FLOW RATING ANALYSIS FOR PUMP STATION S650

By

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SFWMD-HIST-018

Hydro Data Management Section

Infrastructure Management Bureau

South Florida Water Management District

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ACKNOWLEDGEMENT

The authors wish to express their appreciation to Jiangchang Cai and John Creswell for collecting the pump performance curve and pump design information for this rating analysis.

DEFINITIONS

Acronyms

AARE	Average absolute relative error
ARE	Absolute relative error
SFWMD	South Florida Water Management District
STA	Stormwater treatment area
TDH	Total dynamic head
TSH	Total static head

EXECUTIVE SUMMARY

Pump Station S650 houses three electric pumps: one with design capacity of 100 cfs and the other two with design capacity of 75 cfs. This report summarizes a flow rating analysis for each type of the pump at Pump Station S650 based on their corresponding pump performance curves. The developed rating equations will be used to compute flow through the pump station.

1.0 INTRODUCTION

1.1 Background

Pump Station S650 houses three electric pumps: pump P-321 with design capacity of 100 cfs and P-322 and P-323 with 75 cfs. Pump Station S650 conveys water from the improved L-64 Canal to the Distribution Canal of Lake Ranch Stormwater Treatment Area (STA-N). The station is located near the northwest corner of the STA-N bounded to the north by the improved L-64 Canal, as shown in **Figure 1**. Both manual and remote operations of the pumping units are possible. Remote operation is from the SFWMD's Operations Control Center in West Palm Beach. Telemetry control is also available to the remote operators.

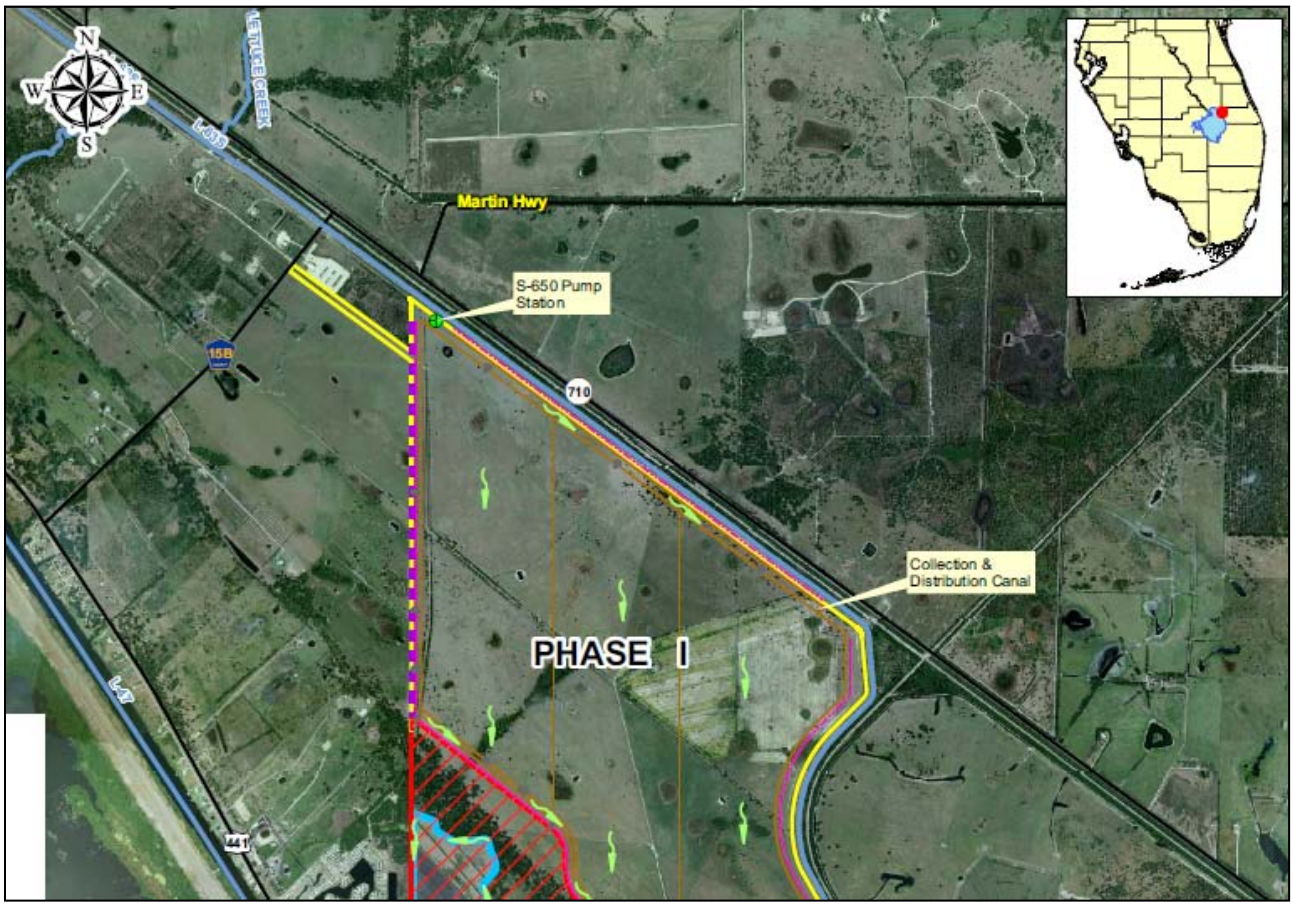


Figure 1. Location map for Pump Station S650

1.2 Objectives and Scope

We will conduct a preliminary rating analysis to develop a flow rating equation for each type of the pump at Pump Station S650 to compute flow through the pump station.

2.0 STATION DESIGN

Pump Station S650 houses three electric pump units, P-321 with design capacity of 100 cfs and P-322 and P-323 with 75 cfs. Pumps P-322 and P323 are identical. **Table 1** presents more detailed description for S650. **Figure 2** illustrates the plan view of Pump Station S650. **Figure 3** and **Figure 4** show the profile view of the pump of 100 cfs and 75 cfs, respectively.

Table 1. Description for Pump Station S650

Pump Type	Item	Description
P-321: 100 cfs	Number of pumps	1
	Design pump capacity	100 cfs
	Engine motor horsepower	200 Hp
	Design pump speed	591 rpm
	Discharge pump diameter	48 in
P-322 & P-323: 75 cfs	Number of pumps	2
	Design pump capacity	75 cfs
	Engine motor horsepower	200 Hp
	Design pump speed	591 rpm
	Discharge pump diameter	42 in
Elevation	Operating Floor Elevation	34.0 ft, NAVD
	Intake Floor Elevation	3.0 ft, NAVD
	Minimum Intake Water Elevation	14.5 ft, NAVD
	Maximum Intake Water Elevation	18.0 ft, NAVD
	Centerline Discharge Pipe Elevation (Pump P-321, Pump P-322 & P-323)	24.76 ft NAVD
	Maximum Discharge Pool Elevation (Pump P-321)	30.26 ft NAVD
	Maximum Discharge Pool Elevation (Pump P-322 & P-323)	30.17 ft NAVD

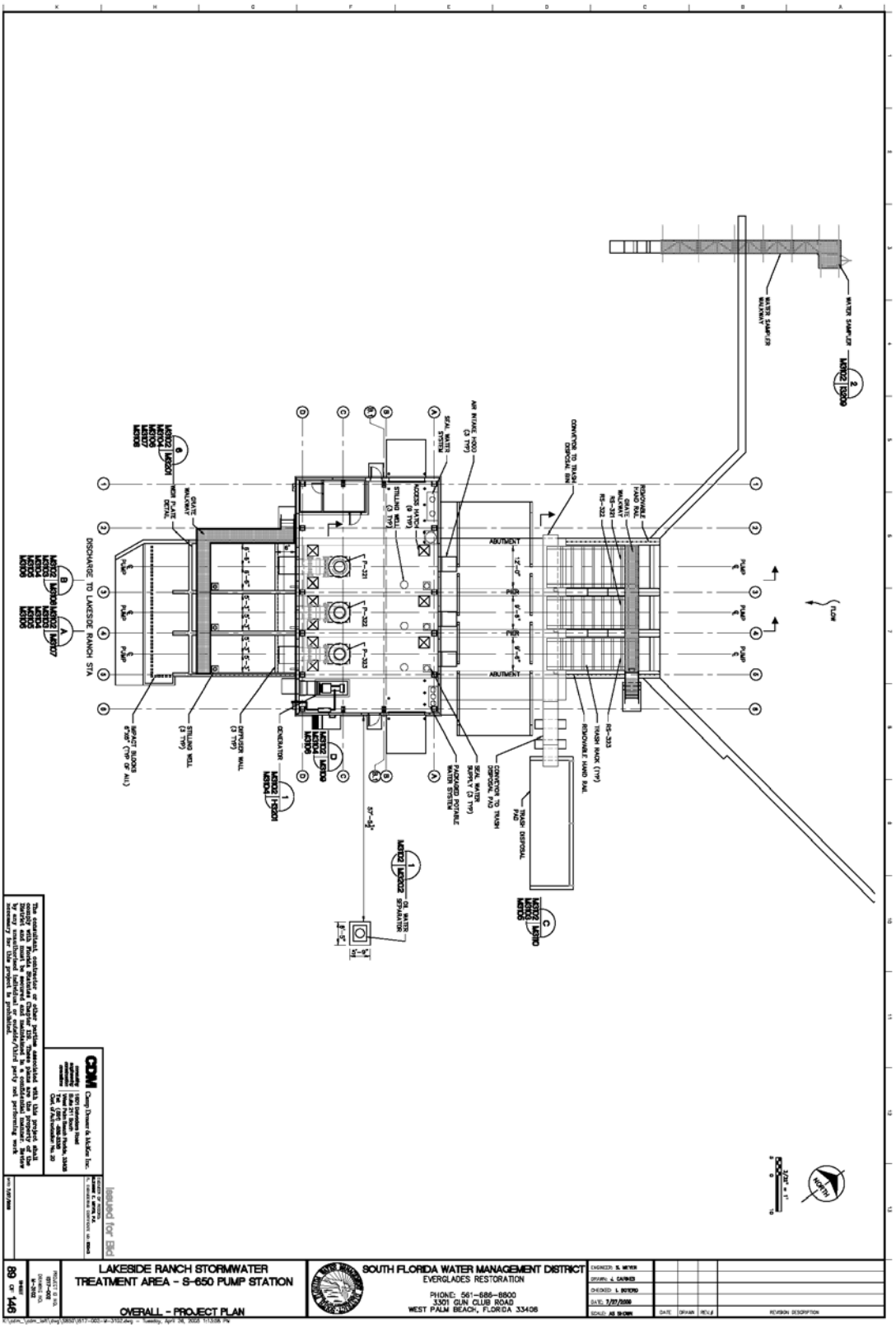


Figure 2. Plan view of Pump Station S650

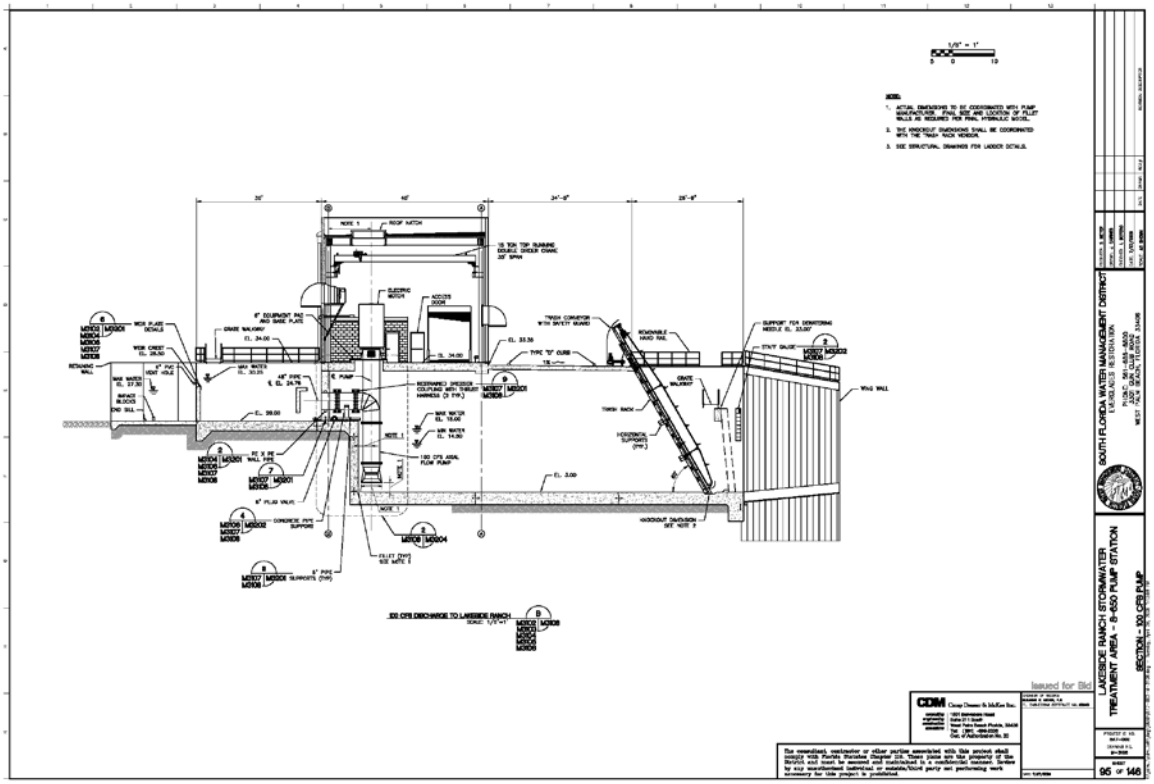


Figure 3. Profile view of the pump of 100 cfs

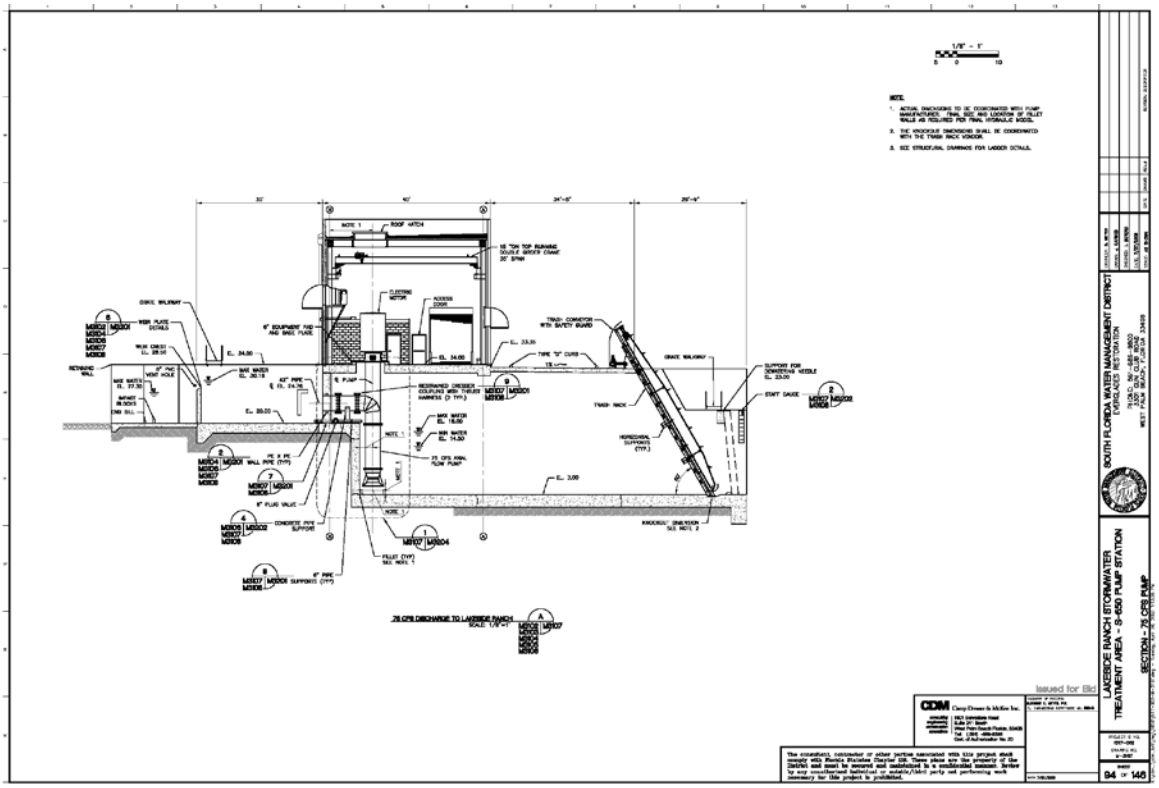


Figure 4. Profile view of the pump of 75 cfs

2.1. Pump Performance Curves for S650

The manufacturer provides the pump performance curves for P-321 with 100 cfs and P-322 & P-323 with 75 cfs based on the pump tests, as shown in **Figure 5** through **Figure 7**. Appendix A through C present the corresponding calculation sheets for these curves.

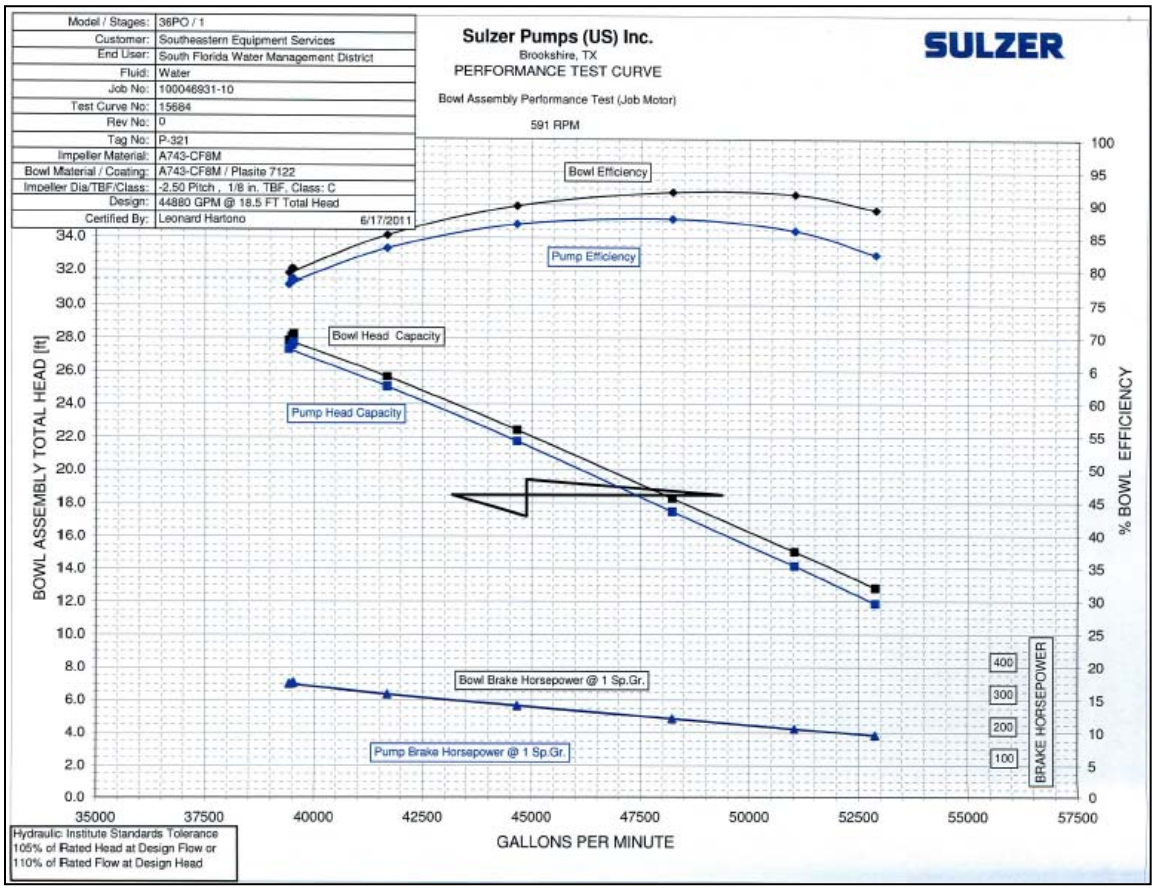


Figure 5. Pump performance curve for P-321 (100 cfs)

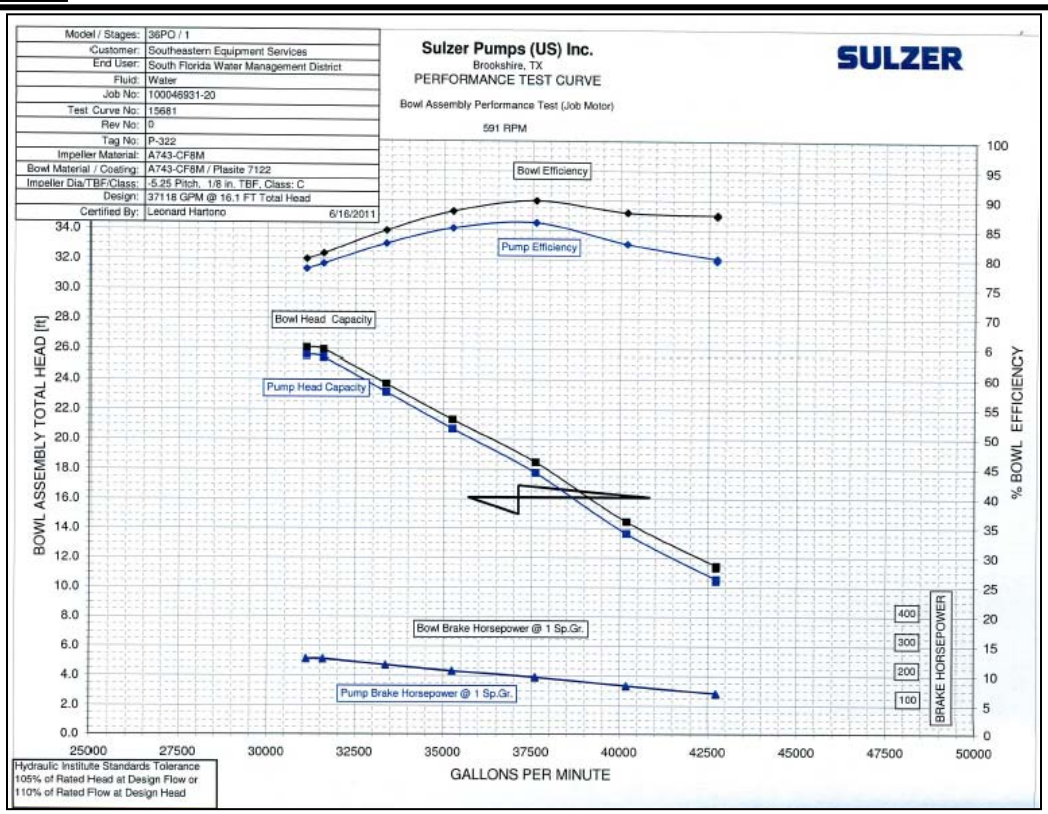


Figure 6. Pump performance curve for P-322 (75 cfs)

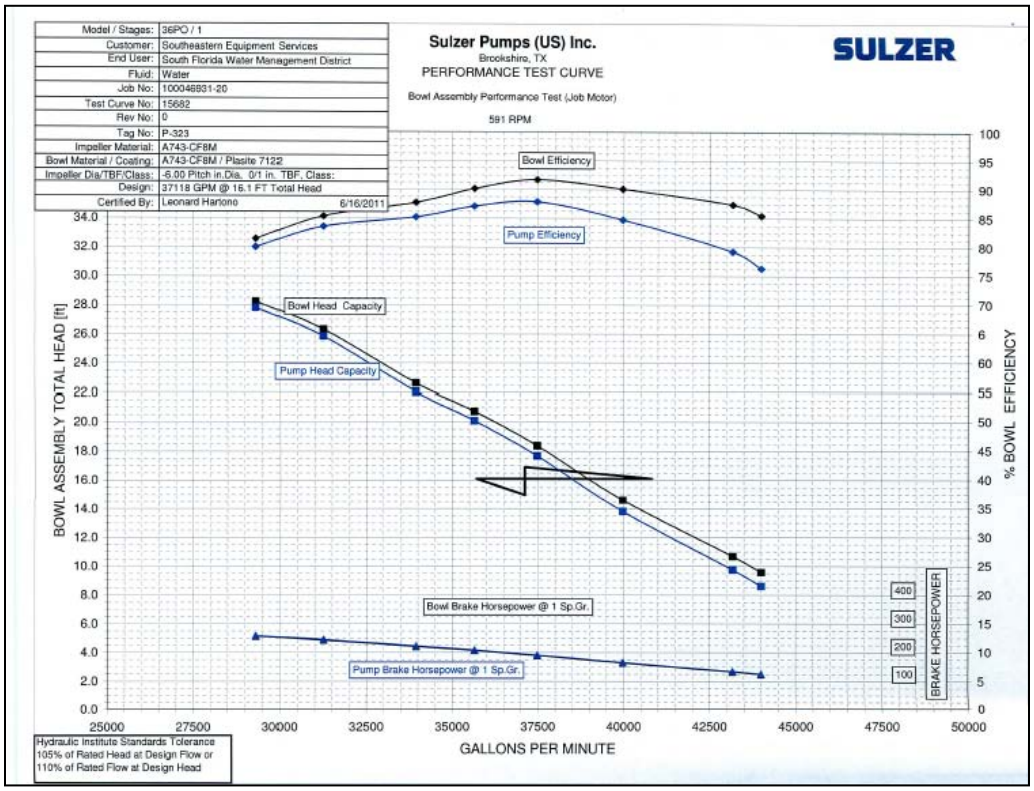


Figure 7. Pump performance curve for P-323 (75 cfs)

3.0 RATING ANALYSIS

We will develop a Case 8 flow rating equation for each type of pump at Pump Station SS650, based on the factory pump performance curves obtained from the pump tests. Case 8 rating equation is developed based on dimensional analysis and pump affinity laws. This conventional rating equation represents all the possible cases, as documented in Damisse (2001) and Imru and Wang (2003). Equation below shows the Case 8 flow rating equation.

$$Q = A\left(\frac{N}{No}\right) + BH^{C}\left(\frac{No}{N}\right)^{2C-1} \quad (1)$$

$$H = \max\{CL, TW\} - HW \quad (2)$$

Where

Q:	Discharge in cfs;
H:	Total static head (TSH);
N:	Pump engine speed in rpm;
No:	Design pump engine speed in rpm (= 591 rpm);
A, *B* and *C*:	Regression coefficients determined through regression analysis (A > 0, B < 0, and C > 1.0).
CL:	Discharge pipe outlet centerline elevation;
TW:	Tailwater elevation;
HW:	Headwater elevation.

For electric pumps with constant speed, $N = N_o$, and Equation (1) becomes

$$Q = A + BH^{C} \quad (3)$$

The *H* versus *Q* relationship can be estimated by subtracting the total head losses through the intake and discharge works from total dynamic head (TDH) on the pump performance curve. We will then conduct a non-linear regression analysis using SAS NLIN function to determine the coefficients in the above equation.

We computed TSH by subtracting total head loss from TDH. The total head loss includes friction loss and minor losses. Friction head loss was provided by the pump manufacturer as given in Appendix A through C. **Table 2** presents the minor loss coefficients for pump inlet, outlet, and bend (HIE, 1990).

Table 2. Minor Loss Coefficients

Minor loss coefficient	Value
Bell Mouth Inlet	0.05
Pipe Exit - Projecting Exit	1.00
90 Degree Elbow	0.195
Total	**1.25**

Table 3 and **Table 4** present TDH, total head loss, and TSH vs. *Q* values for the pump of 100 cfs and the pump of 75 cfs, respectively. **Table 5** provides the flow rating equation coefficients of Eq. (3) corresponding to each type of the pump, which were estimated by nonlinear regression analysis.

Table 3. TDH, Head Loss, TSH and Discharge Relations for Pump -100 cfs

Flow		Pump total head (ft)	Head loss (ft)			Total static head (ft)	Pump speed (rpm)
GPM	CFS		Velocity head loss	Minor loss	Total		
44801.4	99.8	21.8	7.4	1.225	8.625	13.175	590
39495.2	88.0	27.6	5.7	0.952	6.652	20.948	588
39432.1	87.9	27.3	5.7	0.949	6.649	20.651	590
41753.6	93.0	25.1	6.4	1.064	7.464	17.636	590
44736.4	99.7	21.7	7.3	1.221	8.521	13.179	591
48392.9	107.8	17.5	8.6	1.429	10.029	7.471	593
51292.3	114.3	14.2	9.6	1.605	11.205	2.995	593
39600.3	88.2	27.7	5.7	0.957	6.657	21.043	588

Table 4. TDH, Head Loss, TSH and Discharge Relations for Pump -75 cfs

Pump #	Flow		Pump Total Head (ft)	Head loss (ft)			Total static head (ft)	Pump Speed (rpm)
	GPM	CFS		Velocity head loss	Minor loss	Total		
P-322	37557.2	83.7	17.7	5.2	1.468	6.668	11.032	591
	31427.2	70.0	25.4	3.6	1.028	4.628	20.772	588
	33254.1	74.1	23.2	4.0	1.151	5.151	18.049	589
	35191.2	78.4	20.7	4.5	1.289	5.789	14.911	590
	37543	83.6	17.7	5.2	1.467	6.667	11.033	590
	40326.4	89.9	13.6	6.0	1.693	7.693	5.907	593
	42877.9	95.5	10.5	6.7	1.914	8.614	1.886	593
	42942.2	95.7	10.4	6.8	1.920	8.720	1.680	594
	30952.7	69.0	25.6	3.5	0.997	4.497	21.103	588
P-323	37306.5	83.1	18.2	5.1	1.449	6.549	11.651	590
	31092.5	69.3	25.8	3.5	1.006	4.506	21.294	588
	33890.2	75.5	22	4.2	1.196	5.396	16.604	590
	35592.5	79.3	20.1	4.6	1.319	5.919	14.181	590
	37483	83.5	17.7	5.1	1.463	6.563	11.137	591
	40110.1	89.4	13.8	5.9	1.675	7.575	6.225	593
	43315.8	96.5	9.8	6.9	1.953	8.853	0.947	593
	29166.8	65.0	27.8	3.1	0.886	3.986	23.814	588

Table 5. Flow Rating Coefficients for the Pumps at S650

Pump Type	Rating Coefficient	Estimate	Approximate Lower 95% Confidence Limit	Approximate Upper 95% Confidence Limit
P-321 of 100 cfs	A	117.6	114.6	120.6
	B	-1.229	-2.162	-0.296
	C	1.040	0.819	1.261
P-322 & P-323 of 75 cfs	A	96.839	96.131	97.546
	B	-0.956	-1.173	-0.740
	C	1.094	1.026	1.163

Figure 8 illustrates the developed rating curve for the pump of 100 cfs, and **Figure 9** for the pump of 75 cfs. These diagrams illustrate that the rating curves from the developed rating equation well fits the tested data. **Table 6** and **Table 7** present the relative errors between tested and calculated flows for the pump of 100 cfs and 75 cfs, respectively. The AARE for the pump of 100 cfs is 0.3% and the pump of 75 cfs is 0.4%. These results indicate that the developed ratings well represent the relationship between total static head and discharge obtained from the manufactory pump tests.

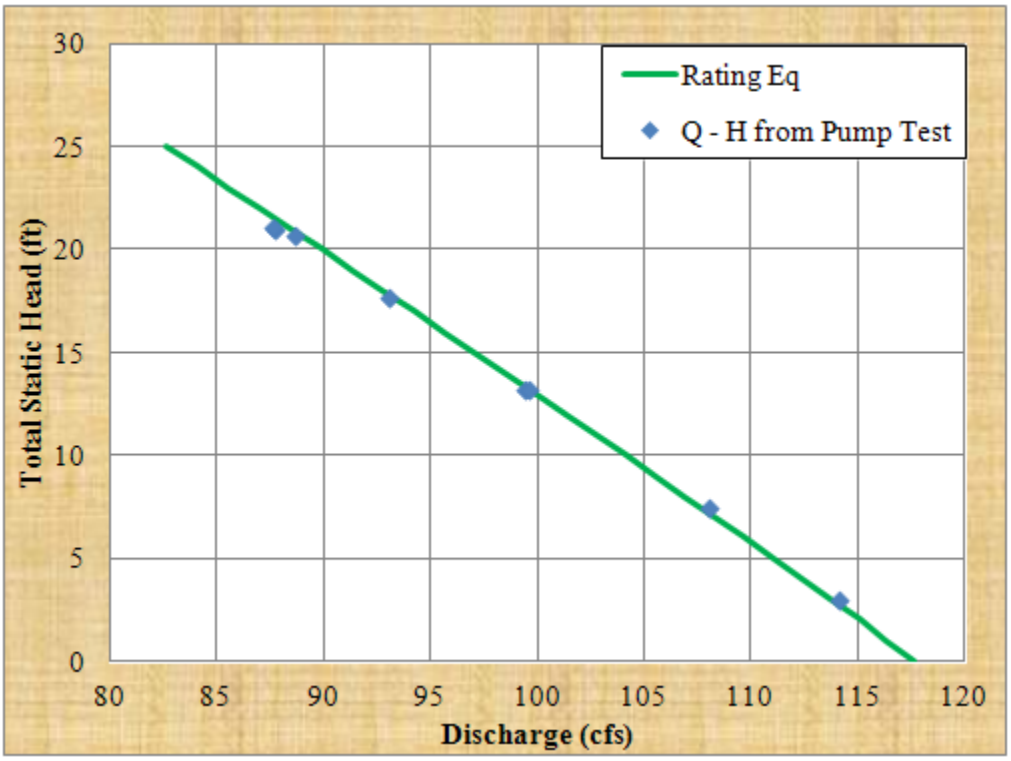


Figure 8. Flow rating curve the pump with design capacity of 100 cfs

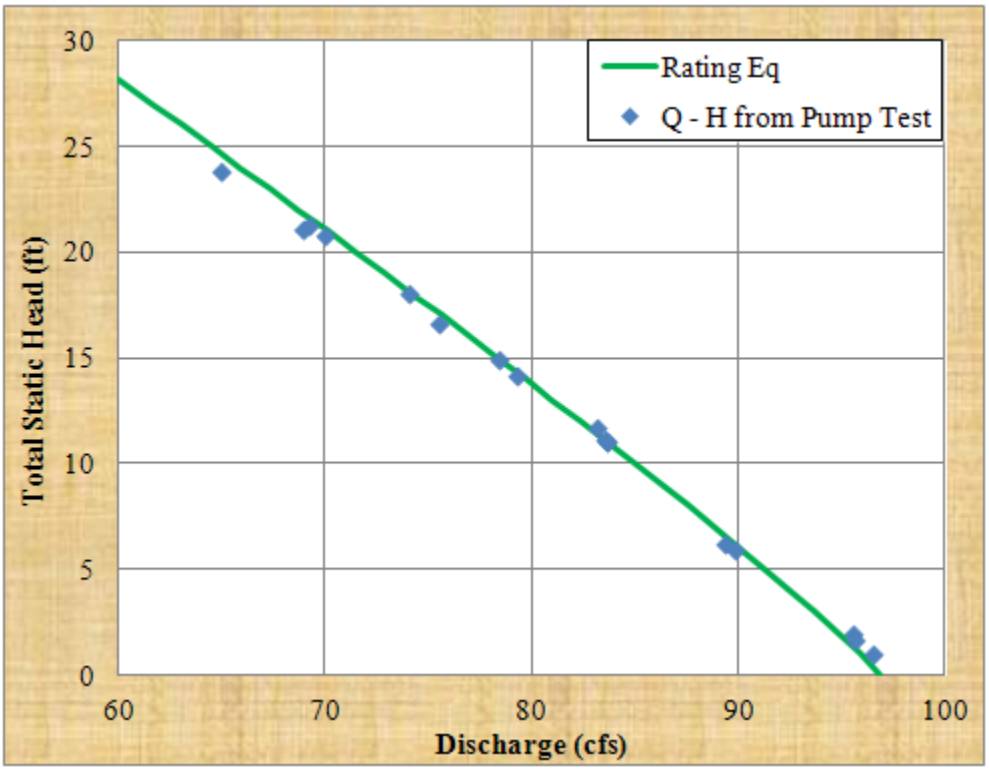


Figure 9. Flow rating curve the pump with design capacity of 75 cfs

Table 6. Comparison between Tested and Calculated Flows for Pump of 100 cfs

TSH (ft)	Pump speed at test (rpm)	Discharge from pump test (cfs)	Discharge from New Rating (cfs)	Absolute Relative Error (%)
13.175	590	99.8	99.4	0.4
20.948	588	88.0	87.8	0.3
20.651	590	87.9	88.7	1.0
17.636	590	93.0	93.0	0.0
13.179	591	99.7	99.6	0.0
7.471	593	107.8	108.1	0.2
2.995	593	114.3	114.2	0.1
21.043	588	88.2	87.6	0.7
Average Absolute Relative Error (AARE)				**0.3**

Table 7. Comparison between Tested and Calculated Flows for pump of 75 cfs

TSH (ft)	Pump speed at test (rpm)	Discharge from pump test (cfs)	Discharge from New Rating (cfs)	Absolute Relative Error (%)
11.032	591	83.7	83.6	0.1
20.772	588	70.0	69.8	0.4
18.049	589	74.1	73.8	0.4
14.911	590	78.4	78.3	0.2
11.033	590	83.6	83.4	0.3
5.907	593	89.9	90.5	0.7
1.886	593	95.5	95.3	0.3
1.680	594	95.7	95.7	0.0
21.103	588	69.0	69.3	0.5
11.651	590	83.1	82.6	0.6
21.294	588	69.3	69.0	0.3
16.604	590	75.5	76.0	0.6
14.181	590	79.3	79.2	0.1
11.137	591	83.5	83.5	0.0
6.225	593	89.4	90.1	0.8
0.947	593	96.5	96.3	0.3
23.814	588	65.0	65.5	0.8
Average Absolute Relative Error (AARE)				**0.4**

4.0 CONCLUDING REMARKS

We conducted rating analysis for the each type of the pump at Pump Station SS650 based on the pump performance curves. **Table 5** presents the coefficients of the flow rating equations for the pump units at Pump Station S650. The flow rating equations need to be calibrated, and to be potentially improved based on future flow measurements after the pump stations are constructed and operated.

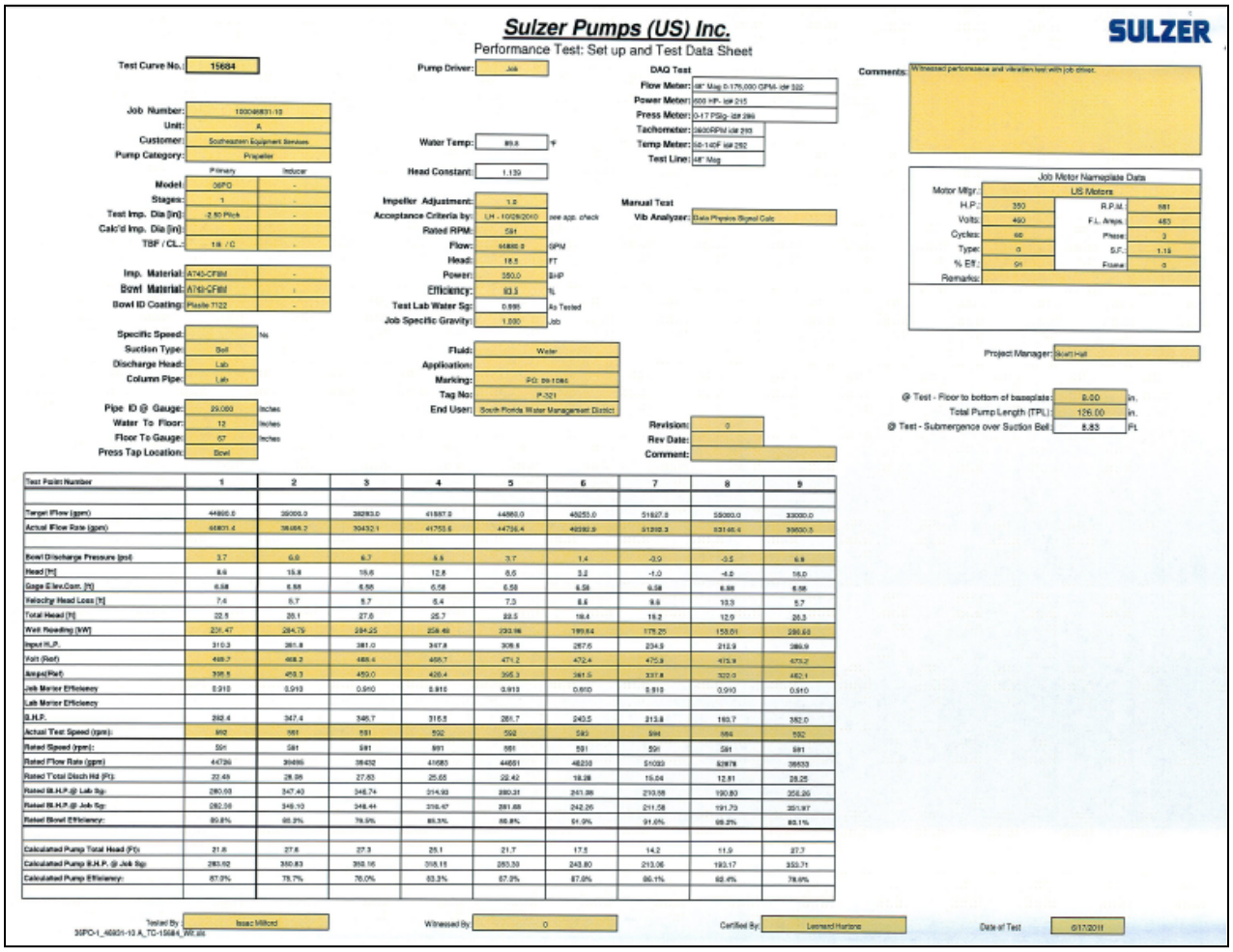
REFERENCES

Damisse, E. 2001. Flow rating development for G335 Pump Station in STA-2. Hydrologic Data Management Division, South Florida Water Management District, West Palm Beach, Florida.

HIE, 1990. Hydraulic Institute Engineering Data Book, 2nd Edition. Hydraulic Institute, Cleveland, Ohio.

Imru, M. and Y. Wang. 2003. Flow Rating Analysis Procedures for Pumps. Technical Publication EMA # 413, South Florida Water Management District, West Palm Beach, Florida.

Appendix A: P-321 pump curve calculation sheet



Sulzer Pumps (US) Inc.

Performance Test: Set up and Test Data Sheet

SULZER

Test Point Number	1	2	3	4	5	6	7	8	9
Target Flow (gpm)	44890.0	39060.0	38283.0	41887.0	44860.0	46253.0	51827.0	58060.0	33000.0
Actual Flow Rate (gpm)	44801.4	38484.2	38432.1	41753.6	44736.4	46282.9	51202.3	57845.4	33000.3
Bowl Discharge Pressure (psi)	3.7	6.0	6.7	5.5	3.7	1.4	-0.9	-3.5	6.9
Head (ft)	8.6	15.8	15.6	12.8	8.6	3.2	-1.0	-4.8	16.0
Gage Elev.Corr. (ft)	6.58	6.58	6.58	6.58	6.58	6.58	6.58	6.58	6.58
Velocity Head Loss (ft)	7.4	8.7	8.7	8.4	7.3	6.6	9.6	13.3	8.7
Total Head (ft)	22.5	29.1	27.8	25.7	22.5	16.4	15.2	12.9	26.3
Watt Reading (kW)	231.47	284.75	284.25	258.48	232.98	199.64	178.25	158.61	286.68
Input H.P.	310.3	381.8	381.0	347.8	308.5	267.6	234.9	212.9	386.9
Volt (Ref)	468.7	468.2	468.4	468.7	471.2	472.4	475.9	473.9	473.2
Amps(Ref)	395.5	458.3	459.0	426.4	395.3	361.5	337.8	322.0	482.1
Job Motor Efficiency	0.910	0.913	0.910	0.915	0.913	0.910	0.915	0.910	0.910
Lab Motor Efficiency									
B.H.P.	282.4	347.4	346.7	316.5	281.7	243.5	213.8	193.7	352.0
Actual Test Speed (rpm):	592	591	591	592	592	593	594	594	592
Rated Speed (rpm):	591	591	591	591	591	591	591	591	591
Rated Flow Rate (gpm)	44726	39486	39432	41683	44681	46238	51033	57978	33033
Rated Total Disch Hd (Ft):	22.49	28.06	27.83	25.65	22.42	18.28	15.04	12.81	28.25
Rated B.H.P.@ Lab Sg:	280.59	347.40	346.74	314.93	280.31	241.96	213.58	190.80	356.26
Rated B.H.P.@ Job Sg:	282.56	349.10	348.44	316.47	281.68	242.26	211.58	191.79	351.97
Rated Bowl Efficiency:	80.8%	86.3%	79.9%	85.3%	86.8%	91.9%	91.6%	88.2%	83.1%
Calculated Pump Total Head (Ft):	21.8	27.6	27.3	25.1	21.7	17.5	14.2	11.9	27.7
Calculated Pump B.H.P. @ Job Sg:	283.02	350.83	350.16	318.15	283.39	243.80	213.06	193.17	353.71
Calculated Pump Efficiency:	67.0%	78.7%	76.0%	83.3%	87.9%	87.6%	86.1%	82.4%	78.6%

Job Number: 150048831-10 | Unit: A | Customer: Southeastern Equipment Services | Pump Category: Propeller (Primary / Inducer)

Model: 36PO | Stages: 1 | Test Imp. Dia [in]: 2.50 Pitch | Calc'd Imp. Dia [in]: | TBF / CL.: 1/8 / C

Imp. Material: AT40-CF8M | Bowl Material: AT40-CF8M | Bowl ID Coating: Plasite 7122

Specific Speed: | Suction Type: Bell | Discharge Head: Lab | Column Pipe: Lab

Pipe ID @ Gauge: 29.000 Inches | Water To Floor: 12 Inches | Floor To Gauge: 67 Inches | Press Tap Location: Bowl

Test Curve No.: 15684 | Pump Driver: Job

Water Temp: 89.6 °F | Head Constant: 1.139

Impeller Adjustment: 1.0 | Acceptance Criteria by: IJH - 10/28/2010 see app. check | Rated RPM: 591 | Flow: 44890.0 GPM | Head: 16.5 FT | Power: 350.0 BHP | Efficiency: 83.5 % | Test Lab Water Sg: 0.995 As Tested | Job Specific Gravity: 1.000 Job

Fluid: Water | Application: | Marking: PO: 09-1086 | Tag No: P-321 | End User: South Florida Water Management District

Revision: 0 | Rev Date: | Comment:

DAQ Test | Flow Meter: 18" Mag 0-175,000 GPM- ser 332 | Power Meter: 500 HP- ser 215 | Press Meter: 0-17 PSig- ser 286 | Tachometer: 0600RPM ser 293 | Temp Meter: 50-140F ser 252 | Test Line: 18" Mag

Manual Test | Vib Analyzer: Data Physics Signal Calc

Comments: Witnessed performance and vibration test with job sheet.

Job Motor Nameplate Data

Motor Mfgr.:	US Motors		
H.P.:	350	R.P.M.	591
Volts:	460	F.L. Amps.	483
Cycles:	60	Phase	3
Type:	0	S.F.	1.15
% Eff.:	91	Frame	0
Remarks:			

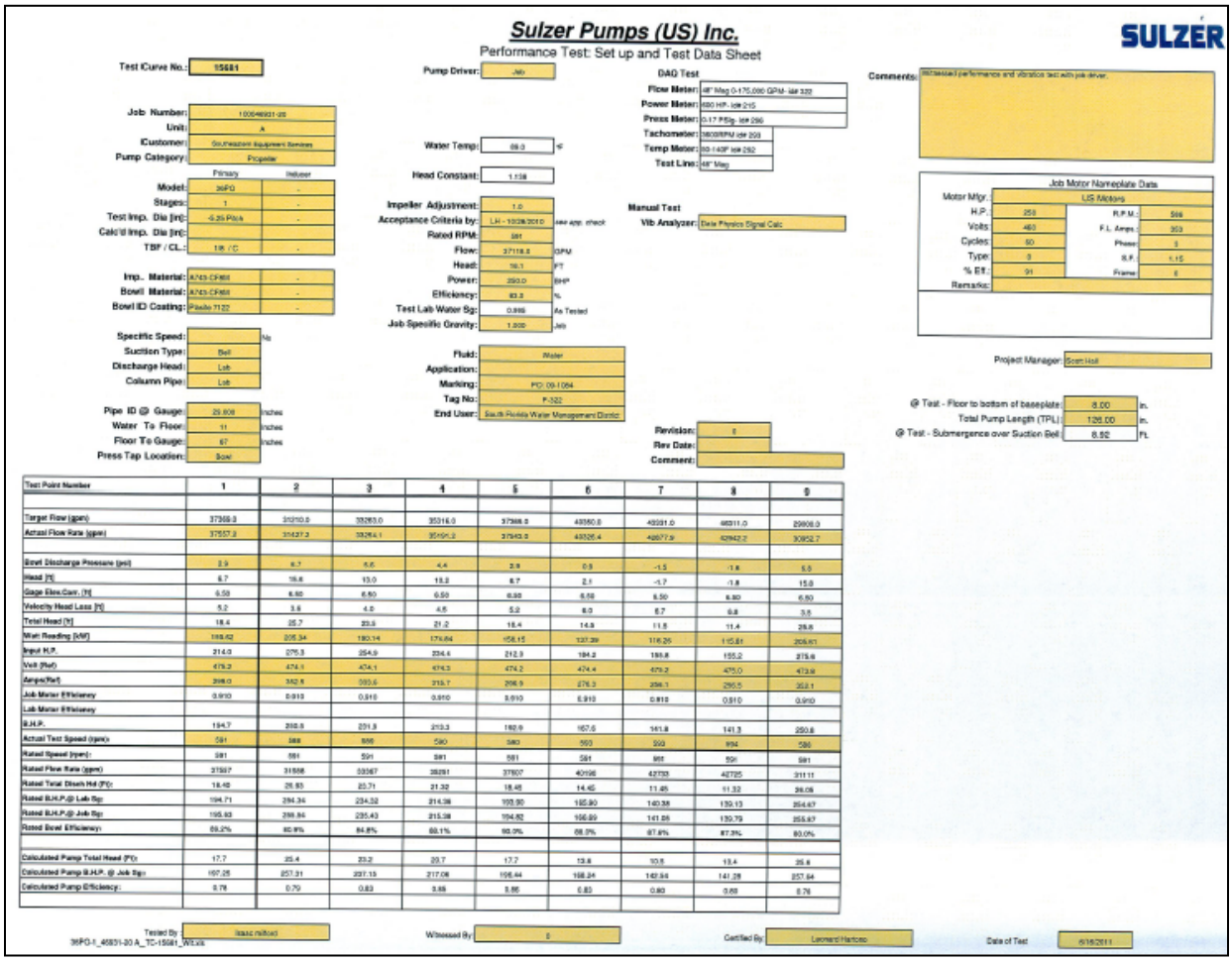
Project Manager: Scott Hall

@ Test - Floor to bottom of baseplate: 8.00 in. | Total Pump Length (TPL): 126.00 in. | @ Test - Submergence over Suction Bell: 8.83 Ft

Tested By: Isaac Millord | Witnessed By: 0 | Certified By: Leonard Horiono | Date of Test: 6/17/2011

36PO-1_46831-10 A_TC-15684_WE.xls

Appendix B: P-322 pump curve calculation sheet



Sulzer Pumps (US) Inc.

Performance Test: Set up and Test Data Sheet

SULZER

Test \Curve No.: 15681

Pump Driver: Jet

DAQ Test

Flow Meter: 48" Mag 0-170,000 GPM- Isn 320

Power Meter: 480 HP- Isn 215

Press Meter: 0-17 PSig- Isn 299

Tachometer: 3600RPM Isn 209

Temp Meter: 50-140F Isn 252

Test Line: 48" Mag

Comments: Witnessed performance and vibration test with jet driver.

Job Number: 100046931-20

Unit: A

\Customer: Southeastern Equipment Services

Pump Category: Propeller

	Primary	Reducer
Model:	36PD	-
Stages:	1	-
Test Imp. Dia [in]:	35.25 Pl/A	-
Calc'd Imp. Dia [in]:		-
TBF / CL.:	106 / C	-
Imp.. Material:	A743-CF8M	-
Bowl Material:	A743-CF8M	-
Bowl ID Coating:	Plasite 7122	-

Water Temp: 69.0 °F

Head Constant: 1.138

Impeller Adjustment: 1.0

Acceptance Criteria by: LH - 1024/2010 see app. sheet

Rated RPM: 591

Flow: 37118.8 GPM

Head: 16.1 FT

Power: 293.0 BHP

Efficiency: 83.3 %

Test Lab Water Sg: 0.995 As Tested

Job Specific Gravity: 1.000 Job

Manual Test

Vib Analyzer: Data Physics Signal Calc

Job Motor Nameplate Data

Motor Mfgr.:	US Motors		
H.P.:	250	R.P.M.:	596
Volts:	460	F.L. Amps.:	303
Cycles:	60	Phase:	3
Type:	3	S.F.:	1.15
% Eff.:	91	Frame:	6
Remarks:			

Specific Speed: No

Suction Type: Bell

Discharge Head: Lab

Column Pipe: Lab

Fluid: Water

Application:

Marking: PO: 09-1064

Tag No: P-322

End User: South Florida Water Management District

Project Manager: Scott Hall

Pipe ID @ Gauge: 25.808 Inches

Water To Floor: 11 Inches

Floor To Gauge: 67 Inches

Press Tap Location: Bowl

@ Test - Floor to bottom of baseplate: 8.00 in.

Total Pump Length (TPL): 126.00 in.

@ Test - Submergence over Suction Bell: 8.92 Ft.

Revision: 0

Rev Date:

Comment:

Test Point Number	1	2	3	4	5	6	7	8	9
Target Flow (gpm)	37366.0	36210.0	35263.0	35316.0	37366.0	40350.0	43231.0	46311.0	49806.0
Actual Flow Rate (gpm)	37557.2	36427.2	35264.1	35491.2	37643.3	40326.4	43077.9	42942.2	30952.7
Bowl Discharge Pressure (psi)	2.9	2.7	2.6	2.4	2.0	0.9	-1.5	-1.8	5.0
Head [ft]	6.7	15.6	13.0	13.2	8.7	2.1	-1.7	-1.8	15.8
Gage Elev.Corr. [ft]	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
Velocity Head Loss [ft]	5.2	3.6	4.0	4.5	5.2	6.0	6.7	6.8	3.5
Total Head [ft]	18.4	25.7	23.5	21.2	18.4	14.6	11.5	11.4	25.8
Watt Reading [kW]	168.62	205.34	190.14	176.64	158.15	137.39	116.26	115.81	205.61
Input H.P.	214.0	276.3	254.9	234.4	212.3	184.2	155.8	155.2	275.8
Volt (Rel)	475.2	474.1	474.1	474.3	474.2	474.4	475.2	475.0	473.8
Amps/Rel	298.0	342.8	303.6	215.7	206.9	276.3	206.1	295.5	353.1
Job Motor Efficiency	0.910	0.913	0.910	0.910	0.910	0.910	0.910	0.910	0.910
Lab Motor Efficiency									
B.H.P.	194.7	252.3	231.9	213.3	192.9	167.6	141.8	141.3	250.8
Actual Test Speed (rpm)	591	588	586	590	590	590	594	594	586
Rated Speed (rpm):	591	591	591	591	591	591	591	591	591
Rated Flow Rate (gpm)	37557	31558	33367	35291	37807	40196	42733	42725	31111
Rated Total Disch Hd (Ft):	18.40	26.65	23.71	21.32	18.48	14.45	11.45	11.32	26.08
Rated B.H.P.@ Lab Sg:	194.71	264.34	234.32	214.38	193.90	165.90	140.38	139.13	264.47
Rated B.H.P.@ Job Sg:	195.93	266.04	235.43	215.38	194.82	166.89	141.05	139.79	255.67
Rated Bowl Efficiency:	89.2%	80.9%	84.8%	88.1%	90.9%	88.3%	87.8%	87.3%	80.0%
Calculated Pump Total Head (Ft):	17.7	25.4	23.2	20.7	17.7	13.8	10.8	10.4	25.8
Calculated Pump B.H.P. @ Job Sg:	197.25	257.31	237.15	217.06	196.44	168.24	142.84	141.28	257.64
Calculated Pump Efficiency:	0.78	0.79	0.83	0.86	0.86	0.83	0.80	0.80	0.78

Tested By: Isaac Hilliard

Witnessed By:

Certified By: Leonard Hartzac

Date of Test: 6/16/2011

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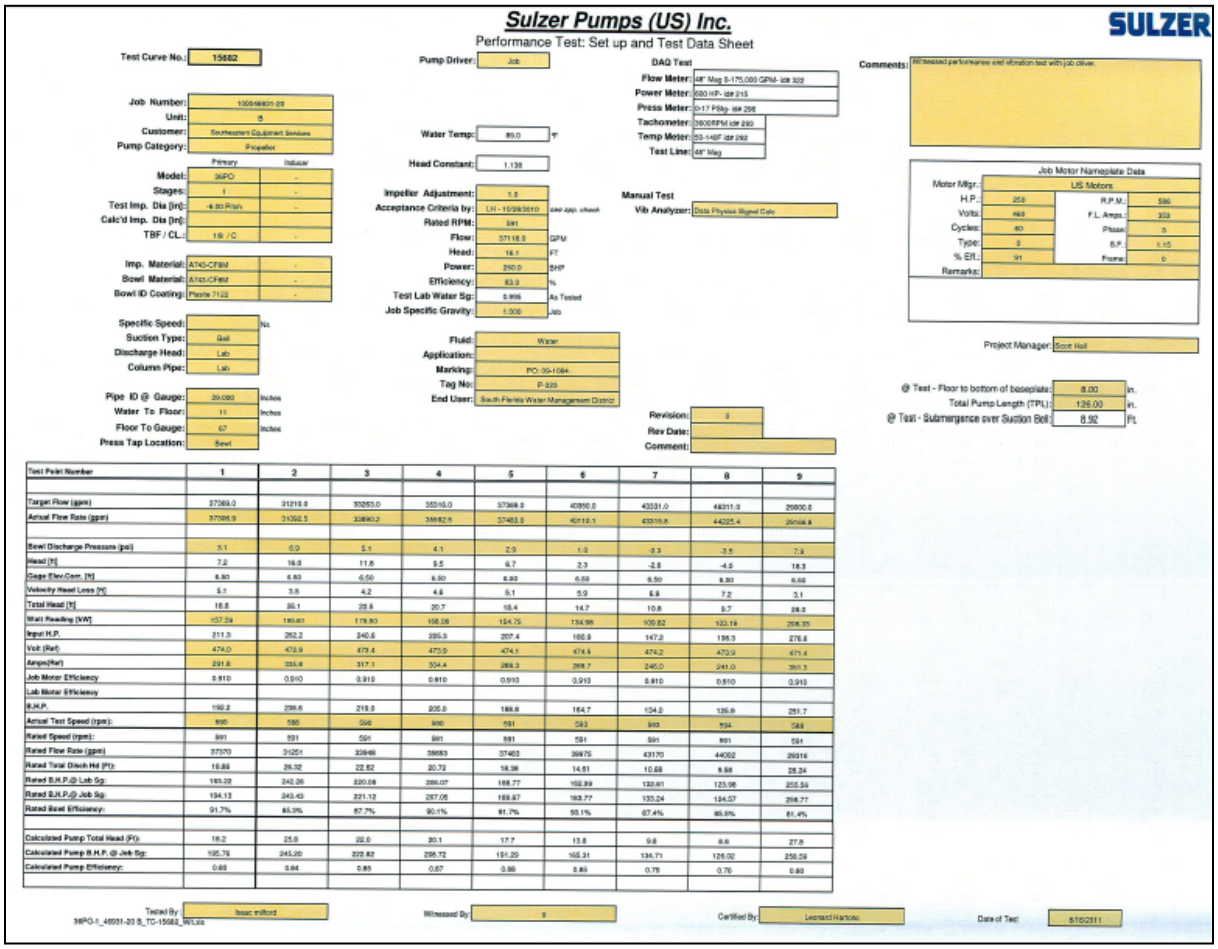
Appendix C: P-323 pump curve calculation sheet



Sulzer Pumps (US) Inc.

SULZER

Performance Test: Set up and Test Data Sheet

Test Curve No.: 15682

Pump Driver: Job

DAQ Test

Flow Meter: 48" Mag 0-175,000 GPM- Idx 322

Power Meter: 600 HP- Idx 215

Press Meter: 0-17 PSIg- Idx 206

Tachometer: 3600RPM Idx 293

Temp Meter: 53-148F Idx 292

Test Line: 48" Mag

Comments: Witnessed performance and vibration test with job driver.

Job Number: 1009/66031-20

Unit: 5

Customer: Southeastern Equipment Services

Pump Category: Propeller

Primary / Inducer

Model: 36PO / -

Stages: 1 / -

Test Imp. Dia (in): 4.80 Pitch / -

Calc'd Imp. Dia (in): / -

TBF / CL: 1/8 / C / -

Imp. Material: A743-CF8M / -

Bowl Material: A743-CF8M / -

Bowl ID Coating: Plasite 7122 / -

Water Temp: 80.0 °F

Head Constant: 1.139

Impeller Adjustment: 1.5

Acceptance Criteria by: LH - 10/28/2010 (see app. sheet)

Rated RPM: 591

Flow: 37118.8 GPM

Head: 18.1 FT

Power: 250.0 BHP

Efficiency: 83.0 %

Test Lab Water Sg: 0.998 As Tested

Job Specific Gravity: 1.000 Job

Manual Test

Vib Analyzer: Data Physics Signal Calc

Job Motor Nameplate Data

Motor Mfgr.: US Motors

H.P.: 250 / R.P.M.: 590

Volts: 460 / F.L. Amps: 353

Cycles: 60 / Phase: 3

Type: S / S.F.: 1.15

% Eff.: 91 / Frame: S

Remarks:

Specific Speed: No

Suction Type: Bell

Discharge Head: Lab

Column Pipe: Lab

Fluid: Water

Application:

Marking: PO: 09-1084

Tag No: P-323

End User: South Florida Water Management District

Project Manager: Scott Hall

Pipe ID @ Gauge: 29.000 Inches

Water To Floor: 11 Inches

Floor To Gauge: 67 Inches

Press Tap Location: Bowl

Revision: 0

Rev Date:

Comment:

@ Test - Floor to bottom of baseplate: 6.00 in.

Total Pump Length (TPL): 126.00 in.

@ Test - Submergence over Suction Bell: 8.92 Ft.

Test Point Number	1	2	3	4	5	6	7	8	9
Target Flow (gpm)	37069.0	31218.9	33263.0	35316.0	37368.9	40950.0	43331.0	46311.0	29600.8
Actual Flow Rate (gpm)	37069.9	31062.5	33890.2	35882.5	37463.8	40518.1	43315.6	44225.4	29566.8
Bowl Discharge Pressure (psi)	3.1	5.9	5.1	4.1	2.9	1.0	-2.3	-3.5	7.9
Head [ft]	7.2	13.6	11.8	9.5	6.7	2.3	-5.5	-8.0	18.3
Gage Elev.Corr. [ft]	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
Velocity Head Loss [ft]	5.1	3.5	4.2	4.8	5.1	5.9	6.9	7.2	3.1
Total Head [ft]	18.8	26.1	22.5	20.7	18.4	14.7	10.8	9.7	28.0
Watt Reading [kW]	157.59	190.61	178.80	168.08	154.75	134.99	109.82	103.19	204.35
Input H.P.	211.3	262.2	240.6	225.3	207.4	180.9	147.2	138.3	276.6
Volt (Ref)	474.0	472.9	473.4	473.0	474.1	474.8	474.2	473.9	471.4
Amps(Ref)	291.6	333.8	317.1	304.4	289.3	268.7	246.0	241.0	391.3
Job Motor Efficiency	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.910	0.910
Lab Motor Efficiency									
B.H.P.	192.2	238.6	219.0	205.0	188.9	164.7	134.0	125.9	251.7
Actual Test Speed (rpm):	590	580	588	590	591	593	593	594	588
Rated Speed (rpm):	591	591	591	591	591	591	591	591	591
Rated Flow Rate (gpm)	37570	31251	33848	35883	37463	39975	43170	44002	29316
Rated Total Disch Hd (Ft):	18.88	26.32	22.62	20.72	18.38	14.51	10.68	9.58	28.24
Rated B.H.P.@ Lab Sg:	193.20	242.26	220.08	206.07	188.77	162.99	132.61	123.96	255.59
Rated B.H.P.@ Job Sg:	194.13	243.43	221.12	207.05	189.67	163.77	133.24	124.57	256.77
Rated Bowl Efficiency:	91.7%	85.3%	87.7%	90.1%	91.7%	93.1%	97.4%	95.9%	81.4%
Calculated Pump Total Head (Ft):	18.2	25.8	22.0	20.1	17.7	13.8	9.8	8.8	27.8
Calculated Pump B.H.P. @ Job Sg:	195.76	245.20	222.82	208.72	191.29	165.31	134.71	126.02	258.59
Calculated Pump Efficiency:	0.88	0.84	0.85	0.87	0.88	0.89	0.79	0.76	0.80

Tested By: Isaac milford

Witnessed By: 0

Certified By: Leonard Hartoto

Date of Test: 5/16/2011

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