voltage (4 CH)	1492-CONACAB020N7	-	
			1756-IRT8I		RTD (4 CH)	-	1492-CONACAB020N44	126
			1756-IF8I		Current (4 CH)	1492-CONACAB020N34	-	
			1756-IR6I		RTD (4 CH)	-	1492-CONACAB020N4	127
			1756-IF6I		Current (4 CH)	1492-CONACAB020N3	-	
	1771-NIVT		1756-IRT8I		Thermocouple (4 CH)	-	1492-CONACAB020N54	128
			1756-IF8I		Voltage (4 CH)	1492-CONACAB020N74	-	
			1756-IT6I		Thermocouple (4 CH)	-	1492-CONACAB020N5	129
			1756-IF6I		Voltage (4 CH)	1492-CONACAB020N7	-	
			1756-IRT8I		Thermocouple (4 CH)	-	1492-CONACAB020N54	130
			1756-IF8I		Current (4 CH)	1492-CONACAB020N34	-	
			1756-IT6I		Thermocouple (4 CH)	-	1492-CONACAB020N5	131
			1756-IF6I		Current (4 CH)	1492-CONACAB020N3	-	

Specifications

Attribute		Value
Dimensions (H x D x W)		300 x 111.25 x 38.1 mm (11.81 x 4.38 x 1.5 in.)
Approximate Shipping Weight		260g (0.57 lb)
Storage Temperature		Storage Temperature -40...+85 °C (-40...+185 °F)
Operating Temperature		Operating Temperature 0...+60 °C (+32...+140 °F)
Operating Humidity		Operating Humidity 5...95% at +55 °C (+131 °F)
Shock	Nonoperating	50 g
	Operating	30 g
Operational Vibration		2 g at 10...500 Hz
Agency Certifications		UL Classified (UL File No. E113724)
CE Certifications		Compliant for all applicable directives
Pollution Degree		2
Environmental Rating		IP20

Appendix D

Existing PLCs Summary

Wellington Water Reclamation Facility

Location	Headworks	Aeration Basin #3	Generator Building			Filter Dosing Building	Gravity Filter Building
Name	PLC-1	CP-2000	MCP-2			PLC-5000	Main Control Panel
Enclosure Dimensions	60" H x 36" W x 20" D	36" H x 36" W x 12" D	90" H x 72" W x 24" D			60" H x 36" W x 20" D	90" H x 72" W x 24" D
Indoor/Outdoor	Indoor	Outdoor, Direct Sun Exposure	Indoor, Conditioned			Indoor	Indoor
Connection to SCADA	Ethernet	Ethernet	Ethernet	Ethernet	Ethernet	Ethernet	Ethernet
Chassis Size	10	7	10	10	10	10	13
Processor	SLC5/05	SLC5/05	SLC5/05	SLC5/05	SLC5/05	SLC5/05	SLC5/05
1746-IB16	2	2	9	4		3	
1746-IA16							2
1746-IO12							
1746-OB16	1			3		1	
1746-OW16							
1746-OW8		1					
1746-OX8							2
1746-NI4							
1746-NI8	2	1			7	3	1
1746-NO8I		1			2	1	
1746-NO4							
1746-NO4I							1
1746-NO8							
1746-NT8							
Space	4	1		2		1	6
Panelview	No	Yes	No			Yes	Yes

Location	**Sludge Dryer Facility**	**Belt Filter Press Building**	**Belt Filter Press Building**	**Belt Filter Press Building**
Name	CP9005-2	Belt Filter Press PLC	Cake Pump PLC	Solids Stabilization Control Panel
Enclosure Dimensions	90" H x 48" W x 18" D	80" H x 36" W x 18" D	62" H x 48" W x 12" D	60" H x 60" W x 12" D
Indoor/Outdoor	Indoor	Indoor, Conditioned	Indoor	Outdoor, Limited Sun Exposure
Connection to SCADA	Ethernet	Ethernet	Ethernet	Ethernet
Chassis Size	13	13	7	10
Processor	SLC5/05	SLC5/05	SLC5/05	SLC5/05
1746-IB16				1
1746-IA16	4	5	2	4
1746-IO12	1			
1746-OB16				3
1746-OW16	3	4		
1746-OW8			1	
1746-OX8				
1746-NI4				
1746-NI8	1	2	1	
1746-NO8I		1		
1746-NO4	1			
1746-NO4I			1	
1746-NO8				
1746-NT8	2			
Space			1	1
Panelview	Yes	No	Yes	No

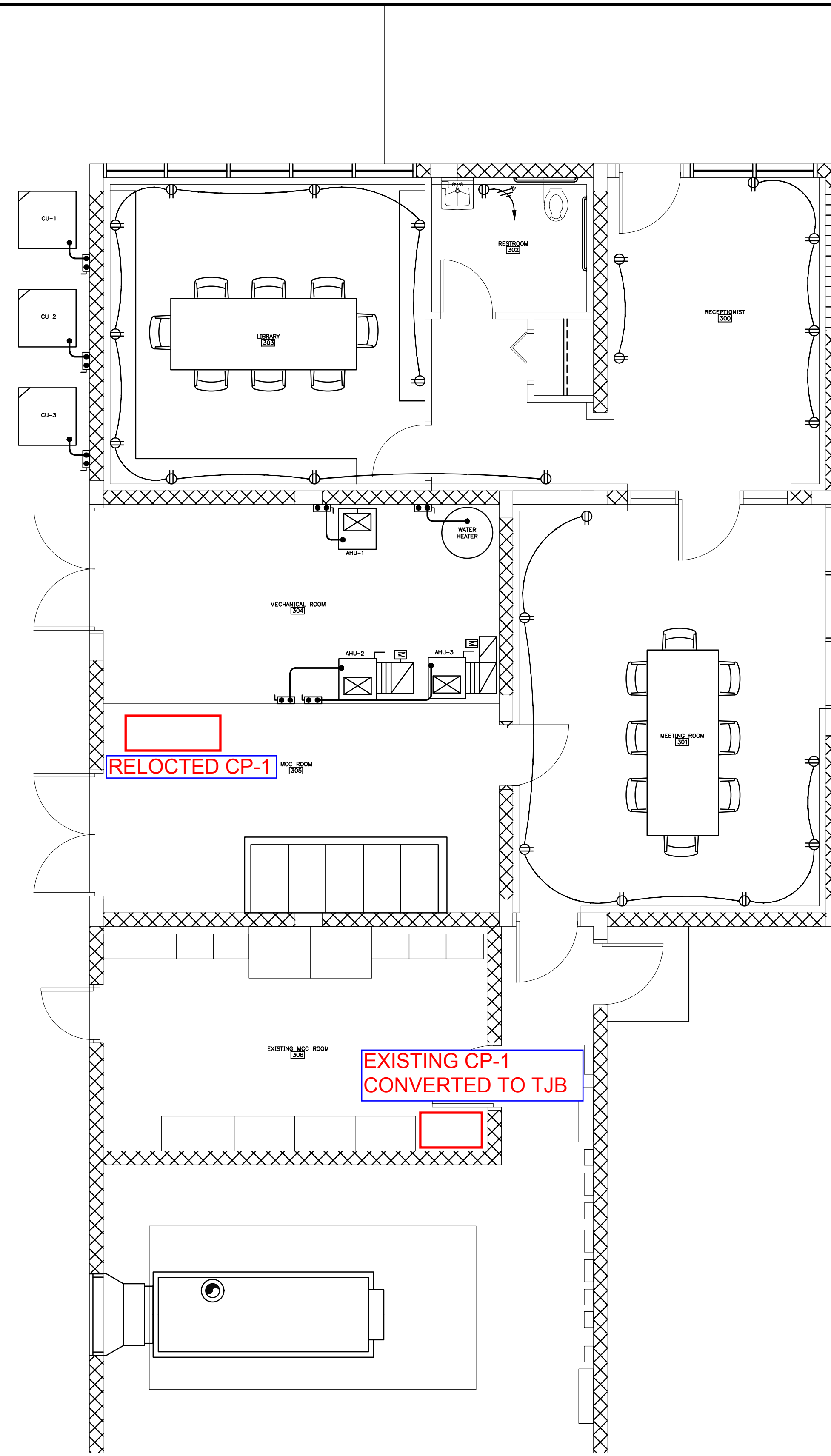
Wellington Water Reclaimation Facility

Existing PLC Summary - PLC/5

Location	Blower Room	MCC Room Main Building	
Name	Alka-Pro PLC	CP-1	
Enclosure Dimensions	48" H x 36" W x 12" D	48" H x 48" W x 12" D	
Indoor/Outdoor	Indoor	Indoor, Conditioned	
Connection to SCADA	15 Pin Ethernet Xceiver	DH+ to Alka-Pro PLC	DH+ to Alka-Pro PLC
Chassis Size	13	17	17
Processor	PLC-5/40E	RIO Adapter	RIO Adapter
1771-IAD	4		12
1771-OW16	1		2
1771-OBN			1
1771-OBD	1		
1771-IB			
1771-OAD			1
1771-IFE	1	2	
1771-OFE	2		
1771-IFE/C	1	5	
1771-OFE2/B		3	
Space	2	6	
Panelview	No	No	

Appendix E

Expansion Project Control Building MCC Room Layout



MODIFICATION OF EXISTING
CONTROL BUILDING
SCALE: 1/4" = 1'-0"

PROJECT NO. 43196
ENG. BUS. NO. 1567
JHHAM ENGINEERING

No.	REVISIONS	DATE	BY

Kimley»Horn
1920 WEKIVA WAY SUITE 200, WEST PALM BEACH, FL 33411
PHONE: 561-845-0665 FAX: 561-863-8175
WWW.KIMLEY-HORN.COM CA 00000696

KHA PROJECT	144957010
DATE	JAN. 2018
SCALE	AS NOTED
DESIGNED BY	JHH
DRAWN BY	TVG
CHECKED BY	JMH

WASTEWATER TREATMENT PLANT EXPANSION
PREPARED FOR
VILLAGE OF WELLINGTON
MUNICIPALITY FL

LICENSED PROFESSIONAL
ROBERT GARCIA
FL LICENSE NUMBER 31103
DATE: ____

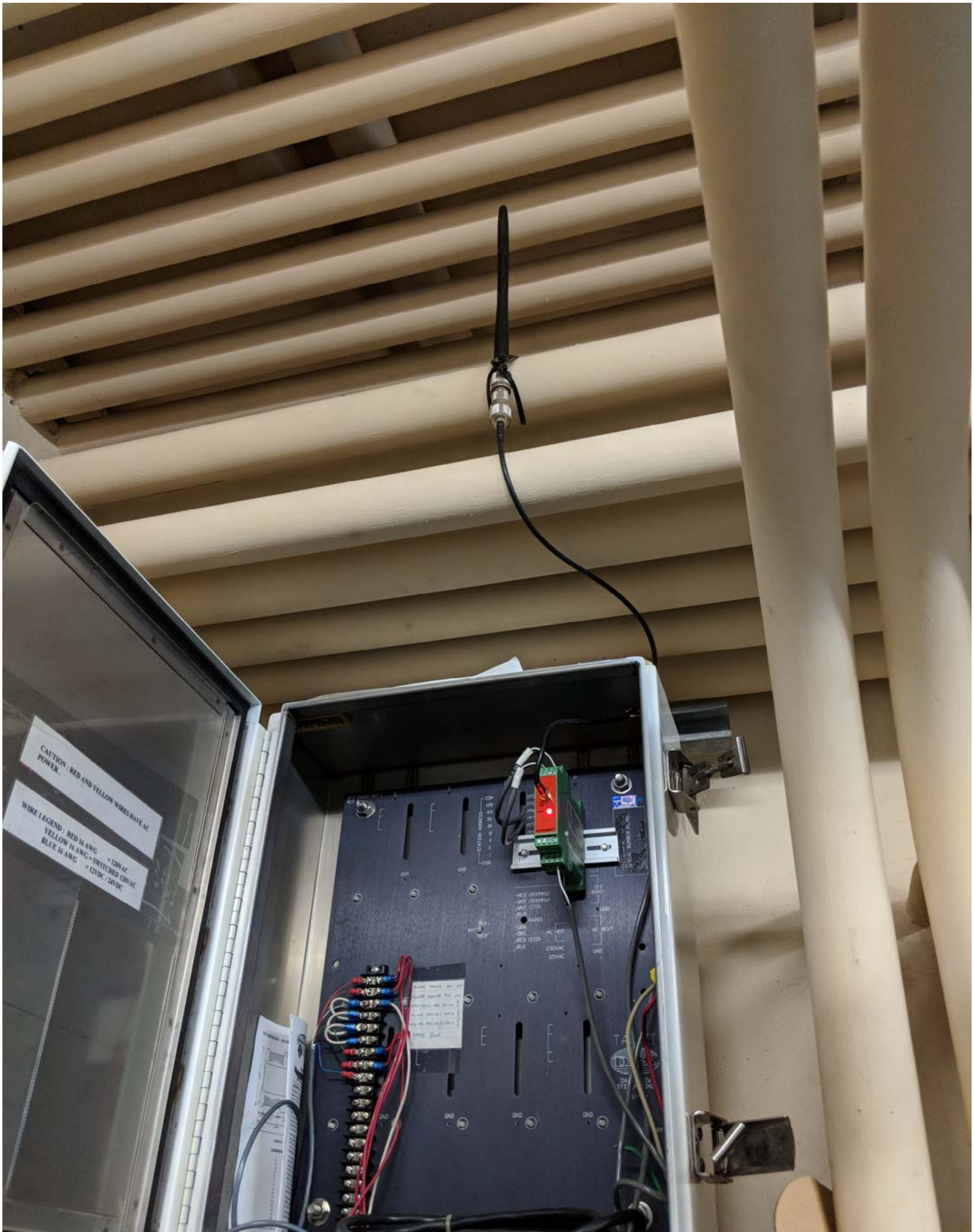
EXISTING CONTROL BUILDING ELECTRICAL POWER MODIFICATION PLAN

DRAWING NUMBER
E-28
SHEET NUMBER
160 OF 213

Appendix F

Existing RTU Enclosures near CP-1

Existing CP-1 and RTU Enclosures



Existing RTU Enclosure Above CP-1