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CITY OF HALLANDALE BEACH
City of Choice

Memorandum

Transfer pumping Evaluation

To: Distribution

Date: May 30, 2014

Background

Based on observations and available information, two of the three transfer/backwash pumps at the City of Hallandale Beach (City) Water Treatment Plant (WTP) were installed in 1968 with the third apparently replaced at a later date. All three pumps discharge to a common transfer manifold and filter backwash water is also supplied from this manifold. The pumps are at or beyond the end of their normal economic lives (typically 20-30 years). City staff have reported that current pump capacities have decreased to approximately 80% of their original design capacities. The transfer pumping station transfers all finished water to storage, including lime softened product and nano-filtration product. Total transfer pumping capacity is currently less than the WTP's rated capacity of 16.0 MGD.

Modification of transfer piping and construction of the 2.0 MG storage tank in 1980 created the current configuration in which the pressure available for filter backwashing is dependent on the level in the 2.0 MG tank. This has apparently contributed to filter backwashing deficiencies.

The analysis summarized in this memorandum was authorized by the City as Hazen and Sawyer (H&S) Work Authorization No. 26. This work authorization also included a High Service Pump Evaluation which was the subject of a separate memorandum submitted to the City on May 7, 2014. The goals of this transfer pumping evaluation are as follows:

- Maximize utilization of existing transfer pumping infrastructure
- Increase transfer pumping capacity commensurate with the rated WTP capacity

- Improve transfer pumping energy efficiency
- Revise transfer/backwash pump station piping to provide adequate pressure for filter backwash and improve locations of electric valve actuators

Existing Transfer Pumping System

There are currently three transfer/backwash pumps in service. Based on available information, the design characteristics are as follows:

Pump Designation	Flow (GPM/MGD)	Pump Head (ft.)	Drive HP and Type	Speed
Transfer Pump No.1	3,500/5.0	36	50 electric	Constant (1,170 RPM)
Transfer Pump No.2	3,500/5.0	36	50 electric	Constant (1,170 RPM)
Backwash Pump	3,500/5.0	36	50 electric	Constant (1,170 RPM)

All existing pumps are of the vertical turbine, single stage type with hollow shaft motors. They are mounted on the deck of the transfer pump station sump. Generically, these pumps are of bronze-fitted, cast iron construction. The bronze alloy used in pumps of this vintage was typically 85-5-5-5 composition which included 5% lead and 5% zinc. These levels of lead and zinc are no longer permitted in new pumps for drinking water service.

Original pump performance curves are not available but the make and model of the original pumps was known allowing curves to be located in the manufacturer's catalog. The Fairbanks Morse Pumps data sheet for the 18XHC bowl with T5KB268 enclosed impeller is attached to this memorandum.

As previously noted, the pumps are operating at approximately 80% of design capacity. Estimated pumping head varies from a maximum of approximately 35 ft. down to less than 20 ft. depending on the level in the 2.0 MG storage tank to which all finished water is normally transferred. Transfer pumps operate at constant speed and are started and stopped to control level in the transfer sump. At the current average production of approximately 6.5 MGD, transfer pumping capacity is adequate.

Filter Backwash

Water for filter backwash is taken from the transfer manifold. The two manifold outlets to the storage tanks are equipped with motor operated valves. Based on available information, it is believed that the valves operate in open-closed mode and do not throttle or modulate. The pressure in the manifold available for backwash varies mostly according to the level in the 2.0 MG tank. Hydraulic grade in the manifold, referenced to vertical datum, may vary from approximately +45 ft. to +15 ft. from full tank to empty tank. A rough estimate of the required grade for backwash is +35 ft. for filters as configured at this WTP and it could be higher if the underdrains and medium support gravel are significantly clogged with sludge deposits. Thus, the available head for filter backwash may not always be adequate.

The record drawings for construction of the 2.0 MG tank in 1980 indicate that the tank was constructed with an external tank inlet pipe entering the tank at an elevation of over +30 ft. This pipe does not actually exist. Construction drawings obtained from the tank contractor indicate that the tank was constructed with a bottom inlet pipe that extends to an elevation of roughly +14 ft. This is the reason the head in the transfer system depends on tank level.

Record drawings indicate that the filter medium installed in the filters in 1968 was anthracite with an effective size of 1.0 mm. A backwash rate of 18 GPM/sq. ft. was estimated to fully expand the bed during backwash at the highest expected water temperature. This compares to the design backwash rate of 15 GPM/sq. ft. The larger filter bays at this WTP each have an area of 216 sq. ft. so the corresponding maximum backwash flow required is 3,900 GPM.

Proposed Pumps

The transfer pumping capacity goals for this facility are a total capacity of 16 MGD, a firm capacity of 12 MGD with one pump out of service and the ability to pump the current average production of 6.5 MGD with one pump. The existing transfer pump station can accommodate no more than three pumps. It is proposed to retain the existing concept of taking filter backwash water from a common pump discharge manifold but with changes to the control system to provide adequate pressure for filter backwash. For a system with three equally sized pumps, the capacity and head for transfer duty will govern the pump size over filter backwash duty.

Pump efficiencies can be predicted using a Hydraulic Institute standard that takes into account pump type, capacity, speed and other factors. For single stage vertical turbine pumps of this type, the maximum projected efficiency is 83% and typical efficiency is 80%. This efficiency is at the pump's best efficiency point. In actual transfer pumping service with variable flows and heads, the efficiency would be expected to vary between 70 and 80%.

Pumps will be single stage vertical turbine type with enclosed impellers, open lineshafts, mechanical seals and solid shaft motors. Vane strainers will be fitted to the suction bells to prevent vortices. Typical proposed pump characteristics are as follows:

Parameter	**Value**
Pump type	Vertical turbine, single stage
Number of pumps	3
Design flow, GPM	4,170
Head at design flow, ft.	42
Min. efficiency at design flow, %	80

Secondary point flow, GPM	4,600
Head at secondary flow, ft.	36
Max. pump speed, RPM	1,200
Motor horsepower, HP	60
Discharge nozzle flange, in.	14
Bowl material	Cast iron
Impeller material	Aluminum bronze
Discharge head material	Cast iron or fabricated steel

Variable frequency drives (VFDs) are proposed for the transfer pumps. Variable speed operation will allow transfer sump level to be controlled by pump speed. It also allows pumps to operate more efficiently at reduced speed when the storage tank is partially full and at higher speed for filter backwash as required. VFDs of this rating can be installed indoors in non-air conditioned space or outdoors in special cooled enclosures.

Transfer and Backwash Piping and Controls

It is proposed to replace discharge piping and valves including motor operated valves (MOVs) suitable for modulating service on the two connections to storage tank transfer lines. The arrangement will be improved over the existing to allow installation of the MOVs in more accessible locations. Ductile iron and thin-wall stainless steel piping material options will be considered. A preliminary proposed arrangement is shown in Figure 1.

In normal operation, transfer sump level would be controlled by modulating transfer pump speed and the MOV on the active storage tank connection would be wide open. During filter backwash the active MOV would throttle to control pump discharge manifold pressure so that adequate pressure for backwashing is available. Transfer sump level would be controlled by pump speed but a lower limit on speed would be set, consistent with the manifold pressure required for backwash. Backwash flow would be controlled by the existing system. Pump speed and MOV operation would be controlled by a programmable logic controller. Transfer sump level transmitter and discharge manifold pressure transmitter inputs will be required.

A simpler alternative control arrangement would be to use manual valves on the storage tank connections and insert an MOV in the discharge manifold between TP-2 and TP-3 that would operate in open-closed mode. During normal operation all three pumps would be available for transfer duty and transfer sump level would be controlled by modulating transfer pump speed. During filter backwash the MOV would close and TP-3 would become a dedicated transfer pump with backwash flow controlled by VFD speed. In the event that TP-3 was not available the MOV would be opened and backwash flow control would revert to the existing system as a back-up.

Maintenance of Plant Operation during Construction

All water produced by the WTP flows through the transfer pump station. Therefore, provisions are required to maintain operation during pump and piping replacement. Installation of a temporary pumping system would enable construction with minimal, short term interruptions of plant operation. This can be accomplished in the following sequence:

- Remove the backwash pump and blind its connection to the transfer pump discharge manifold.
- Install a temporary, portable transfer pumping system with a suction pipe into the transfer sump through the backwash pump opening and connect to the backwash water supply.
- Isolate the 2.0 MG tank while transferring to the 1.0 MG tanks with the existing pumps.
- Disconnect the pump manifold and connect the temporary system to the 2.0 MG tank transfer pipe and start transferring with the temporary system.
- Remove the existing transfer pumps and piping and install two of the proposed pumps and piping.
- Begin transferring to the 1.0 MG tanks with the proposed transfer pumps.
- Remove the temporary transfer pumping system and make final connections to the 2.0 MG tank and backwash system from the proposed piping.
- Install the third proposed pump.

Efficiency Analysis

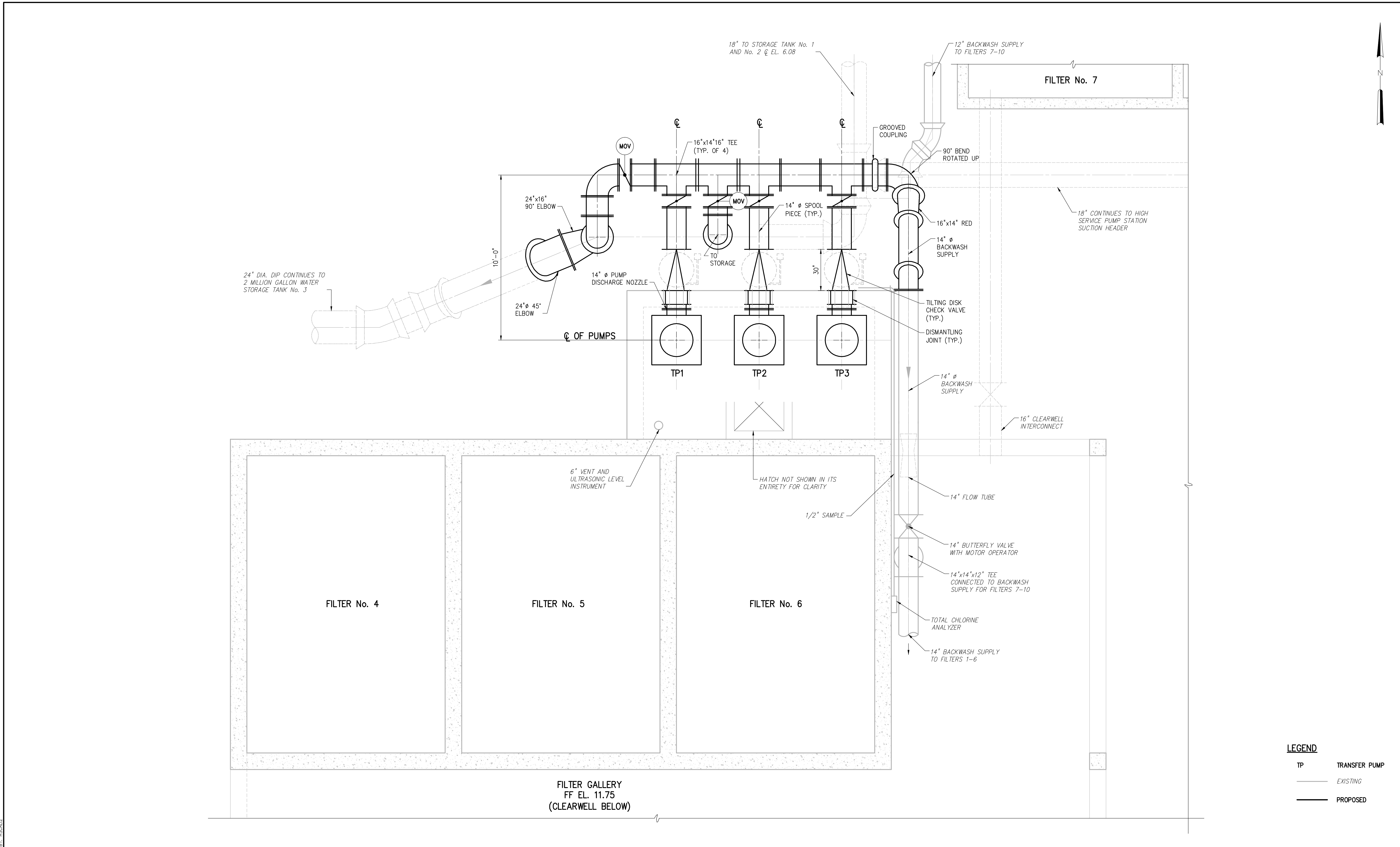
A very approximate estimate of existing transfer pump efficiency was made based on available information and reasonable assumptions. The present typical service condition was assumed to be 6.5 MGD being pumped to a half-full storage tank. Under this condition the existing constant speed pumps alternate between one and two pumps running. Overall wire-to water efficiency was estimated at 55%. Wire-to-water efficiency was estimated at 65% for a proposed transfer pump with VFD at the same service condition. One pump would run at a reduced speed of 85%.

Transfer pumping consumes only about 15% as much electrical energy compared to high service pumping because the pressures are very low. The proposed pumps are expected to consume 15% less electrical energy than the existing pumps for an annual savings of approximately $4,000 under present conditions.

Cost Estimate

A Class 4 cost estimate as defined by AACE International is presented below for transfer pump replacement. This estimate has an expected accuracy range of +50% to -30%.

Description	Line Item Cost	Totals
Total Contractor Costs		$845,000
Transfer pumps	$280,000	
Piping	$105,000	
VFDs and electrical	$75,000	
I&C improvements	$30,000	
Temporary pumping	$30,000	
Contractor indirect costs and profit @ 25%	$130,000	
Estimating contingency @ 30%	$195,000	
Engineering/admin./etc. @ 30%		$250,000
Total Project Cost		**$1,095,000**



PLOT DATE: 5/29/2014 1:53 p.m. BY: HSCALI2

NO.	DATE	ISSUED FOR	BY

DESIGNED ____
DRAWN ____
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PROJ. ENGR. ____

P.E.
No.

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Certificate of Authorization Number: 2771

THE SCALE BAR SHOWN BELOW MEASURES ONE INCH LONG ON THE ORIGINAL DRAWING.

CLIENTS PROJECT: –
ENGINEERS PROJECT: 40612–026
CAD REFERENCE:

Hallandale Beach
CITY OF HALLANDALE BEACH
UTILITIES DEPARTMENT

TRANSFER PUMP EVALUATION

TRANSFER PUMP
PROPOSED PLAN

DATE:
SHEET: FIGURE
DRAWING: 1

CONCEPTUAL PLAN

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