

Memo



Date: July 4, 2006
To: Kevin Stewart, Chad Kudym
From: Markus Ritsch
Subject: June 2006 ALERT Data Analysis

I. ALERT Data Source

Raw ALERT data records extracted from the Urban Drainage and Flood Control District's Nova Star 4.0 base station (ALERT 2) are analyzed for the period June 1 through June 30, 2006.

II. General System Analysis Summary

A total of 194,975 individual data records were analyzed. Meteorological sensors account for seventy-two (72) percent, water level sensors twelve (12) percent, and rain sensors six (6) percent of the total transmissions.

Ninety-nine (99) percent of the received data reports were flagged as "good" by the Nova Star validation process. Roughly two thousand (2,112) reports were flagged as "bad". Of these "bad" reports, approximately half (1,002) originated from the Wind Gust sensor (ID 2189) at Squaw Mountain. Another one hundred (114) "bad" reports originated from the Wind Speed Average sensor (ID 2187) at Squaw Mountain. The reception of "bad" data reports from the Squaw Mountain sensor ID's 2189 and 2187 has been a consistent theme throughout this year.

The system-wide radio traffic loading was approximately six thousand five hundred (6,499) reports per day with an average hourly load of two hundred and seventy (270) reports. The peak hourly traffic loading was seven hundred and ten (710) reports and occurred on June 24th between six (6) and seven (7) in the evening. A plot of monthly average and peak hourly traffic loading is provided.

The sensors reporting most frequently this month include:

1. Boulder Creek at Broadway (ID 4583 this water level sensor reported 3,163 times in the month or one report every twelve minutes)
2. Salisbury Park (ID 2727) with 3,516 reports, and
3. Urban Farm (IDs 1466, 1465, 1464, 1467) with 11,124 reports.

The reports from the above sensors occurred over the entire month and are more-or-less distributed evenly.

III. Rain Sensors Reporting This Month

Approximately one hundred and fifty three (153) rain sensors reported during the month. Several rain sensor IDs had non-incrementing timer reports but had no incrementing rain tip reports during the month (Table 1).

Table 1. Rain Sensors with No Tip Reports

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
----	----	----	----	1020	520						
----	----	----	----	1610	540						
----	----	----	----	2220	1020						
----	----	----	----	4560	1610						
----	----	----	----	-----	2220						
----	----	----	----	-----	4240						
----	----	----	----	-----	4560						

* Jewell Detention (520), Parker/Mississippi (540), and Sunset (4240) have installed rain sensors. Lena at Nolte Pond (1020), Holly Dam (1610), Evergreen Lake (2220), Lyons Diversion NSV (4560) – These stations do not have an installed rain sensor although they report the rain ID.

IV. Rain Sensor Timer Reporting Summary

The following summary assumes that all rain sensors have a 12-hour timer reporting interval. System-wide the base station received ninety-two (92) percent of the non-incrementing timer reports. The following table summarizes those rain sensors with the worst timer reporting performance (Table 2).

Table 2. Monthly Summary of Sensors with Poor Timer Performance

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1010	1460	1460	2340	1460	1460						
1460	1660	4820	1460	1330	4820						
1640	4240	4570	1330	540	4830						
--	--	--	1610	1600	1600						
			1600	4820	2350						

* Stapleton "Urban Farm" (1460), SBC @ San Souci (4830), Idledale (2350), Englewood Dam (1600), Doudy Draw (4820)

Sensors identified as having poor timer performance in multiple months are shaded with unique colors. A developing trend can be identified from the color shading as the year progresses. For example, sensors 1600 and 4820 consistently have a poor timer performance value.

We suspect that sensor 1460 has a 24-hour timer reporting interval so its timer performance value is actually better than reported here (see data analysis report for May, 2006).

V. Rain Sensor Event Reporting Summary

A. District-Wide Total Tip/Count Statistics

The incrementing reports from one hundred and forty-six (146) individual 1-mm rain sensors are analyzed to quantify the District-wide statistical total monthly tip summary (Table 3).

Table 3. March District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	13.75	Only the 1-mm rain sensors were included in the analysis
Median	10	Only the 1-mm rain sensors were included in the analysis
Standard deviation	13.32	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	53.70	Several sensors for the month are outside the Mean +/- 3 Std Dev
Minimum total count	0	Multiple stations (ID 520, 540, and 4240)
Maximum total count	93	Powers Park (ID 1500) – same max reporting sensor as last month!

A monthly summary of the District-wide mean total tip/count is presented (Table 4).

Table 4. Monthly Summary of District-Wide Total 1-mm Tip/Count

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.62	5.92	18.39	20.47	19.44	13.75						

The following sensors had monthly total tip count values that exceeded the system-wide mean plus three standard deviations:

1. Toll Gate at 6th Avenue, ID 700
2. Powers Park, ID 1500
3. Expo Park, ID 420
4. Side Creek Park, ID 830
5. Justice Center, ID 4360

A summary of the visual inspection of the data records for each sensor follows.

1. Toll Gate at 6th Avenue (ID 700)

On June 1, at 4:48 PM, this sensor begins to transmit incrementing count values every three (3) minutes beginning from a raw value of zero (0) and ending with a raw count of one hundred and thirty nine (139) at June 2, at 12:02 AM.

On June 2, at 11:59 AM, this sensor again begins to transmit incrementing count values every three (3) minutes beginning from a raw value of zero (0) and ending with a raw count of fourteen (14) at June 2, at 12:41 PM.

Spurious data transmissions are received for the period June 2 through June 8th.

Beginning on June 9th, the data series looks correct for this sensor.

2. Powers Park (ID 1500)

The monthly count series for this sensor looks reasonable and the total monthly accumulation of ninety-three (93) counts is accurate. This sensor may be affected by lawn irrigation because it always records a high number of incrementing tip counts.

3. Expo Park (ID 420)

The monthly count series for this sensor looks reasonable and the total monthly accumulation of sixty-five (65) counts is accurate. This sensor may be affected by lawn irrigation because it also consistently records a high number of monthly incrementing tip counts.

4. Side Creek Park (ID 830)

The monthly count series for this sensor looks reasonable and the total monthly accumulation of fifty-seven (57) counts is accurate. This sensor may be affected by lawn irrigation because it always records a high number of incrementing tip counts.

5. Justice Center (ID 4360)

The monthly count series for this sensor looks reasonable and the total monthly accumulation of sixty (60) counts is accurate. On June 24th beginning at 5:49 PM this sensor recorded heavy rainfall that ended at approximately 8:15 PM. A total of forty-eight (48) tips or approximately 1.89 inches, were recorded in approximately two and one half (2.5) hours.

B. Sensors with a Jump of Six or More in the Sequential Count

The following rain sensors experienced a jump in their sequential tip count of more than six (6). The data records for these sensors were visually inspected to determine the cause of the large jump.

1. No sensors this month reported sequential tip counts that jumped more than six (6) counts.

C. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing rain tip reports for the month was ninety-one (91) percent. A total of 1,940 incrementing reports were received and a total of 2,130 were expected. The total loss of incrementing reports was approximately nine (9) percent. Those sensors with the worst rain event transmission characteristics are summarized (Table 5).

Table 5. Monthly Summary of Sensors with the Most Missed Tips

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
640	4010	4530	2190	540	4820						
1640	4080	4170	310	1400	1350						
4490	4170	4820	4820	1100	4790						
-----	-----	-----	-----	4820	2340						
-----	-----	-----	-----	1420	2350						

* Doudy Draw (4820), Chatfield COE (1350), Button Rock (4790), Idledale (2350), El Rancho (2340)

Sensors identified as having poor event performance in multiple months are shaded with unique colors. A developing trend can thus be identified from the color shading as the year progresses.

The sensors with poor rain tip performance in June all seemed to experience jumps in sequential count values on June 24th between 5:00 PM and 7:00 PM. This happens to be the period when a large storm with hail moved through the District.

On June 24th, the number of expected single increment tip reports was six hundred and eight (608) and the number actually received was five hundred and one (501). The data loss for June 24th was approximately seventeen (17.60) percent.

VI. Issues Continued from Previous Month

The following issues were identified last month.

1. Doudy Draw (4820) exhibits both poor timer and event transmission performance.
2. The PT at Boulder Creek at Broadway (ID 4583) reported once every ten minutes.
3. The timer reporting interval for Stapleton sensor 1460 (rain) is twenty-four (24) hours, **not** twelve (12) hours as expected. The timer reports are received each day at approximately 11:57:20 pm.
4. The timer reporting interval for Stapleton sensor 1464 (solar radiation) is fifteen (15) minutes, **not** twelve (12) hours as expected.
5. The timer reporting interval for Stapleton sensors 1466, 1465, and 1467, (wind direction, speed, peak) is fifteen (15) minutes, **not** one (1) hour as expected.

VII. Issues Identified this Month

Further investigation into the following issues is recommended:

1. The PT at Boulder Creek at Broadway (ID 4583) reported once every twelve minutes.
2. The rain sensor at Toll Gate at 6th Avenue (ID 700) transmitted erroneous incrementing tip reports beginning June 1 through June 8th. The archival database and the maintenance records should be inspected to confirm the erroneous reporting of this sensor.
3. The timer reporting interval for Stapleton sensor 1460 (rain) is twenty-four (24) hours, **not** twelve (12) hours as expected. The timer reports are received each day at approximately 11:57:20 pm.
4. The timer reporting interval for Stapleton sensor 1464 (solar radiation) is fifteen (15) minutes, **not** twelve (12) hours as expected.
5. The timer reporting interval for Stapleton sensors 1466, 1465, and 1467, (wind direction, speed, peak) is fifteen (15) minutes, **not** one (1) hour as expected.
6. The month-long incrementing rain tip reception rate was very good at approximately ninety-two (92) percent. On June 24th, the event tip reception rate dropped significantly to approximately eighty-two (82) percent. Approximately seventeen (17) percent of the incrementing rain tip reports were lost on June 24th between 5:00 PM and 8:00 PM. A large thunderstorm producing heavy rainfall and hail was present in the District that evening. The peak radio traffic occurred between 6:00 PM and 7:00 PM but was only a moderate seven hundred (710) messages per hour.

General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\data_extracts\Novastar_extract_200606.mdb

First Date in Database	6/1/06 12:00 AM	Total Days	30.0
Last Date in Database	6/30/06 11:59 PM	Total Hours	720.0

Total Records Analyzed 194975

Records by Group

Wind Gust	34952	18%
Temperature	28056	14%
Relative Humidity	27028	14%
Wind Speed Average & Azimuth	17810	9%
Water Level PT-HSE	17626	9%
Wind Direction	16060	8%
Precipitation	12547	6%
Wind Speed Average	10595	5%
Battery Voltage Digital	5820	3%
Battery Voltage HSE	5759	3%
Solar Radiation	4384	2%
Water Level PT	3159	2%
Water Level Float	2996	2%
Barometric Pressure	2215	1%
Fuel Moisture	1390	1%
Fuel Temperature	1385	1%
Repeater Pass List	950	0%
Handar 585 ALARM Status	882	0%
Battery Voltage Analog	649	0%
Longmont Flow Gage	325	0%
12Hr Status Report	242	0%
Soil Moisture	73	0%
Longmont Water Level PT	57	0%
Precipitation-ASCII	9	0%
Solar Power	4	0%
Repeater ON Count	1	0%
Snow (water equiv.)	1	0%
Total	194975	

Records by Major Group

Meteorologic Sensors	141100	72%
Water Level Sensors	24163	12%
Sensor Status Transmissions	14307	7%
Rain Sensors	12556	6%
Soil, Fuel and Snow Sensors	2849	1%
Total	194975	

Records by Validation Type

Good	0	192863	99%
Questionable	1	2112	1%
Total		194975	

Sensors With Most Invalid Data

Description	Sensor	Reports
Squaw Mountain	2189	1002
Quincy Reservoir	753	142
Louisville Rec Ctr	1103	117
Squaw Mountain	2187	114
Aurora Reservoir	907	67

Traffic Loading Summary

Alert Reports	194975
Average Daily Traffic	6499
Average Hourly Traffic	270
Median Hourly Traffic	267
Peak Hourly Traffic	710

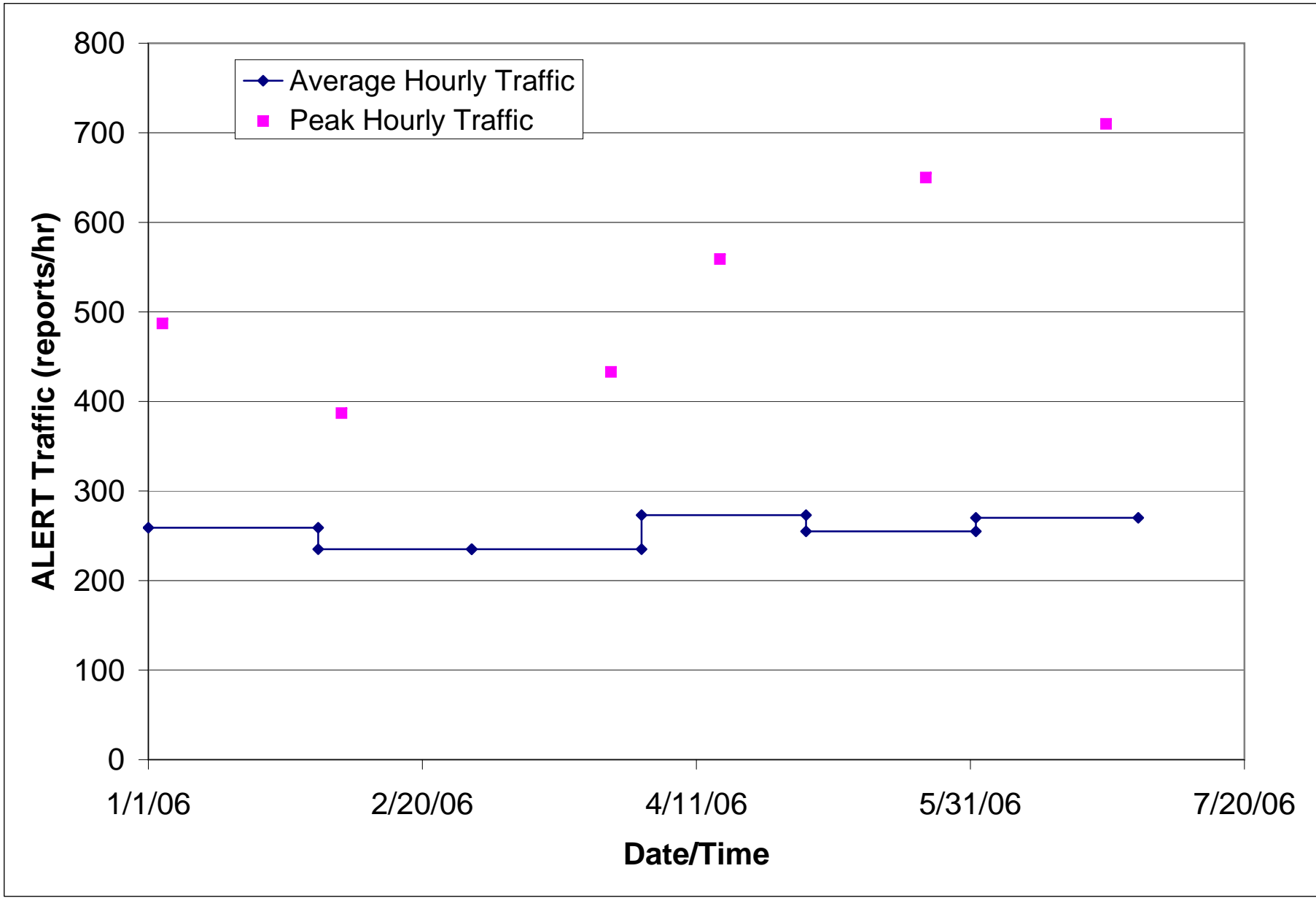
hour beginning
6/24/06 6:00 PM

Total Number of Sensors Defined 783 **Total Number of Sensors Reporting** 535

Reports per Sensor (Highest)

Description	Sensor	Reports	Fraction of Total
Salisbury Park	2727	3516	2%
Boulder Creek @ Broadway	4583	3163	2%
Urban Farm	1464	2834	1%
Urban Farm	1466	2800	1%
Urban Farm	1465	2764	1%
Urban Farm	1467	2726	1%
Elbert	1439	2718	1%
Castle Rock	2744	2709	1%





Rain Timer Performance Analysis

Rain Timer Performance

Analyze Rain Sensors

Rain Sensors	Description	Number of Received Timer Reports	systemwide average (days)	Number of expected Timer Reports	Systemwide Average
			0.5192		92%
			Average Timer Interval	Performance	
100	Carr Street	54	12:42	60.00	90%
110	Ralston Reservoir	54	13:09	60.00	90%
120	West Woods	57	12:25	60.00	95%
140	Blue Mountain	55	12:14	60.00	92%
150	Nott Creek	54	12:15	60.00	90%
200	Leyden Reservoir	58	12:11	60.00	97%
210	Leyden Confluence	52	13:29	60.00	87%
220	Upper Leyden	55	12:14	60.00	92%
300	Van Bibber Park	56	12:11	60.00	93%
310	Guy Hill Ranch	56	12:37	60.00	93%
330	Van Bibber @ Hwy 93	58	12:13	60.00	97%
400	Montview Park	58	12:10	60.00	97%
410	Kelly Dam	56	12:11	60.00	93%
420	Expo Park	56	11:58	60.00	93%
430	Utah Park	59	12:17	60.00	98%
440	Fire Station #7	54	12:53	60.00	90%
500	Havana Park	57	12:13	60.00	95%
510	Virginia Court	56	11:57	60.00	93%
520	Jewell Detention	58	12:10	60.00	97%
530	Fire Station #19	58	12:11	60.00	97%
540	Parker/Mississippi	51	13:52	60.00	85%
600	Harvard Gulch Park	55	12:55	60.00	92%
610	Harvard @ Jackson	58	12:10	60.00	97%
620	Quincy/Highline	55	12:56	60.00	92%
630	Temple Pond at DTC	55	12:21	60.00	92%
640	Goldsmith @ Eastman	57	12:20	60.00	95%
650	Iliff Pond	57	12:11	60.00	95%
700	Toll Gate @ 6th	56	12:31	60.00	93%
710	Horseshoe Park Drop	57	12:25	60.00	95%
720	Confluence Pond	56	12:29	60.00	93%
730	No Name @ Quincy	54	12:57	60.00	90%
740	Smoky Hill	58	12:12	60.00	97%
750	Quincy Reservoir	55	12:56	60.00	92%
760	Mission Viejo Park	55	12:26	60.00	92%
800	Sable Ditch @ 18th	55	12:40	60.00	92%
810	Granby Ditch @ 6th	54	12:43	60.00	90%
820	ETG @ Buckley	56	12:39	60.00	93%
830	Side Creek Park	52	13:27	60.00	87%
840	Fire Station 12	57	12:13	60.00	95%
850	Flying J	49	12:46	60.00	82%
860	Sand Cr at Colfax	87	7:51	60.00	145%
870	Murphy Creek GC	58	12:00	60.00	97%
900	Aurora Reservoir	53	13:16	60.00	88%
1000	Maple Grove Resv.	57	12:05	60.00	95%
1010	Denver West	59	11:57	60.00	98%
1020	Lena @ Nolte Pond	61	11:27	60.00	102%
1030	NREL/S. Table Mtn.	56	12:24	60.00	93%
1040	Lena @ U.S. Hwy 6	57	12:25	60.00	95%
1050	Jeffco Fairgrounds	57	12:23	60.00	95%
1060	Heritage Square	54	12:53	60.00	90%
1100	Louisville Rec Ctr	52	13:34	60.00	87%
1110	Gunbarrel	52	13:31	60.00	87%
1200	Broomfield 3207	55	12:39	60.00	92%
1300	Hidden Lake	55	12:42	60.00	92%
1310	LDC at 64th	56	12:39	60.00	93%
1320	SPR at 3rd Ave	52	13:40	60.00	87%
1330	Roslyn	54	12:40	60.00	90%
1340	Sanderson at Xavier	56	12:48	60.00	93%
1350	Chatfield COE	53	13:28	60.00	88%
1360	Denver Zoo	56	12:40	60.00	93%
1370	West Metro FS13	53	13:01	60.00	88%
1400	Upper Sloan Det.	52	13:29	60.00	87%
1420	Diamond Hill	64	11:05	60.00	107%
1440	Elbert	61	11:36	60.00	102%
1460	Urban Farm	29	23:59	60.00	48%
1480	Third Creek at DIA	57	12:27	60.00	95%
1500	Powers Park	54	11:58	60.00	90%
1520	Marston Lake North	58	12:13	60.00	97%
1530	Bear Creek @ Lowell	54	12:52	60.00	90%
1600	Englewood Dam	44	12:15	60.00	73%
1610	Holly Dam	59	11:58	60.00	98%
1620	Slaughterhouse Glch	52	13:29	60.00	87%
1640	SPR at Union Ave.	54	12:28	60.00	90%
1660	SPR at Henderson	59	12:09	60.00	98%

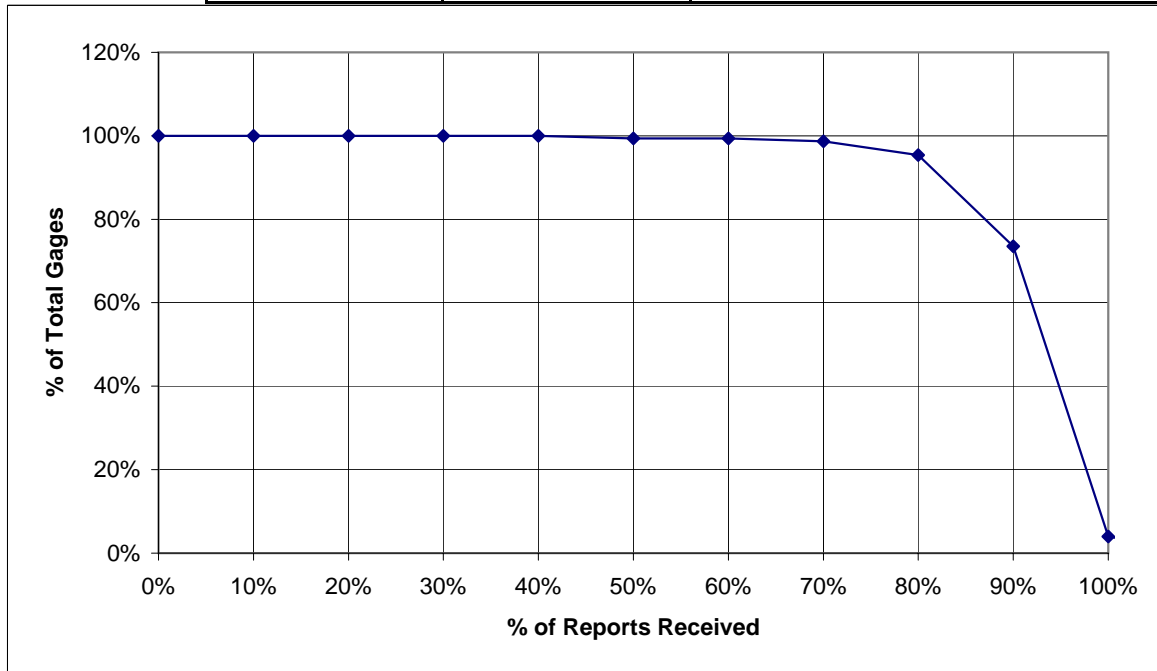
Rain Timer Performance Analysis - Continued

Rain Sensors	Description	Number of Received Timer Reports	Average Timer Interval	Number of expected Timer Reports	Performance
1700	Cherry Cr @ Champa	59	12:00	60.00	98%
1710	Shop Creek	55	12:27	60.00	92%
1720	Cherry Cr @ Steele	57	12:13	60.00	95%
1800	Sand Creek Park	54	13:08	60.00	90%
1810	Sand Creek at mouth	59	12:00	60.00	98%
1900	Niver Detention	57	12:11	60.00	95%
1920	Brighton	60	11:54	60.00	100%
2190	Squaw Mountain	58	11:46	60.00	97%
2210	Hiwan G.C.	47	15:25	60.00	78%
2220	Evergreen Lake	57	12:23	60.00	95%
2230	Bear Cr below Cub	58	12:13	60.00	97%
2240	Cold Sprg Gulch conf	57	12:14	60.00	95%
2250	Rosedale	53	13:15	60.00	88%
2260	Brook Forest	56	12:27	60.00	93%
2270	Cub Cr below Blue	59	12:00	60.00	98%
2280	Kinney Peak	59	12:00	60.00	98%
2310	Genesee Village	59	12:00	60.00	98%
2330	Morrison	53	13:14	60.00	88%
2340	El Rancho	52	12:56	60.00	87%
2350	Idledale	45	13:30	60.00	75%
2360	Indian Hills	55	12:14	60.00	92%
2370	Red Rocks Park	55	12:43	60.00	92%
2710	Highlands Ranch WTP	61	11:46	60.00	102%
2730	Salisbury Park	56	12:40	60.00	93%
2750	Castle Rock	58	12:00	60.00	97%
2810	Pine Cliff Road	56	12:42	60.00	93%
2820	Haskins Gulch Conf	55	12:07	60.00	92%
2840	Sulphur Gulch	52	13:29	60.00	87%
4010	Crescent	49	14:18	60.00	82%
4020	Rio Grande	55	12:26	60.00	92%
4030	Red Garden	58	11:59	60.00	97%
4040	Martin Gulch	55	12:41	60.00	92%
4050	Walker Ranch	56	12:39	60.00	93%
4060	Lakeshore	48	13:52	60.00	80%
4070	Bear Peak	57	12:26	60.00	95%
4080	Twin Sisters	54	12:55	60.00	90%
4090	Magnolia	47	14:45	60.00	78%
4100	Filter Plant	58	12:13	60.00	97%
4110	Betasso	56	12:27	60.00	93%
4130	Swiss Peaks	52	13:27	60.00	87%
4140	Logan Mill	51	13:33	60.00	85%
4150	Gold Hill	53	13:12	60.00	88%
4160	Sunshine	58	12:25	60.00	97%
4170	Pine Brook	56	12:27	60.00	93%
4180	Gold Lake	48	14:05	60.00	80%
4190	Slaughterhouse	53	12:55	60.00	88%
4200	Lazy Acres	51	14:10	60.00	85%
4220	Fling's	56	12:39	60.00	93%
4230	Golden Age	57	12:11	60.00	95%
4240	Sunset	48	14:46	60.00	80%
4250	Geer Canyon	53	12:27	60.00	88%
4260	Taylor Mountain	60	11:58	60.00	100%
4270	Cannon Mountain	57	12:26	60.00	95%
4290	Red Hill	53	12:57	60.00	88%
4300	Big Elk Park	57	12:25	60.00	95%
4310	Johnny Park	56	12:40	60.00	93%
4330	Indian Ruins	58	12:11	60.00	97%
4340	Riverside	57	12:11	60.00	95%
4350	Conifer Hill	56	12:39	60.00	93%
4360	Justice Center	54	12:41	60.00	90%
4470	Little Narrows	53	12:57	60.00	88%
4490	Apple Valley	53	12:56	60.00	88%
4510	Pinewood Springs	53	13:11	60.00	88%
4520	Eagle Ridge	57	12:26	60.00	95%
4530	Winger Ridge	51	13:57	60.00	85%
4560	Lyons Diversion NSV	58	11:58	60.00	97%
4570	St. Antons	56	12:26	60.00	93%
4710	Ward C-1	58	12:13	60.00	97%
4730	Sugarloaf	55	12:53	60.00	92%
4750	Louisville Lake	57	12:27	60.00	95%
4770	Cal-Wood Ranch	56	12:09	60.00	93%
4790	Button Rock	55	12:42	60.00	92%
4810	Shanahan Ridge	56	12:26	60.00	93%
4820	Doudy Draw	42	15:06	60.00	70%
4830	SBC @ San Souci	44	14:03	60.00	73%
4840	SBC@S Boulder Ditch	58	12:25	60.00	97%
4850	Porphory Mtn	52	12:49	60.00	87%
4860	Fairview Peak	51	12:32	60.00	85%

Rain Timer Performance Analysis - Continued

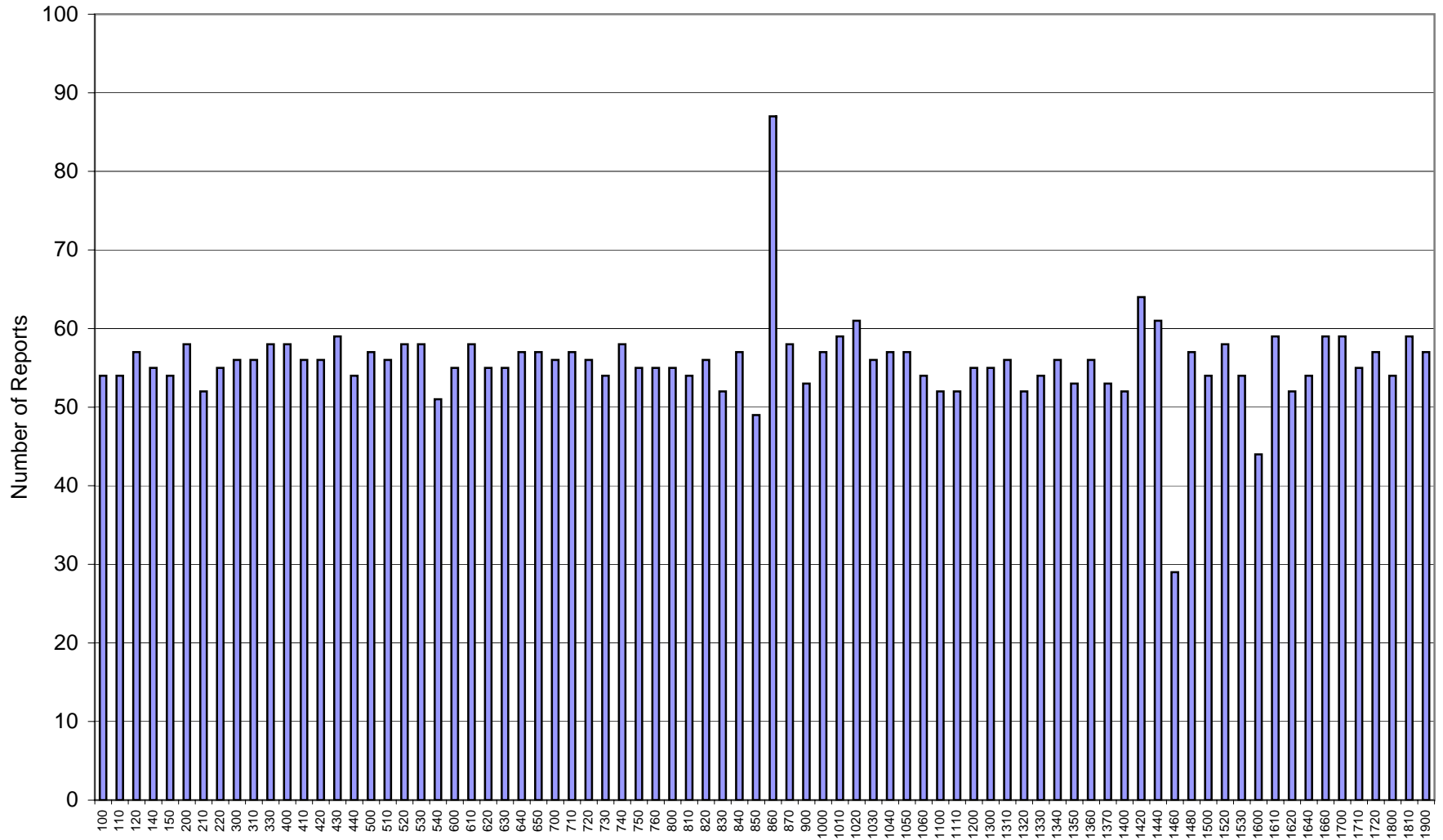
Rain Timer Performance

		total number of gages 151		
% of reports received	frequency		% of gages receiving % or reports or greater	
0%	0		100%	
10%	0		100%	
20%	0		100%	
30%	0		100%	
40%	0		100%	
50%	1		99%	
60%	0		99%	
70%	1		99%	
80%	5		95%	
90%	33		74%	
100%	105		4%	



Number of Timer Reports Received

1460, 1600, 2210, 2350, 4090, 4820, 4830



Sensors with performance <80% noted

Rain Event Performance Analysis

Rain Event Performance

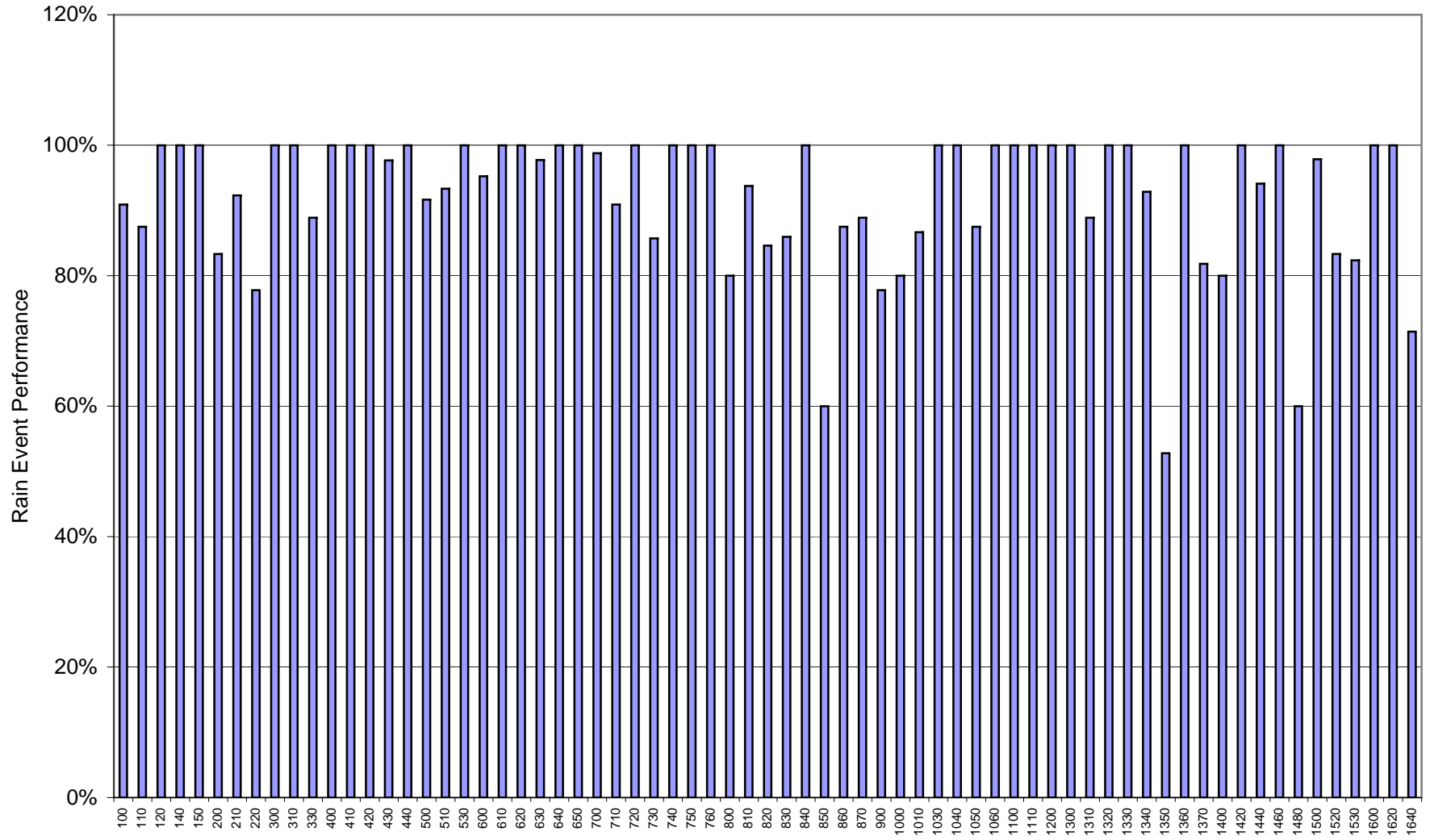
Rain Sensor	Systemwide Avg 92%	Reports Received		Analyze Rain Sensors										Bucket size from Sensorref
		Total Tips Data Loss	1940 2130 8.92%	Number of 1-tips	Number of 2-tips	Number of 3-tips	Number of 4-tips	Number of 5-tips	Number of 6-tips	Number of >6-tips	Number of actual tips	Number of expected tips	Number of missed tips	
100	91%	9	1	0	0	0	0	0	0	10	11	1	0	0.0393701
110	88%	6	0	0	0	0	0	0	0	7	8	1	0	0.0393701
120	100%	7	0	0	0	0	0	0	0	7	7	0	0	0.0393701
140	100%	13	0	0	0	0	0	0	0	13	13	0	1	0.0393701
150	100%	6	0	0	0	0	0	0	0	6	6	0	0	0.0393701
200	83%	4	1	0	0	0	0	0	0	5	6	1	0	0.0393701
210	92%	11	1	0	0	0	0	0	0	12	13	1	0	0.0393701
220	78%	5	2	0	0	0	0	0	0	7	9	2	0	0.0393701
300	100%	17	0	0	0	0	0	0	0	17	17	0	0	0.0393701
310	100%	1	0	0	0	0	0	0	0	1	1	0	0	0.0393701
330	85%	7	1	0	0	0	0	0	0	8	9	1	1	0.0393701
400	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.0393701
410	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.0393701
420	100%	65	0	0	0	0	0	0	0	65	65	0	0	0.0393701
430	98%	41	1	0	0	0	0	0	0	42	43	1	0	0.0393701
440	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.0393701
500	92%	10	1	0	0	0	0	0	0	11	12	1	0	0.0393701
510	93%	26	2	0	0	0	0	0	0	28	30	2	0	0.0393701
530	100%	3	0	0	0	0	0	0	0	3	3	0	0	0.0393701
600	95%	38	2	0	0	0	0	0	0	40	42	2	1	0.0393701
610	100%	6	0	0	0	0	0	0	0	6	6	0	0	0.0393701
620	100%	3	0	0	0	0	0	0	0	3	3	0	0	0.0393701
630	98%	42	1	0	0	0	0	0	0	43	44	1	0	0.0393701
640	100%	32	0	0	0	0	0	0	0	32	32	0	0	0.0393701
650	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.0393701
700	99%	160	2	0	0	0	0	0	0	162	164	2	1	0.0393701
710	91%	9	1	0	0	0	0	0	0	10	11	1	0	0.0393701
720	100%	18	0	0	0	0	0	0	0	18	18	0	0	0.0393701
730	86%	5	1	0	0	0	0	0	0	6	7	1	0	0.0393701
740	100%	1	0	0	0	0	0	0	0	1	1	0	0	0.0393701
750	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.0393701
760	100%	5	0	0	0	0	0	0	0	5	5	0	0	0.0393701
800	80%	3	1	0	0	0	0	0	0	4	5	1	0	0.0393701
810	94%	14	1	0	0	0	0	0	0	15	16	1	0	0.0393701
820	85%	9	2	0	0	0	0	0	0	11	13	2	0	0.0393701
830	86%	43	4	2	0	0	0	0	0	49	57	8	0	0.0393701
840	100%	10	0	0	0	0	0	0	0	10	10	0	0	0.0393701
850	60%	1	2	0	0	0	0	0	0	3	5	2	0	0.0393701
860	88%	6	1	0	0	0	0	0	0	7	8	1	0	0.0393701
870	89%	14	2	0	0	0	0	0	0	16	18	2	0	0.0393701
900	78%	5	2	0	0	0	0	0	0	7	9	2	0	0.0393699
1000	90%	23	4	0	1	0	0	0	0	28	35	7	0	0.0393701
1010	87%	11	2	0	0	0	0	0	0	13	15	2	0	0.0393701
1030	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.0393701
1040	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.0393701
1050	88%	6	1	0	0	0	0	0	0	7	8	1	0	0.0393701
1060	100%	5	0	0	0	0	0	0	0	5	5	0	0	0.0393701
1100	100%	9	0	0	0	0	0	0	0	9	9	0	1	0.0393701
1110	100%	8	0	0	0	0	0	0	0	8	8	0	0	0.0393701
1200	100%	3	0	0	0	0	0	0	0	3	3	0	0	0.0393701
1300	100%	9	0	0	0	0	0	0	0	9	9	0	0	0.0393701
1310	89%	7	1	0	0	0	0	0	0	8	9	1	0	0.0393701
1320	100%	6	0	0	0	0	0	0	0	6	6	0	0	0.0393701
1330	100%	1	0	0	0	0	0	0	0	1	1	0	0	0.0393701
1340	93%	12	1	0	0	0	0	0	0	13	14	1	0	0.0393701
1350	53%	12	3	1	1	1	1	1	1	19	36	17	0	0.0393701
1360	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.0393701
1370	82%	7	2	0	0	0	0	0	0	9	11	2	0	0.0393701
1400	80%	6	2	0	0	0	0	0	0	8	10	2	0	0.0393701
1420	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.0393701
1440	94%	15	1	0	0	0	0	0	0	16	17	1	2	0.0393701
1460	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.0393701
1480	60%	2	0	1	0	0	0	0	0	3	5	2	0	0.0393701
1500	98%	89	2	0	0	0	0	0	0	91	93	2	0	0.0393701
1520	83%	12	3	0	0	0	0	0	0	15	18	3	0	0.0393701
1530	82%	11	3	0	0	0	0	0	0	14	17	3	0	0.0393701
1600	100%	5	0	0	0	0	0	0	0	5	5	0	0	0.0393701
1620	100%	0	0	0	0	0	0	0	0	0	0	0	0	0.0393701
1640	71%	11	3	0	1	0	0	0	0	15	21	6	0	0.0393701
1660	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.0393701
1700	75%	2	1	0	0	0	0	0	0	3	4	1	0	0.0393701
1710	100%	2	0	0	0	0	0	0	0	2	2	0	0	0.0393701
1720	90%	8	1	0	0	0	0	0	0	9	10	1	0	0.0393701
1800	100%	4	0	0	0	0	0	0	0	4	4	0	0	0.0393701

Rain Event Performance Analysis - Continued

Rain Sensor	Total Performance	Number of 1-tips	Number of 2-tips	Number of 3-tips	Number of 4-tips	Number of 5-tips	Number of 6-tips	Number of >6-tips	Number of actual tips	Number of expected tips	Number of missed tips	Number of hold-off transmissions	Bucket size from Sensordef
1810	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
1900	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
1920	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
2190	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
2210	100%	6	0	0	0	0	0	0	6	6	0	1	0.0393701
2230	100%	28	0	0	0	0	0	0	28	28	0	1	0.0393701
2240	95%	18	1	0	0	0	0	0	19	20	1	0	0.0393701
2250	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
2260	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
2270	100%	31	0	0	0	0	0	0	31	31	0	1	0.0393701
2280	91%	27	3	0	0	0	0	0	30	33	3	0	0.0393701
2310	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
2320	100%	13	0	0	0	0	0	0	13	13	0	0	0.0393701
2330	82%	7	2	0	0	0	0	0	9	11	2	0	0.0393701
2340	60%	1	2	0	0	0	0	0	3	5	2	0	0.0393701
2350	67%	6	1	0	1	0	0	0	8	12	4	0	0.0393701
2360	100%	23	0	0	0	0	0	0	23	23	0	0	0.0393701
2370	75%	4	2	0	0	0	0	0	6	8	2	0	0.0393701
2710	89%	7	1	0	0	0	0	0	8	9	1	0	0.0393701
2730	82%	7	2	0	0	0	0	0	9	11	2	0	0.0393701
2750	83%	12	3	0	0	0	0	0	15	18	3	0	0.0393701
2810	96%	21	1	0	0	0	0	0	22	23	1	0	0.0393701
2820	84%	22	3	1	0	0	0	0	26	31	5	0	0.0393701
2840	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4010	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4020	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
4030	85%	9	2	0	0	0	0	0	11	13	2	0	0.0393701
4040	89%	7	1	0	0	0	0	0	8	9	1	0	0.0393701
4050	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4060	86%	10	2	0	0	0	0	0	12	14	2	0	0.0393701
4070	100%	13	0	0	0	0	0	0	13	13	0	0	0.0393701
4080	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
4090	83%	8	2	0	0	0	0	0	10	12	2	0	0.0393701
4100	91%	9	1	0	0	0	0	0	10	11	1	0	0.0393701
4110	85%	10	0	1	0	0	0	0	11	13	2	0	0.0393701
4130	83%	4	1	0	0	0	0	0	5	6	1	0	0.0393701
4140	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
4150	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701
4160	100%	21	0	0	0	0	0	0	21	21	0	0	0.0393701
4170	85%	30	2	2	0	0	0	0	34	40	6	0	0.0393701
4180	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4190	92%	11	1	0	0	0	0	0	12	13	1	0	0.0393701
4200	96%	23	1	0	0	0	0	0	24	25	1	0	0.0393701
4220	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4230	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
4250	100%	17	0	0	0	0	0	0	17	17	0	0	0.0393701
4260	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4270	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
4290	100%	13	0	0	0	0	0	0	13	13	0	0	0.0393701
4300	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
4310	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
4330	89%	15	2	0	0	0	0	0	17	19	2	0	0.0393701
4340	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
4350	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
4360	88%	47	5	1	0	0	0	0	53	60	7	0	0.0393701
4470	74%	10	3	1	0	0	0	0	14	19	5	0	0.0393701
4490	93%	13	1	0	0	0	0	0	14	15	1	0	0.0393701
4510	82%	7	2	0	0	0	0	0	9	11	2	0	0.0393701
4520	71%	3	2	0	0	0	0	0	5	7	2	0	0.0393701
4530	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
4570	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4710	73%	5	3	0	0	0	0	0	8	11	3	0	0.0393701
4730	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
4750	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701
4770	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
4790	66%	15	4	0	1	0	0	0	21	32	11	0	0.0393701
4810	73%	6	1	1	0	0	0	0	8	11	3	0	0.0393701
4820	31%	2	0	0	2	0	1	0	5	16	11	0	0.0393701
4830	79%	11	4	0	0	0	0	0	15	19	4	0	0.0393701
4840	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
Total Tips		1789	129	11	7	2	2	2					

Rain Event Performance

850, 1350, 1480, 2340, 2350, 4790, 4820



Sensor ID Sensors with performance <70% noted

Measured Rain Event Analysis

Rain Sensor	Outliers Removed	
	(mm of rain measured) Measured Bucket Tips	(mm of rain measured) Measured Bucket Tips
100	11	11
110	8	8
120	7	7
140	13	13
150	6	6
200	6	6
210	13	13
220	9	9
300	17	17
310	1	1
330	9	9
400	2	2
410	2	2
420	65	
430	43	43
440	2	2
500	12	12
510	30	30
530	3	3
600	42	42
610	6	6
620	3	3
630	44	44
640	32	32
650	4	4
710	11	11
720	18	18
730	7	7
740	1	1
750	4	4
760	5	5
800	5	5
810	16	16
820	13	13
830	57	
840	10	10
850	5	5
860	8	8
870	18	18
900	9	9
1000	35	35
1010	15	15
1030	2	2
1040	4	4
1050	8	8
1060	5	5
1100	9	9
1110	8	8
1200	3	3
1300	9	9
1310	9	9
1320	6	6
1330	1	1
1340	14	14
1350	36	36
1360	2	2
1370	11	11
1400	10	10
1420	4	4
1440	17	17
1460	2	2
1480	5	5
1500	93	
1520	18	18
1530	17	17
1600	5	5
1620	10	10
1640	21	21
1660	2	2
1700	4	4
1710	2	2

Number of 3-tips	Outliers Removed	
	(mm of rain measured) Measured Bucket Tips	(mm of rain measured) Measured Bucket Tips
1710	2	2
1720	10	10
1800	4	4
1810	5	5
1900	8	8
1920	3	3
2190	8	8
2210	6	6
2230	28	28
2240	20	20
2250	17	17
2260	16	16
2270	31	31
2280	33	33
2310	11	11
2320	13	13
2330	11	11
2340	5	5
2350	12	12
2360	23	23
2370	8	8
2710	9	9
2730	11	11
2750	18	18
2810	23	23
2820	31	31
2840	7	7
4010	3	3
4020	6	6
4030	13	13
4040	9	9
4050	7	7
4060	14	14
4070	13	13
4080	14	14
4090	12	12
4100	11	11
4110	13	13
4130	6	6
4140	10	10
4150	10	10
4160	21	21
4170	40	40
4180	3	3
4190	13	13
4200	25	25
4220	5	5
4230	14	14
4250	17	17
4260	4	4
4270	19	19
4290	13	13
4300	6	6
4310	10	10
4330	19	19
4340	6	6
4350	14	14
4360	60	
4470	19	19
4490	15	15
4510	11	11
4520	7	7
4530	10	10
4570	3	3
4710	11	11
4730	6	6
4750	7	7
4770	19	19
4790	32	32
4810	11	11
4820	16	16
4830	19	19
4840	15	15

Bucket Tip Data Analysis	
Mean	13.75
Median	10.00
Std Deviation	13.32
Mean + 3 st dev	53.70
Mean - 3 st dev	-26.21
Min	1
Max	93