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Memorandum

High Service Pumps Efficiency Evaluation

To: Distribution

Date: May 7, 2014

Background

The existing high service pumps (HSPs) No. 1 through 4 at the City of Hallandale Beach (City) Water Treatment Plant (WTP) were installed in 1967. It has been reported by staff that the HSP Nos. 1 and 2 were replaced in the early 1980s. Hence, the pumps age range from about 30 to 47 years old. The useful life of pumps in this service generally ranges from 20 to 30 years. The pumps are at or beyond the end of their normal economic lives. Pump efficiencies and capacities have declined because of internal wear. In addition, total firm HSP capacity is insufficient to meet projected future peak hour flow capacity and provide sufficient pressure in the future for adequate fire flows and level of service in some parts of the service area.

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 Transfer Pump Evaluation which will be the subject of a separate memorandum. The goals of this HSP evaluation are as follows:

- Maximize utilization of existing HSP infrastructure
- Meet projected year 2025 HSP capacity and pressure requirements (consistent with existing infrastructure)
- Estimate and maximize HSP energy efficiency over existing HSPs

Existing HSP System

There are currently six HSPs in service. Five of the HSPs are housed in the HSP room and the sixth is a large diesel driven pump housed in a separate structure. The HSPs being considered for replacement are the five units in the HSP room. These are as follows:

Pump Designation	Flow (GPM/MGD)	Discharge Head (ft)	Drive HP and Type	Speed
Inside diesel	3,000/4.2	150	150 diesel	Constant (1,780 RPM)
No.1	3,000/4.2	150	150 electric	Constant (1,780 RPM)
No.2	3,000/4.2	150	150 electric	Constant (1,780 RPM)
No.3	1,500/2.1	150	75 electric	Constant (1,780 RPM)
No.4	500/0.7	150	40 electric	Constant (1,780 RPM)

The diesel driven pump located outside the HSP room is not included in this analysis. The City has decided to retain that pump as a backup because of its large capacity (6.0 MGD) and relatively newer construction. This strategy will facilitate installation of replacement HSPs.

All existing pumps are of the horizontal split case, double suction type. This type of pump has the advantages of high efficiency, moderate cost and relative ease of maintenance. 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. This level of lead is no longer permitted in new pumps for drinking water service.

On February 26, 2014 H&S staff made electrical and hydraulic measurements on the existing electric motor driven HSPs No.1, No.2, and No.3 that are used for virtually all normal pumping duty. Pump No.4 is seldom used and has very small capacity. For these reasons it has negligible effect on HSP pumping efficiency and was not included in these measurements. The data are summarized as follows:

Pump Designation	Flow (GPM)	Head (ft)	Phase	Amperes	Phases	Voltage
No.1	3,010*	131	A	163	A-B	481
			B	157	A-C	480
			C	152	B-C	477
No.2	3,010*	131	A	*	A-B	*
			B	*	A-C	*
			C	*	B-C	*
No.3	1,430	115	A	78	A-B	482
			B	78	A-C	481
			C	73	B-C	478

** HSPs No.1 and No.2 are identical units and it was assumed that flow was split equally while running together and that electrical data from No.1 was representative of No.2.*

The pumping efficiencies calculated from the data are as follows:

Pump Designation	Wire-Water Efficiency (%)	Approx. Pump Efficiency (%)
No. 1	67.8	73
No. 2	67.8	73
No. 3	57.4	<70

As would be expected, the efficiencies are far below those attainable with new pumps and the smaller pump No.3 has lower efficiencies than those of the larger pumps.

The suction and discharge manifolds in the pump room are 30-inch and 24-inch diameter, respectively. The suction manifold maximum velocity imposes a capacity limit of 25.4 MGD if the Hydraulic Institute (HI) recommendation of 8.0 ft./sec is observed. The manifolds are accessible in trenches and constructed of flanged ductile iron pipe, so it is feasible to change the size of branches for individual pumps as required.

It was noted during recent visits to the WTP by H&S staff that the electrical service and distribution equipment for the HSP facility is obsolete and undersized for expansion of HSP capacity. This would require upgrading as part of improvements to the facility.

Proposed Pumps

The Water and Wastewater Model Updates report dated December 2007 projected a firm HSP capacity of 23.3 MGD for the year. Since that report was issued, the rate of population growth slowed considerably and one of the elevated storage tanks was taken out of service. These changes will have offsetting tendencies so the projected capacity may still be reasonable. The water and wastewater hydraulic models are due to be updated later this year and will provide a better estimate of HSP capacity.

The Water and Wastewater Model Update also identified future areas of inadequate fire flows and level of service during high flow periods. The report recommended that HSP facility discharge pressure be increased to 70 psig in conjunction with distribution piping upgrades to correct the projected deficiencies. An increase of design condition pump head to 175 ft. would allow a discharge pressure of 70 psig to be met with low ground storage tank levels.

HSP capacity within the existing HSP room footprint can be maximized by replacing the five existing HSPs with four larger HSPs. The largest size unit that will fit in the space available is 250 HP. A firm HSP capacity (with the largest HSP out of service) of approximately 25 MGD can be achieved with four 250 HP units and the existing outside diesel HSP.

Pump efficiencies can be predicted using a HI standard that takes into account pump type, capacity, speed and other factors. For 250 HP horizontal split case, double suction pumps, the maximum projected efficiency is 87% and typical efficiency is 84%. Maximum speed can be either 1,200 or 1,800 RPM with approximately equivalent efficiencies. The 1,800 RPM pumps and motors would be slightly smaller than the 1,200 RPM units and thus be easier to accommodate but either should fit the available space.

Typical pump characteristics are as follows:

Parameter	**Value**
Pump type	Horiz. split case, double suction
Number of pumps	4
Design flow, GPM	4,500
Head at design flow, ft.	175
Min. efficiency at design flow, %	84
Max. pump speed, RPM	1,200-1,800
Motor horsepower, HP	250
Suction nozzle flange, in.	14
Discharge nozzle flange, in.	12
Casing material	Cast iron
Impeller material	Aluminum bronze

Variable frequency drives (VFDs) are proposed for the HSPs. VFDs would allow the pressure to be increased during high demand periods or in response to a major fire flow. Pressure can be decreased during periods of low demand to save energy or to conserve water during drought restrictions.

Figure 1 is a conceptual layout showing locations of pumps, VFDs and main switchboard. HSP No. 4 has been eliminated so that adequate space can be provided for the other pumps and sections of the suction and discharge manifolds have been replaced. The proposed VFDs will be housed in the space now occupied by a retired diesel generator which will be demolished. This area is an existing open electrical room which will be enclosed and air conditioned.

Efficiency Analysis

A comparison between annual electrical energy costs for the existing and proposed HSPs was developed. The basis is the current average day demand of approximately 6.5 MGD with a HSP head of 150 ft. (60 psig discharge pressure). For existing pumps, the pumping duty was allocated between pumps No.1, No.2 and No.3 according to capacities. For the proposed pumps motor efficiency is 94% and VFD efficiency is 97% for a projected average load of 90% of 250 HP rated power. The results are as follows for a range of electrical energy costs:

Annual costs	**Unit Electrical Energy Cost, $/kWH**			
	0.08	**0.09**	**0.10**	**0.11**
Annual cost, existing HSPs, $1,000	136.6	153.7	170.8	187.9
Annual cost, proposed HSPs, $1,000	116.3	130.9	145.4	160.0
Annual savings, $1,000	20.3	22.8	25.4	27.9
Present worth of savings, $1,000*	233	262	291	320

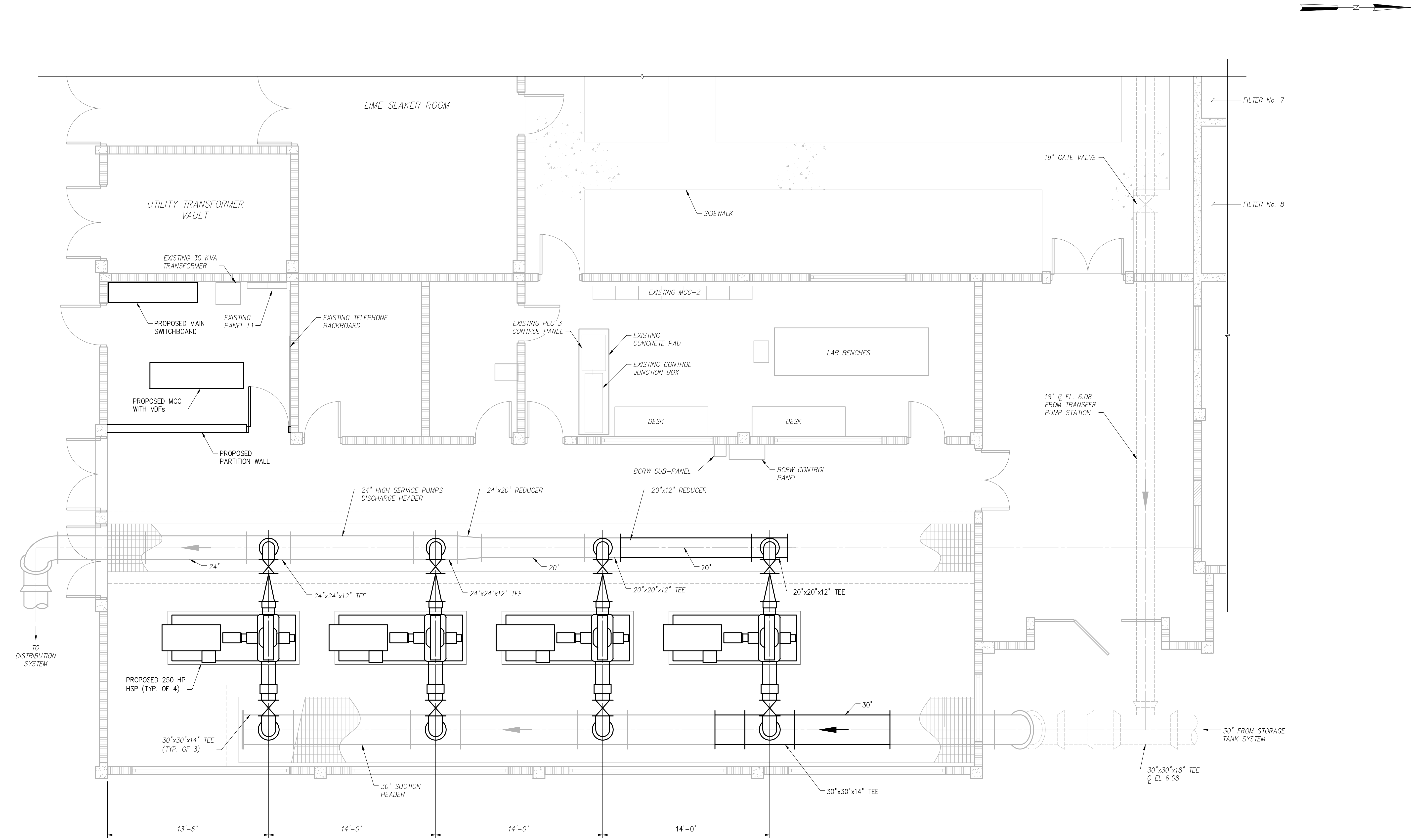
* *20 years, 6% interest*

The City will save $20,000 to almost $30,000 per year in electric energy costs associated with the more efficient pumps even with higher horsepower motors.

Cost Estimate

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

Description	**Line Item Cost**	**Totals**
Total Contractor Costs		$2,015,000
High service pumps	$600,000	
Piping	$220,000	
MCC/VFDs	$160,000	
Equipment wiring	$20,000	
Electrical service upgrade	$150,000	
Electrical room air conditioning	$10,000	
Demolition	$40,000	
Electrical room renovation	$40,000	
Contractor indirect costs and profit @ 25%	$310,000	
Estimating contingency @ 30%	$465,000	
Engineering/admin./etc. @ 30%		$605,000
Total Project Cost		**$2,620,000**



LEGEND:

EXISTING

PROPOSED

HAZEN AND SAWYER
Environmental Engineers & Scientists
4000 Hollywood Boulevard, Suite 750N
Hollywood, Florida 33021
Certificate of Authorization Number: 2771

PLOT DATE: 5/6/2014 9:38 a.m. BY: HSCALI2

Hallandale Beach

CITY OF HALLANDALE BEACH
UTILITIES DEPARTMENT

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PUMP STATION EVALUATION

HIGH SERVICE PUMP PROPOSED PLAN

FIGURE 1

90% SUBMITTAL

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