

## **Flow Equation & Ratings Status Report #2 for Stormwater Treatment Area (STA)**

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January, 23, 2012 (revised)

This report has been prepared by staff in the Hydro Data Management section to briefly describe the current status of flow equation and ratings at the inflow and outflow structures of the following STAs:

<b>STA</b>	<b>Type</b>	<b>Structure</b>	<b>Location</b>
STA-1E	Outflow	S-362	Compliance
STA-1W	Outflow	G-251	Compliance
STA-1W	Outflow	G-310	Compliance
STA-2	Outflow	G-335	Compliance
STA-34	Outflow	G-376A-F	Compliance
STA-34	Outflow	G-381A-F	Compliance
STA-5	Outflow	G344A-F	Compliance
STA-6	Outflow	G-606	Compliance
STA-6	Outflow	G-354A-C	Compliance
STA-6	Outflow	G-393A-C	Compliance
STA-6	Outflow	G-352A-C	Compliance
STA-1E	Inflow	S-319	Compliance
STA-1E	Inflow	S-361	Compliance
STA-1E	Inflow	G-311	Compliance
STA-1W	Inflow	G-302	Compliance
STA-1W	Inflow	G-250	Compliance
STA-2	Inflow	S-6	Compliance
STA-2	Inflow	G-328_P	Compliance
STA-2	Outflow	G-328I_P	Compliance
STA-2	Outflow	G-328I_C	Compliance
STA-2	Inflow	G-338	Compliance
STA-2	Inflow	G-339	Compliance
STA-34	Inflow	G-370	Compliance
STA-34	Inflow	G-372	Compliance
STA-34	Inflow	G-372HL	Compliance
STA-5	Inflow	G-342A-F	Compliance

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<b>STA</b>	<b>Type</b>	<b>Structure</b>	<b>Location</b>
STA-6	Inflow	G-600	Compliance
STA-6	Inflow	G-601	Compliance
STA-6	Inflow	G-602	Compliance
STA-6	Inflow	G-603	Compliance
STA-6	Inflow	G-396A-C	Compliance
STA-6	Inflow	G-353A-C	Compliance

The averaged absolute relative deviations of computed flows from measured flows, is the metrics used to indicate the level of accuracy of the initial and current ratings. Whenever a new structure is put online, new or initial flow ratings are implemented based on calibrated flow ratings of similar structures. When enough field flow measurements (10 to 15) become available, the initial ratings are calibrated or replaced by more reliable ones. Based on the Hydro Data Management SOP for data change, the existing rating should not be replaced unless the proposed rating is at least 5% more accurate than the existing one.

Table 1 provides a summary of current status of flow ratings along with the averaged absolute relative errors, and comments regarding the equations, ratings and data collection status.

Appendix A provides the detailed information for each STA cell and inflow and outflow structure used to develop the summary for Table 1.

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**Table 1. Summary of Current Status of Flow Equation Ratings for STA Cell Inflow/Outflow Structures**

STA/Cell	Inflows					Outflows				
	Station	Structure Type	Current Avg. Abs Relative Error	Effective Date for current rating	Comments	Station	Structure Type	Current Avg. Abs Relative Error	Effective Date for current rating	Comments
STA-1E	G-311	Spillway	16.6%	Sep-05		S-362	Pump Station	18.9%	Sep-08	A
STA-1E	S-319	Pump Station	8.6%	Nov-08	A					
STA-1E / Cell 4S	S-361	Pump Station	N/A	Sep-08	A					
STA-1W / Cell 1A	G-250S_P	Pump Station	N/A	Sep-93	A	G-251_P	Pump Station	7.8%	Oct-93	
STA-1W	G-302_S	Spillway	8.8%	Jul-99		G-310_P	Pump Station	3.6%	Jun-04	Calibration from Pump #3 & #6
STA-2	G-328_P	Pump	13.1%	Jul-01		G-328I_C	Culvert	27.0%	Dec-00	A
STA-2	S-6	Pump	6.9%	Mar-91		G-328I_P	Pump	N/A	Jul-01	A
Bypass to STA-2	G-338	Spillway	N/A	Mar-02	A	G-335	Pump Station	16.8%	Aug-08	
Bypass to STA-2	G-339	Spillway	N/A	Mar-01	A					
STA-34	G-370	Pump	2.2%	Jan-03						
STA-34	G-372	Pump	6.0%	Jan-03						
STA-34 Holeyland	G-372HL	Culvert	N/A	Jan-03	Not in use					
STA-34 / Cell 1B						G-376A-C	Culvert	N/A	Jan-11	A
STA-34 / Cell 1B						G-376D-F	Culvert	16.1%	Jan-11	
STA-34 / Cell 3B						G-381A-C	Culvert	5.3%	Jan-11	
STA-34 / Cell 3B						G-381D-F	Culvert	8.7%	Jan-11	
STA-34 / Cell 3B						G-381D-F	Culvert	8.7%	Jan-11	
STA-5 / Cell 1A	G-342A	Culvert	16.0%	Aug-10	A					
STA-5 / Cell 1A	G-342B	Culvert	8.0%	Aug-10	A					
STA-5 / Cell 2A	G-342C	Culvert	8.0%	Aug-10						
STA-5 / Cell 2A	G-342D	Culvert	23.7%	Aug-10	A					
STA-5 / Cell 3A	G-342E	Culvert	N/A	Apr-08	A					
STA-5 / Cell 3A	G-342F	Culvert	N/A	Apr-08	B					
STA-5 / Cell 1B						G-344A-B	Culvert	8.6%	May-99	
STA-5 / Cell 2B						G-344C-D	Culvert	8.6%	May-99	
STA-5 / Cell 3B						G-344E-F	Culvert	N/A	May-99	B
STA-6 / Sec 2	G-396A-C	Culvert	28.7%	Apr-08	A, Calibration from G-396C	G-352A-C	Culvert	23.1%	Apr-08	Calibration from G352A
STA-6 / Sec 2	G-600	Pump	6.0%	Aug-05	Not in use					
STA-6 / Cell 3	G-603	Weir	18.9%	Dec-97		G-393A-C	Culvert	6.0%	Sep-11	Calibration from G393B
STA-6 / Cell 3	G-353C	Culvert	N/A	Apr-08	A, C					
STA-6 / Cell 5	G-353A	Culvert	N/A	Apr-08	C	G-354A	Culvert	6.6%	Sep-11	
STA-6 / Cell 5	G-353B	Culvert	N/A	Apr-08	A, C	G-354B	Culvert	6.7%	Sep-11	
STA-6 / Cell 5	G-601	Weir	30.1%	Dec-97		G-354C	Culvert	17.1%	Sep-11	
STA-6 / Cell 5	G-602	Weir	41.8%	Dec-97						
STA-6	G-607	Culvert			Not in use					

**Color Key**

	Flow equation and data collection are most likely stable
	Additional data collection and calibrations are needed

- A: More flow measurements needed
- B: Theoretical initial rating; no flow measurements obtained yet
- C: The rating will be improved after investigating the abnormality in stages.
- N/A: Not enough good streamgauging data to evaluate the quality of the rating.

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**Appendix A**  
**Table A.1 Detailed Flow Equation Rating Information**

STA	Station	Structure Type	Dominant Flow Type	Inflow/Outflow	Theoretical Rating Parameters	Effective Date for Initial Rating	Current Rating Parameters	Effective Date for current rating	No. of Flow Measurements	Initial Avg. Abs Relative Error	Current Avg. Abs Relative Error	Comments	Revised Comments	
STA-1E	G-311	Spillway	Case 5 (controlled submerged)	Inflow to STA-1E	N/A	Jan-04	a=1.0, b=0.3	Sep-05	17	N/A	16.6%	F		
	S-319	Pump Station	Case 8	Inflow to STA-1E	Pump 1-2: a=640, b=-7.81, c=1.2 Pump 3-5: a=1135, b=-10.15, c=1.4 A=34.0, B=-0.019, C=2.0	Jun-04	Pump 1-2: a=659.7, b=-2.554, c=1.2 Pump 3-5: a=1156.7, b=-1.845, c=1.584	Nov-08	6	N/A	8.6%			
	S-361	Pump Station	Case 8	Inflow to Cell 4S	A=34.0, B=-0.019, C=2.0	Jan-04	A=33.25, B=-0.062, C=1.66	Sep-08	2	N/A	N/A	G		
	S362	Pump Station	Case 8	Outflow from STA-1E	Pump 1-2: a=602, b=-8.84, c=1.2 Pump 3-5: a=1040, b=-19.05, c=1.2 pump6-7: a=129, b=-1.7, c=1.2	Jan-04	Pump 1-2: a=620.4, b=-7.616, c=1.248 Pump 3-5: a=1106.4, b=-14.218, c=1.3266 pump6-7: a=125.3, b=-1.4256, c=1.253	Sep-08	5	N/A	18.9%			
STA-1W	G251_P	Pump Station	Outlet submerged	Outflow	C0=80.8235, C1=-0.12071, C2=-0.41882	Oct-93		Oct-93	12		7.8%			
	G310_P	Pump #1 & #2	Outlet submerged	Outflow	A=105.27, B=-0.00182, C= 3.3	0/01/2000	A=105, B=-0.34, C=2.0	Jun-04	29	6.77%	3.6%			
	G310_P	Pump #3 & #6	Outlet submerged	Outflow	A=591.91, B=-3.14, C= 1.58	0/01/2000	A=592, B=-1.3, C=2.0	Jun-04						
	G310_P	Pump #4 & #5	Outlet submerged	Outflow	A=1218.95, B=-8.37, C= 1.45	0/01/2000	A=1220, B=-2.4, C=2.0	Jun-04						
	G-250S_P	Pump	Outlet submerged	Inflow to Cell 1A	A=74.1401, B=-0.1344, C=2.0716	Sep-93		Sep-93	4	N/A	N/A	G		
	G-302_S	Spillway	Controlled Submerged	Inflow to STA-1W	a= 1.102, b=0.324	Jul-99		Jul-99	35	N/A	8.8%			
STA-2	G-335	Pump	Case 8	Outflow from STA-2	Unit # 1&2: A=104.3, B=-0.004, C=3.06; Unit # 4&5: A=1137.84, B=-6.66, C=1.6; and Unit # 3&6: A=550.56, B=-1.94, C=1.8	Nov-00	Unit # 1&2: A=104.4, B=-0.00074, C=3.6; Unit # 4&5: A=1147.9, B=-13.18, C=1.34; and Unit # 3&6: A=609.2, B=-4.31, C=1.48	Aug-08	24	N/A	16.8%			
	G-328_P	Pump	Case 8	Inflow to STA-2	N/A	Jul-01	A = 109.35; B= -0.49; C = 1.46	Jul-01	11	N/A	13.1%			
	G-328I_C	Culvert	Orifice Flow	Outflow from STA-2	N/A	Dec-00	a = 0.9; b=0.42	Dec-00	7	N/A	27.0%			
	G-328I_P	Pump	Case 8	Outflow from STA-2	N/A	Jul-01	A = 109.35; B= -0.49; C = 1.46	Jul-01	1	N/A	N/A	G		
	G-338	Spillway	Controlled Submerged	Bypass to STA-2	Cd = 0.75	Mar-02	Cd = 0.75	Mar-02	4	N/A	N/A	G		
	G-339	Spillway	Controlled Submerged	Bypass to STA-2	Cd = 0.75	Mar-01	Cd = 0.75	Mar-01	0	N/A	N/A	G		
	S-6	Pump	Case 3	Inflow to STA-2	c10=791.643; c11= 84.1988; c12=23.87446; c13=1.260101; c20=980.786; c21=69.0429; c22=-19.34632; c23=1.0631313; LowEndRpm=450; HighEndRpm=514	Apr-57	c10=791.643; c11= 84.1988; c12=23.87446; c13=1.260101; c20=980.786; c21=69.0429; c22=-19.34632; c23=1.0631313 ;LowEndRpm=613; HighEndRpm=700	Mar-91	13	N/A	6.9%			
STA-34	G376A-C	Culvert	Full Pipe Flow	Outflow from STA3/4 Cell 1B	Cd = 0.75	Jan-03	Cd = 0.75	Jan-03	4	N/A	N/A	B, G		
	G376D-F	Culvert	Full Pipe Flow	Outflow from STA3/4 Cell 1B	Cd = 0.75	Jan-03	Cd = 0.75	Jan-03	18	N/A	16.1%	B		
	G381A-C	Culvert	Full Pipe Flow	Outflow from STA3/4 Cell 3B	Cd = 0.75	Jan-03	Cd = 0.75	Jan-03	10	N/A	5.3%	B		
	G381D-F	Culvert	Full Pipe Flow	Outflow from STA3/4 Cell 3B	Cd = 0.75	Jan-03	Cd = 0.831	Jan-03	16	N/A	8.7%	B		
	G-370	Pump	Case 8	Inflow to STA-34	A=1020, B=-6.67, C=1.60	Jan-03	A=1020, B=-6.67, C=1.60	Jan-03	12	N/A	2.2%	H		
	G-372	Pump	Case 8	Inflow to STA-34	A=1050, B=-5.5, C=1.60	Jan-03	A=1050, B=-5.5, C=1.60	Jan-03	13	N/A	6.0%	H		
	G-372HL	Culvert	Full Pipe Flow	Inflow to Holeyland	Cd = 0.75	Jan-03	Cd=0.85	Jan-03		N/A	N/A	B	Not in use.	
	STA-5	G-342A	Culvert	Full Pipe Flow	Inflow to Cell 1A	n=0.012	Jun-99	n=0.012, Ke=0.81	Aug-10	7	22.26%	16.0%	B	
		G-342B	Culvert	Full Pipe Flow	Inflow to Cell 1A	n=0.012	Jun-99	n=0.012, Ke=0.87	Aug-10	7	11.76%	8.0%	B	
		G-342C	Culvert	Full Pipe Flow	Inflow to Cell 2A	n=0.012	Jun-99	n=0.012, Ke=0.76	Aug-10	11	14.31%	8.0%	B	
G-342D		Culvert	Full Pipe Flow	Inflow to Cell 2A	n=0.012	Jun-99	n=0.012, Ke=0.79	Aug-10	8	62.42%	23.7%	B		
G-342E		Culvert	Full Pipe Flow	Inflow to Cell 3A	n=0.012	Apr-08	n=0.012, Ke=0.85	Apr-08	1	N/A	N/A	B, G		
G-342F		Culvert	Full Pipe Flow	Inflow to Cell 3A	n=0.012	Apr-08	n=0.012, Ke=0.85	Apr-08	0			B, G		
G344A-D		Culvert	Full Pipe Flow	Outflow from STA5	n=0.012	May-99	n=0.012, Ke=0.78	May-99	34		8.6%	B		
G344E		Culvert	Full Pipe Flow	Outflow from STA5	n=0.012	Apr-08	n=0.012, Ke=0.85	May-99	0			B, G		
G344F		Culvert	Full Pipe Flow	Outflow from STA5	n=0.012	Apr-08	n=0.012, Ke=0.85	May-99	0			B, G		

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**Table A.1 Detailed Flow Equation Rating Information (Continued)**

STA	Station	Structure Type	Dominant Flow Type	Inflow/Outflow	Theoretical Rating Parameters	Effective Date for Initial Rating	Current Rating Parameters	Effective Date for current rating	No. of Flow Measurements	Initial Avg. Abs Relative Error	Current Avg. Abs Relative Error	Comments	Revised Comments
STA-6	G-353A	Culvert	Full Pipe Flow	Inflow to Cell 5	n=0.012 Cd = 0.85	Apr-08	n=0.012 Cd = 0.85	Apr-08	11	N/A	N/A	B	J
	G-353B	Culvert	Full Pipe Flow	Inflow to Cell 5	n=0.012 Cd = 0.85	Apr-08	n=0.012 Cd = 0.85	Apr-08	1	N/A	N/A	B, G	J
	G-353C	Culvert	Full Pipe Flow	Inflow to Cell 3	n=0.012 Cd = 0.85	Apr-08	n=0.012 Cd = 0.85	Apr-08	9	N/A	N/A	B	J
	G-396A-C	Culvert	Full Pipe Flow	Inflow to Sec 2	n=0.012 Cd = 0.85	Apr-08	n=0.012 Cd = 0.85	Apr-08		N/A	28.7%	B	Calibration fr
	G-600	Pump	Outlet Submerged	Inflow to Sec 2	C0=1800, C1=-1.1, C2=36000, C3=19	Oct-97	A=83.3645, B=-0.0080, C=3.125	Aug-05	10	15.60%	6.0%		Not in use.
	G-601	Weir	Submerged flow ov	Inflow to Cell 5		Dec-97	Cd = 4.8	Dec-97	20	30.13%	30.1%	I	
	G-602	Weir	Submerged flow ov	Inflow to Cell 5		Dec-97	Cd = 4.49	Dec-97	17	41.84%	41.8%	I	
	G-603	Weir	Submerged flow ov	Inflow to Cell 3		Dec-97	Cd = 2.21	Dec-97	21	18.90%	18.9%	I	
	G607	Culvert	Submerged flow over crest and/or	Outflow from STA6 Canal	n=0.024 Ke=0.8		n=0.024 Ke=0.8			N/A		C	Not in use.
	G354A	Culvert	Weir Control Flow	Outflow from STA6 Section 2	weUFFC1= 0.58	Jul-09	weUFFC1= 0.578	Sep-11	10	7.61%	6.6%	D	A
	G354B	Culvert	Weir Control Flow	Outflow from STA6 Section 2	weUFFC1= 0.73	Jul-09	weUFFC1= 0.614	Sep-11	10	14.49%	6.7%	D	A
	G354C	Culvert	Weir Control Flow	Outflow from STA6 Section 2	weUFFC1= 0.50	Jul-09	weUFFC1= 0.564	Sep-11	16	18.52%	17.1%	D	A
	G393A	Culvert	Weir Control Flow	Outflow from STA6 Section 2	weUFFC1= 0.60	Jul-09	weUFFC1= 0.566	Sep-11		N/A		D	Calibration
	G393B	Culvert	Weir Control Flow	Outflow from STA6 Section 2	weUFFC1= 0.60	Jul-09	weUFFC1= 0.566	Sep-11	14	7.49%	6.0%	D	A
	G393C	Culvert	Weir Control Flow	Outflow from STA6 Section 2	weUFFC1= 0.60	Jul-09	weUFFC1= 0.566	Sep-11		N/A		D	Calibration
	G352A	Culvert	Overtop Flow	Outflow from STA6 Section 2	n=0.012 Cd = 0.85	Apr-08	Cd = 0.75	Apr-08		N/A		E	
G352B	Culvert	Overtop Flow	Outflow from STA6 Section 2	n=0.012 Cd = 0.85	Apr-08	Cd = 0.75	Apr-08	45	N/A	23.1%	E		
G352C	Culvert	Overtop Flow	Outflow from STA6 Section 2	n=0.012 Cd = 0.85	Apr-08	Cd = 0.75	Apr-08		N/A		E		
A: The latest rating improvement was conducted due to datum adjustment and resurvey of weir box elevations.													
B: The new standard culvert flow equations in the District's Flow Altas is applied.													
C: The old standard culvert flow equations in the District's Flow Altas is applied.													
D: The flow equations for weir-box culvert (W1) in the District's Flow Altas is applied.													
E: The flow equations for double-leaf culvert in the District's Flow Altas is applied.													
F: The new standard spillway flow equations in the District's Flow Altas is applied.													
G: More flow measurements needed													
H: Case 8 pump flow equn. In the District Flow Atlas is applied													
I: Rating will be improved based on flow measurements.													
J: The rating will be improved after investigating the abnormality in stages.													

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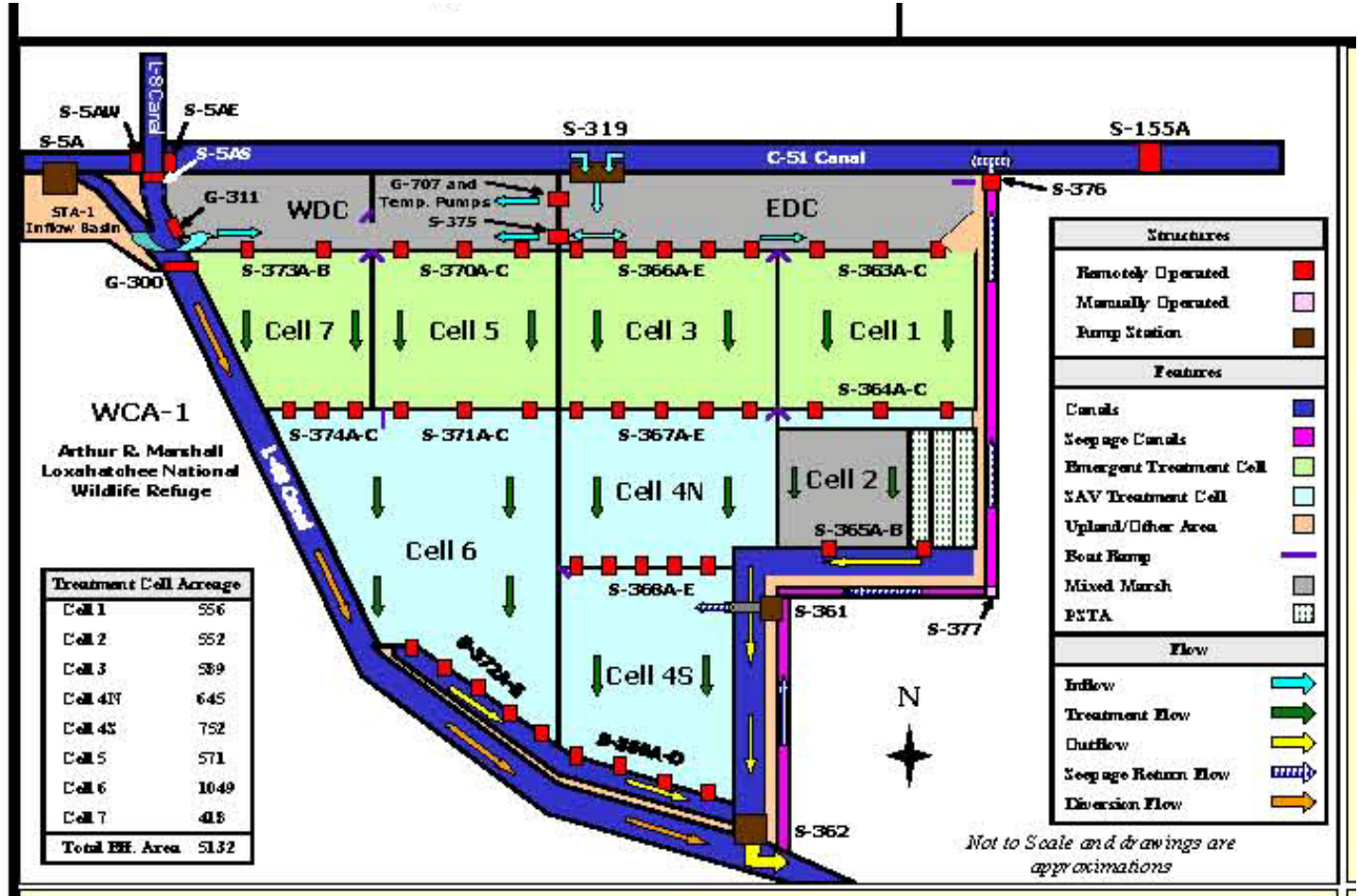
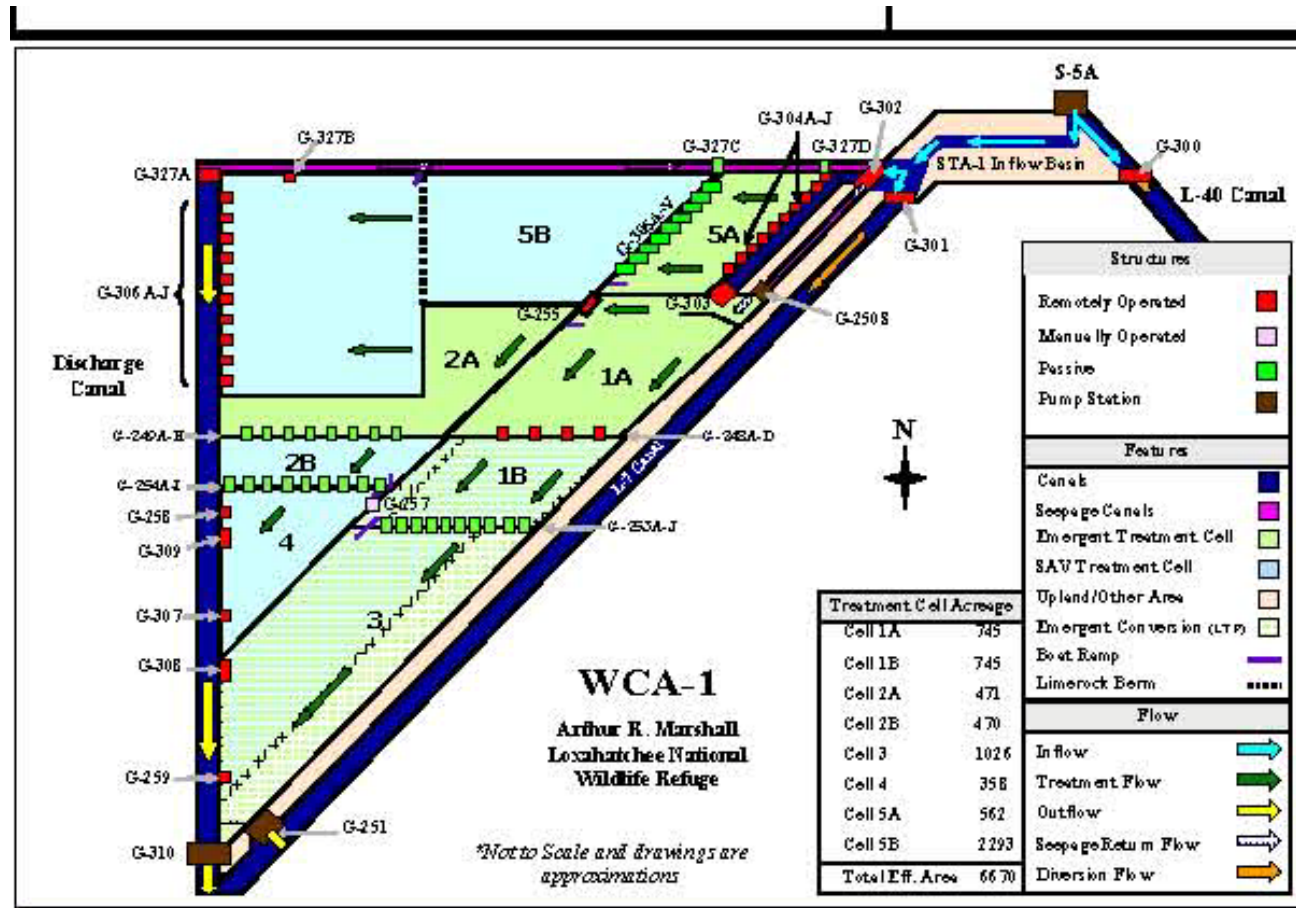


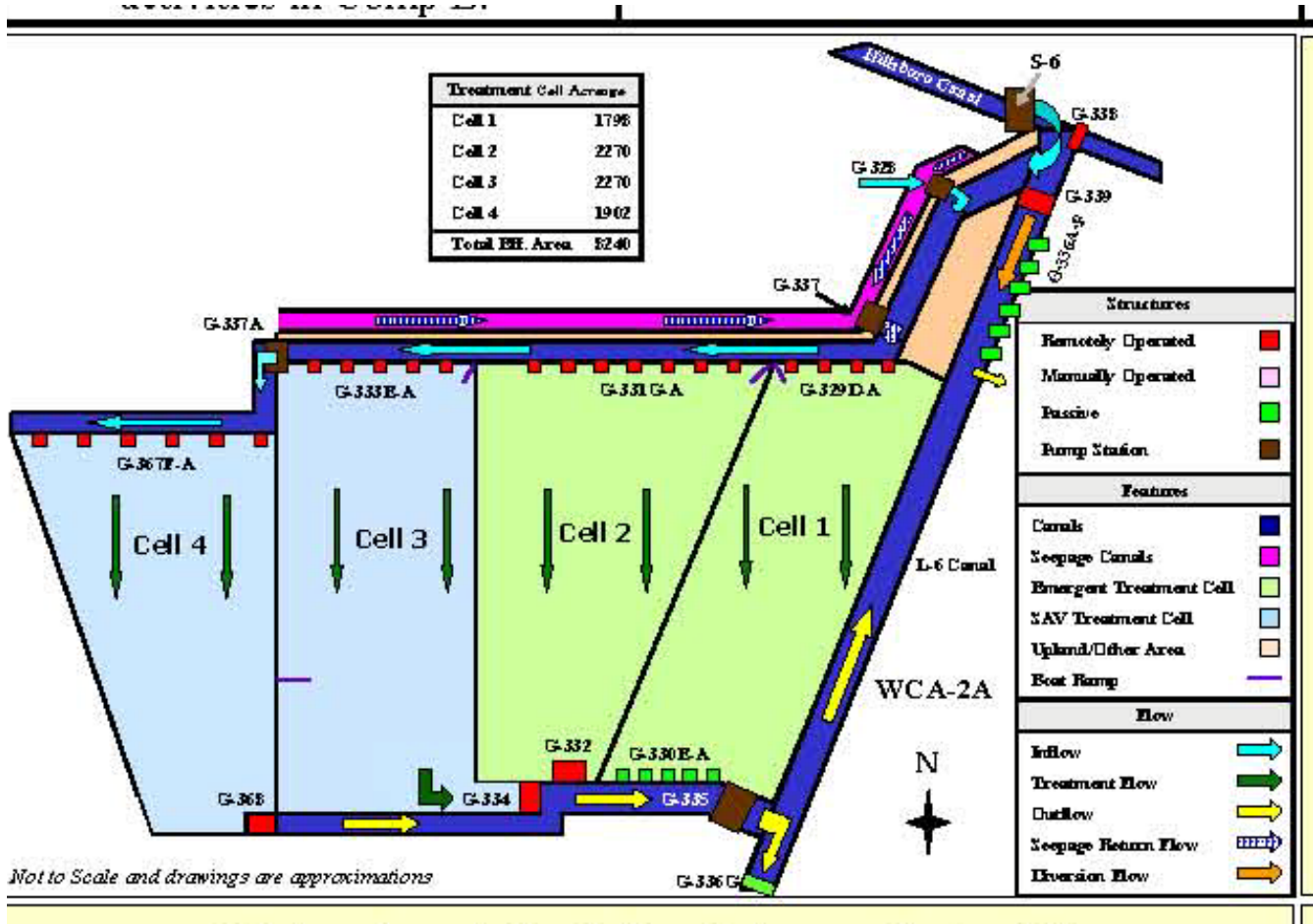
Figure A.1 STA-1E Cell Configuration and Structure Locations

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**Figure A.2 STA-1W Cell Configuration and Structure Locations**

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**Figure A.3 STA-2 Cell Configuration and Structure Locations**



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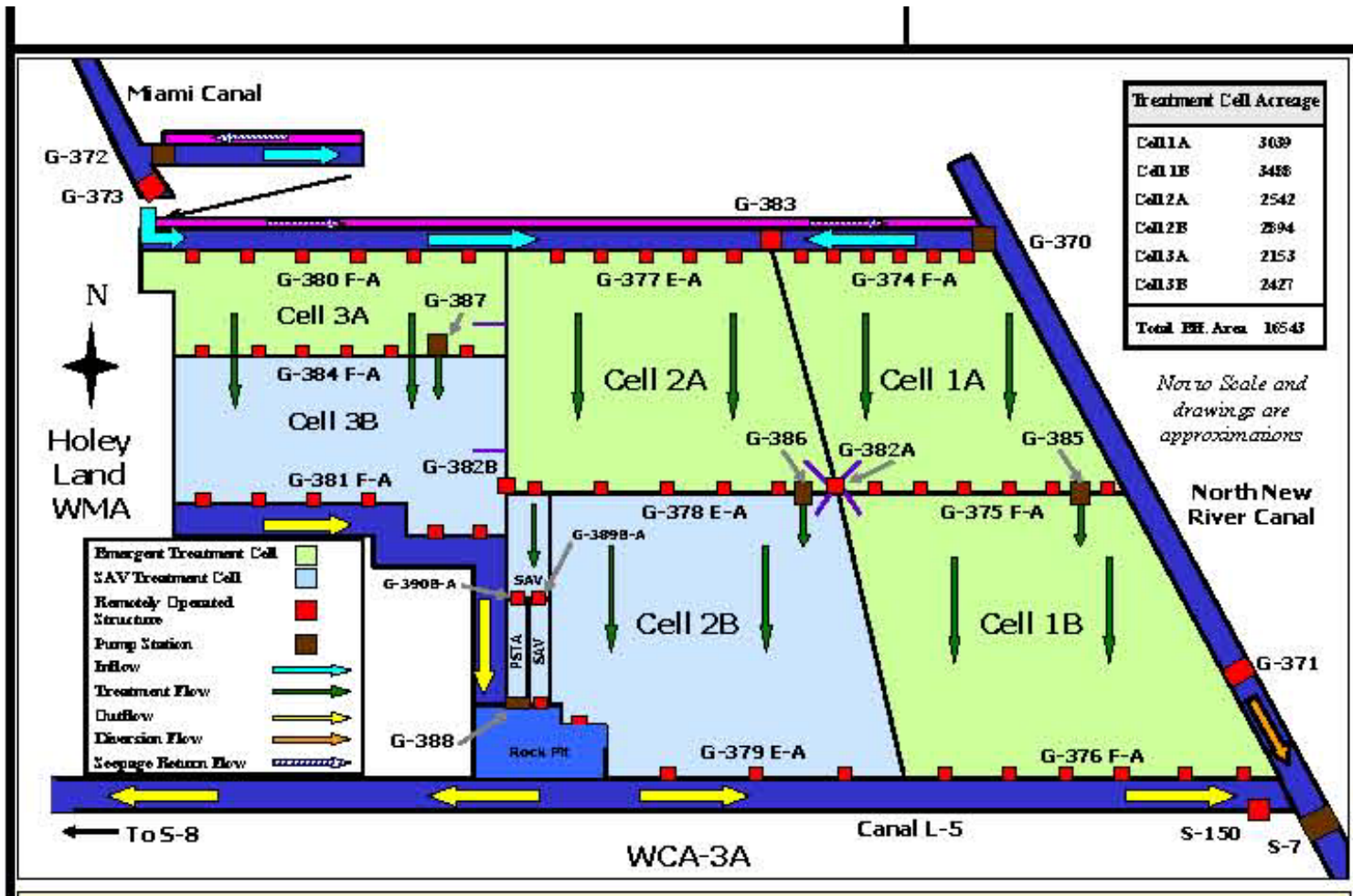


Figure A.4 STA-3/4 Cell Configuration and Structure Locations

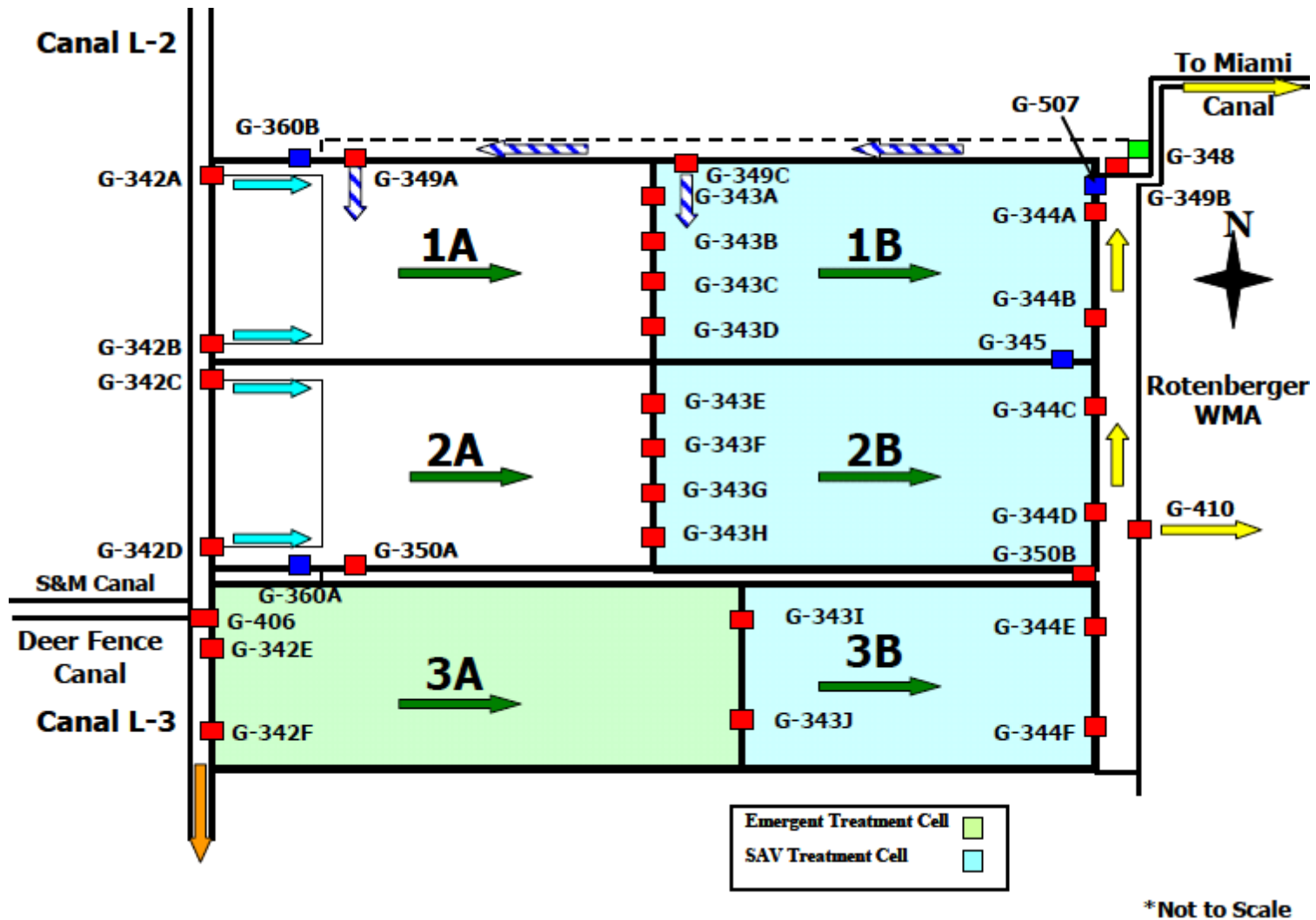
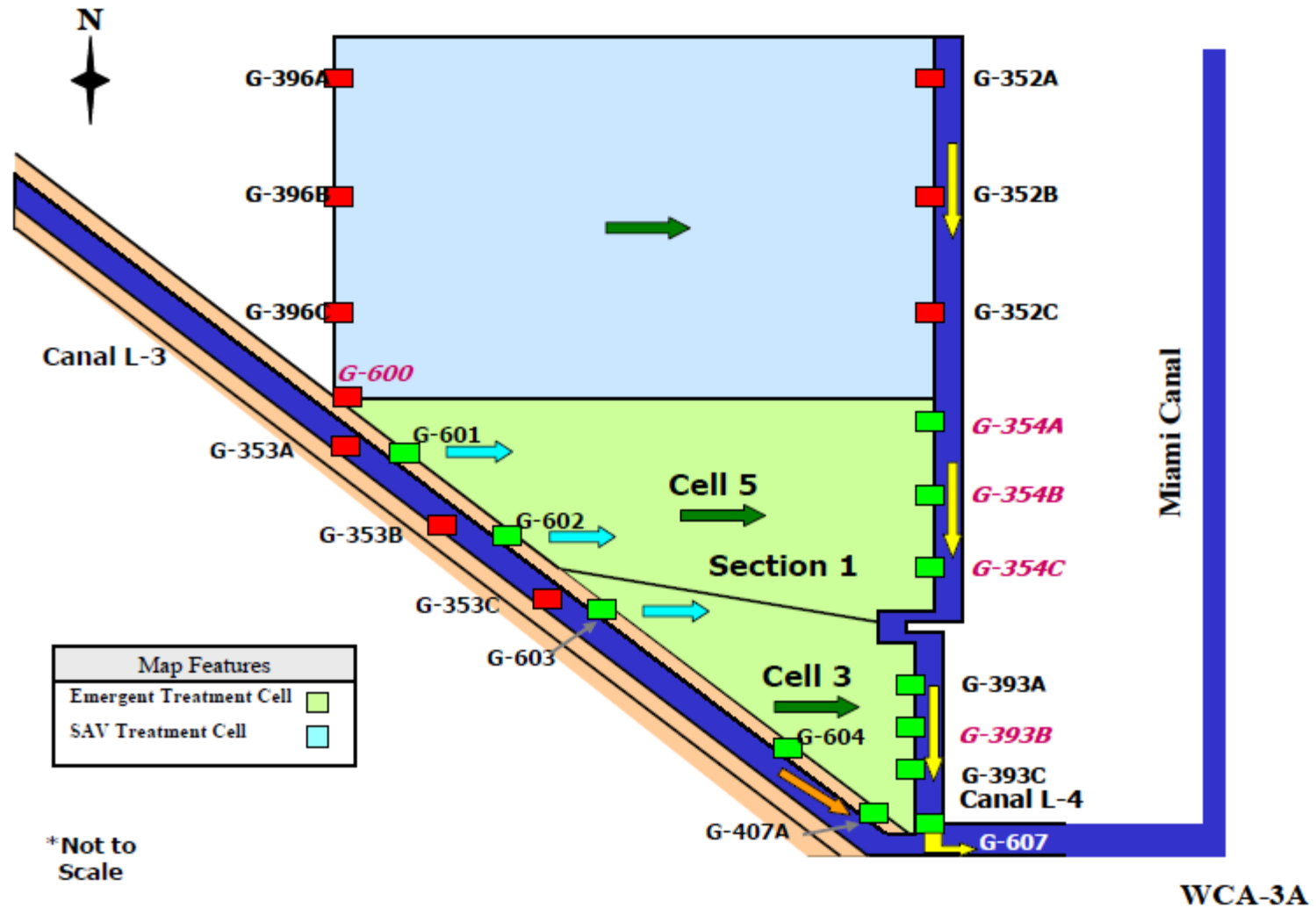


Figure A.5 STA-5 Cell Configuration and Structure Locations



**Figure A.6 STA-6 Cell Configuration and Structure Locations**