## Memorandum

*To:* *David Abbaspour*

*From:* *Craig Montgomery* CCM

*Date:* *January 10, 2014*

*Subject:* *Southwest Water Reclamation Facility*
*Reclaimed Water Pump Station Modifications*

# 1.0 Background

The high-service reclaimed water pump station at the City of St. Petersburg's Southwest Water Reclamation Facility (SWWRF) includes five 250-hp, variable speed vertical turbine pumps. It pumps treated reclaimed water effluent from the SWWRF into reclaimed water distribution system and to deep injection wells and aquifer storage and recovery (ASR) wells located on the plant site. Reclaimed water storage tanks and reject water storage tanks are also located on the site.

Construction of force mains, gravity sewer systems, and pump stations is currently underway that will allow the City to divert all influent raw wastewater from the Albert Whitted Water Reclamation Facility (AWWRF) to the SWWRF. Once these new facilities are placed into operation, the AWWRF will be decommissioned, although deep injection wells located on the site will be retained. These wells are currently used for disposal of excess reclaimed water generated at the AWWRF but, upon completion of the facilities currently under construction, the City will have the ability to transmit reclaimed water through its reclaimed water distribution system to these injection wells.

The diversions of raw wastewater flow from the AWWRF to the SWWRF will increase the quantities of reclaimed water effluent at the SWWRF. Based on recent wet weather peak flows, the City has determined that additional high-service reclaimed water pumping capacity is needed.

# 2.0 Purpose

The City has contracted with CDM Smith to more fully develop and evaluate two options for increasing the capacity of the reclaimed water pump station at the SWWRF. These options were identified in the agreement as:

- Option 1 – Install two larger capacity pumps in place of two of the five existing 250-hp pumps.
- Option 2 – Install two additional pumps while retaining all five of the existing 250-hp pumps.

While the agreement between the City and CDM Smith indicated that alternatives involving both new and relocated (from AWWRF) pumps would be considered, due to schedule and budget concerns, the City advised CDM Smith that both Options 1 and 2 should be based on relocation of two existing 450-hp pumps from the AWWRF. Under both options, it was also agreed that new variable frequency drives should be provided since the existing drives are over 10 years old, which makes them more difficult to service and maintain.

This technical memorandum presents descriptions of both of the options under consideration, evaluates these options, and makes a recommendation regarding the preferred option.

## 3.0 Data Collection

The City performed reviews of flow records for the SWWRF and AWWRF and performed hydraulic modeling to determine performance requirements for the reclaimed water pump station. Performance requirements for both discharges to the injection wells and discharges to the reclaimed water distribution system were determined. These requirements were conveyed to CDM Smith during a meeting with the City.

CDM Smith also attended a meeting with City staff and other City consultants to develop an understanding of the scope and status of the planned modifications to the plant-wide 12-KV electrical distribution system.

CDM Smith also conducted site visits to both the SWWRF and AWWRF and reviewed record drawings to become familiar with existing process mechanical systems, electrical systems, instrumentation and controls systems, HVAC systems, structures, and yard piping. CDM Smith also reviewed available performance data and manufacturer's dimensional drawings for the two existing 450-hp dual-use vertical turbine pumps currently located at the AWWRF. As part of the site visit, CDM Smith also collected measurements to confirm the amount of space available within the existing electrical building for placement of new electrical equipment.

## 4.0 Existing Facilities

### 4.1 Civil/Mechanical/Structural Description

The existing reclaimed water pump station includes five 250-hp, variable-speed vertical turbine pumps. The vertical turbine pumps are mounted on the top slab over the reclaimed water pump station wet well. The wet well has interior concrete walls that partition the wet well into five separate pump bays, each approximately 5 feet wide. The top slab is supported by the outer walls of the wet well and by the interior partition walls.

The pump station discharge header is located below the top slab and penetrates through the interior partition walls and through the outer walls of the wet well. A section of the partition wall between the second and third pump bays has been previously removed to allow a butterfly valve to be inserted into the discharge header between the pump no. 2 and pump no. 3 discharge piping connections.

From the south end of the discharge header, a 36-inch pipeline continues through the plant site to three injection wells. From the north end of the header, 36-inch piping continues out of the plant site to connect to the City's public access reuse system. A branch off of the City's distribution system also supplies cooling water (approximately 3 mgd) to Eckerd College.

### 4.2 Electrical Systems Description

The pump station is powered from a 2500A, 480V, three phase, Siemens switchboard (designated as SWBD-200) located in Electrical Enclosure No. 1, just east of the pump station. It is a split bus, secondary selective system in a main-tie-main configuration. Both main breakers are normally closed while the tie breaker is normally open. The main and tie breakers are low voltage power circuit breakers with solid state trip units. The two service entrance main breakers are fed from a single 1500 KVA transformer (designated T3).

Downstream of each main device is a 2500A, 3 pole ZTG Series Automatic Transfer Switch (ATS), built into SWBD-200. Each ATS is by GE Zenith, and switches from utility to emergency power based on loss of utility power, or based on a load sharing program with the power company. An existing 900KW 480V generator provides standby power to SWBD-200. The generator feeds SWBD-200E, a 1200A, 3-pole, 4-wire switchboard, which splits the generator feed between the two automatic transfer switches. Each feed to an ATS is protected in SWBD-200E by a Molded Case Circuit Breaker (MCCB) with a solid state trip unit. There is a kirk key interlock system in place to prevent the tie breaker on SWBD-200 from closing, if both circuit breakers in SWBD-200E are open.

The existing electrical loads are roughly evenly split between the two sides of SWBD-200.

Bus A feeds the following loads:

- (1) 225A, 480 Volt Power Panel PP200, which feeds Light Panelboard LP200 through a 45 KVA transformer, T200
- (1) 225A, 480 Volt Panelboard HWP-1, located at the Headworks
- (2) 250-hp Effluent High Service Pumps on VFD (Pump Nos. 4 and 5)

Bus B feeds the following loads

- (3) 250-hp Effluent High Service Pumps on VFD (Pump Nos. 1, 2, and 3)
- (1) 60-hp Reject Water Pump on VFD

## 4.3 Instrumentation/Automation Systems Description

The existing PLC located in control panel SP-600 is an Allen Bradley SLC 5/05, which was installed in 2006. The PLC communicates on the plant's multi-mode fiber ring using Ethernet communications. Field I/O points are hardwired into Allen Bradley Flex I/O modules located in SP-600 which communicates using DeviceNet. Phoenix Contact Ethernet switches and fiber convertors are used to establish communications with the plant network. All I/O from the VFDs is hardwired to SP-600.

A Rosemount pressure transmitter is located on the distribution system side of the discharge header. In addition there is an Endress + Hauser Promag magnetic flow meter measuring flow out to the distribution system. Flow and pressure instrumentation for the ASR and injection wells are located at the well sites. There currently is a Siemens bubbler system for monitoring of level within the effluent pump station wet well.

Control panel SP-600 is located on the plant's fiber ring between control panels SP-100 and SP-700. There are a number of I/O spares located on the flex I/O modules available for future use as summarized below.

- Spare Digital Inputs: 13
- Spare Digital Outputs: 10
- Spare Analog Inputs: 7
- Spare Analog Outputs: 2

## 4.4 Existing Operations

The motorized valves located between the Pump No. 2 and Pump No. 3 discharge connections to the discharge header and at the opposite ends of the discharge header allow the operator to allocate three pumps (nos. 3, 4, and 5) to the injection wells and two pumps (nos. 1 and 2) to the distribution system, or to allocate all five pumps to the distribution system or to the injection wells.

The positions of the valves are controlled by the operator from the control room. In addition, these valves can be controlled from local panels located near each valve.

Currently there is no automatic control for the reclaimed water pumps. Pump speed is selected by the operator (manual remote) to achieve a pumping rate that the operator deems appropriate based on a multitude of factors including plant influent flowrate, reclaimed water storage tank levels, and time of day, among others. Throttling valves at the discharge of the reclaimed water storage tanks automatically modulate to maintain the reclaimed water level in the wet well.

The reclaimed water supplied to Eckerd College for cooling (through piping that branches off of the distribution system) is returned to the chlorine contact chamber. As such, it represents an additional demand on reclaimed water system pumping capacity.

## 5.0 Descriptions of Options

After attending meetings with City staff to understand capacity and operational flexibility requirements, and after conducting site visits and reviewing additional information, CDM Smith has further refined the two options for increasing the capacity of the reclaimed water pump station.

Elements **common to Option 1 and to Option 2** include:

- Relocation of two 450-hp dual use pumps from the AWWRF to the SWWRF (following refurbishment/repair of the pump in a local pump repair shop).
- Installation of two new 450-hp VFDs in Electrical Enclosure No. 1. The new VFDs would most likely be located on the east side of the north interior wall. VFDs would match the existing 250-hp VFDs, in make, style, options, accessories and manufacturer.
- Modification of SWBD-200 with two (2) new Molded Case Circuit Breakers (MCCBs) with solid state trip units to feed their respective VFD and pump motor. MCCBs will match the existing installation, manufacturer, short circuit current interrupting rating, etc.
- New conduit and wiring to the new pumps and field devices.
- New 24-inch diameter pump discharge piping, fittings, check valves (with limit switches), and manual butterfly valves.
- A pressure transmitter would be installed between the discharge of the new pumps and the connection to the existing effluent pump station discharge header.
- No modifications would be required at control panel SP-600 to accommodate the new equipment and instruments. All I/O from the new VFDs would be hardwired into existing spares in control panel SP-600. There are spare Ethernet connections within SP-600 if Ethernet communication to new VFDs is desired in the future.

- The new (relocated) pumps will not have any automatic controls. Pump speed for all pumps will continue to be remotely controlled by the operator. High discharge pressure switches and limit switches (located on the check valves) would be installed in discharge piping for the new pumps for protection.

The electrical changeover time under both Options 1 and 2 would be kept to a minimum; however, should the downtime exceed a few hours, temporary power would need to be supplied to Panelboard HWP-1, which feeds the loads at the Headworks. This is a critical load without means to be fed from another location when Bus A is de-energized. While beyond the scope of this investigation, CDM Smith recommends adding a second feeder from Bus B on SWBD-200 to Panelboard HWP-1. The existing feeder from Bus A would be re-worked and both feeders would run through a Manual Transfer Switch (MTS) to power Panelboard HWP-1. This would provide simple redundancy to the Headworks without significant additional work.

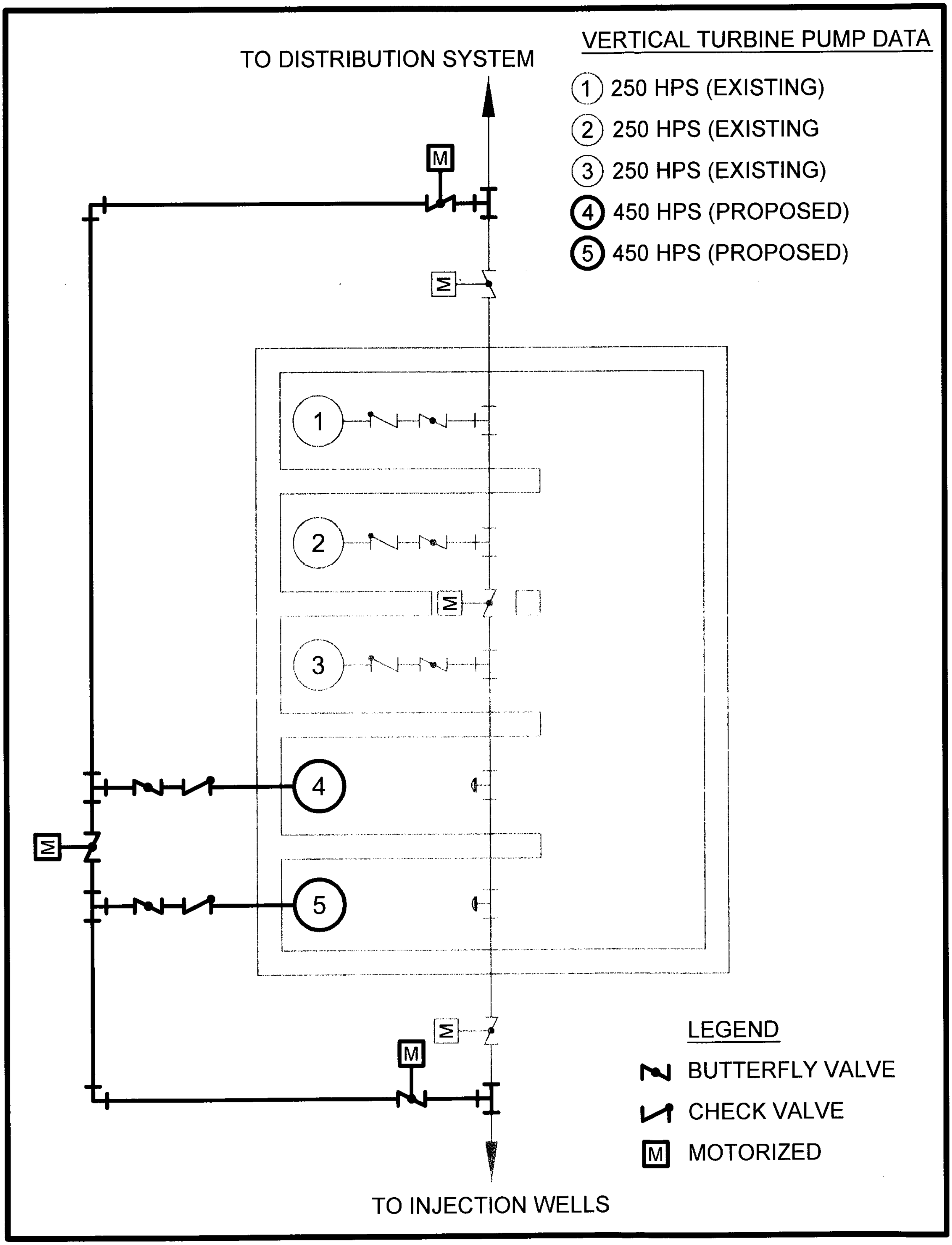
A simplified layout plan for Option 1 is provided on **Figure 1**. Elements that are **unique to Option 1** include:

- Existing 250-hp Pump Nos. 4 and 5 would be removed along with the associated 24-inch diameter check valves and butterfly valves and ductile iron pipe and fittings. Blind flanges would be installed on the 24-inch branches of two 24-inch x 36-inch tees on the discharge header where discharge piping from Pump Nos. 4 and 5 previously connected.

- The two existing raised concrete pump support bases (for pump nos. 4 and 5) would be chipped away down to the height of the rest of the concrete top slab. The existing 25-inch openings in the top slab would also be widened to a minimum of 34 inches to accommodate the larger 450-hp pumps. A new reinforced concrete top slab would then be poured over the existing concrete slab spanning the bays for Pump Nos. 4 and 5, and designed to support the larger loads associated with the 450-hp pumps and in accordance with current code requirements.

- In conjunction with their repair and refurbishment, the existing 450-hp pumps would be shortened in order to fit into the existing wet well.

- Discharge piping (24-inch) for both of the relocated 450-hp pumps would extend to the northwest and connect to a new buried 36-inch discharge header that would be installed around the northeast, northwest, and southwest sides of the wet well and connect to opposite ends of the existing discharge header. Three buried 36-inch motorized butterfly valves would provide flexibility to use Pump Nos. 4 and 5 to pump reclaimed water to the injection wells or to the distribution system, or to split pumping between the injection wells and the distribution system.






CDM Smith

Figure No. 1
Option 1
DEC 2013

- In order to limit the amount of time that operations are limited to only three of the existing 250-hp pumps, the new 450-hp VFDs would be installed and electrical connections to SWBD-200 Bus A made during the time that structural modifications (which require removal of existing Pump Nos. 4 and 5) are under construction.

- In order to make the final connections to SWBD-200, Main Circuit Breaker (CB200A) would need to be opened, effectively de-energizing Bus A. Bus A, which powers Pump Nos. 4 and 5, would be taken offline, while Bus B operates the remaining loads of the pump station. During this downtime on Bus A, new circuit breakers feeding the 450-hp VFDs would be installed and connected to their VFDs. Afterwards, Bus A can be reenergized.

- Under Option 1, all electrical loads on SWBD-200 can be run while the tie breaker between Bus A and Bus B (in SWBD-200) is closed, without overloading the switchboard.

A simplified layout plan for Option 2 is provided on **Figure 2**. Elements that are **unique to Option 2** include:

- All five of the existing 250-hp pumps would remain, and two new (relocated) 450-hp pumps would be added.

- Two new 48-inch diameter concrete-encased steel pump suction cans would be installed in a deep excavation located to the southwest of the existing pump station wet well. The suction cans would extend to approximately 20 feet below grade, and would accommodate the relocated 450-hp pumps without requiring the pumps to be shortened.

- A single 48-inch pipe penetration would be cored through the southeast wall of the pump station wet well. A portion of the wet well would have to be isolated and dewatered to allow the coring operation, but all five of the existing pumps could potentially remain in service during this coring operation. The 48-inch pipe would serve as the pump suction header for new Pump Nos. 6 and 7. The cans would be connected to the suction header through 36-inch diameter branch connections.

- New 24-inch discharge piping from each of the 450-hp pumps would tie into the existing 36-inch piping leading to the injection wells. The new pumps would be dedicated to pumping to the injection wells because sufficient capacity to pump reclaimed water to the distribution system is provided by retaining all five of the existing 250-hp pumps.

- This option represents a larger increase in electrical load versus Option 1.

- In order to maintain maximum operating time during construction, the new 450-hp VFDs will be installed while the existing 250-hp pumps remain in service. The electrical connections to the relocated pumps can be established while all five existing pumps remain in in service, but the connections to Bus A and Bus B in SWBD-200 will require each bus to be briefly taken offline while the other bus operates the remaining loads of the pump station. As one bus of

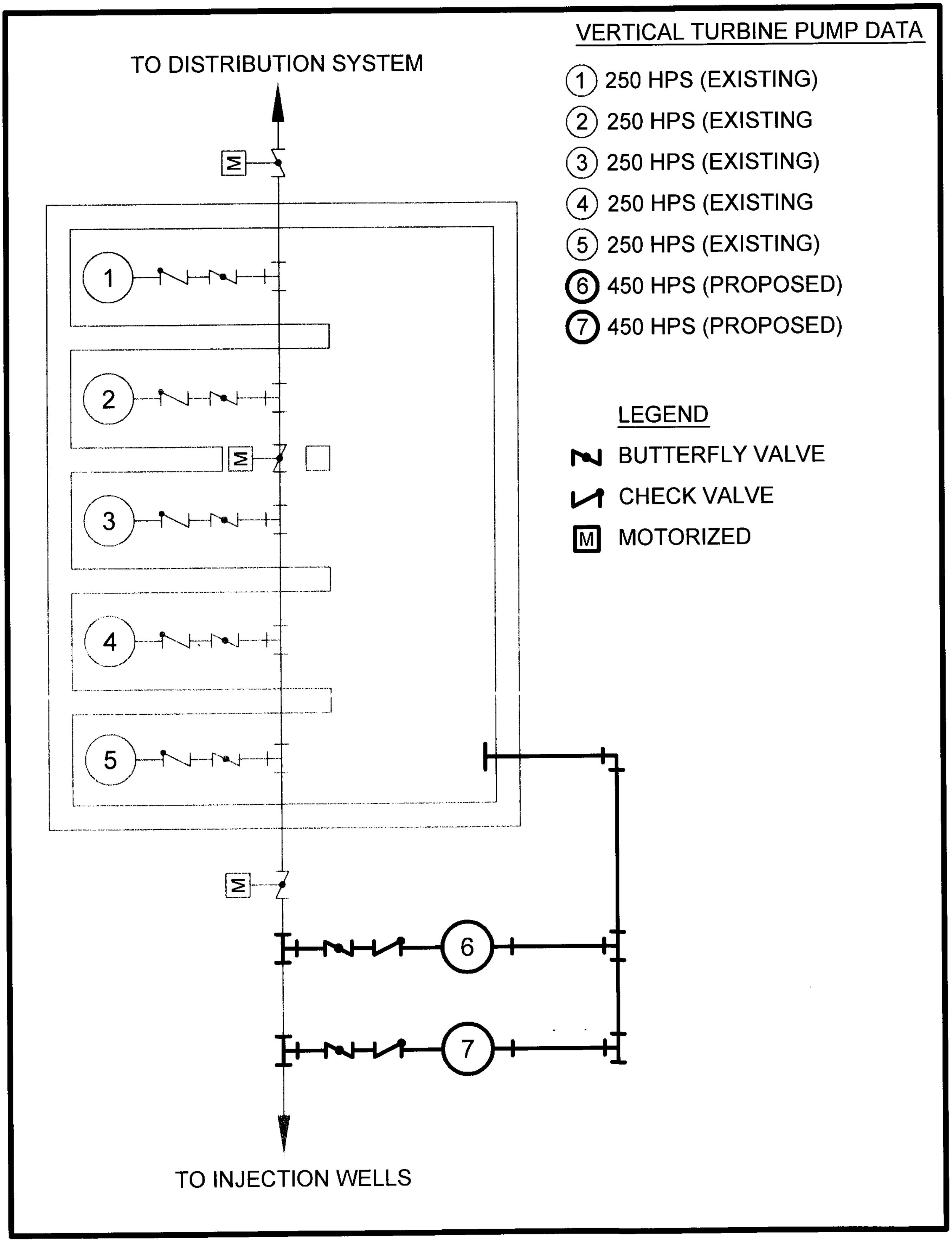



Figure No. 2
Option 2
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SWBD-200 is taken offline, one of the circuit breakers feeding a 450-hp VFD, along with its electrical connections, can be installed on the switchboard. Once finished, this bus can be reenergized. The process then repeats for the other bus.

- Under Option 2, all electrical loads on SWBD-200 cannot be run while the tie breaker is closed, without overloading the switchboard. If the tie breaker is closed, one 450-hp pump or two 250-hp pumps must be prevented from running in order to avoid overloading the switchboard. Under this option, SCADA programming or maintenance supervision must be provided in order to prevent these loads from operating whenever the tie breaker is closed.

## 6.0 Evaluations of Options

Primary factors considered in the evaluation of these alternatives included:

- Construction Cost
- System Capacity and Operational Flexibility
- Complexity of Operation
- Maintenance of Service during Construction
- Consistency with Other Projects
- Consistency with Long-Term Planning
- Schedule

With regard to comparing these options from the perspective of "schedule", it is important to note that the existing 450-hp pumps are needed at the AWWRF until that plant is shutdown and flow is diverted to the SWWRF. Between the time that flow is diverted and the time that the relocated pumps are placed into service at the SWWRF, there is a potential for an occurrence of peak wet weather flows at SWWRF in excess of reclaimed water pumping capacity. Accordingly, the comparison of the two options from a "schedule" perspective is a relative comparison of the potential time required to complete the relocation of the 450-hp pumps following the initiation of flow transfer from the AWWRF.

**Table 1 - Options Comparison**

| Evaluation Criteria | Option 1 | Option 2 |
|---|---|---|
| **Construction Cost** | The EOPCC for this option is approximately $1.3 million, excluding the cost of any temporary pumping systems that might be installed to reduce the risk of an overflow during the construction period. | The EOPCC for this option is approximately $1.7 million. |
| **System Capacity and Operational Flexibility** | Because this option retains only three of the existing 250-hp pumps, it provides substantially less total reclaimed water effluent pumping capacity and provides reduced operational flexibility versus Option 2. | Because this option retains all five of the existing 250-hp pumps, it provides substantially greater total reclaimed water effluent pumping capacity and operational flexibility versus Option 1. |
| **Complexity of Operation** | Because it provides substantially less capacity and operational flexibility versus Option 2, this option requires operators to much more carefully manage usage of reclaimed water storage capacity during peak wet-weather flows. | Because it provides substantially greater pumping capacity and operational flexibility, management of the available reclaimed water storage capacity during peak wet-weather flows becomes significantly less critical versus Option 1. |
| **Maintenance of Service During Construction** | For a substantial period of time during the construction of Option 1, the City would have only three of the existing 250-hp pumps available to pump the entire reclaimed water production of the SWWRF. Accordingly, from maintenance of service perspective, this option is considerably more risky than Option 2. Temporary pumps could potentially be installed to reduce this risk. | Because the relocated 450-hp pumps would be installed in new pump suction cans and all five existing 250-hp pumps would be available throughout the construction period (and after), from a maintenance of service perspective, this option is considerably less risky than Option 1. |
| **Consistency with other Near-Term Projects** | Option 1 does not create any significant impediment to construction of a third reclaimed water storage tank. Options 1 and 2 have similar impacts on the 12 KV loop upgrade project (see further discussion under "Other Issues" at the end of this Technical Memorandum). | Option 2 does not create any significant impediment to construction of a third reclaimed water storage tank. Options 1 and 2 have similar impacts on the 12 KV loop upgrade project (see further discussion under "Other Issues" at the end of this Technical Memorandum). |
| **Consistency with Long-Term Planning** | Since wastewater flows to the SWWRF are not projected to increase in the future (beyond the increase attributable to the transfer of flow from the AWWRF), Options 1 and 2 are considered equal from the perspective of long-term planning. | Since wastewater flows to the SWWRF are not projected to increase in the future (beyond the increase attributable to the transfer of flow from the AWWRF), Options 1 and 2 are considered equal from the perspective of long-term planning. |
| **Schedule** | Since, in addition to repair and refurbishment, the 450-hp pumps would also have to be shortened before they could be relocated to the SWWRF, the time required to complete the relocation of the pumps following flow transfer is potentially longer for Option 1 as compared to Option 2. | Since, the 450-hp pumps would not have to be modified for this option, the time required to complete the relocation of the pumps following flow transfer is potentially shorter for Option 2 as compared to Option 1. |

### 6.1 Other Considerations

Under Option 1, the existing pumps must be shortened before being set into the existing wet well. Before being modified, it is recommended that analyses should be performed to determine whether the modified pump assembly would be expected to have vibration characteristics that are in excess of standards adopted by the Hydraulic Institute. If the analyses indicate that the pump would be subject to excessive vibration, then additional analyses may be performed to identify further modifications that could reduce the excessive vibration.

By placing the unaltered pumps in a standard pump suction can intake design, Option 2 avoids this concern associated with Option 1.

## 7.0 Recommendations

Option 2 is recommended over Option 1 because it offers significant advantages in terms of higher capacity, increased operational flexibility, reduced complexity, and significantly improved ability to maintain service during construction. The only advantage that Option 1 appears to offer over Option 2 is an apparent lower cost of construction.

## 8.0 Other Issues

### 8.1 New Transformer Sizing

Concurrent with the proposed modifications to the Reclaimed Water Pump Station, City Project No. 13036-111 (SWWRF Electrical Distribution Infrastructure Replacement) will be under construction. This project is the first phase of a larger multi-phase project involving the replacement of the existing power company-owned overhead lines, service drops, and transformers with a City-owned 12.47 KV, single loop, distribution system feeding City-owned transformers. In this initial phase, the existing power company-owned overhead 12.47 KV power lines will be replaced with an underground system.

The power company's distribution voltage will be brought directly into the SWWRF at a single point overhead, located in the northwest corner of the site. From there, the distribution system will transition underground and feed new city owned pad mounted transformers. The transformers will step-down the voltage from 12.47 KV to 480/277 V, which will then feed the existing 480 V distribution systems throughout the SWWRF. The 480 V distribution systems will largely remain unchanged.

Two pad mounted switches will communicate with each other and the individual power monitors at each transformer over SCADA. These pad mounted switches will operate as automated switchgear, capable of switching the medium voltage loop from utility to generator, upon loss of power. An existing 2,000 KW generator (located elsewhere on the plant site), through a step-up transformer, will act as standby power to the medium voltage loop during the first phase.

In later phases of the project, multiple improvements will take place. The single-loop medium voltage distribution will be completed, increasing reliability. Additionally digester gas powered generators will provide power for the entire SWWRF, with utility becoming the back-up source of power.

While the medium voltage loop in City Project No. 13036-111 is sufficiently sized to handle the maximum additional load proposed in the upgrades to the Reclaimed Water Pump Station, the existing (and proposed new) 1,500 KVA transformer (T3) is not. CDM Smith understands that the City is currently planning to issue an addenda or a change order to increase the size of Transformer T3 from 1,500 KVA to 2,500 KVA.

## 8.2 Existing 480 V Standby Generator Capacity

It should also be noted that, with the addition of the two 450-hp motors, the existing 480 V standby generator (DG-2) is no longer adequately sized to supply sufficient power to run the pump station at full pumping capacity while running on generator power. This issue occurs regardless of the option selected. While beyond the scope of this investigation, this standby generator would need to be replaced with a larger generator, or be run in parallel with another generator, in order to meet the full electrical demands of the upgraded pump station. Additionally, the distribution switchboard for the generator, SWBD-200E, would need to be increased to match the capacity of the new generator or generators.

## 8.3 Potential 12.47 KV to 480 V Transformer Redundancy

In the later phases of City Project No. 13036-111, standby generator DG-2 is planned to be removed. Once the generator is removed, transformer T3 is a single point of failure that can render the entire pump station inoperable. While not part of the scope of this investigation, there is an electrical option to increase reliability and remove the single point of failure in the pump station electrical distribution system.

In order to mitigate this future problem, a redundant 2500 KVA transformer would be provided. Instead of a split feed off of transformer T3 feeding both of the main circuit breakers in SWBD-200, a single transformer would feed a single main circuit breaker. The redundant 2500KVA transformer

would include an internal VFI, to match the transformers provided in City Project No. 13036-111. With the redundant transformers powering SWBD-200, one transformer can fail completely, without affecting the ability to power the pump station to its full pumping capacity.

Within the remainder of the 480 V power distribution system, a single failure would reduce the maximum pumping capacity, but would not create a complete shutdown. With the installation of the redundant transformer, additional conduit and wire would need to be installed between the new transformer and one of the main breakers in SWBD-200.

# Appendix A
# Electrical Design Criteria

The following are design criteria to be incorporated into the electrical design.

Codes, Standards and References

All electrical work will be designed in accordance with the latest editions of the National Electrical Code (NEC) and local electrical codes. The following are the pertinent codes, standards and references that will govern the design.

National Fire Protection Association (NFPA), with the most relevant codes and standards including:

- NFPA 70 – National Electrical Code

Other relevant codes and standards include:

- National Electrical Safety Code (NESC)
- Occupational Safety and Health Administration (OSHA)
- National Electrical Manufacturers Association (NEMA)
- American National Standards Institute (ANSI)
- Insulated Cable Engineers Association (ICEA)
- Instrument Society of America (ISA)
- Underwriters Laboratories (UL)
- Factory Mutual (FM)
- International Electrical Testing Association (NETA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Florida Building Code (FBC)

All electrical equipment and materials shall be listed by Underwriters Laboratories, and shall bear the appropriate UL listing mark or classification marking. Equipment, materials, etc. utilized not bearing a UL certification shall be field or factory UL certified prior to equipment acceptance and use.

Electrical Enclosures

NEMA enclosure, area and equipment classifications will be as follows:

- NEMA 1, 1A and 12 for dry areas such as electrical or non-process rooms above grade.
- NEMA 3R or 4X for process areas and all exterior areas. Enclosures shall be type 316 stainless steel.

Raceways

Rigid aluminum conduit will be used in interior dry and wet locations. Direct buried underground conduits will be Reinforced Thermosetting Resin Conduit (RTRC) type XW. The minimum size of conduit allowed will be ¾-inch.

The existing distribution out of SWBD-200 is run underground. New conduits required within the Electrical Enclosure No. 1 will run exposed overhead.

All underground conduits will be provided with detectable warning tape above the conduits. Underground electrical conduits will be placed at least 24 inches below grade. Working clearances between underground electrical utilities and other nonelectric underground utilities should be 12 inches (minimum) in addition to other specific equipment requirements.

Conductors

All wire and cables will be run in conduit. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.

Power wiring, rated 600V and less shall be NEC type XHHW for sizes 4/0 AWG and smaller, and shall be NEC type RHW for sizes 250 MCM (kcmil) and larger. Minimum power wiring size shall be No. 12 AWG.

Control wiring (120VAC) shall be No. 14 AWG Type XHHW/XHWN, stranded.

Motors

The motors used on this project will be two existing vertically mounted motors, provided with the relocated vertical turbine pumps from the Albert Whitted Waste Water Treatment Plant. These motors are 460 volt, 450 HP rated, Custom 3000 ASD Induction Motors, rated for adjustable speed duty, manufactured by GE Motors in July 2000. Prior to installation at the SWWRF, CDM Smith recommends that the motors and motor bearings be disassembled and greased according to manufacturer recommendations.

Due to their large size, local disconnects are not practical. An emergency stop push button will be supplied at the pump to provide local disconnecting means. Lock-Out/Tag-Out procedures will have to be used in order to meet NEC requirements.

Variable Frequency Drives

Both motors will be powered and controlled through Variable Frequency Drives (VFDs), fed from SWBD-200. The VFDs will be low voltage rated and be of the voltage source inverter, pulse width modulated (PWM) type. Power output will be generated through insulated gate bi-polar transistors (IGBTs). Power waveform distortion limits will conform to IEEE 519 (1992), through the use of harmonic filters and/or phase shifting transformers, as required and provided by the VFD manufacturer.

In order to maintain consistency with existing manufacturers used on site, VFDs will be provided by Yaskawa. Using this manufacturer allows continuity of operations and maintenance practices, as well as minimizes training and acclimation with the new equipment.