

ALERT Data Analysis Tool Development

Pilot Study for Implementation in 2006

Prepared For:
Urban Drainage and Flood Control District
2480 West 26th Avenue, Suite 156B
Denver, CO 80211

Prepared By:
Water & Earth Technologies, Inc.
1225 Red Cedar Circle, Suite A
Fort Collins, CO 80524

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1 Introduction

The Urban Drainage and Flood Control District (District) operates an extensive ALERT-based monitoring network along the Front Range. Radio frequencies are used to communicate data from remote stations, through repeaters, to multiple receiving base stations that run the NovaStar software. Due to the random, event-based reporting inherent of ALERT systems, it is sometimes difficult to ascertain how well individual stations are performing on a month-to-month basis. As the system expands and new gages are added, the potential for data degradation due to collision and through frequency saturation also increases. With an understanding of the ALERT protocol and the District network, it is possible to proactively quantify the performance of individual sensors on an on-going basis throughout the monitoring season. Water & Earth Technologies, Inc. (WET) has developed a set of ALERT performance metrics tools that can be run using the information contained in an existing NovaStar database. The tool set will be run to generate concise reports summarizing the health and performance of individual stations and the network in general.

2 Strategic Value

The ability to quickly review a concise report and ascertain the quality of data transmissions and the performance of individual stations within the network will help the District to focus and optimize their field maintenance resources.

3 Consideration for Service to be Provided in 2006

The District has commissioned the development of the ALERT analysis tool and the data extraction process from the NovaStar database in this pilot study. The results from the pilot study will be used by the District to evaluate the implementation of the reporting tool on a monthly basis in the 2006 monitoring season. If implemented in 2006, HydroLynx Systems, Inc. and WET will utilize the developed extraction and reporting tools to automatically extract data from the District's NovaStar system, analyze the data for a specified period, and send the reports to the District for review and use in an operational setting. The tool set may also be utilized after a storm event to quantify and document the ALERT system's performance, during the event

4 Discussion of Extraction and Analysis Methods

The data analysis reports are created using a combination of database queries and Excel workbook functions to calculate various performance measures on validated ALERT data contained in the NovaStar database. The methods are described briefly below.

4.1 NovaStar Data Extraction

HydroLynx Systems, Inc. has written a set of data query and extraction functions that are run remotely by Mr. Dave Leader. Under authority from the District, Dave can log onto the NovaStar system and run the extraction functions. ALERT data transmissions are exported from the Novastar database into two comma separated values (.csv) files that are placed on a HydroLynx server (<http://alert2.udfcd.org/WET>). The files are transferred (FTP) to WET using an Internet connection.

Once WET has obtained the csv files from HydroLynx, they are imported into a Microsoft Access relational database that contains two tables. One table describes the sensors in the District network using fields for Sensor ID, Site ID, Type, Group and Description among other sensor-specific data such as calibration slope and offset. A second table contains the validated ALERT data which are described using the following fields: Date/Time, Sensor ID, Raw Count Values, Data Type (1 – good, 0 – questionable), and Data Value (engineered data).

4.2 General System Analysis

An Excel workbook connects to the MS Access database and performs the data analysis. The individual summary reports are written to individual sheets within the workbook. The first report summarizes the general aspects of the ALERT network, which includes:

1. Name of the database analyzed in the study
2. Date of first record in the database
3. Date of last record in the database
4. Total duration (hours and days) of analysis
5. Total records analyzed for study period
6. Distribution of total ALERT messages by sensor group
7. Distribution of total ALERT messages by secondary groupings (water level, rain, weather station, status, soil and fuel)
8. Distribution of total ALERT messages by data validation type (0 or 1)
9. Sensors with highest number of questionable/invalid data reports (top 5 offenders)
10. Radio traffic loading summary
 - a. Average daily radio traffic (messages per day)
 - b. Average hourly radio traffic (messages per hour)
 - c. Median hourly radio traffic (messages per hour)
 - d. Peak hourly radio traffic (messages per hour) including the hour and date of occurrence
11. Total number of sensors defined in the system
12. Total number of sensors that had at least one report for the study period.
13. The 10 sensors with the highest number of reports for the analysis period

4.3 Non-Incrementing Rain Sensor Timer Report

A second macro within the workbook is run to summarize the non-incrementing timer “I’m alive” reports for rain sensors. The analysis quantifies the number of expected timer reports, the number of received timer reports, and the timer performance percentage. This report called Rain Timer Performance includes the following metrics for each rain sensor:

1. **Number of Received Timer Reports** – Count of valid (Data Type $\langle \rangle$ 1) non-incrementing records in database
2. **Average Timer Interval** – Computed average change in date/time field between non-incrementing records
3. **Number of Expected Timer Reports** – (Analysis Period)/(12 hours)
4. **Performance** – Number of Received Timer Reports/ Number of Expected Timer Reports as a percentage. Outliers less than 2% or greater than 200% cleared out and not used in system-wide analysis.
5. **Timer Report Frequency Plot** - Percentage of sensors receiving % reports or greater
6. **Rain Timer Plot** – Visual display of sensors versus the number of received timer reports (outliers identified)

4.4 Incrementing Rain Sensor Report

A third macro is run to summarize the incrementing event reporting characteristics for each rain sensor. The rain event performance analysis quantifies the number of expected incrementing reports, the number of received incrementing reports, and the event performance percentage. This report can be run after a large storm event to summarize the performance of the system under heavy traffic loading.

The Rain Event Performance report includes the following metrics for each sensor:

1. **Total Performance** – (Number of Received Tips/Number of Expected Tips) as a percentage, measure of transmissions received if tips are not held-off by transmitter
2. **Number of one-tips, two-tips, three-tips, four-tips, five-tips, six-tips and >six-tips** – The total number of sequential valid transmissions that changed by 1, 2, 3, 4, 5, 6, or more than 6 counts
3. **Number of Actual Tips** – The total number of incrementing transmissions received during the study period
4. **Number of Expected Tips** – The total number of expected incrementing transmissions for the study period
5. **Number of Missed Tips** – (Number of Expected Tips - Number of Actual Tips)
6. **Number of Hold-off Transmissions** – Hold-off transmissions are counted if the time interval between transmissions is between 13 seconds and 20 seconds.
7. **Bucket Size** – The Slope field from the Sensordef table is returned as the bucket size for the rain sensor.

8. **Rain Event Performance Plot** – Visual display of event transmission performance versus sensor with outlier sensors identified (performance less than 75%)

5 Proposed Implementation in 2006

The complete set of analysis reports (General, Non-Incrementing, and Incrementing Performance Reports) are currently created using a two step process. First Dave Leader must login to the District's NovaStar computer and run the data extraction functions to create the comma separated values text files. The text files are written to a server with Internet access at the following address: <http://alert2.udfcd.org/WET>

The second step is completed by WET and consists of retrieving the text files from the server, populating an MS Access database, and running the MS Excel data analysis workbook. Once the workbook macros are run, the reports are printed and a brief quality assurance and quality control (QA/QC) check is performed by a WET engineer.

WET will generate and submit the reports to the District on a monthly basis. Just after the first of the month the reports will be generated to quantify the previous month's data.

5.1 2006 Monthly Data Analysis Report Service

WET is proposing to provide a monthly ALERT data analysis report service for a fixed-price flat monthly fee. The monthly deliverables to the District will include:

1. Remote extraction of ALERT data from NovaStar by Dave Leader
2. Population of an MS Access database with the extracted data by WET
3. Creation and QA/QC of the General System Analysis Report
4. Creation and QA/QC of the Rain Timer Performance Analysis Report
5. Creation and QA/QC of the Rain Event Performance Analysis Report
6. Delivery of the three analysis reports to Mr. Kevin Stewart and Mr. Chad Kudym via email as PDF files
7. Availability to answer questions regarding the data analysis results posed by Mr. Kevin Stewart or Mr. Chad Kudym (WET response to data analysis questions will be limited to those posed by District staff only)
8. Modification to the existing general, non-incrementing rain, and incrementing rain analysis procedures, algorithms, and report format output as requested by the District

6 Pilot Study Report – July 1 through October 1, 2005

General System Analysis

Database Name P:\A207-UDFCD Data Analysis\Novastar_extract_2005_7-9.mdb

Summarize

First Date in Database	7/1/05 12:00 AM	Total Days	92.0
Last Date in Database	10/1/05 12:00 AM	Total Hours	2208.0
Total Records Analyzed		474952	

Records by Group

Temperature	80756	17%
Relative Humidity	73952	16%
Water Level PT-HSE	54432	11%
Wind Gust	47533	10%
Precipitation	44122	9%
Wind Speed Average & Azimuth	42183	9%
Wind Direction	40177	8%
Wind Speed Average	21577	5%
Battery Voltage Digital	17606	4%
Water Level PT	11537	2%
Water Level Float	10202	2%
Barometric Pressure	5952	1%
Solar Radiation	4268	1%
Fuel Moisture	4236	1%
Fuel Temperature	4186	1%
Battery Voltage HSE	3966	1%
Handar 585 ALARM Status	2559	1%
Repeater Pass List	2552	1%
Battery Voltage Analog	1841	0%
12Hr Status Report	562	0%
Longmont Flow Gage	555	0%
Longmont Water Level PT	164	0%
Soil Moisture	21	0%
Precipitation-ASCII	10	0%
Repeater Status Report	2	0%
Solar Power	1	0%
Total	474952	

Records by Major Group

Meteorologic Sensors	316398	67%
Water Level Sensors	76890	16%
Rain Sensors	44132	9%
Sensor Status Transmissions	29089	6%
Soil and Fuel Sensors	8443	2%
Total	474952	

Records by Validation Type

Good	0	471017	99%
Questionable	1	3935	1%
Total		474952	

Sensors With Most Invalid Data

Description	Sensor	Reports
Squaw Mountain	2189	1679
Squaw Mountain	2187	448
Quincy Reservoir	753	318
Button Rock	4791	126
Leyden Confluence	213	109

Traffic Loading Summary

Alert Reports	474952	
Average Daily Traffic	5107	
Average Hourly Traffic	212	
Median Hourly Traffic	208	hour beginning
Peak Hourly Traffic	1110	8/4/05 4:00 AM

Total Number of Sensors Defined
780

Total Number of Sensors Reporting
529

Reports per Sensor (highest)

Description	Sensor	Reports	Fraction of Total
Montview Park	403	7332	2%
Elbert	1438	7220	2%
Squaw Mountain	2188	7108	1%
Hiwan G.C.	2208	7035	1%
Quincy Reservoir	751	7026	1%
Blue Mountain	138	6863	1%
Blue Mountain	139	6783	1%
Squaw Mountain	2189	6742	1%
Quincy Reservoir	747	6460	1%
WTG above Conf Pond	723	6451	1%



Water & Earth Technologies, Inc.

Water Resources and Environmental Consulting

Rain Timer Performance Analysis

Rain Timer Performance

Analyze Rain Sensors

			systemwide average (days) 0.5275			Systemwide Average 89%
Rain Sensors	Description	Number of Received Timer Reports	Average Timer Interval	Number of expected Timer Reports	Performance	
100	Carr Street	170	12:44	186.00	91%	
110	Ralston Reservoir	135	14:55	186.00	73%	
120	West Woods	175	12:29	186.00	94%	
140	Blue Mountain	170	12:33	186.00	91%	
150	Nott Creek	158	12:52	186.00	85%	
200	Leyden Reservoir	178	12:11	186.00	96%	
210	Leyden Confluence	175	12:25	186.00	94%	
220	Upper Leyden	171	12:09	186.00	92%	
300	Van Bibber Park	172	12:48	186.00	92%	
310	Guy Hill Ranch	158	12:56	186.00	85%	
320	Sports Complex	120	12:04	186.00	65%	
330	Van Bibber @ Hwy 93	169	12:56	186.00	91%	
400	Montview Park	178	12:07	186.00	96%	
410	Kelly Dam	171	12:26	186.00	92%	
420	Expo Park	176	11:58	186.00	95%	
430	Utah Park	166	12:22	186.00	89%	
440	Fire Station #7	172	12:34	186.00	92%	
500	Havana Park	166	12:10	186.00	89%	
510	Virginia Court	170	12:33	186.00	91%	
520	Jewell Detention	175	12:15	186.00	94%	
530	Fire Station #19	167	12:58	186.00	90%	
540	Parker/Mississippi	150	14:23	186.00	81%	
600	Harvard Gulch Park	177	12:24	186.00	95%	
610	Harvard @ Jackson	172	12:15	186.00	92%	
620	Quincy/Highline	171	12:35	186.00	92%	
630	Temple Pond at DTC	171	12:18	186.00	92%	
640	Goldsmith @ Eastman	170	12:18	186.00	91%	
650	Iliff Pond	164	12:37	186.00	88%	
700	Toll Gate @ 6th	170	12:52	186.00	91%	
710	Horseshoe Park Drop	173	12:38	186.00	93%	
720	Confluence Pond	165	13:00	186.00	89%	
730	No Name @ Quincy	173	12:34	186.00	93%	
740	Smoky Hill	177	12:13	186.00	95%	
750	Quincy Reservoir	168	12:38	186.00	90%	
760	Mission Viejo Park	176	12:21	186.00	95%	
800	Sable Ditch @ 18th	172	12:34	186.00	92%	
810	Granby Ditch @ 6th	171	12:35	186.00	92%	
820	ETG @ Buckley	171	12:39	186.00	92%	
830	Side Creek Park	169	12:11	186.00	91%	
840	Fire Station 12	162	12:58	186.00	87%	
850	Flying J	167	12:51	186.00	90%	
870	Murphy Creek GC	152	13:52	186.00	82%	
900	Aurora Reservoir	166	12:50	186.00	89%	
1000	Maple Grove Resv.	175	12:34	186.00	94%	
1010	Denver West	171	12:39	186.00	92%	
1020	Lena @ Nolte Pond	171	12:50	186.00	92%	
1030	NREL/S. Table Mtn.	173	12:39	186.00	93%	
1040	Lena @ U.S. Hwy 6	153	14:05	186.00	82%	
1050	Jeffco Fairgrounds	171	12:49	186.00	92%	
1060	Heritage Square	157	12:38	186.00	84%	
1100	Louisville Rec Ctr	149	14:19	186.00	80%	
1110	Gunbarrel	162	13:23	186.00	87%	
1200	Broomfield 3207	167	12:55	186.00	90%	
1300	Hidden Lake	173	12:39	186.00	93%	
1310	LDC at 64th	172	12:34	186.00	92%	
1320	SPR at 3rd Ave	172	12:43	186.00	92%	
1330	Roslyn	176	12:26	186.00	95%	
1340	Sanderson at Xavier	167	12:52	186.00	90%	
1350	Chatfield COE	166	12:42	186.00	89%	
1360	Denver Zoo	176	12:26	186.00	95%	
1370	West Metro FS13	169	12:32	186.00	91%	
1400	Upper Sloan Det.	169	12:35	186.00	91%	
1420	Diamond Hill	175	12:25	186.00	94%	
1440	Elbert	174	12:28	186.00	94%	
1460	Urban Farm	2		186.00		
1480	Third Creek at DIA	170	12:54	186.00	91%	
1500	Powers Park	174	12:11	186.00	94%	
1520	Marston Lake North	160	12:39	186.00	86%	
1530	Bear Creek @ Lowell	172	12:34	186.00	92%	
1600	Englewood Dam	130	13:02	186.00	70%	
1610	Holly Dam	44	12:31	186.00	24%	
1620	Slaughterhouse Glch	167	12:31	186.00	90%	
1660	SPR at Henderson	174	12:24	186.00	94%	
1700	Cherry Cr @ Champa	174	12:22	186.00	94%	
1710	Shop Creek	163	13:06	186.00	88%	
1720	Cherry Cr @ Steele	161	12:49	186.00	87%	
1800	Sand Creek Park	166	12:49	186.00	89%	
1810	Sand Creek at mouth	127	12:56	186.00	68%	

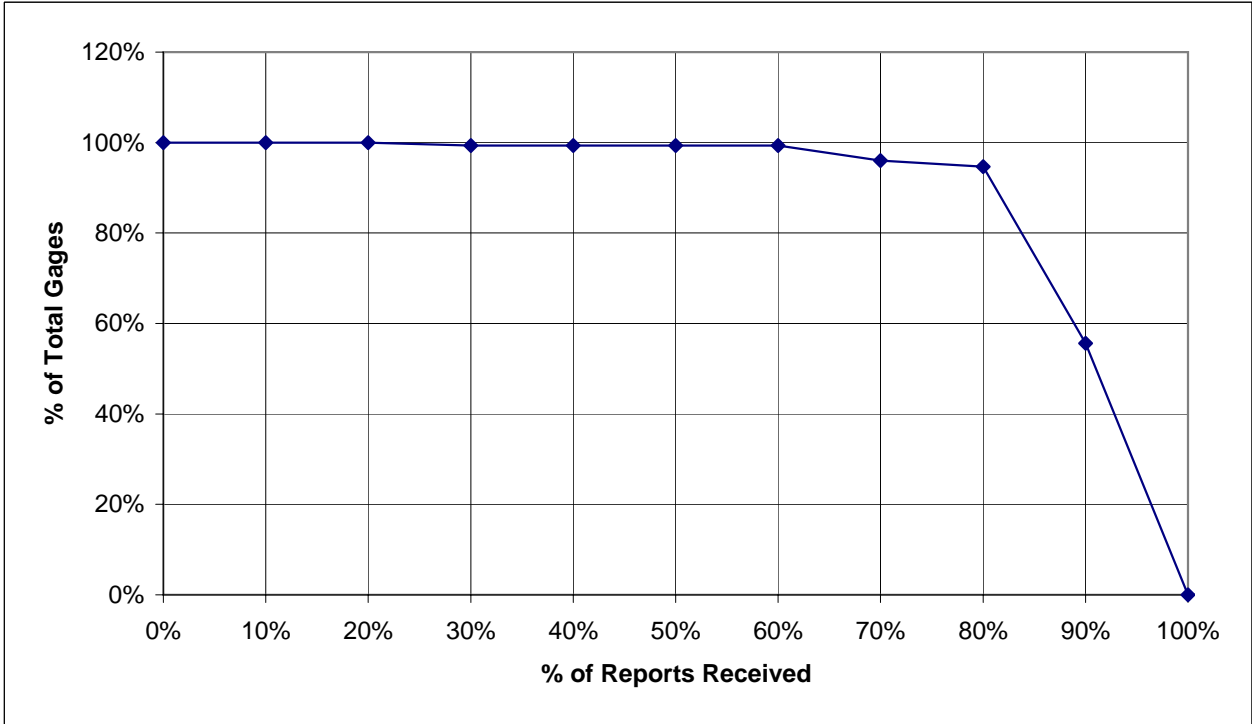
Rain Timer Performance Analysis

Rain Sensors	Description	Number of Received Timer Reports	Average Timer Interval	Number of expected Timer Reports	Performance
1900	Niver Detention	171	12:38	186.00	92%
1920	Brighton	171	12:13	186.00	92%
2190	Squaw Mountain	174	12:10	186.00	94%
2210	Hiwan G.C.	164	13:15	186.00	88%
2220	Evergreen Lake	174	12:39	186.00	94%
2230	Bear Cr below Cub	169	12:19	186.00	91%
2240	Cold Sprg Glch conf	173	12:18	186.00	93%
2250	Rosedale	168	12:25	186.00	90%
2260	Brook Forest	173	12:20	186.00	93%
2270	Cub Cr below Blue	167	12:36	186.00	90%
2280	Kinney Peak	173	12:09	186.00	93%
2310	Genesee Village	166	12:44	186.00	89%
2320	Choke Cherry Resvr	621		186.00	
2330	Morrison	158	13:30	186.00	85%
2340	El Rancho	155	13:13	186.00	83%
2350	Idledale	168	12:04	186.00	90%
2360	Indian Hills	172	12:09	186.00	92%
2370	Red Rocks Park	155	12:22	186.00	83%
2710	Highlands Ranch WTP	179	12:15	186.00	96%
2730	Salisbury Park	178	12:15	186.00	96%
2750	Castle Rock	172	12:49	186.00	92%
2810	Pine Cliff Road	157	12:19	186.00	84%
2820	Haskins Gulch Conf	166	13:04	186.00	89%
2840	Sulphur Gulch	164	13:04	186.00	88%
4010	Crescent	168	12:57	186.00	90%
4020	Rio Grande	168	12:46	186.00	90%
4030	Red Garden	169	12:28	186.00	91%
4040	Martin Gulch	173	12:30	186.00	93%
4050	Walker Ranch	171	12:36	186.00	92%
4060	Lakeshore	157	13:14	186.00	84%
4070	Bear Peak	126	16:41	186.00	68%
4080	Twin Sisters	160	13:11	186.00	86%
4090	Magnolia	160	13:27	186.00	86%
4100	Filter Plant	175	12:27	186.00	94%
4110	Betasso	173	12:27	186.00	93%
4130	Swiss Peaks	156	13:41	186.00	84%
4140	Logan Mill	158	13:37	186.00	85%
4150	Gold Hill	160	13:27	186.00	86%
4160	Sunshine	170	12:42	186.00	91%
4170	Pine Brook	161	13:24	186.00	87%
4180	Gold Lake	152	14:17	186.00	82%
4190	Slaughterhouse	172	12:36	186.00	92%
4200	Lazy Acres	155	14:21	186.00	83%
4220	Fling's	166	13:00	186.00	89%
4230	Golden Age	175	12:30	186.00	94%
4240	Sunset	155	13:39	186.00	83%
4250	Geer Canyon	173	12:36	186.00	93%
4260	Taylor Mountain	175	12:30	186.00	94%
4270	Cannon Mountain	163	13:08	186.00	88%
4290	Red Hill	154	13:46	186.00	83%
4300	Big Elk Park	168	12:53	186.00	90%
4310	Johnny Park	173	12:35	186.00	93%
4330	Indian Ruins	167	12:51	186.00	90%
4340	Riverside	165	13:09	186.00	89%
4350	Conifer Hill	170	12:30	186.00	91%
4360	Justice Center	170	12:51	186.00	91%
4470	Little Narrows	161	13:07	186.00	87%
4490	Apple Valley	166	13:23	186.00	89%
4510	Pinewood Springs	160	13:45	186.00	86%
4520	Eagle Ridge	160	13:21	186.00	86%
4530	Winiger Ridge	153	13:21	186.00	82%
4550	Boulder Jail	169	12:46	186.00	91%
4560	Lyons Diversion NSV	164	13:27	186.00	88%
4570	St. Antons	160	13:30	186.00	86%
4710	Ward C-1	170	12:06	186.00	91%
4730	Sugarloaf	162	13:34	186.00	87%
4750	Louisville Lake	170	12:37	186.00	91%
4770	Cal-Wood Ranch	176	12:27	186.00	95%
4790	Button Rock	171	12:56	186.00	92%
4810	Shanahan Ridge	147	13:10	186.00	79%
4820	Doudy Draw	127	15:28	186.00	68%
4830	SBC @ San Souci	159	12:58	186.00	85%
4840	SBC@S Boulder Ditch	165	13:26	186.00	89%
4850	Porphory Mtn	170	12:42	186.00	91%
4860	Fairview Peak	158	13:12	186.00	85%
8000	Test	718		186.00	
9100	Basin Avg-Bear Creek	4175		186.00	
9101	Lena Basin Mean	1502		186.00	

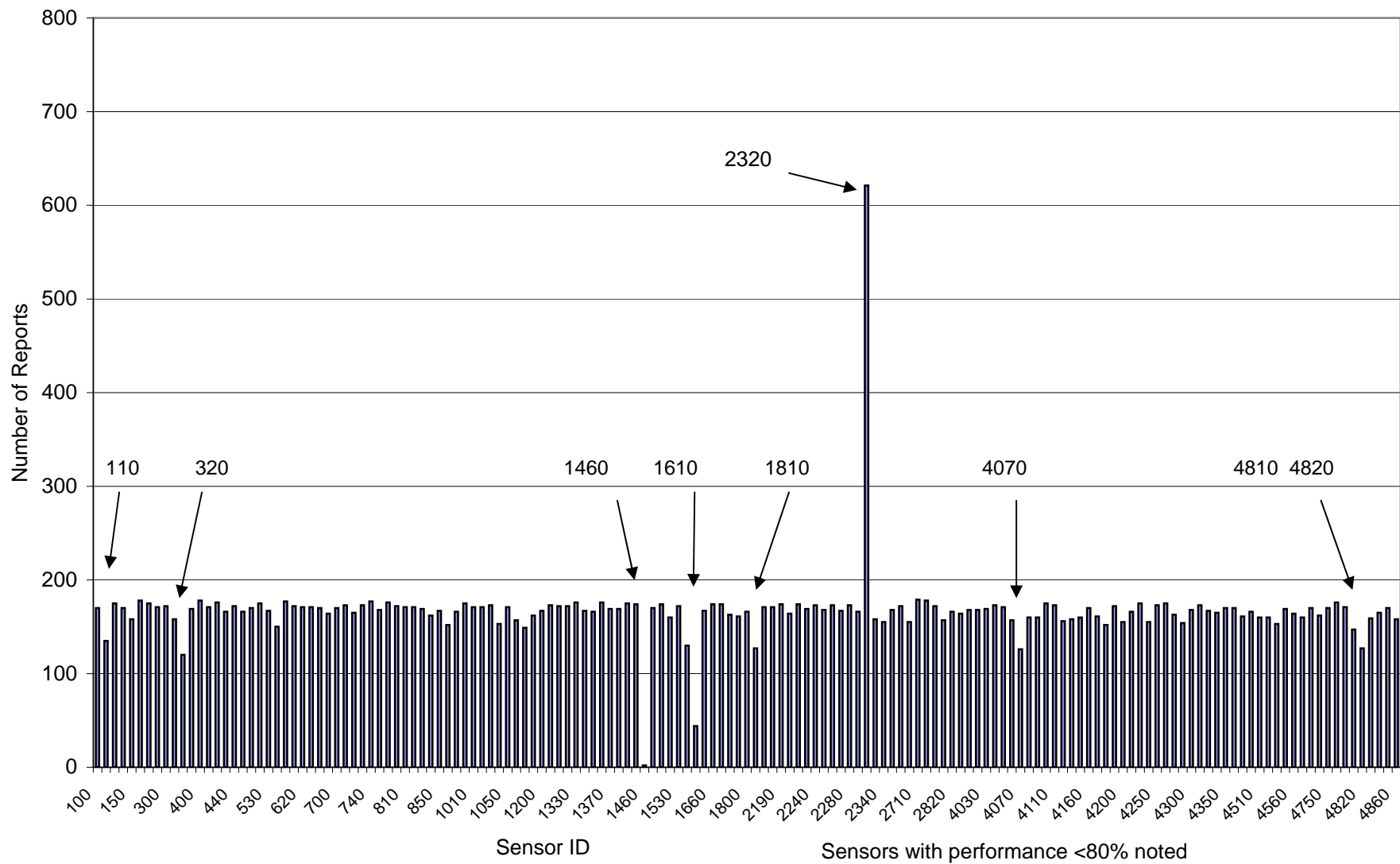
Rain Timer Frequency Plot

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%	1	99%
40%	0	99%
50%	0	99%
60%	0	99%
70%	5	96%
80%	2	95%
90%	59	56%
100%	84	0%



Number of Timer Reports Received



Rain Event Performance Analysis

Rain Event Performance

Reports Received 12391
 Total Tips 14136
 Data Loss 12.34%

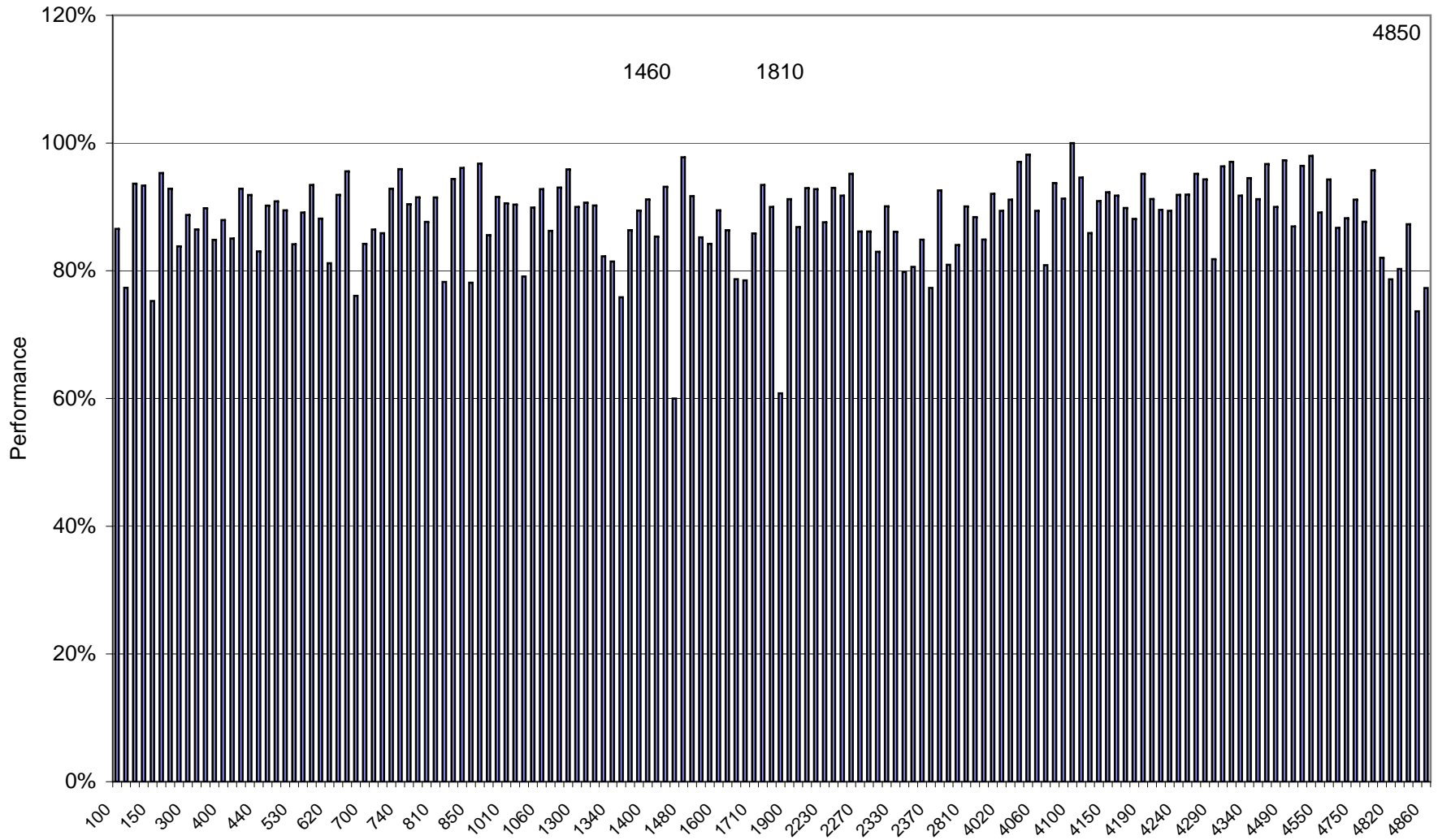
Analyze Rain Sensors

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 Sensor
100	87%	50	7	1	0	0	0	0	58	67	9	0	0.0393701
110	77%	48	5	2	0	1	1	0	57	75	18	1	0.0393701
120	94%	55	4	0	0	0	0	0	59	63	4	0	0.0393701
140	93%	66	3	1	0	0	0	0	70	75	5	1	0.0393701
150	75%	53	12	4	1	0	0	0	70	93	23	0	0.0393701
200	95%	58	3	0	0	0	0	0	61	64	3	0	0.0393701
210	93%	59	3	0	1	0	0	0	64	70	5	0	0.0393701
220	84%	47	7	1	1	0	0	0	56	68	12	1	0.0393701
300	89%	55	8	0	1	0	0	0	63	71	8	0	0.0393701
310	86%	54	10	0	0	0	0	0	64	74	10	0	0.0393701
320	90%	39	5	0	0	0	0	0	44	49	5	0	0.0393701
330	85%	73	7	4	0	0	0	0	84	99	15	21	0.0393701
400	88%	66	5	1	1	0	0	0	73	83	10	0	0.0393701
410	85%	61	10	2	0	0	0	0	73	87	14	0	0.0393701
420	93%	169	9	3	0	0	0	0	181	196	15	0	0.0393701
430	92%	198	15	2	0	0	0	0	215	234	19	0	0.0393701
440	83%	80	9	3	0	1	0	0	93	112	19	0	0.0393701
500	90%	116	12	1	0	0	0	0	129	143	14	0	0.0393701
510	91%	174	11	4	0	0	0	0	189	208	19	0	0.0393701
520	89%	90	12	0	0	0	0	0	102	114	12	0	0.0393701
530	84%	72	11	1	1	0	0	0	85	101	16	0	0.0393701
540	89%	74	7	0	1	0	0	0	82	92	10	0	0.0393701
600	93%	106	8	0	0	0	0	0	114	122	8	0	0.0393701
610	88%	72	7	1	0	0	0	0	81	93	12	0	0.0393701
620	81%	67	12	2	1	0	0	0	82	101	19	0	0.0393701
630	92%	210	15	1	0	0	0	0	227	247	20	0	0.0393701
640	96%	144	7	0	0	0	0	0	151	158	7	0	0.0393701
650	76%	51	15	1	2	0	0	0	69	92	23	1	0.0393701
700	84%	69	7	4	0	0	0	0	80	95	15	0	0.0393701
710	86%	71	11	1	0	0	0	0	83	96	13	0	0.0393701
720	86%	55	10	1	0	0	0	0	66	78	12	0	0.0393701
730	93%	72	6	0	0	0	0	0	78	84	6	0	0.0393701
740	96%	91	2	1	0	0	0	0	94	98	4	0	0.0393701
750	90%	78	5	2	0	0	0	0	85	94	9	0	0.0393701
760	92%	89	7	1	0	0	0	0	97	106	9	0	0.0393701
800	88%	65	3	2	1	0	0	0	71	81	10	0	0.0393701
810	91%	78	8	0	0	0	0	0	86	94	8	0	0.0393701
820	78%	59	8	3	2	0	0	0	72	92	20	0	0.0393701
830	94%	161	5	1	1	0	0	0	168	178	10	0	0.0393701
840	96%	67	5	0	0	0	0	1	72	77	5	0	0.0393701
850	78%	38	10	2	0	0	0	0	50	64	14	1	0.0393701
870	97%	87	3	0	0	0	0	0	90	93	3	0	0.0393701
900	86%	79	16	0	0	0	0	0	95	111	16	1	0.0393699
1000	92%	70	5	1	0	0	0	0	76	83	7	0	0.0393701
1010	91%	88	6	2	0	0	0	0	96	106	10	0	0.0393701
1030	90%	68	6	1	0	0	0	0	75	83	8	0	0.0393701
1040	79%	59	9	2	2	0	0	0	72	91	19	0	0.0393701
1050	90%	79	10	0	0	0	0	0	89	99	10	0	0.0393701
1060	93%	82	6	1	0	0	0	0	89	97	8	0	0.0393701
1100	86%	59	9	1	0	0	0	0	69	80	11	0	0.0393701
1110	93%	37	3	0	0	0	0	0	40	43	3	1	0.0393701
1200	96%	65	4	0	0	0	0	0	69	73	4	0	0.0393701
1300	90%	58	4	0	1	0	0	0	63	70	7	0	0.0393701
1310	91%	62	5	1	0	0	0	0	68	75	7	0	0.0393701
1320	90%	74	9	0	0	0	0	0	83	92	9	0	0.0393701
1330	82%	42	8	0	1	0	0	0	51	62	11	0	0.0393701
1340	81%	65	0	10	4	0	0	0	79	97	18	0	0.0393701
1350	76%	55	6	0	0	1	0	0	66	87	21	0	0.0393701
1360	86%	49	7	1	0	0	0	0	57	66	9	0	0.0393701
1370	89%	83	9	1	0	0	0	0	93	104	11	0	0.0393701
1400	91%	28	3	0	0	0	0	0	31	34	3	0	0.0393701
1420	85%	61	6	3	0	0	0	0	70	82	12	0	0.0393701
1440	93%	64	3	1	0	0	0	0	68	73	5	0	0.0393701
1460	60%	3	2	1	0	0	0	0	6	10	4	2	0.0393701
1480	98%	43	1	0	0	0	0	0	44	45	1	0	0.0393701
1500	92%	255	19	1	0	1	0	0	276	301	25	0	0.0393701
1520	85%	63	8	3	0	0	0	0	74	88	14	1	0.0393701
1530	84%	82	12	1	0	1	0	0	96	114	18	0	0.0393701
1600	89%	89	8	1	0	0	1	0	99	114	15	0	0.0393701
1620	86%	48	9	0	0	0	0	0	57	66	9	0	0.0393701
1660	79%	39	5	4	0	0	0	0	48	61	13	1	0.0393701
1700	78%	60	8	4	0	1	0	0	73	93	20	0	0.0393701
1710	86%	76	9	4	0	0	0	1	89	106	17	0	0.0393701
1720	93%	52	3	1	0	0	0	0	56	61	5	0	0.0393701

Rain Event Performance Analysis

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 Sensor/del
1800	90%	113	12	1	0	0	0	0	126	140	14	0	0.0393701
1810	61%	26	8	6	1	2	0	0	43	74	31	0	0.0393701
1900	91%	47	5	0	0	0	0	0	52	57	5	1	0.0393701
1920	87%	57	8	1	0	0	0	0	66	76	10	0	0.0393701
2190	93%	150	4	4	0	0	0	0	158	170	12	1	0.0393701
2210	93%	83	7	0	0	0	0	0	90	97	7	2	0.0393701
2230	88%	94	7	3	1	0	0	0	105	121	16	3	0.0393701
2240	93%	85	6	1	0	0	0	0	92	100	8	1	0.0393701
2250	92%	123	8	1	1	0	0	0	133	146	13	2	0.0393701
2260	95%	110	6	1	0	0	0	1	117	125	8	1	0.0393701
2270	86%	98	10	1	1	0	0	0	111	130	19	2	0.0393701
2280	86%	98	9	2	2	0	0	0	111	130	19	0	0.0393701
2310	83%	62	9	3	0	1	0	2	75	94	19	0	0.0393701
2320	90%	81	10	0	0	0	0	0	91	101	10	2	0.0393701
2330	86%	83	5	5	0	0	0	0	93	108	15	0	0.0393701
2340	80%	71	6	4	1	1	0	0	83	104	21	0	0.0393701
2350	81%	60	16	2	0	0	0	0	78	98	20	0	0.0393701
2360	85%	88	7	3	2	0	0	0	100	119	19	0	0.0393701
2370	77%	58	11	3	2	0	0	0	74	97	23	0	0.0393701
2710	93%	69	6	0	0	0	0	0	75	81	6	0	0.0393701
2730	81%	54	12	2	0	0	0	0	68	84	16	0	0.0393701
2750	84%	83	16	0	1	0	0	0	100	119	19	0	0.0393701
2810	90%	104	12	1	0	0	0	0	117	131	14	0	0.0393701
2820	88%	109	11	1	1	0	0	0	122	138	16	0	0.0393701
2840	85%	64	5	4	0	0	0	0	73	86	13	0	0.0393701
4010	92%	54	3	1	0	0	0	0	58	63	5	0	0.0393701
4020	89%	54	3	2	0	0	0	0	59	66	7	0	0.0393701
4030	91%	65	7	0	0	0	0	0	72	79	7	0	0.0393701
4040	97%	64	2	0	0	0	0	0	66	68	2	0	0.0393701
4050	98%	53	1	0	0	0	0	0	54	55	1	0	0.0393701
4060	89%	54	4	0	1	0	0	0	59	66	7	0	0.0393701
4070	81%	46	6	2	1	0	0	0	55	68	13	0	0.0393701
4080	94%	70	5	0	0	0	0	0	75	80	5	0	0.0393701
4090	91%	58	4	1	0	0	0	0	63	69	6	0	0.0393701
4100	100%	45	0	0	0	0	0	0	45	45	0	0	0.0393701
4110	95%	66	4	0	0	0	0	0	70	74	4	0	0.0393701
4130	86%	52	8	1	0	0	0	0	61	71	10	0	0.0393701
4140	91%	64	5	0	0	0	0	0	70	77	7	0	0.0393701
4150	92%	68	3	0	1	0	0	0	72	78	6	0	0.0393701
4160	92%	72	5	1	0	0	0	0	78	85	7	0	0.0393701
4170	90%	47	6	0	0	0	0	0	53	59	6	0	0.0393701
4180	88%	80	6	3	0	0	0	0	89	101	12	0	0.0393701
4190	95%	75	4	0	0	0	0	0	79	83	4	1	0.0393701
4200	91%	67	5	1	0	0	0	0	73	80	7	0	0.0393701
4220	90%	83	11	0	0	0	0	0	94	105	11	0	0.0393701
4230	89%	55	3	0	0	1	0	0	59	66	7	0	0.0393701
4240	92%	64	2	2	0	0	0	0	68	74	6	0	0.0393701
4250	92%	53	3	1	0	0	0	0	57	62	5	0	0.0393701
4260	95%	75	4	0	0	0	0	0	79	83	4	0	0.0393701
4270	94%	78	5	0	0	0	0	0	83	88	5	0	0.0393701
4290	82%	45	7	1	1	0	0	0	54	66	12	0	0.0393701
4300	96%	77	1	1	0	0	0	0	79	82	3	0	0.0393701
4310	97%	64	2	0	0	0	0	0	66	68	2	0	0.0393701
4330	92%	61	6	0	0	0	0	0	67	73	6	0	0.0393701
4340	95%	65	4	0	0	0	0	0	69	73	4	0	0.0393701
4350	91%	47	5	0	0	0	0	0	52	57	5	0	0.0393701
4360	97%	57	2	0	0	0	0	0	59	61	2	1	0.0393701
4470	90%	48	6	0	0	0	0	0	54	60	6	0	0.0393701
4490	97%	35	1	0	0	0	0	0	36	37	1	0	0.0393701
4510	87%	54	4	1	1	0	0	0	60	69	9	0	0.0393701
4520	96%	48	4	0	0	0	0	1	52	56	4	1	0.0393701
4530	98%	48	1	0	0	0	0	0	49	50	1	0	0.0393701
4550	89%	36	5	0	0	0	0	0	41	46	5	0	0.0393701
4570	94%	62	4	0	0	0	0	0	66	70	4	0	0.0393701
4710	87%	95	12	0	0	0	1	1	109	128	19	0	0.0393701
4730	88%	53	6	1	0	0	0	0	60	68	8	0	0.0393701
4750	91%	66	5	1	0	0	0	0	72	79	7	0	0.0393701
4770	88%	57	6	0	1	0	0	0	64	73	9	0	0.0393701
4790	96%	43	2	0	0	0	0	0	45	47	2	0	0.0393701
4810	82%	54	8	1	0	1	0	0	64	78	14	0	0.0393701
4820	79%	45	9	4	0	0	0	0	58	75	17	0	0.0393701
4830	80%	48	6	2	0	1	0	0	57	71	14	0	0.0393701
4840	87%	48	6	1	0	0	0	0	55	63	8	0	0.0393701
4850	74%	251	49	15	7	2	2	1	326	444	118	62	0.01
4860	77%	259	46	16	6	0	0	0	327	423	96	41	0.01
Total Tips		11025	1088	205	51	16	6	0	327	423	96	41	

Rain Event Performance



Sensors with performance <75% noted