

# Memo



**Date:** February 2, 2011  
**To:** Kevin Stewart  
**From:** Markus Ritsch  
**Subject:** January 2011 ALERT Data Analysis

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## I. ALERT Data Source

Raw ALERT data records extracted from the Urban Drainage and Flood Control District's NovaStar base station were analyzed for the period January 1 through January 31, 2011.

## II. General System Analysis Summary

A total of 313,618 ALERT (legacy) data reports were analyzed. Meteorological sensors account for 85 percent, water level sensors 3 percent, and rain sensors 2 percent of the total monthly records.

The system-wide radio traffic loading was 10,117 reports per day with an average hourly loading of 422 reports. The peak hourly traffic loading was 632 reports, which occurred on January 5, between 4:00 PM and 5:00 PM. A plot of monthly average and peak hourly traffic loading is provided.

### A. Specific Issues Identified this Month

Performance of the following sensors (Table 1) was unacceptable this month.

**Table 1. Rain Sensors with Unacceptable Performance Characteristics**

Rain ID	Description	Timer	Event	Comments
140	Wx-Blue Mountain	69%	100%	Poor timer performance
1420	Wx-Diamond Hill	81%	63%	Poor event performance
1440	Wx-Elbert	63%	100%	Poor timer performance
1460	Wx-Urban Farm	68%	67%	Poor timer performance
1520	Wx-Marston Lake North	61%	100%	Poor timer performance
1570	Wx-Brighton Ditch	73%	100%	Poor timer performance
2710	Wx-Highlands Ranch WTP	87%	75%	Poor event performance
4080	Twin Sisters	74%	100%	Poor timer performance
4330	Hansen Rain	85%	71%	Poor event performance
4470	Little Narrows	63%	69%	Poor timer performance
4490	Apple Valley	79%	100%	Poor timer performance
4750	Wx-Louisville Lake	74%	100%	Poor timer performance

### III. Rain Sensor Timer Reporting Summary

The following analysis assumes that each rain sensor has a 12-hour timer-reporting interval. The worst performing rain sensors for the month are summarized (Table 2).

**Table 2. Monthly Summary of Sensors with Poor Timer Performance (Sensor ID)**

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*
1520											
1440											
4470											
1460											
140											
1570											

\*- Only sensors that operate year-round (weather stations and stations in Boulder County) are included for the analysis in these months.

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

### IV. Rain Sensor Event Reporting Summary

#### A. District-Wide Total Tip/Count Statistics

The incrementing reports from all 1-mm rain sensors were analyzed to quantify the District-wide statistical total monthly tip summary (Table 3).

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

Statistical Parameter	Value	Comments
Mean	6.78	Only the 1-mm rain sensors were included in the analysis
Median	6	Only the 1-mm rain sensors were included in the analysis
Standard deviation	4.08	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	19.02	Only the 1-mm rain sensors were included in the analysis
Minimum total count	1	ID 900 (Aurora Reservoir)
Maximum total count	16	ID 1420 and 4470 (Diamond Hill and Little Narrows)

#### B. Monthly Average Tip/Count Summary

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

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

Year	Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*	Ave
2006	4.62	5.92	18.39	20.47	19.44	13.75	74.03	46.89	24.17	41.13	5.04	16.45	24.19
2007	11.56	5.40	29.75	65.03	68.30	15.87	36.20	46.38	22.13	29.50	6.54	11.29	29.00
2008	4.05	7.38	12.26	20.57	54.82	26.06	16.43	90.20	37.54	19.59	2.82	9.24	25.08
2009	6.33	3.11	11.37	59.26	63.45	68.00	65.00	20.00	27.29	30.24	11.00	5.60	30.89
2010	5.97	11.90	32.54	70.57	39.63	56.04	50.23	31.01	4.18	18.31	8.30	3.31	27.67
2011	6.78												

\*- Only sensors that operate year-round (weather stations and stations in Boulder County) are included for the analysis in these months.

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

Several sensors experienced a large jump in the sequential tip count (Table 5).

**Table 5. Sensors with a Jump of 6 or More in Sequential Count**

Sensor Description	Sensor ID	Comment
Apple Valley	4490	A large jump occurred on January 11, 2011 (may be related to field maintenance)

### D. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 94.56 percent. A total of 487 incrementing reports were received and a total of 515 reports were expected. The total loss of incrementing reports for the month was approximately 5.44 percent. Those sensors with the worst event transmission performance are summarized (Table 6).

**Table 6. Monthly Summary of Sensors with the Most Missed Tips**

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*
1420											
1460											
4470											
4330											
2710											
1640											

\*-Only sensors that are operational year-round (weather stations and stations in Boulder County) are included for the analysis in these months.

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.

## V. Heavy Radio Traffic Analysis

Periods exceeding 500 messages per hour were analyzed independently in an attempt to quantify data loss rates from rain sensors using the sequential tip count series.

### A. The Heaviest Hourly Traffic Periods This Month

The hourly periods of highest radio traffic this month are shown (Table 7). Each hour exceeding 500 reports was analyzed to quantify the number of missing rain reports for that hour.

**Table 7. Heavy Radio Traffic Periods**

Peak Traffic Periods	Reports/hour	Missing Rain Reports (% loss)	Hour Beginning
Peak Hourly Traffic	632	0 %	1/5/2011 4:00 PM
2nd Max	586	0 %	1/6/2011 8:00 AM
3rd Max	579	0 %	1/19/2011 3:00 PM
4th Max	574	0 %	1/5/2011 1:00 PM
5th Max	570	0 %	1/5/2011 10:00 AM

## VI. Unknown Device Analysis – Received Data Log

The ALERT IDs present in the audio signal received by the decoder are compared against a list of “active” device IDs that are defined within NovaStar. Those IDs received by the decoder that are not defined within NovaStar are considered to be “unknown” and may be the result of radio noise or problems with the telemetry system. The reception of “unknown” device reports for the month is summarized (Table 8).

**Table 8. Summary of Unknown IDs**

Description	Quantity
Total number of unknown IDs (IDs without a device definition)	480
Total reports from unknown IDs	1,231
Unknown IDs with only a single received report (potential noise)	317
Total reports from all IDs – RecData Log entire month	313,618
Unknown reports as a fraction of total reports	0.39%

The total number of reports from unknown sensors is very small relative to the total reports received for the month. Shown below (Table 9) are the total reports received from unknown sensor IDs for each month of the year.

**Table 9. Monthly Summary of Total Reports from Unknown IDs**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	1,220	1,474	1,276	1,174	721	5,707	610	1,738	442	533	2,857	6,396
2011	1,231											

The fraction of reports from unknown sensors relative to the total number of reports is shown below (Table 10).

**Table 10. Monthly Percent of Unknown Sensor Reports**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	0.42%	0.56%	0.38%	0.32%	0.20%	1.61%	0.17%	0.49%	0.13%	0.16%	0.93%	1.88%
2011	0.39%											

Any month shaded in yellow has an excessive number of reports from unknown sensors.

A number of “unknown” sensors had multiple reports, which may indicate the existence of a transmitter that is sending information on an ID that is not currently defined within NovaStar. The unknown IDs with multiple reports including the number of reports received by each are shown (Table 11).

**Table 11. Reports Received by Unknown IDs**

Unknown Sensor ID	Total Reports
1470	34
1423	33
2811	28
1926	22
1446	19
1486	19
2748	19
1933	18
2239	18
1918	17
1923	17
1934	17
2768	16
1949	15
2784	15
1454	14
1443	12
1954	11
2808	11
206	10
1453	10
1919	10
2771	10
1478	9
1502	9
1528	9
2715	9
2746	9
2754	9
1433	8
1529	8
1579	8
1929	8
1953	8
2708	8
2776	8
1413	7
1531	7
1653	7
2352	7
2745	7
2760	7
152	6
153	6
154	6

202	6
1415	6
1631	6
1651	6
1950	6
1951	6
2329	6
2713	6
2753	6
2775	6
208	5
1457	5
1506	5
1511	5
1534	5
1915	5
2756	5
131	4
148	4
575	4
1391	4
1430	4
1958	4
1970	4
2705	4
2736	4
4838	4

The “unknown” device reports are analyzed temporally to understand when they are received during the day (Table 12). The goal of this analysis is to determine a pattern of occurrence that may correspond to a source of noise in the system, such as the use of a wireless microphone nearby.

**Table 12. Temporal Distribution of Received Reports**

Hour (AM)	Reports	Hour (PM)	Reports
0:00-00:59	37	12:00-12:59	36
1:00-1:59	50	1:00-1:59	28
2:00-2:59	30	2:00-2:59	47
3:00-3:59	42	3:00-3:59	75
4:00-4:59	35	4:00-4:59	59
5:00-5:59	48	5:00-5:59	62
6:00-6:59	35	6:00-6:59	25
7:00-7:59	31	7:00-7:59	47
8:00-8:59	59	8:00-8:59	94
9:00-9:59	62	9:00-9:59	125
10:00-10:59	25	10:00-10:59	101
11:00-11:59	42	11:00-11:59	36

## VII. Sensors with Invalid Reports

The following precipitation sensors had a large number of invalid reports (bit flip/contention errors/random decode):

Sensor ID	Description	Nov 10	Dec 10	Jan 11	Feb 11	Mar 11
140	Wx-Blue Mountain	3	5	4		
1420	Wx-Diamond Hill	2	0	3		
1440	Wx-Elbert	2	4	2		
1460	Wx-Urban Farm	2	2	1		
1920	Wx-Brighton	0	0	4		
2190	Wx-Squaw Mountain	2	1	1		
2750	Wx-Castle Rock	0	0	4		
4010	Crescent	13	6	0		
4030	Red Garden	4	6	0		
4060	Lakeshore	13	7	1		
4080	Twin Sisters	5	6	0		
4090	Magnolia	65	27	0		
4530	Winiger Ridge	3	2	0		
4570	St. Antons	3	1	0		
4730	Wx-Sugarloaf	7	0	0		
4770	Wx-Cal Wood Ranch	2	0	0		
4830	SBC - San Souci	7	4	1		
4840	SBC - S. Boulder Ditch	3	1	1		
4860	Fairview Peak	8	4	0		



# General System Analysis

**Database Name** P:\A207-UDFCD-Data-Analysis\2011\01-2011\Novastar\_extract\_2011Jan.mdb

<b>First Date in Database</b>	1/1/11 12:00 AM	<b>Total Days</b>	31.0
<b>Last Date in Database</b>	1/31/11 11:59 PM	<b>Total Hours</b>	744.0

**Total Records Analyzed** 313618

## Records by Group

Wind Gust	55349	18%
Temperature	54476	17%
Relative Humidity	53038	17%
Wind Speed Average & Azimuth	30814	10%
Barometric Pressure	27566	9%
Wind Direction	18303	6%
Wind Speed Average	17918	6%
Solar Radiation	8520	3%
Precipitation	5628	2%
Fuel Moisture	5127	2%
Fuel Temperature	5108	2%
Water Level PT-HSE	4359	1%
Battery Voltage HSE	4316	1%
Water Level Float	3823	1%
Battery Voltage Analog	3539	1%
Battery Voltage Digital	3520	1%
Battery	2953	1%
Soil Moisture	2367	1%
Repeater Status Report	2327	1%
Water Level PT	1572	1%
Unknown IDs	1231	0%
Wing Gust	726	0%
Repeater Pass List	633	0%
12Hr Status Report	345	0%
Solar Power	28	0%
Battery Voltage	20	0%
ALERT/A2 Testing	6	0%
Handar 585 ALARM Status	6	0%
<b>Total</b>	<b>313618</b>	

## Records by Major Group

Meteorologic Sensors	265984	85%
Sensor Status Transmissions	14714	5%
Soil and Fuel Sensors	12602	4%
Water Level Sensors	9754	3%
Rain Sensors	5628	2%
<b>Total</b>	<b>308682</b>	

## Traffic Loading Summary

Alert Reports	313618	
Average Daily Traffic	10117	
Average Hourly Traffic	422	
Median Hourly Traffic	425	hour beginning
Peak Hourly Traffic	632	Jan 05, 2011 4:00 PM
2nd Max	586	Jan 06, 2011 8:00 AM
3rd Max	579	Jan 19, 2011 3:00 PM
4th Max	574	Jan 05, 2011 1:00 PM
5th Max	570	Jan 05, 2011 10:00 AM



# Rain Timer Performance

Boulder County and UDFCD Weather Stations

Analyze Rain Sensors

12:54

Rain Sensors	Description	Rcv	Timer	Exp	Performance
1520	Wx-Marston Lake North	38	15:46	62.00	61%
1440	Wx-Elbert	39	16:25	62.00	63%
4470	Little Narrows	39	19:41	62.00	63%
1460	Wx-Urban Farm	42	14:26	62.00	68%
140	Wx-Blue Mountain	43	15:23	62.00	69%
1570	Wx-Brighton Ditch	45	15:00	62.00	73%
4080	Twin Sisters	46	15:40	62.00	74%
4750	Wx-Louisville Lake	46	14:24	62.00	74%
4490	Apple Valley	49	13:47	62.00	79%
1420	Wx-Diamond Hill	50	12:32	62.00	81%
2750	Wx-Castle Rock	50	12:30	62.00	81%
4510	Pinewood Springs	50	13:13	62.00	81%
4130	Swiss Peaks	51	14:23	62.00	82%
4530	Winiger Ridge	51	13:49	62.00	82%
4220	Fling's	52	12:30	62.00	84%
1920	Wx-Brighton	53	12:44	62.00	85%
4170	Pine Brook	53	13:46	62.00	85%
4330	Hansen Rain	53	13:11	62.00	85%
4710	Wx-Ward C-1	53	13:52	62.00	85%
4850	Porphory Mtn	53	13:10	62.00	85%
2710	Wx-Highlands Ranch WTP	54	12:28	62.00	87%
4010	Crescent	54	13:27	62.00	87%
4070	Bear Peak	54	13:16	62.00	87%
4300	Big Elk Park	54	13:36	62.00	87%
4790	Wx-Button Rock	54	13:13	62.00	87%
4820	Doudy Draw	54	13:09	62.00	87%
4020	Rio Grande	55	13:20	62.00	89%
4060	Lakeshore	55	12:42	62.00	89%
4140	Logan Mill	55	12:27	62.00	89%
4150	Gold Hill	55	13:16	62.00	89%
4240	Sunset	55	13:08	62.00	89%
4570	St. Antons	55	12:43	62.00	89%
4040	Martin Gulch	56	12:12	62.00	90%
4090	Magnolia	56	12:55	62.00	90%
4190	Slaughterhouse	56	12:55	62.00	90%
4230	Golden Age	56	13:03	62.00	90%
4260	Taylor Mountain	56	12:26	62.00	90%
4350	Conifer Hill	56	13:07	62.00	90%
4360	Justice Center	56	13:08	62.00	90%
4550	Boulder Jail	56	13:11	62.00	90%
2930	Wx-Spring Valley Rd-DougCnty	57	12:52	62.00	92%
4030	Red Garden	57	12:40	62.00	92%
4180	Gold Lake	57	12:37	62.00	92%
4250	Geer Canyon	57	12:53	62.00	92%
4310	Johnny Park	57	12:27	62.00	92%
4340	Riverside	57	12:53	62.00	92%
4770	Wx-Cal-Wood Ranch	57	12:55	62.00	92%
4810	Shanahan Ridge	57	12:51	62.00	92%
4830	SBC @ San Souci	57	12:54	62.00	92%
750	Wx-Quincy Reservoir	58	12:37	62.00	94%
920	Wx-Aurora Town Hall	58	12:37	62.00	94%
2730	Wx-Salisbury Park	58	12:39	62.00	94%
2990	Wx-Tomah Rd-DougCnty	58	12:00	62.00	94%
4730	Wx-Sugarloaf	58	12:27	62.00	94%
4840	SBC@S Boulder Ditch	58	12:26	62.00	94%
4860	Fairview Peak	58	12:26	62.00	94%
2190	Wx-Squaw Mountain	59	12:12	62.00	95%
3020	Wx-West Creek WX	59	12:27	62.00	95%
4050	Walker Ranch	59	12:35	62.00	95%
4160	Sunshine	59	12:24	62.00	95%
4270	Cannon Mountain	59	12:23	62.00	95%
900	Wx-Aurora Reservoir	60	12:12	62.00	97%
2210	Wx-Hiwan G.C.	60	12:13	62.00	97%
4100	Filter Plant	60	12:12	62.00	97%
4110	Betasso	60	11:59	62.00	97%
4200	Lazy Acres	60	11:59	62.00	97%
4290	Red Hill	60	12:11	62.00	97%
4520	Eagle Ridge	60	12:00	62.00	97%

Rain Event Performance				Analyze Rain Sensors					Boulder County and UDFCD Weather Station				
	Reports Received	487											
	Systemwide Avg	Total Tips	515										
	94.56%	Data Loss	5.44%										
Rain ID	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Rcv	Exp	Miss	Hold	Bucket
1420	63%	7	2	0	0	1	0	0	10	16	6	0	0.0393701
1460	67%	5	0	0	1	0	0	0	6	9	3	1	0.0393701
4470	69%	8	2	0	1	0	0	0	11	16	5	0	0.0393701
4330	71%	4	0	1	0	0	0	0	5	7	2	0	0.0393701
1100	75%	2	1	0	0	0	0	0	3	4	1	0	0.0393701
2710	75%	2	1	0	0	0	0	0	3	4	1	0	0.0393701
1640	80%	6	2	0	0	0	0	0	8	10	2	0	0.0393701
2370	83%	4	1	0	0	0	0	1	5	6	1	0	0.0393701
4510	85%	10	0	1	0	0	0	0	11	13	2	0	0.0393701
4190	86%	5	1	0	0	0	0	0	6	7	1	0	0.0393701
1660	88%	6	1	0	0	0	0	0	7	8	1	0	0.0393701
4550	90%	8	1	0	0	0	0	0	9	10	1	1	0.0393701
4290	92%	11	1	0	0	0	0	0	12	13	1	0	0.0393701
4310	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
110	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
140	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
700	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
750	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
900	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393699
970	100%	1	0	0	0	0	0	0	1	1	0	0	0.0393701
1000	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
1480	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
1520	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
1700	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701
1810	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701
1920	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
2210	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
2320	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
2330	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
2730	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
2750	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
2930	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
2990	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
3020	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
4010	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4020	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4030	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
4040	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
4050	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4060	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4070	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701
4080	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4090	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4100	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4110	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
4130	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4140	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
4150	100%	13	0	0	0	0	0	0	13	13	0	0	0.0393701
4160	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4170	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
4180	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4200	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
4220	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
4240	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4250	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
4260	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4270	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4300	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4340	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4350	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4360	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
4490	100%	1	0	0	0	0	0	1	1	1	0	0	0.0393701
4520	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4530	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4570	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4710	100%	2	0	0	0	0	0	0	2	2	0	0	0.0393701
4730	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
4750	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
4770	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4790	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
4810	100%	3	0	0	0	0	0	0	3	3	0	0	0.0393701
4820	100%	4	0	0	0	0	0	0	4	4	0	0	0.0393701
4830	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
4840	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
4850	100%	2	0	0	0	0	0	0	2	2	0	0	0.01
4860	100%	5	0	0	0	0	0	0	5	5	0	0	0.01
	Total Tips	468	14	2	2	1	0	2	487	515	28	2	

# 2011 Monthly ALERT Radio Traffic Summary

