FLOW RATING ANALYSIS FOR PUMP STATION G435

Sheng Yue & Emile Damisse

November 2011

SFWMD-HIST-021

Hydro Data Management Section
Operation & Infrastructure Bureau
South Florida Water Management District

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENT

The authors wish to express their appreciation to Larry Vicars for collecting the pump performance curve and pump design information for this rating analysis.

DEFINITIONS

Acronyms

TDH	Total dynamic head
TSH	Total static head
SFWMD	South Florida Water Management District
STA	Stormwater treatment area

EXECUTIVE SUMMARY

This report summarizes a preliminary flow rating analysis for Pump Station G435, based on the pump performance curve. The developed rating equation will be used to compute flows through the pump station.

1.0 INTRODUCTION

1.1 Background

Pump Station G435 is the Compartment B South Build-out inflow pump station. The station discharges into the southwest corner of the South Build-out (SBO) Area of the Compartment B Stormwater Treatment Area (STA). The station is located on the east side of U.S. Highway 27, south of Belle Glade, in the vicinity of the Okeelanta Bridge. The station's intake canal connects directly to the North New River Canal. Pump Station G435 consists of three identical electric stormwater pumps, each with capacity of 160 cfs. The location of Compartment B is shown in **Figure 1**.

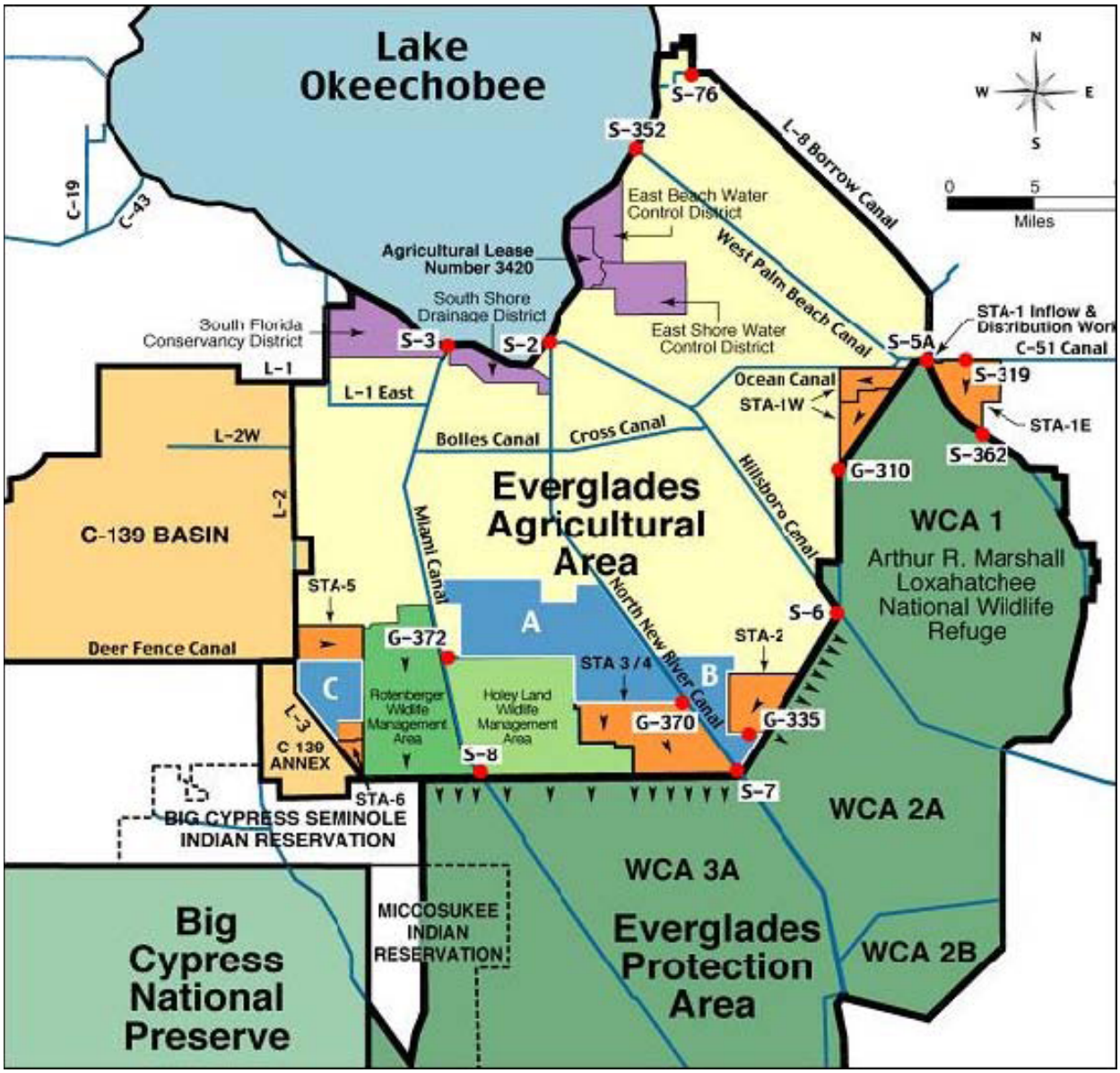

Figure 1. Location map for Compartment B STA

1.2 Objectives and Scope

We will conduct a preliminary rating analysis to develop a flow rating equation for Pump Station G435 to compute flows through the pump station.

2.0 STATION DESIGN

Pump Station G435 consists of three identical electric stormwater pumps each with capacity of 160 cfs. **Figure 2** illustrates the cross-section view of the pump station. **Table 1** presents more detailed description of the station.

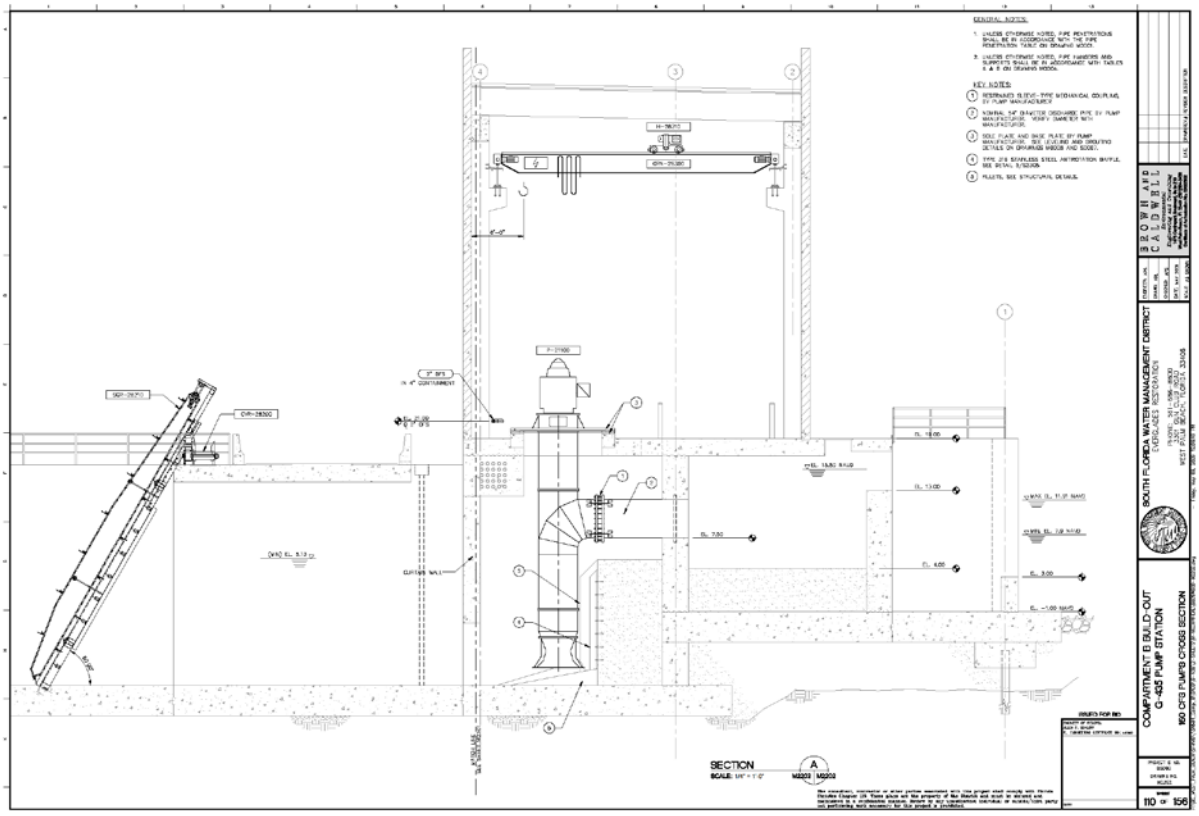

Figure 2. Cross section view of Pump Station G435

Table 1. Description for Pump Station G435

Pump Type	Items	Description
Electric Stormwater pump	Number of pumps	3
	Design pump capacity	160 cfs
	Design engine speed	394 rpm
	Pump impeller speed	394 rpm
	Propeller Diameter	44.1 in
	Discharge pump diameter	53.75 in
Elevation	Maximum upstream water surface elev.	12.5 ft, NAVD
	Maximum downstream water surface elev.	11.9 ft, NAVD
	Minimum upstream water surface elev.	5.1 ft, NAVD
	Minimum downstream water surface elev.	7.9 ft, NAVD
	Discharge weir elevation	13.0 ft NAVD

2.1. Pump Performance Curves for G435

The factory provides the pump performance curves for the pumps at Pump Station G434, as shown in **Figure 3.**

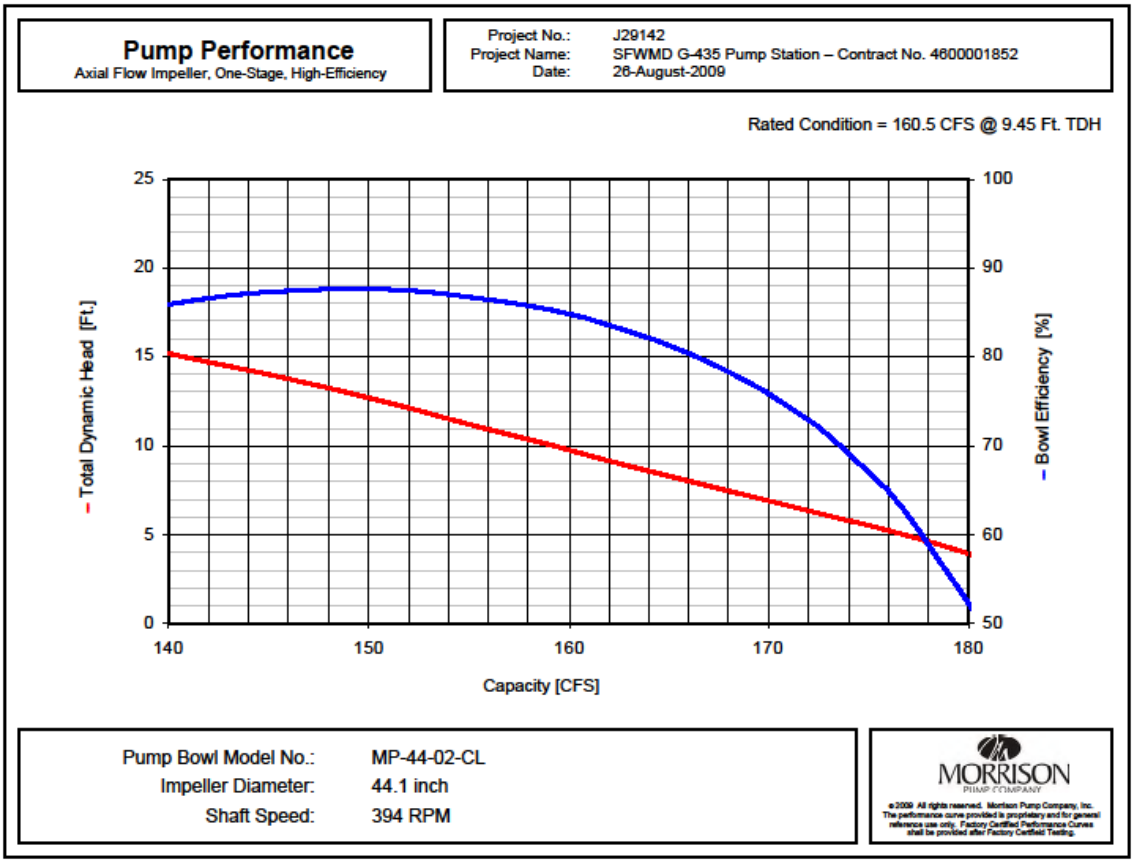

Figure 3. Pump performance curve for the pumps at Pump Station G435

3.0 RATING ANALYSIS

We will develop a Case 8 flow rating equation for Pump Station G435 based on the factory pump performance curve. Case 8 rating equation is developed by dimensional analysis and the pump affinity laws, which is the conventional rating equation representing 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, which is equal to 394 rpm for Pump Station G435;

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.

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 coefficient in the above equation.

We computed TSH by subtracting total head loss from TDH. The total head loss includes friction loss and minor losses, which were computed based on the loss coefficients provided by the pump manufactory. **Table 2** presents TDH, total head loss, and TSH corresponding to discharge (*Q*) values. **Table 3** gives the flow rating equation coefficients of Eq. (1), estimated by nonlinear regression analysis. **Figure 4** illustrates the developed rating curve for the pumps at Pump Station G435. The diagram illustrate that the rating curve from the developed rating equation fits the TSH well.

Table 2. TDH, TSH, Head Loss and Discharge Relations for Pumps at G435

Flow Rate (cfs)	TDH (ft)	Head Loss (ft)	TSH (ft)
140	15.163	1.867	13.296
142	14.650	1.920	12.730
144	14.250	1.974	12.276
146	13.725	2.029	11.696
148	13.213	2.085	11.127
150	12.725	2.141	10.584
152	12.150	2.199	9.951
154	11.575	2.257	9.318
156	11.000	2.315	8.685
158	10.425	2.375	8.050
160	9.788	2.435	7.353
162	9.225	2.496	6.729
164	8.575	2.557	6.018
166	8.075	2.620	5.455
168	7.500	2.683	4.817
170	6.925	2.747	4.178
172	6.350	2.812	3.538
174	5.775	2.877	2.898
176	5.238	2.943	2.294
178	4.575	3.010	1.565
180	4.000	3.078	0.922

Table 3. Flow Rating Coefficients for G435

Rating Coefficient	Estimate	Approximate Lower 95% Confidence Limit	Approximate Upper 95% Confidence Limit
A	182.2	181.5	182.8
B	-2.5859	-2.8625	-2.3092
C	1.0741	1.0364	1.1118

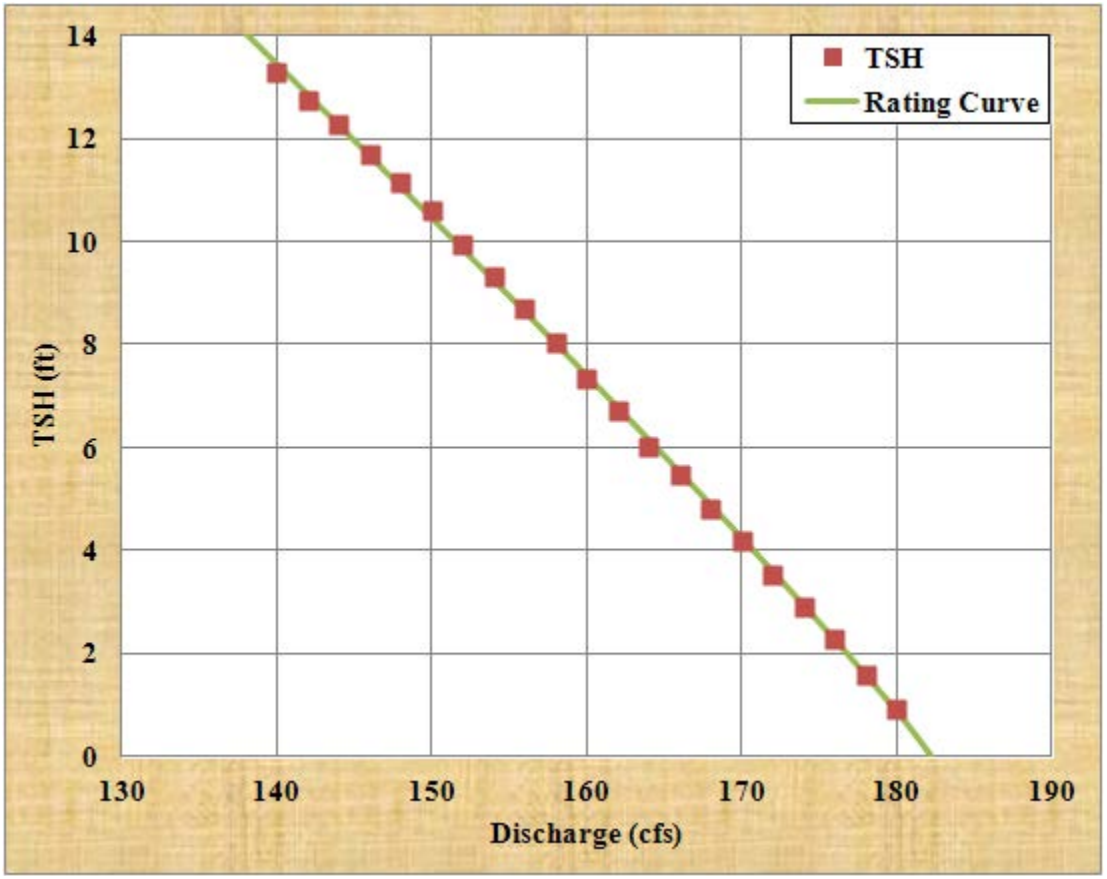

Figure 4. Rating curve for pumps at Pump Station G435

4.0 CONCLUDING REMARKS

We conducted preliminary rating analysis for the three pumps at Pump Station G435 based on the pump performance curve. **Table 3** presents the coefficients of the flow rating equation for Pump Station G435. The preliminary flow rating equation needs 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.

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.