

Memo



Date: May 8, 2006
To: Kevin Stewart, Chad Kudym
From: Markus Ritsch, P.E.
Subject: April 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 April 1 through April 30, 2006.

II. General System Analysis Summary

A total of 196,823 individual data records were analyzed. Meteorological sensors account for seventy-four (74) percent, water level sensors ten (10) percent, and rain sensors (7) 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 (2,115) reports were flagged as "bad". Of these "bad" reports, approximately half (1,003) originated from the Wind Gust sensor (ID 2189) at Squaw Mountain. Another ninety-eight (98) "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 for the past four months.

The system-wide radio traffic loading was approximately six thousand five hundred (6,561) reports per day with an average hourly load of two hundred and seventy-three (273) reports. The peak hourly traffic loading was just over five hundred and fifty (559) reports and occurred on April 15th between seven and eight in the morning. A plot of monthly average and peak hourly traffic loading is provided.

The sensors reporting most frequently this month include:

1. Salisbury Park (sensor ID 2727) with 4,217 reports or one report every twelve to thirteen minutes, and
2. Quincy Reservoir (ID 747) with 2,980 reports, and
3. Castle Rock (ID 2747) with 2,857 reports.

The reports from these sensors are all related to wind and are distributed evenly over the entire month.

III. Rain Sensor Timer Reporting Summary

A total of one hundred and fifty three (153) rain sensors reported during the month of April. For the rain stations that were operational in April, the base station received ninety (90) percent of the non-incrementing timer reports. The following table summarizes those rain sensors with the worst timer reporting performance (Table 1).

Table 1. 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	1660	4820	1460								
1640	4240	4570	1330								
--	--	--	1610								
			1600								

*Stapleton "Urban Farm" (1460), El Rancho (2340), Roslyn (1330), Holly Dam (1610), Englewood Dam (1600)

IV. Rain Sensor Event Reporting Summary

A. District-Wide Total Tip/Count Statistics

The incrementing reports from one hundred and forty-seven (147) individual 1-mm rain sensors were analyzed to quantify the District-wide statistical total monthly tip summary (Table 2).

Table 2. March District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	20.47	Only the 1-mm rain sensors were included in the analysis
Median	20	Only the 1-mm rain sensors were included in the analysis
Standard deviation	7.32	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	42.44	All sensor data for the month are within the Mean +/- 3 Std Dev
Minimum total count	3	Shop Creek (ID 1710)
Maximum total count	53	Powers Park (ID 1500), the only station outside three standard deviations

A monthly summary of the District-wide mean total tip/count is presented (Table 3).

Table 3. Monthly Summary of District-Wide Mean 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								

B. Sensors With Six or More Jumps in Sequential Count

The data records for the following sensors were visually examined because a jump of more than six (6) counts occurred in the sequential data transmissions as determined by the automated data analyses.

1. Sand Creek at Colfax, ID 860
2. Chatfield COE, ID 1350
3. Diamond Hill, ID 1420

The following information should be compared to the field maintenance records to confirm whether field/calibration work was being completed during the time that the large jump in count values was noticed.

1. Sand Creek at Colfax (860)

On April 27, 2006 between 10:00 am and 1:00 pm the count value jumped from thirteen (13) to fifty-one (51). It looks as though NovaStar validated this jump and the official historical record should be reviewed for this sensor for this period to confirm that this jump did not result in an inaccurate accumulation of rainfall.

2. Chatfield COE (1350)

On April 7, 2006 between 10:29 am and 11:52 am the count value jumped from nine hundred twenty-nine (929) to nine hundred thirty-six (936). This jump was validated by NovaStar and was recorded as observed rainfall in the database. The accumulation was approximately 0.28 inches in eighty-three (83) minutes.

3. Diamond Hill (1420)

On April 5, 2005 the count value was reset to zero (0) at 11:10 am from a previous value of nine hundred and twenty-eight (928). This was most likely the result of scheduled field service to the station. Throughout the day, however, the transmitter continued to count upwards in sporadic jumps and reached a value of sixty (60) by 11:00 pm on April 5th. The majority of the data transmissions were validated by NovaStar which resulted in a total accumulation of 1.73 inches for the day. This accumulation of rain is mostly likely erroneous and should be deleted from the official corrected historical data record.

On April 6, 2005 the count value was again reset to zero (0) at 11:27 am, most likely the result of a second field visit to the station. From April 6, the count value seems to increment in a stable fashion for the remainder of the month.

C. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing rain/snow tip reports for the month was ninety-three (93) percent. A total of 2,797 incrementing reports were received and a total of 3,002 were expected. The total loss of incrementing reports was 6.83 percent. The following table summarizes those sensors with the worst rain transmission performance (Table 4).

Table 4. 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								
1640	4080	4170	310								
4490	4170	4820	4820								

*Squaw Mountain (2190), Guy Hill Ranch (310), Doudy Draw (4820)

The rain sensor at Squaw Mountain (2190) was very noisy and contained numerous transmissions that were invalidated by NovaStar. The continuous count series for IDs 310 and 4820 looked reasonable, they just contained many missed reports.

V. Issues Continued from Previous Month

The following issues were identified last month and continue to be a problem.

1. The Squaw Mountain sensors (ID 2189 and 2187) show a large amount of invalid or “bad” data in the NovaStar database.
2. The Stapleton rain sensor (ID 1460) continues to exhibit poor timer performance. This could indicate a marginal radio path or the station’s radio/antenna system is not functioning properly. The maintenance records for this station should be reviewed and the standing wave ratio and radio output power should be verified.
3. Continue to observe rain transmissions from Doudy Draw (4820) for possible problems with the increment reporting.

VI. Issues Identified this Month

Further investigation into the following issues is recommended:

1. The raw count series for the Squaw Mountain rain sensor (2190) was “noisy” and contained a large volume of invalid data transmissions. The volume of bad data transmissions on this ID may impact the accuracy of the rain accumulation.
2. The solar radiation sensor at the Stapleton “Urban Farm” station (ID 1464) reports too frequently.
3. The data records for the following sensors should be reviewed in the District’s long-term archival database. The rainfall accumulations for these sensors may be incorrect for periods during the month of April due to large jumps in the sequential raw count series.
 - a. Sand Creek at Colfax (ID 860)
 - b. Chatfield COE (ID 1350)
 - c. Diamond Hill (ID 1420)

General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\data_extracts\Novastar_extract_200604.mdb

First Date in Database	4/1/06 12:00 AM	Total Days	30.0
Last Date in Database	4/30/06 11:59 PM	Total Hours	720.0
Total Records Analyzed	196823		

Records by Group

Wind Gust	35313	18%
Temperature	26394	13%
Relative Humidity	26053	13%
Wind Speed Average & Azimuth	24173	12%
Wind Direction	16284	8%
Precipitation	13474	7%
Water Level PT-HSE	12634	6%
Wind Speed Average	11204	6%
Battery Voltage Digital	5810	3%
Battery Voltage HSE	5719	3%
Water Level PT	4538	2%
Solar Radiation	4155	2%
Water Level Float	2715	1%
Barometric Pressure	2657	1%
Fuel Moisture	1388	1%
Fuel Temperature	1360	1%
Repeater Pass List	974	0%
Handar 585 ALARM Status	935	0%
Battery Voltage Analog	538	0%
12Hr Status Report	205	0%
Longmont Flow Gage	110	0%
Soil Moisture	76	0%
Longmont Water Level PT	53	0%
Total	196762	

Records by Major Group

Meteorologic Sensors	146233	74%
Water Level Sensors	20050	10%
Sensor Status Transmissions	14181	7%
Rain Sensors	13474	7%
Soil and Fuel Sensors	2824	1%
Total	196762	100%

Records by Validation Type

Good	0	194708	99%
Questionable	1	2115	1%
Total		196823	

Sensors With Most Invalid Data

Description	Sensor	Reports
Squaw Mountain	2189	1003
Elbert	1439	130
Quincy Reservoir	753	107
Squaw Mountain	2187	98
Blue Mountain	139	91

Traffic Loading Summary

Alert Reports	196823
Average Daily Traffic	6561
Average Hourly Traffic	273
Median Hourly Traffic	268
Peak Hourly Traffic	559

hour beginning 4/15/06 7:00 AM

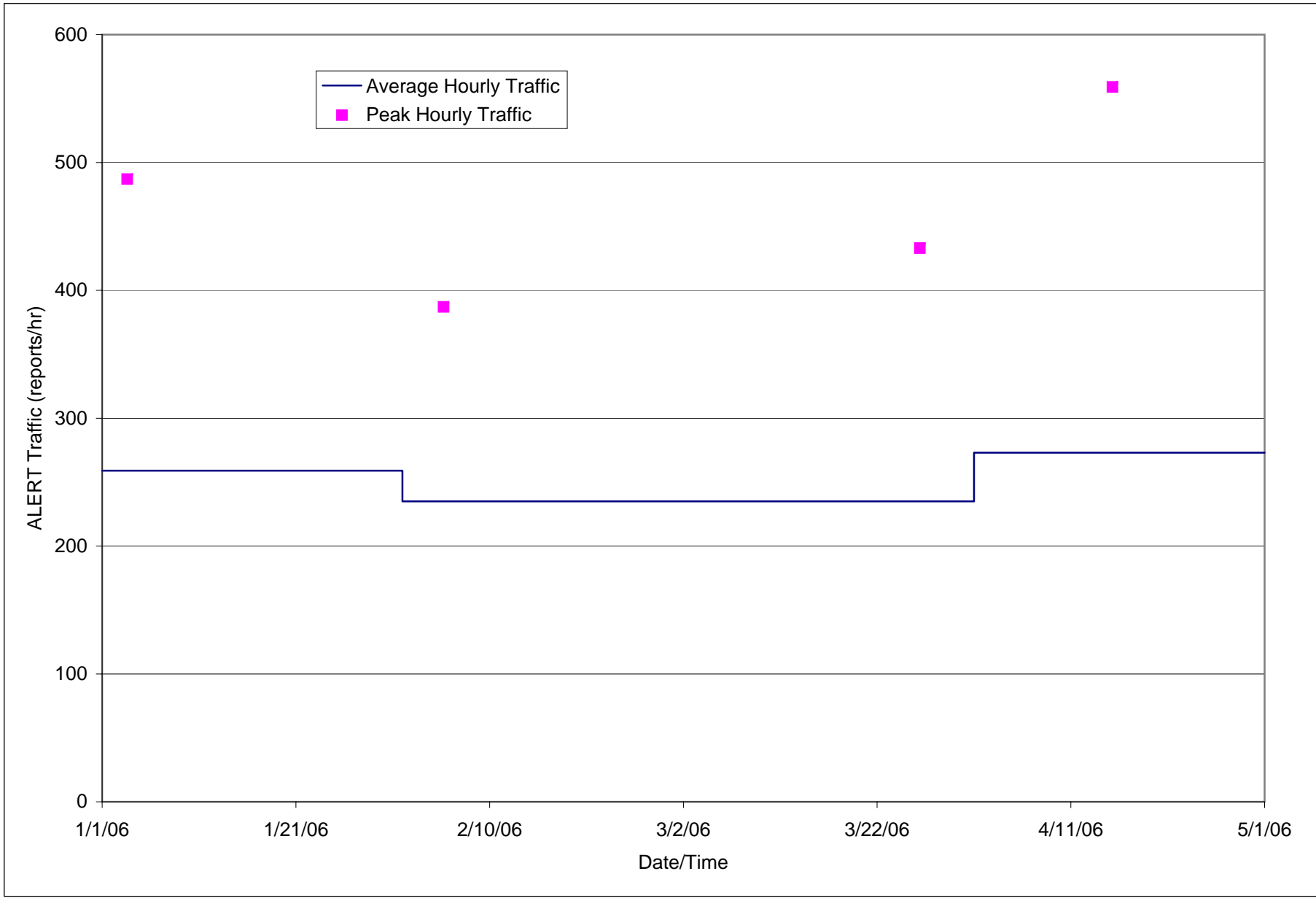
Total Number of Sensors Defined
780

Total Number of Sensors Reporting
511

Reports per Sensor

Description	Sensor	Reports	Fraction of Total
Salisbury Park	2727	4217	2%
Quincy Reservoir	747	2980	2%
Castle Rock	2747	2857	1%
Elbert	1439	2766	1%
Urban Farm	1464	2757	1%
Urban Farm	1466	2743	1%
Marston Lake North	1521	2742	1%
Castle Rock	2744	2739	1%
Salisbury Park	2724	2706	1%
Marston Lake North	1526	2699	1%
Urban Farm	1467	2689	1%
Urban Farm	1465	2685	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
			0.5207		90%
			Average Timer Interval	Performance	
100	Carr Street	54	12:46	60.00	90%
110	Ralston Reservoir	49	13:53	60.00	82%
120	West Woods	59	11:59	60.00	98%
140	Blue Mountain	59	12:01	60.00	98%
150	Nott Creek	55	12:31	60.00	92%
200	Leyden Reservoir	55	11:57	60.00	92%
210	Leyden Confluence	54	12:30	60.00	90%
220	Upper Leyden	56	12:42	60.00	93%
300	Van Bibber Park	57	12:27	60.00	95%
310	Guy Hill Ranch	45	14:54	60.00	75%
330	Van Bibber @ Hwy 93	57	12:01	60.00	95%
400	Montview Park	55	12:43	60.00	92%
410	Kelly Dam	43	10:18	60.00	72%
420	Expo Park	57	12:13	60.00	95%
430	Utah Park	51	13:51	60.00	85%
440	Fire Station #7	54	13:00	60.00	90%
500	Havana Park	57	12:12	60.00	95%
510	Virginia Court	54	12:45	60.00	90%
520	Jewell Detention	55	12:29	60.00	92%
530	Fire Station #19	54	12:29	60.00	90%
540	Parker/Mississippi	40	15:04	60.00	67%
600	Harvard Gulch Park	56	12:44	60.00	93%
610	Harvard @ Jackson	59	11:58	60.00	98%
620	Quincy/Highline	56	12:28	60.00	93%
630	Temple Pond at DTC	53	12:53	60.00	88%
640	Goldsmith @ Eastman	57	12:15	60.00	95%
650	Iliff Pond	68	9:14	60.00	113%
700	Toll Gate @ 6th	57	12:29	60.00	95%
710	Horseshoe Park Drop	57	11:59	60.00	95%
720	Confluence Pond	57	12:26	60.00	95%
730	No Name @ Quincy	55	12:27	60.00	92%
740	Smoky Hill	58	12:02	60.00	97%
750	Quincy Reservoir	56	12:28	60.00	93%
760	Mission Viejo Park	52	13:30	60.00	87%
800	Sable Ditch @ 18th	57	12:26	60.00	95%
810	Granby Ditch @ 6th	57	11:59	60.00	95%
820	ETG @ Buckley	53	13:00	60.00	88%
830	Side Creek Park	56	12:27	60.00	93%
840	Fire Station 12	50	13:05	60.00	83%
850	Flying J	54	12:28	60.00	90%
860	Sand Cr at Colfax	58	11:47	60.00	97%
870	Murphy Creek GC	56	12:00	60.00	93%
900	Aurora Reservoir	59	12:14	60.00	98%
1000	Maple Grove Resv.	68	9:35	60.00	113%
1010	Denver West	58	11:57	60.00	97%
1020	Lena @ Nolte Pond	56	12:40	60.00	93%
1030	NREL/S. Table Mtn.	57	12:13	60.00	95%
1040	Lena @ U.S. Hwy 6	62	10:51	60.00	103%
1050	Jeffco Fairgrounds	56	12:13	60.00	93%
1060	Heritage Square	53	13:00	60.00	88%
1100	Louisville Rec Ctr	52	13:19	60.00	87%
1110	Gunbarrel	54	13:14	60.00	90%
1200	Broomfield 3207	52	13:30	60.00	87%
1300	Hidden Lake	56	12:13	60.00	93%
1310	LDC at 64th	54	12:29	60.00	90%
1320	SPR at 3rd Ave	58	11:59	60.00	97%
1330	Roslyn	30	18:45	60.00	50%
1340	Sanderson at Xavier	53	13:06	60.00	88%
1350	Chatfield COE	52	13:17	60.00	87%
1360	Denver Zoo	53	13:21	60.00	88%
1370	West Metro FS13	55	12:31	60.00	92%
1400	Upper Sloan Det.	54	12:44	60.00	90%
1420	Diamond Hill	68	9:26	60.00	113%
1440	Elbert	67	10:21	60.00	112%
1460	Urban Farm	26	23:59	60.00	43%
1480	Third Creek at DIA	54	12:44	60.00	90%
1500	Powers Park	54	12:19	60.00	90%
1520	Marston Lake North	52	12:31	60.00	87%
1530	Bear Creek @ Lowell	50	13:38	60.00	83%
1600	Englewood Dam	35	11:57	60.00	58%
1610	Holly Dam	34	11:58	60.00	57%
1620	Slaughterhouse Glich	59	12:12	60.00	98%
1640	SPR at Union Ave.	49	14:35	60.00	82%
1660	SPR at Henderson	56	12:15	60.00	93%
1700	Cherry Cr @ Champa	55	12:15	60.00	92%

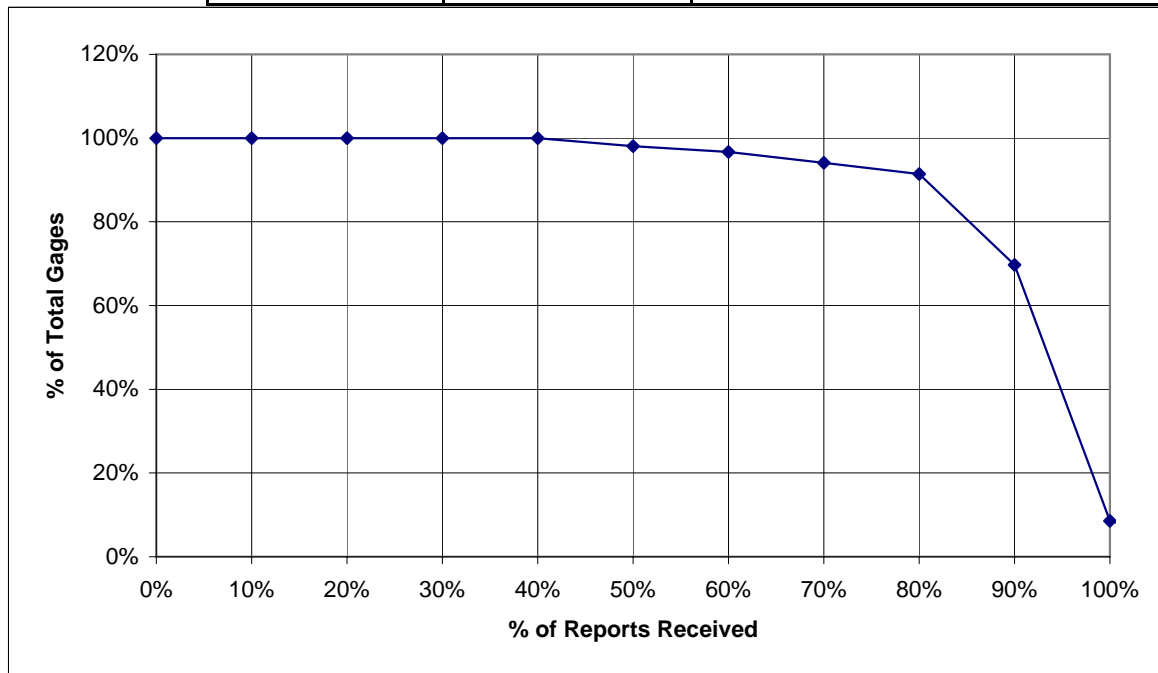
Rain Timer Performance Analysis - Continued

Rain Sensors	Description	Number of Received Timer Reports	Average Timer Interval	Number of expected Timer Reports	Performance
1710	Shop Creek	47	13:41	60.00	78%
1720	Cherry Cr @ Steele	51	13:21	60.00	85%
1800	Sand Creek Park	62	10:42	60.00	103%
1810	Sand Creek at mouth	55	12:01	60.00	92%
1900	Niver Detention	54	12:56	60.00	90%
1920	Brighton	56	12:15	60.00	93%
2190	Squaw Mountain	38	14:30	60.00	63%
2210	Hiwan G.C.	58	12:10	60.00	97%
2220	Evergreen Lake	57	12:32	60.00	95%
2230	Bear Cr below Cub	55	12:31	60.00	92%
2240	Cold Sprg Glch conf	57	12:01	60.00	95%
2250	Rosedale	56	12:47	60.00	93%
2260	Brook Forest	57	12:16	60.00	95%
2270	Cub Cr below Blue	59	12:01	60.00	98%
2280	Kinney Peak	57	12:30	60.00	95%
2310	Genesee Village	51	13:27	60.00	85%
2320	Choke Cherry Resvr	206		60.00	
2330	Morrison	58	12:53	60.00	97%
2340	El Rancho	26	12:32	60.00	43%
2350	Idledale	55	12:01	60.00	92%
2360	Indian Hills	57	12:15	60.00	95%
2370	Red Rocks Park	56	12:31	60.00	93%
2710	Highlands Ranch WTP	58	12:14	60.00	97%
2730	Salisbury Park	55	12:45	60.00	92%
2750	Castle Rock	57	12:14	60.00	95%
2810	Pine Cliff Road	57	11:59	60.00	95%
2820	Haskins Gulch Conf	57	12:16	60.00	95%
2840	Sulphur Gulch	57	12:29	60.00	95%
4010	Crescent	50	13:39	60.00	83%
4020	Rio Grande	59	11:39	60.00	98%
4030	Red Garden	57	12:32	60.00	95%
4040	Martin Gulch	59	11:57	60.00	98%
4050	Walker Ranch	57	12:27	60.00	95%
4060	Lakeshore	54	13:12	60.00	90%
4070	Bear Peak	57	12:02	60.00	95%
4080	Twin Sisters	52	13:19	60.00	87%
4090	Magnolia	62	11:33	60.00	103%
4100	Filter Plant	56	12:08	60.00	93%
4110	Betasso	57	12:31	60.00	95%
4130	Swiss Peaks	52	13:34	60.00	87%
4140	Logan Mill	52	13:39	60.00	87%
4150	Gold Hill	52	13:26	60.00	87%
4160	Sunshine	59	11:59	60.00	98%
4170	Pine Brook	49	13:46	60.00	82%
4180	Gold Lake	41	17:48	60.00	68%
4190	Slaughterhouse	56	12:29	60.00	93%
4200	Lazy Acres	60	11:35	60.00	100%
4220	Fling's	53	12:46	60.00	88%
4230	Golden Age	56	12:02	60.00	93%
4240	Sunset	56	12:40	60.00	93%
4250	Geer Canyon	56	12:42	60.00	93%
4260	Taylor Mountain	60	11:59	60.00	100%
4270	Cannon Mountain	59	11:59	60.00	98%
4290	Red Hill	60	11:41	60.00	100%
4300	Big Elk Park	61	11:23	60.00	102%
4310	Johnny Park	56	12:44	60.00	93%
4330	Indian Ruins	59	11:43	60.00	98%
4340	Riverside	56	13:01	60.00	93%
4350	Conifer Hill	60	11:59	60.00	100%
4360	Justice Center	57	12:23	60.00	95%
4470	Little Narrows	52	12:39	60.00	87%
4490	Apple Valley	53	13:13	60.00	88%
4510	Pinewood Springs	54	13:01	60.00	90%
4520	Eagle Ridge	56	12:31	60.00	93%
4530	Winiger Ridge	50	13:18	60.00	83%
4560	Lyons Diversion NSV	51	13:47	60.00	85%
4570	St. Antons	52	13:37	60.00	87%
4710	Ward C-1	55	13:05	60.00	92%
4730	Sugarloaf	55	12:05	60.00	92%
4750	Louisville Lake	56	12:33	60.00	93%
4770	Cal-Wood Ranch	60	12:00	60.00	100%
4790	Buton Rock	56	12:01	60.00	93%
4810	Shanahan Ridge	46	13:57	60.00	77%
4820	Doudy Draw	50	13:33	60.00	83%
4830	SBC @ San Souci	53	13:30	60.00	88%
4840	SBC@S Boulder Ditch	53	12:45	60.00	88%
4850	Porphyry Mtn	42	15:18	60.00	70%
4860	Fairview Peak	53	12:52	60.00	88%

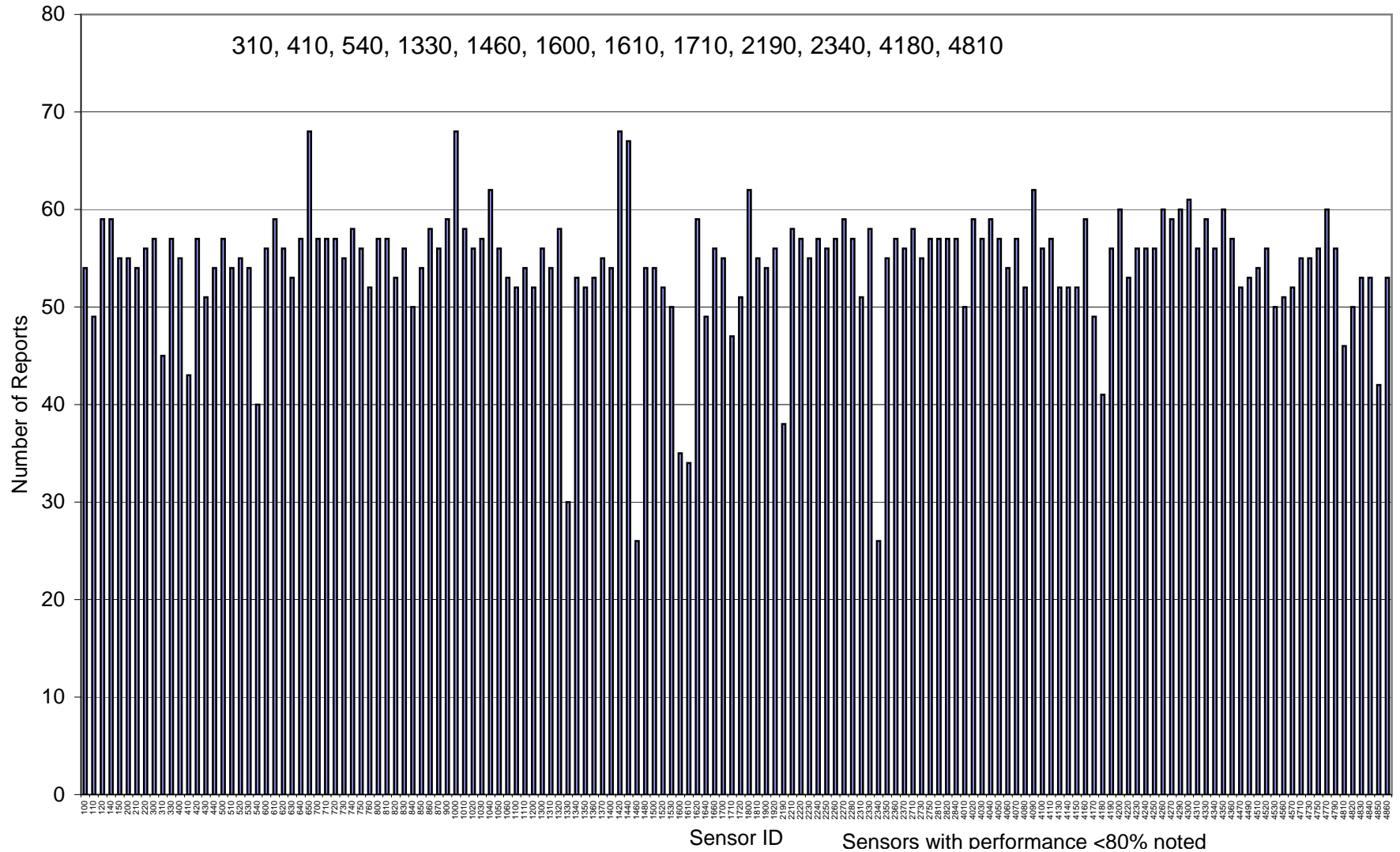
Rain Timer Performance Analysis - Continued

Rain Timer Performance

		total number of gages 152		
% 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%	3		98%	
60%	2		97%	
70%	4		94%	
80%	4		91%	
90%	33		70%	
100%	93		9%	



Number of Timer Reports Received



Rain Event Performance Analysis

Rain Event Performance

Systemwide Avg	Reports Received	2797
93%	Total Tips	3002
	Data Loss	6.83%

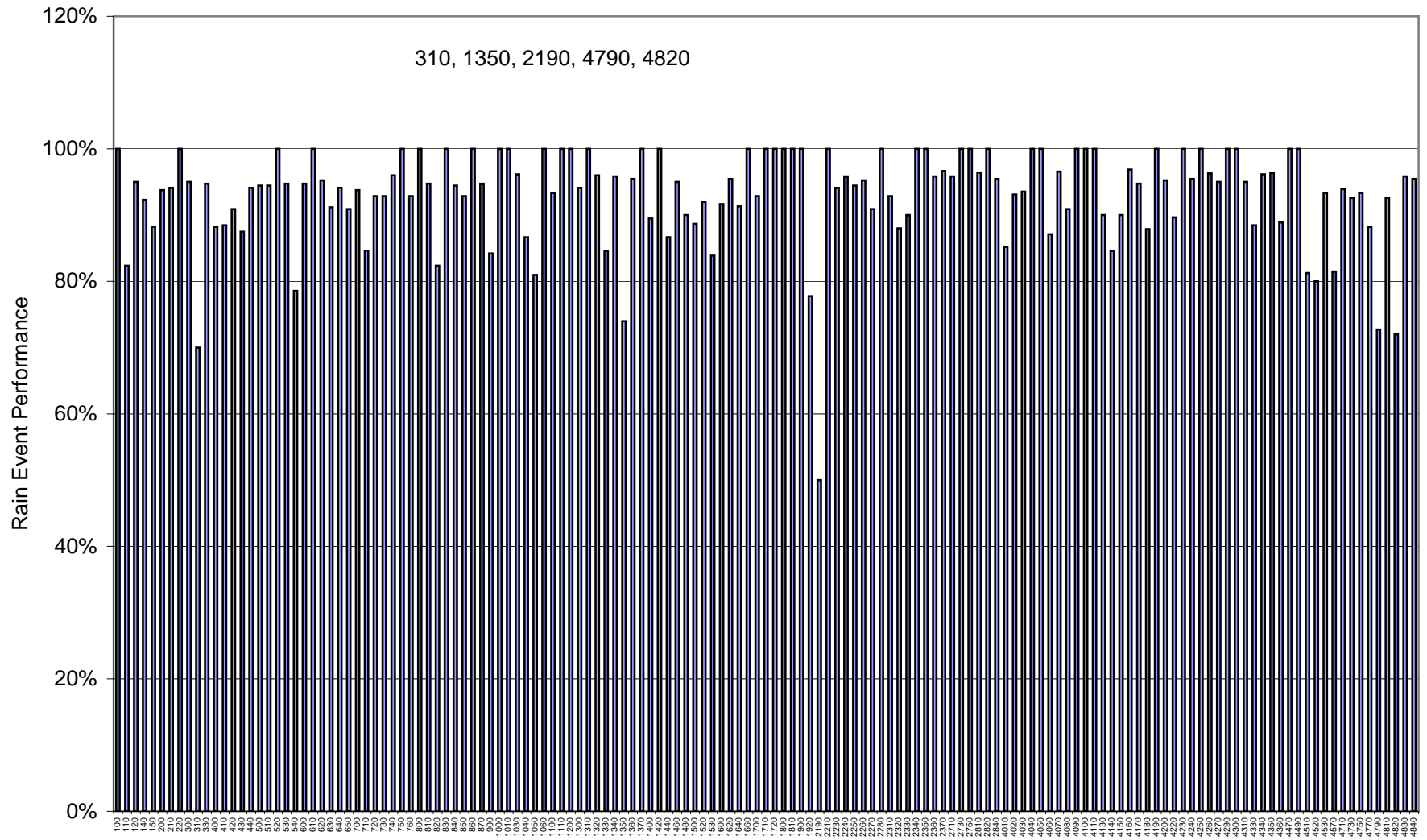
Analyze Rain Sensors

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
100	100%	18	0	0	0	0	0	0	18	18	0	0	0.0393701
110	82%	11	3	0	0	0	0	0	14	17	3	0	0.0393701
120	95%	18	1	0	0	0	0	0	19	20	1	0	0.0393701
140	92%	11	1	0	0	0	0	0	12	13	1	0	0.0393701
150	88%	13	2	0	0	0	0	0	15	17	2	0	0.0393701
200	94%	14	1	0	0	0	0	0	15	16	1	0	0.0393701
210	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
220	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
300	95%	18	1	0	0	0	0	0	19	20	1	0	0.0393701
310	70%	5	1	1	0	0	0	0	7	10	3	0	0.0393701
330	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
400	88%	13	2	0	0	0	0	0	15	17	2	0	0.0393701
410	88%	20	3	0	0	0	0	0	23	26	3	0	0.0393701
420	91%	18	2	0	0	0	0	0	20	22	2	0	0.0393701
430	88%	13	0	1	0	0	0	0	14	16	2	0	0.0393701
440	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
500	94%	16	1	0	0	0	0	0	17	18	1	0	0.0393701
510	94%	16	1	0	0	0	0	0	17	18	1	0	0.0393701
520	100%	20	0	0	0	0	0	0	20	20	0	0	0.0393701
530	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
540	73%	9	1	0	0	0	0	0	11	14	3	0	0.0393701
600	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
610	100%	22	0	0	0	0	0	0	22	22	0	0	0.0393701
620	95%	19	1	0	0	0	0	0	20	21	1	0	0.0393701
630	91%	29	1	1	0	0	0	0	31	34	3	0	0.0393701
640	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
650	91%	18	2	0	0	0	0	0	20	22	2	0	0.0393701
700	94%	14	1	0	0	0	0	0	15	16	1	0	0.0393701
710	85%	9	2	0	0	0	0	0	11	13	2	0	0.0393701
720	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
730	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
740	96%	23	1	0	0	0	0	0	24	25	1	0	0.0393701
750	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
760	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
800	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
810	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
820	82%	12	1	1	0	0	0	0	14	17	3	0	0.0393701
830	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
840	94%	16	1	0	0	0	0	0	17	18	1	0	0.0393701
850	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
860	100%	3	0	0	0	0	0	1	3	3	0	0	0.0393701
870	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
900	84%	13	3	0	0	0	0	0	16	19	3	0	0.0393699
1000	100%	26	0	0	0	0	0	0	26	26	0	0	0.0393701
1010	100%	24	0	0	0	0	0	0	24	24	0	0	0.0393701
1030	96%	24	1	0	0	0	0	0	25	26	1	0	0.0393701
1040	87%	23	2	1	0	0	0	0	26	30	4	0	0.0393701
1050	81%	14	2	1	0	0	0	0	17	21	4	0	0.0393701
1060	100%	26	0	0	0	0	0	0	26	26	0	0	0.0393701
1100	93%	13	1	0	0	0	0	0	14	15	1	0	0.0393701
1110	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
1200	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
1300	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
1310	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
1320	96%	23	1	0	0	0	0	0	24	25	1	0	0.0393701
1330	85%	9	2	0	0	0	0	0	11	13	2	0	0.0393701
1340	96%	22	1	0	0	0	0	0	23	24	1	0	0.0393701
1350	74%	23	1	1	0	0	0	1	26	35	9	0	0.0393701
1360	95%	20	1	0	0	0	0	0	21	22	1	0	0.0393701
1370	100%	26	0	0	0	0	0	0	26	26	0	0	0.0393701
1400	89%	15	2	0	0	0	0	0	17	19	2	0	0.0393701
1420	100%	26	0	0	0	0	0	2	26	26	0	1	0.0393701
1440	87%	11	2	0	0	0	0	0	13	15	2	0	0.0393701
1460	95%	18	1	0	0	0	0	0	19	20	1	1	0.0393701
1480	90%	8	1	0	0	0	0	0	9	10	1	0	0.0393701
1500	89%	43	3	0	1	0	0	0	47	53	6	0	0.0393701
1520	92%	22	0	1	0	0	0	0	23	25	2	0	0.0393701
1530	84%	22	3	1	0	0	0	0	26	31	5	0	0.0393701
1600	92%	10	1	0	0	0	0	0	11	12	1	0	0.0393701
1620	93%	20	1	0	0	0	0	0	21	22	1	0	0.0393701
1640	91%	19	2	0	0	0	0	0	21	23	2	0	0.0393701
1660	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
1700	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
1710	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
1720	100%	17	0	0	0	0	0	0	17	17	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
1800	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
1810	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
1900	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
1920	78%	5	2	0	0	0	0	0	7	9	2	0	0.0393701
2190	50%	3	0	0	0	1	0	0	4	8	4	0	0.0393701
2210	100%	17	0	0	0	0	0	0	17	17	0	1	0.0393701
2230	94%	15	0	0	0	0	0	0	16	17	0	1	0.0393701
2240	96%	22	1	0	0	0	0	0	23	24	1	0	0.0393701
2250	94%	16	1	0	0	0	0	0	17	18	1	0	0.0393701
2260	95%	19	1	0	0	0	1	0	20	21	0	0	0.0393701
2270	91%	18	2	0	0	0	0	0	20	22	2	1	0.0393701
2280	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
2310	93%	24	2	0	0	0	0	0	26	28	2	0	0.0393701
2320	88%	19	3	0	0	0	0	0	22	25	3	0	0.0393701
2330	90%	16	2	0	0	0	0	0	18	20	2	0	0.0393701
2340	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
2350	100%	26	0	0	0	0	0	0	26	26	0	0	0.0393701
2360	96%	22	1	0	0	0	0	0	23	24	1	0	0.0393701
2370	97%	28	1	0	0	0	0	0	29	30	1	0	0.0393701
2710	96%	22	1	0	0	0	0	0	23	24	1	0	0.0393701
2730	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
2750	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
2810	96%	26	1	0	0	0	0	0	27	28	1	0	0.0393701
2820	100%	39	0	0	0	0	0	0	30	30	0	1	0.0393701
2840	95%	20	1	0	0	0	0	0	21	22	1	0	0.0393701
4010	85%	19	4	0	0	0	0	0	23	27	4	0	0.0393701
4020	93%	25	2	0	0	0	0	0	27	29	2	1	0.0393701
4030	94%	27	2	0	0	0	0	0	29	31	2	0	0.0393701
4040	100%	28	0	0	0	0	0	0	28	28	0	0	0.0393701
4050	100%	22	0	0	0	0	0	0	22	22	0	0	0.0393701
4060	87%	23	4	0	0	0	0	0	27	31	4	0	0.0393701
4070	97%	27	1	0	0	0	0	0	28	29	1	0	0.0393701
4080	91%	18	2	0	0	0	0	0	20	22	2	0	0.0393701
4090	100%	29	0	0	0	0	0	0	29	29	0	0	0.0393701
4100	100%	19	0	0	0	0	0	0	19	19	0	0	0.0393701
4110	100%	30	0	0	0	0	0	0	30	30	0	0	0.0393701
4130	90%	24	3	0	0	0	0	0	27	30	3	0	0.0393701
4140	85%	20	0	2	0	0	0	0	22	26	4	0	0.0393701
4150	90%	24	3	0	0	0	0	0	27	30	3	0	0.0393701
4160	97%	30	1	0	0	0	0	0	31	32	1	0	0.0393701
4170	93%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
4180	88%	25	4	0	0	0	0	0	29	33	4	0	0.0393701
4190	100%	22	0	0	0	0	0	0	22	22	0	0	0.0393701
4200	95%	19	1	0	0	0	0	0	20	21	1	0	0.0393701
4220	90%	23	3	0	0	0	0	0	26	29	3	0	0.0393701
4230	100%	18	0	0	0	0	0	0	18	18	0	0	0.0393701
4240	95%	20	1	0	0	0	0	0	21	22	1	0	0.0393701
4250	100%	21	0	0	0	0	0	0	21	21	0	0	0.0393701
4260	96%	25	1	0	0	0	0	0	26	27	1	0	0.0393701
4270	95%	18	1	0	0	0	0	0	19	20	1	0	0.0393701
4290	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
4300	100%	20	0	0	0	0	0	0	20	20	0	0	0.0393701
4310	95%	18	1	0	0	0	0	0	19	20	1	0	0.0393701
4330	88%	20	3	0	0	0	0	0	23	26	3	0	0.0393701
4340	96%	24	1	0	0	0	0	0	25	26	1	1	0.0393701
4350	96%	26	1	0	0	0	0	0	27	28	1	1	0.0393701
4360	89%	22	1	0	0	0	0	0	24	27	3	0	0.0393701
4470	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
4490	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
4510	81%	11	1	1	0	0	0	0	13	16	3	0	0.0393701
4520	80%	6	2	0	0	0	0	0	8	10	2	0	0.0393701
4530	93%	26	2	0	0	0	0	0	28	30	2	0	0.0393701
4570	81%	19	2	0	1	0	0	0	22	27	5	1	0.0393701
4710	94%	29	2	0	0	0	0	0	31	33	2	0	0.0393701
4730	93%	23	2	0	0	0	0	0	25	27	2	0	0.0393701
4750	93%	13	1	0	0	0	0	0	14	15	1	0	0.0393701
4770	88%	13	2	0	0	0	0	0	15	17	2	0	0.0393701
4790	73%	12	3	0	1	0	0	0	16	22	6	0	0.0393701
4810	93%	23	2	0	0	0	0	0	25	27	2	0	0.0393701
4820	72%	15	0	2	1	0	0	0	18	25	7	0	0.0393701
4830	96%	22	1	0	0	0	0	0	23	24	1	0	0.0393701
4840	95%	20	1	0	0	0	0	0	21	22	1	0	0.0393701
Total Tips		2619	157	16	4	1	0	0					

Rain Event Performance



Sensor ID Sensors with performance <75% noted

Measured Rain Event Analysis

Rain Sensor	Outliers Removed	
	(mm of rain measured) Measured Bucket Tips	(mm of rain measured) Measured Bucket Tips
100	18	18
110	17	17
120	20	20
140	13	13
150	17	17
200	16	16
210	17	17
220	16	16
300	20	20
310	10	10
330	19	19
400	17	17
410	26	26
420	22	22
430	16	16
440	17	17
500	18	18
510	18	18
520	20	20
530	19	19
540	14	14
600	19	19
610	22	22
620	21	21
630	34	34
640	17	17
650	22	22
700	16	16
710	13	13
720	14	14
730	14	14
740	25	25
750	14	14
760	14	14
800	12	12
810	19	19
820	17	17
830	14	14
840	18	18
850	14	14
860	3	3
870	19	19
900	19	19
1000	26	26
1010	24	24
1030	26	26
1040	30	30
1050	21	21
1060	26	26
1100	15	15
1110	7	7
1200	8	8
1300	17	17
1310	14	14
1320	25	25
1330	13	13
1340	24	24
1350	35	35
1360	22	22
1370	26	26
1400	19	19
1420	26	26
1440	15	15
1460	20	20
1480	10	10
1500	53	53
1520	25	25
1530	31	31
1600	12	12
1620	22	22
1640	23	23
1660	6	6
1700	14	14
1710	3	3
1720	17	17

Rain Sensor	Outliers Removed	
	(mm of rain measured) Measured Bucket Tips	(mm of rain measured) Measured Bucket Tips
1800	16	16
1810	14	14
1900	6	6
1920	9	9
2190	8	8
2210	17	17
2230	17	17
2240	24	24
2250	18	18
2260	21	21
2270	22	22
2280	15	15
2310	28	28
2320	25	25
2330	20	20
2340	11	11
2350	26	26
2360	24	24
2370	30	30
2710	24	24
2730	15	15
2750	7	7
2810	28	28
2820	30	30
2840	22	22
4010	27	27
4020	29	29
4030	31	31
4040	28	28
4050	22	22
4060	31	31
4070	29	29
4080	22	22
4090	29	29
4100	19	19
4110	30	30
4130	30	30
4140	26	26
4150	30	30
4160	32	32
4170	19	19
4180	33	33
4190	22	22
4200	21	21
4220	29	29
4230	18	18
4240	22	22
4250	21	21
4260	27	27
4270	20	20
4290	15	15
4300	20	20
4310	20	20
4330	26	26
4340	26	26
4350	28	28
4360	27	27
4470	15	15
4490	8	8
4510	16	16
4520	10	10
4530	30	30
4570	27	27
4710	33	33
4730	27	27
4750	15	15
4770	17	17
4790	22	22
4810	27	27
4820	25	25
4830	24	24
4840	22	22

Bucket Tip Data Analysis	
Mean	20.47
Median	20.00
Std Deviation	7.32
Mean + 3 st dev	42.44
Mean - 3 st dev	-1.50
Min	3
Max	53