

# Memo



**Date:** February 13, 2006  
**To:** Kevin Stewart, P.E., Chad Kudym  
**From:** Markus Ritsch, P.E.  
**Subject:** January 2006 ALERT Data Analysis

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## I. ALERT Data Source

The Urban Drainage and Flood Control District (District) operates multiple computer base stations to receive and process Automated Local Evaluation in Real-Time (ALERT) data transmissions from remote gages. ALERT data extracted from the District's Nova Star 4.0 base station are analyzed in this report. The period of analysis extends from January 1 through January 31, 2006, and includes a total of 193,406 individual data transmissions.

## II. General System Analysis Summary

Meteorological sensors accounted for eighty-seven (87) percent of the total transmissions. The distribution of meteorological data reports includes: Wind Gust (42,229 reports), Wind Speed Average and Azimuth (31,465 reports), Relative Humidity (28,816 reports), Temperature (26,334 reports), Wind Direction (16,681 reports), and Wind Speed Average (16,108 reports). A considerable amount of radio bandwidth is used to carry information related to wind. In comparison, reports from precipitation sensors (6,016 reports) accounted for only three (3) percent of the total transmissions. January was relatively dry and windy.

Ninety-eight (98) percent of the received data reports were flagged as "good" by the Nova Star validation process. Roughly three thousand (3,378) reports or two (2) percent of the total were flagged as "bad". Of these, almost half (1,497) originated from the Wind Gust sensor (ID 2189) at Squaw Mountain. Another three hundred and sixty-three (363) "bad" reports originated from the Wind Speed Average sensor (ID 2187) at Squaw Mountain. The reason for these "bad" reports is not known, but should be understood. The Squaw Mountain sensors (ID 2189 and 2187) and their corresponding validation parameters may be incorrectly defined within the Nova Star base station application. A third sensor reporting very frequently is the Wind Gust sensor (139) at Blue Mountain which also has a high number of "bad" reports.

The network generated approximately six thousand (6,238) reports per day with an average hourly load of approximately two hundred and fifty (253) reports. The peak hourly traffic load was just under five hundred (487) reports and occurred on January 3<sup>rd</sup> between two and three in the afternoon.

The two sensors (ID 1465 Wind Speed Average and 1467 Wind Gust) that reported most frequently are both installed at a station defined as "Urban Farm." These sensors reported approximately every six (6) minutes. It was our understanding that the Urban Farm station had been discontinued in 2005.

## III. Rain Sensor Timer Reporting Summary

The system-wide reception of non-incrementing timer reports from rain sensors was eighty-nine (89) percent. Overall, the percentage of timer reports received for the system is very high. Several sensors, however, warrant some additional attention.

Three sensors in particular had very few timer reports. These sensors are Goldsmith at Eastman (ID 640), Sand Creek at Colfax (ID 860), and Denver West (ID 1010). We should continue to monitor the timer transmissions from these sensors.

One sensor, Choke Cherry Reservoir (ID 2320), had a very high number of timer reports. This sensor averaged one timer transmission every three and one-half (3.5) hours. This higher-than-expected frequency of timer reports occurred throughout the entire month of January, 2006.

The rain sensor (ID 4820) at Doudy Draw had a larger than expected computed timer transmission interval of almost sixteen (16) hours. It is possible the transmitter at this station is configured to send the timer transmission every 16 hours or the clock on-board the transmitter is drifting. The frequency of timer reports for this sensor was consistent throughout the entire month of January, 2006.

One sensor had no timer reports at all but did have a few incrementing rain reports. This was the rain sensor at Button Rock (ID 32).

## **IV. Rain Sensor Event Reporting Summary**

The system-wide reception of incrementing rain (or in this case maybe snow-melt) tip reports was ninety-five (95) percent.

Overall, the rain tip reporting for the system seems healthy. Several sensors, however, warrant some additional attention. Of particular concern from the analysis are Blue Mountain (ID 140), Goldsmith at Eastman (ID 640), SPR at Union Avenue (ID 1640), and Apple Valley (ID 4490).

The Blue Mountain sensor had too many incrementing reports relative to the rest of the system and relative to the actual amount of precipitation received. More than two hundred single increment reports and numerous double and triple tip reports were recorded in the database. Further investigation showed that the majority of incrementing reports from this sensor were received between 1/3/2006 12:25 PM and 1/3/2006 7:02 PM, where the frequency of transmissions was approximately one per minute. We can only speculate why so many incrementing reports were received. No other sensor transmissions from this site were received at this high frequency during this time. This type of behavior has been observed in other systems where proper grounding of the station is a problem.

Goldsmith at Eastman showed only double-incrementing reports; no single tip reports were received. This could indicate a problem with the mechanics or magnetic reed switch when reports only in one direction of the tipping mechanism are transmitted.

Both Union Avenue and Apple Valley missed a relatively high number of incrementing reports.

We recommend further observation of data from these sensors (ID 640, 1640, and 4490) to see if the problems persist into months with more precipitation.

## **V. Issues Requiring Follow-Up Work**

Further investigation into the following issues is recommended:

1. Why do the Squaw Mountain sensors (ID 2189 and 2187) show so much “bad” data in the NovaStar database? Are the validation parameters correctly defined in the NovaStar application?
2. What is the status of the station called “Urban Farm?” Is it an active station and where is it located?
3. The Urban Farm sensors, Wind Speed Average (ID 1465) and Wind Gust (ID 1467), are reporting once every six to seven minutes. The transmission criteria programmed into the transmitter should be adjusted so that this station reports less frequently and at an interval consistent with the other wind monitoring stations.
4. Why does Choke Cherry Reservoir (ID 2320) send a timer transmission every three and one-half (3.5) hours?
5. The rain sensor at Blue Mountain (140) significantly over-reported rainfall for a seven (7) hour period on January 3<sup>rd</sup>. Continue to observe data from this station to see if the observed anomaly occurs again.
6. Continue to observe data transmissions from Goldsmith at Eastman (ID 640), SPR at Union Avenue (ID 1640), and Apple Valley (ID 4490) for possible problems with their increment reporting.



### Rain Timer Performance Analysis

Rain Timer Performance

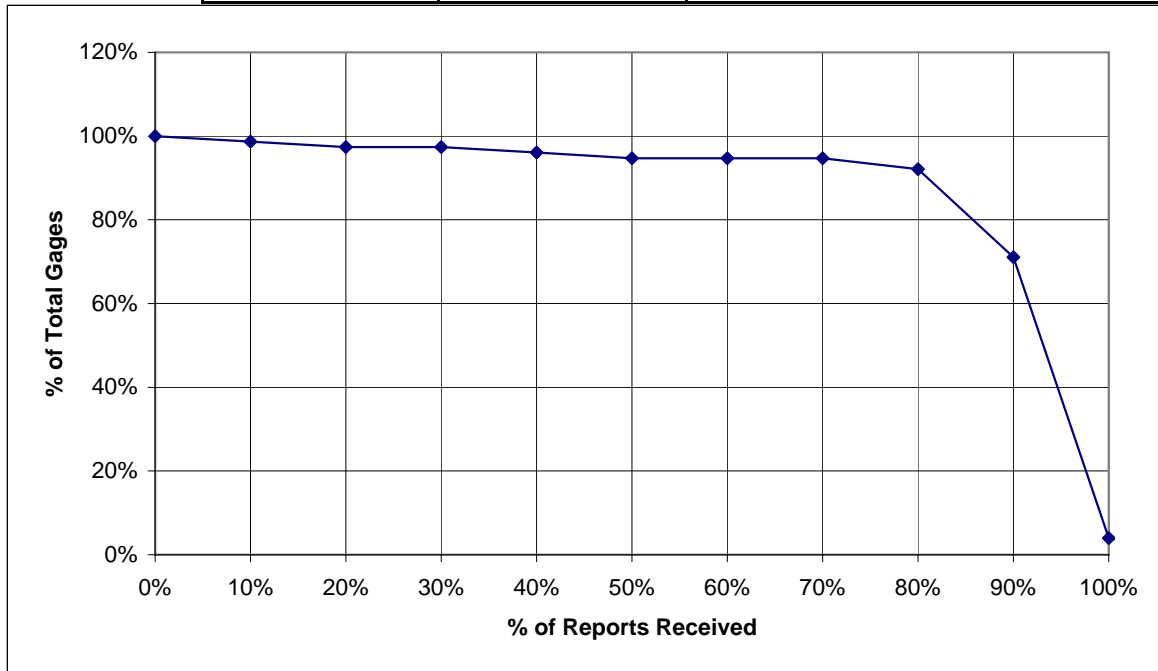
Analyze Rain Sensors

Rain Sensors	Description	Number of Received Timer Reports	systemwide average (days)	Number of expected Timer Reports	Systemwide Average
			0.5318		89%
			Average Timer Interval	Performance	
140	Blue Mountain	57	12:42	61.00	93%
640	Goldsmith @ Eastman	7	0:00	61.00	11%
740	Smoky Hill	60	12:12	61.00	98%
750	Quincy Reservoir	60	12:12	61.00	98%
860	Sand Cr at Colfax	6	18:58	61.00	10%
900	Aurora Reservoir	56	13:06	61.00	92%
1000	Maple Grove Resv.	57	12:51	61.00	93%
1010	Denver West	20	0:01	61.00	33%
1420	Diamond Hill	59	12:25	61.00	97%
1440	Elbert	59	12:25	61.00	97%
1460	Urban Farm	29	0:55	61.00	48%
1480	Third Creek at DIA	61	12:00	61.00	100%
1520	Marston Lake North	53	13:57	61.00	87%
1640	SPR at Union Ave.	46	12:50	61.00	75%
1660	SPR at Henderson	56	13:08	61.00	92%
1700	Cherry Cr @ Champa	54	13:26	61.00	89%
1810	Sand Creek at mouth	57	12:40	61.00	93%
1920	Brighton	60	12:00	61.00	98%
2190	Squaw Mountain	61	12:00	61.00	100%
2210	Hiwan G.C.	59	12:25	61.00	97%
2220	Evergreen Lake	57	12:49	61.00	93%
2320	Choke Cherry Resvr	212		61.00	
2330	Morrison	56	12:55	61.00	92%
2710	Highlands Ranch WTP	59	12:13	61.00	97%
2730	Salisbury Park	58	12:12	61.00	95%
2750	Castle Rock	60	12:12	61.00	98%
2820	Haskins Gulch Conf	58	12:39	61.00	95%
4010	Crescent	52	13:55	61.00	85%
4020	Rio Grande	57	12:38	61.00	93%
4030	Red Garden	56	12:54	61.00	92%
4040	Martin Gulch	56	13:08	61.00	92%
4050	Walker Ranch	57	12:51	61.00	93%
4060	Lakeshore	54	12:54	61.00	89%
4070	Bear Peak	60	12:10	61.00	98%
4080	Twin Sisters	56	13:03	61.00	92%
4090	Magnolia	58	12:38	61.00	95%
4100	Filter Plant	60	11:59	61.00	98%
4110	Betasso	58	12:42	61.00	95%
4130	Swiss Peaks	52	13:31	61.00	85%
4140	Logan Mill	52	14:02	61.00	85%
4150	Gold Hill	54	13:22	61.00	89%
4160	Sunshine	58	12:24	61.00	95%
4170	Pine Brook	52	13:42	61.00	85%
4180	Gold Lake	54	13:26	61.00	89%
4190	Slaughterhouse	59	12:24	61.00	97%
4200	Lazy Acres	59	12:25	61.00	97%
4220	Fling's	57	12:37	61.00	93%
4230	Golden Age	59	12:10	61.00	97%
4240	Sunset	56	13:03	61.00	92%
4250	Geer Canyon	57	12:51	61.00	93%
4260	Taylor Mountain	57	12:49	61.00	93%
4270	Cannon Mountain	51	14:21	61.00	84%
4290	Red Hill	59	12:23	61.00	97%
4300	Big Elk Park	58	12:35	61.00	95%
4310	Johnny Park	58	12:37	61.00	95%
4330	Indian Ruins	58	12:36	61.00	95%
4340	Riverside	60	12:10	61.00	98%
4350	Conifer Hill	60	12:10	61.00	98%
4360	Justice Center	58	12:39	61.00	95%
4470	Little Narrows	55	13:18	61.00	90%
4490	Apple Valley	57	12:52	61.00	93%
4510	Pinewood Springs	58	12:37	61.00	95%
4520	Eagle Ridge	56	13:07	61.00	92%
4530	Winiger Ridge	55	13:08	61.00	90%
4560	Lyons Diversion NSV	54	12:54	61.00	89%
4570	St. Antons	55	13:07	61.00	90%
4710	Ward C-1	57	12:52	61.00	93%
4730	Sugarloaf	58	12:26	61.00	95%
4750	Louisville Lake	58	12:39	61.00	95%
4770	Cal-Wood Ranch	58	12:39	61.00	95%
4790	Button Rock	61	12:00	61.00	100%
4810	Shanahan Ridge	52	13:25	61.00	85%
4820	Doudy Draw	46	15:51	61.00	75%
4830	SBC @ San Souci	54	13:22	61.00	89%
4840	SBC@S Boulder Ditch	49	14:49	61.00	80%
4850	Porphory Mtn	52	14:07	61.00	85%
4860	Fairview Peak	51	14:36	61.00	84%

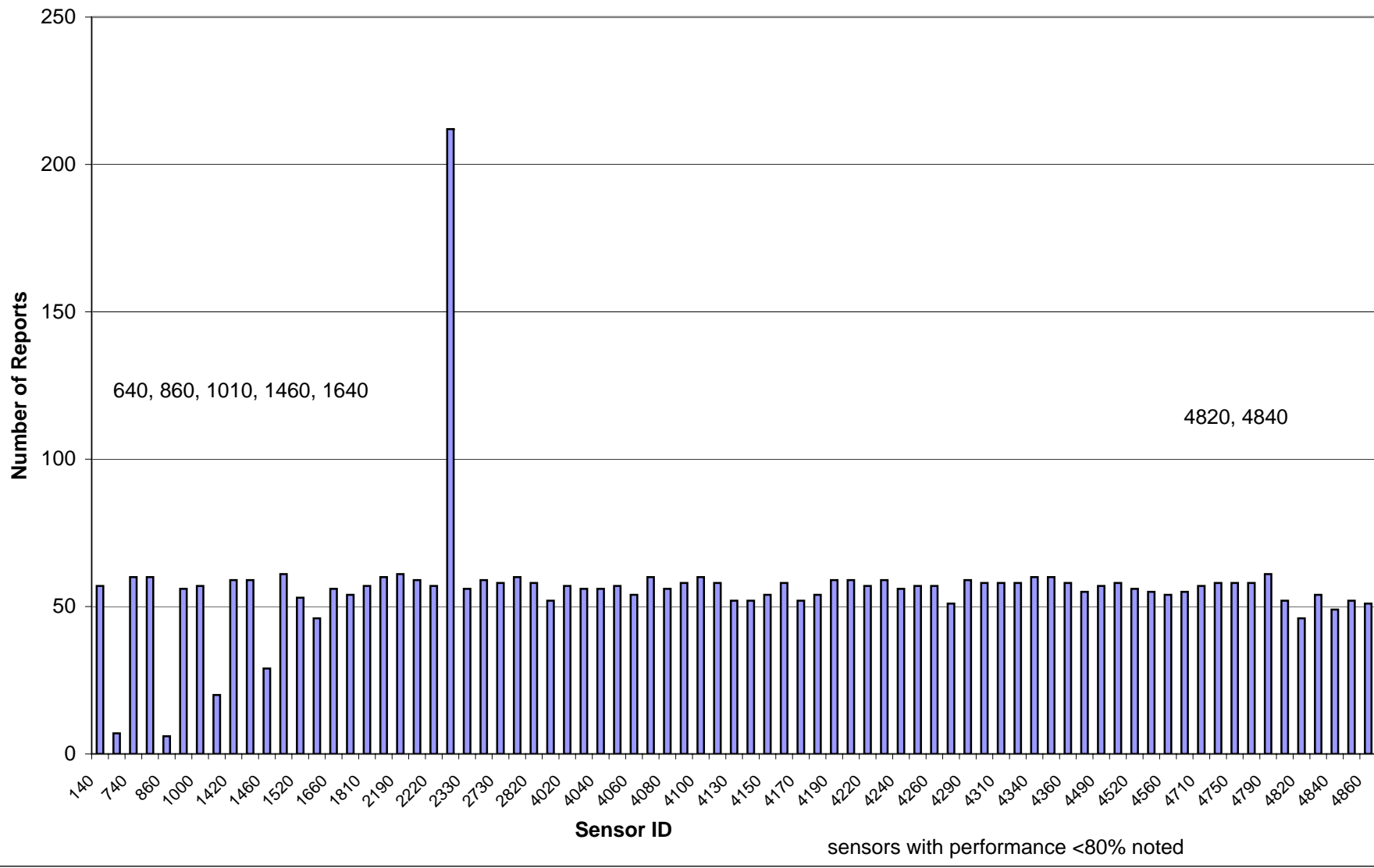
# Rain Timer Frequency Plot

## Rain Timer Performance

total number of gages 76		
% of reports received	frequency	% of gages receiving % or reports or greater
0%	0	100%
10%	1	99%
20%	1	97%
30%	0	97%
40%	1	96%
50%	1	95%
60%	0	95%
70%	0	95%
80%	2	92%
90%	16	71%
100%	51	4%



Number of Timer Reports Received

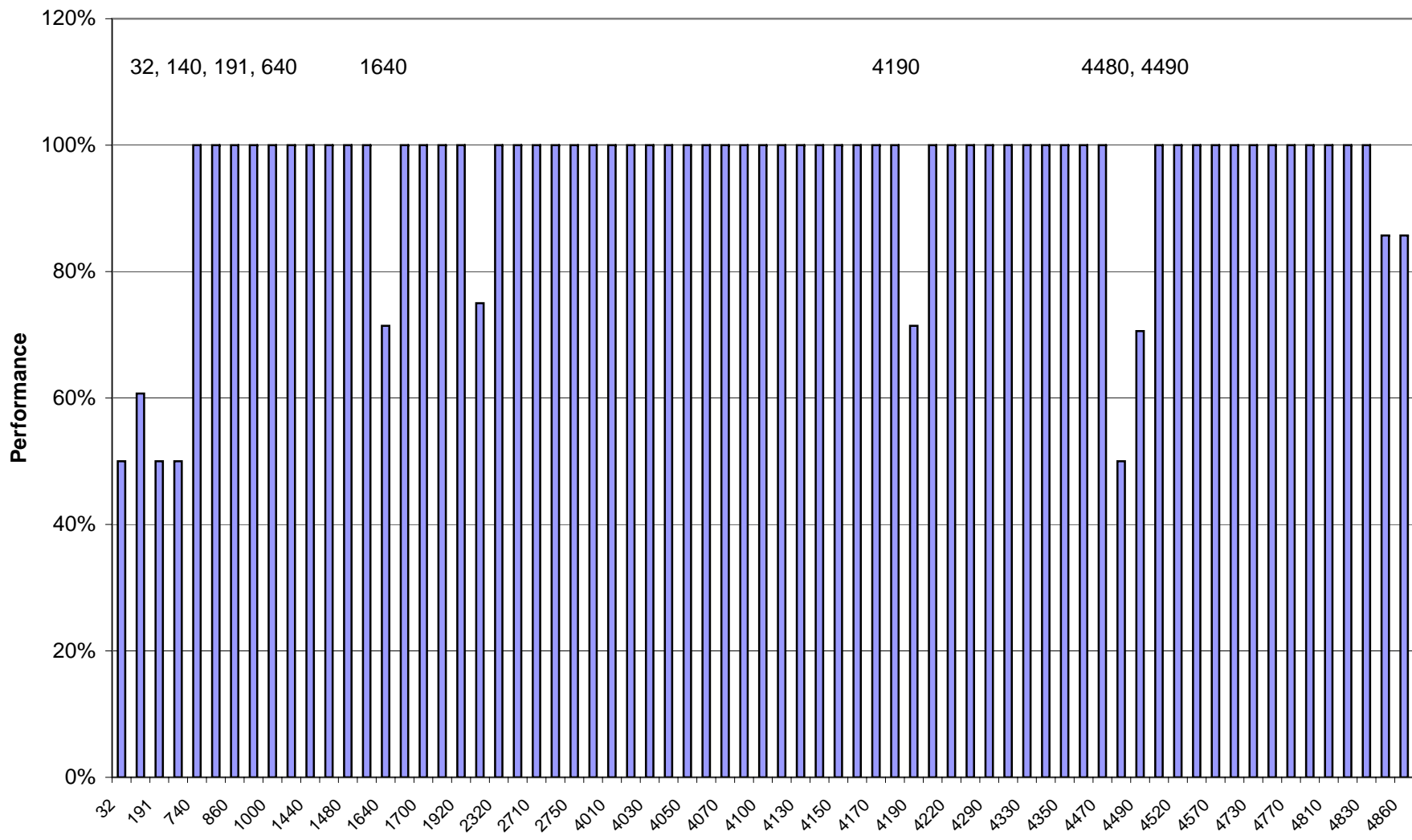


Rain Event Performance Analysis

Rain Event Performance

Rain Sensor	Systemwide Avg 95%	Reports Received		Analyze Rain Sensors										
		Total Tips Data Loss	617 846 27.07%	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
32	50%	0	1	0	0	0	0	0	1	1	2	1	0	0.0393701
140	61%	209	63	25	13	8	5	17	323	532	209	147	0	0.0393701
191	50%	0	1	0	0	0	0	0	1	2	1	0	0	0.0393701
640	50%	0	3	0	0	0	0	0	3	6	3	2	0	0.0393701
740	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
750	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
860	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
900	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393699
1000	100%	11	0	0	0	0	0	0	11	11	0	0	0	0.0393701
1420	100%	11	0	0	0	0	0	0	11	11	0	0	0	0.0393701
1440	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
1460	100%	8	0	0	0	0	0	0	8	8	0	0	0	0.0393701
1480	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
1520	100%	11	0	0	0	0	0	0	11	11	0	0	0	0.0393701
1640	71%	8	1	0	1	0	0	0	10	14	4	0	0	0.0393701
1660	100%	8	0	0	0	0	0	0	8	8	0	2	0	0.0393701
1700	100%	9	0	0	0	0	0	0	9	9	0	0	0	0.0393701
1810	100%	7	0	0	0	0	0	0	7	7	0	0	0	0.0393701
1920	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
2210	75%	2	1	0	0	0	0	0	3	4	1	0	0	0.0393701
2320	100%	3	0	0	0	0	0	0	3	3	0	0	0	0.0393701
2330	100%	9	0	0	0	0	0	0	9	9	0	0	0	0.0393701
2710	100%	8	0	0	0	0	0	0	8	8	0	0	0	0.0393701
2730	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
2750	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
2820	100%	7	0	0	0	0	0	0	7	7	0	0	0	0.0393701
4010	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
4020	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
4030	100%	7	0	0	0	0	0	0	7	7	0	0	0	0.0393701
4040	100%	5	0	0	0	0	0	0	5	5	0	0	0	0.0393701
4050	100%	4	0	0	0	0	0	0	4	4	0	0	0	0.0393701
4060	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
4070	100%	3	0	0	0	0	0	0	3	3	0	0	0	0.0393701
4090	100%	9	0	0	0	0	0	0	9	9	0	0	0	0.0393701
4100	100%	4	0	0	0	0	0	0	4	4	0	0	0	0.0393701
4110	100%	9	0	0	0	0	0	0	9	9	0	0	0	0.0393701
4130	100%	4	0	0	0	0	0	0	4	4	0	0	0	0.0393701
4140	100%	5	0	0	0	0	0	0	5	5	0	0	0	0.0393701
4150	100%	4	0	0	0	0	0	0	4	4	0	0	0	0.0393701
4160	100%	4	0	0	0	0	0	0	4	4	0	0	0	0.0393701
4170	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
4180	100%	5	0	0	0	0	0	0	5	5	0	0	0	0.0393701
4190	71%	3	2	0	0	0	0	0	5	7	2	0	0	0.0393701
4200	100%	3	0	0	0	0	0	0	3	3	0	0	0	0.0393701
4220	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
4250	100%	5	0	0	0	0	0	0	5	5	0	0	0	0.0393701
4290	100%	5	0	0	0	0	0	0	5	5	0	0	0	0.0393701
4310	100%	6	0	0	0	0	0	0	6	6	0	0	0	0.0393701
4330	100%	3	0	0	0	0	0	0	3	3	0	0	0	0.0393701
4340	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
4350	100%	3	0	0	0	0	0	0	3	3	0	0	0	0.0393701
4360	100%	8	0	0	0	0	0	0	8	8	0	0	0	0.0393701
4470	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
4480	50%	0	1	0	0	0	0	0	1	2	1	0	0	0.0393701
4490	71%	8	3	1	0	0	0	0	12	17	5	0	0	0.0393701
4510	100%	5	0	0	0	0	0	0	5	5	0	0	0	0.0393701
4520	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
4530	100%	6	0	0	0	0	0	0	6	6	0	0	0	0.0393701
4570	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
4710	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
4730	100%	3	0	0	0	0	0	0	3	3	0	0	0	0.0393701
4750	100%	4	0	0	0	0	0	0	4	4	0	0	0	0.0393701
4770	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
4790	100%	1	0	0	0	0	0	0	1	1	0	0	0	0.0393701
4810	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
4820	100%	2	0	0	0	0	0	0	2	2	0	0	0	0.0393701
4830	100%	5	0	0	0	0	0	0	5	5	0	0	0	0.0393701
4840	86%	5	1	0	0	0	0	0	6	7	1	0	0	0.0393701
4860	86%	5	1	0	0	0	0	0	6	7	1	0	0	0.0393701
		Total Tips	486	78	26	14	8	5						0.01

### Rain Event Performance



sensors with performance <75% noted