

Memo

Date: September 10, 2012
To: Kevin Stewart
From: Markus Ritsch
Subject: August 2012 ALERT Data Analysis

I. ALERT Data Source

Raw ALERT data records extracted from the Urban Drainage and Flood Control District's NovaStar 5.0 base station were analyzed for the period August 1 through August 31, 2012.

II. General System Analysis Summary

A total of 387,512 legacy ALERT data reports were analyzed. Meteorological sensors account for 46 percent, water level sensors 5 percent, and rain sensors 3 percent of the total monthly records.

The system-wide radio traffic loading was 12,500 reports per day with an average hourly loading of 521 reports. The peak hour of radio traffic loading was 760 reports, which occurred on August 11th, between 7:00 PM and 8:00 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 questionable this month.

Table 1. Rain Sensors with Poor Performance Characteristics

Rain ID	Description	Timer	Event	Comments
2270	Cub Creek below Blue	42%	85%	
2320	Choke Cherry Res	52%	91%	
2860	CC at Stroh Road	97%	50%	
2980	Dakan Road	95%	67%	
3070	Newlin Gulch	97%	30%	
3090	Highland Heritage Park	65%	100%	
4330	Hansen Rain	73%	92%	
4490	Apple Valley	84%	67%	
4790	Button Rock	97%	43%	
1621, 1622, 1624	Many reports on these IDs. Slaughterhouse (1620) may be sending undefined IDs			
4323	Lee Hill 2012 new rain gage is sending stage ID			

B. Continuous Operation of Base Receiver/Decoder

The ALERT and ALERT2 data feeds on the NS5 base station computer were in continuous operation for the entire month.

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*
2320	4550	4270	2890	1710	1660	1660	2270				
1460	1460	4870	1640	2230	2950	2790	2320				
1520	4470	4790	2270	4870	540	4330	3090				
1440	1520	4850	2970	1900	1710	2270	4330				
1000	1440	4570	4490	1660	4330	2320	870				
4520	140	4070	3010	4330	2320	4870	4270				

*. 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). For the months of January, February, March, October, November and December only the stations that operate year-round are included in the rain event analysis. These stations include all weather stations and the stations in Boulder County.

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

Statistical Parameter	Value	Comments
Mean	11.31	Only the 1-mm rain sensors were included in the analysis
Median	8	Only the 1-mm rain sensors were included in the analysis
Standard deviation	11.10	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	44.63	Only the 1-mm rain sensors were included in the analysis
Minimum total count	1	Numerous sites
Maximum total count	94	ID 630 (Temple Pond at DTC – influenced by irrigation)

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	7.45	7.54	33.94	92.68	39.42	90.87	18.25	37.67	25.73	10.41	13.59	32.03
2012	4.89	13.57	2.35	30.17	38.97	19.35	73.03	11.31					

*. 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
Salisbury Park	2730	Maintenance 8-30-2012
Red Garden	4030	Corrupt data point received 8-19-2012
Newlin Gulch	3070	Poor data sequence for the entire month
Spring Valley Road	2930	Field maintenance 8-30-2012

D. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 93 percent. A total of 3,110 incrementing reports were received and a total of 3,345 reports were expected. The total loss of incrementing reports for the month was approximately 7 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*
1700	2980	2710	4490	2270	700	3070	3070				
1420	3030	4860	2980	4870	2970	4470	4790				
4490	4240	2930	1660	4470	3070	4330	2860				
2980	1520	3030	3010	2980	400	2980	4490				
1660	4490	2990	2320	310	2730	4870	2980				
4090	1420	4050	4470	2280	4330	2870	620				

*-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 700 messages per hour are analyzed independently in an attempt to quantify data loss rates from rain sensors using their 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 1,000 reports was analyzed to quantify the number of missing rain reports for that hour.

Table 7. Heavy Radio Traffic Periods

Day	Hour	Expected	Received	Total Load	Loss
11	19	71	71	760	0
1	16	108	98	724	9.25

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)	248
Total reports from unknown IDs	683
Unknown IDs with only a single received report (potential noise)	197
Total reports from all IDs – RecData Log entire month	387,512
Unknown reports as a fraction of total reports	0.18%

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	2,165	3,065	1,254	2,051	439	489	456	191	683	747	861
2012	692	750	1,575	977	5,469	11,016	453	683				

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%	0.73%	0.90%	0.37%	0.58%	0.12%	0.12%	0.05%	0.12%	0.18%	0.22%	0.26%
2012	0.30%	0.25%	0.43%	0.26%	1.37%	2.74%	0.11%	0.18%				

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 ID	Total No of Reports
1621	107
1622	97
1624	63
4323	60
1628	12
3047	12
1627	10
4031	9
3052	8
2239	7
2812	5

VII. Rain Sensors with Invalid Reports

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

Sensor	Description	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
710	Horseshoe Park Drop					1,311	0				
900	Wx-Aurora Reservoir		8	5	16	9	1				
2210	Wx-Hiwan G.C.					3	1				
2280	Kinney Peak					3	0				
2810	Pine Cliff Road					5	4				
3020	West Creek WX					0	4				
3090	Highland Heritage Park	0	0	0	16	0	0				
4330	Hansen Rain			4	3	4	3				

General System Analysis

Database Name

P:\A207-UDFCD-Data-Analysis\2012\08-2012\Novastar_extract_2012Aug.mdb

First Date in Database

8/1/12 12:00 AM

Total Days

31.0

Last Date in Database

8/31/12 11:59 PM

Total Hours

744.0

Total Records Analyzed

387,512

Records by Group

Wind Data	134,328	35%
Temperature	72,538	19%
Relative Humidity	63,303	16%
Barometric Pressure	32,473	8%
Battery Voltage	20,130	5%
Water Level	17,922	5%
Precipitation	13,514	3%
Solar Radiation	10,902	3%
Fuel Temperature	5,927	2%
Fuel Moisture	5,921	2%
Soil Moisture	2,904	1%
Repeater Status Report	2,340	1%
Flasher Status	1,806	0%
Evapotranspiration	1,260	0%
Unknown	683	0%
Repeater Pass List	622	0%
12Hr Status Report	477	0%
Hayman Battery	383	0%
Handar 585 ALARM Status	77	0%
Dewpoint Temperature	1	0%
Solar Power	1	0%
Total	387,512	

Records by Major Group

Meteorologic Sensors	179,216	46%
Water Level Sensors	17,922	5%
Soil and Fuel Sensors	14,752	4%
Rain Sensors	13,514	3%
Sensor Status Transmissions	3,517	1%
Total	228,921	

Traffic Loading Summary

Alert Reports	387,512	
Average Daily Traffic	12,500	
Average Hourly Traffic	521	
Median Hourly Traffic	519	hour beginning
Peak Hourly Traffic	760	Aug 11, 7:00 PM
2nd Max	725	Aug 1, 4:00 PM
3rd Max	665	Aug 11, 8:00 PM
4th Max	656	Aug 11, 1:00 PM
5th Max	656	Aug 1, 3:00 PM

Rain Timer Performance

Analyze Rain Sensors

Rain Sensors	Description	Rcv	Timer	Exp	Performance
2270	Cub Cr below Blue	26	18:53	62	42%
2320	Choke Cherry Resvr	32	19:23	62	52%
3090	Highland Heritage Park	40	17:13	62	65%
4330	Hansen Rain	45	13:42	62	73%
870	Murphy Creek GC	46	16:11	62	74%
4270	Cannon Mountain	47	14:57	62	76%
4510	Pinewood Springs	48	15:33	62	77%
2280	Kinney Peak	49	13:38	62	79%
540	Parker/Mississippi	50	14:33	62	81%
2790	W. Cherry Creek Wx	50	14:48	62	81%
2940	Willow Creek - DougCnty	51	14:20	62	82%
1660	SPR at Henderson	52	14:07	62	84%
4290	Red Hill	52	14:18	62	84%
4490	Apple Valley	52	13:22	62	84%
4870	SBC @ SB Road	52	14:01	62	84%
2900	Russelville Gulch-Douglas	53	12:00	62	85%
4470	Little Narrows	53	13:36	62	85%
1710	Shop Creek	54	13:09	62	87%
2230	Bear Cr below Cub	54	13:29	62	87%
2240	Cold Sprg Glch conf	54	13:31	62	87%
3010	EPC at Hwy 105	54	12:48	62	87%
620	Quincy/Highline	55	12:39	62	89%
1110	Gunbarrel	55	12:51	62	89%
2880	Happy Canyon at N Surrey Dr	56	13:05	62	90%
4130	Swiss Peaks	56	12:44	62	90%
4170	Pine Brook	56	13:08	62	90%
4180	Gold Lake	56	12:39	62	90%
4190	Slaughterhouse	56	12:55	62	90%
400	Montview Park	57	12:24	62	92%
1530	Bear Creek @ Lowell	57	12:49	62	92%
2820	Haskins Gulch Conf	57	12:40	62	92%
2840	Sulphur Gulch	57	12:57	62	92%
3050	East/West Trailhead	57	12:13	62	92%
4150	Gold Hill	57	12:12	62	92%
4240	Sunset	57	12:53	62	92%
4530	Winiger Ridge	57	13:01	62	92%
4850	Porphory Mtn	57	12:30	62	92%
4860	Fairview Peak	57	12:49	62	92%
110	Ralston Reservoir	58	12:36	62	94%
330	Van Bibber @ Hwy 93	58	12:36	62	94%
410	Kelly Dam	58	12:24	62	94%
500	Havana Park	58	12:15	62	94%
840	Fire Station 12	58	12:13	62	94%
850	Flying J	58	12:30	62	94%
1340	Sanderson at Xavier	58	12:39	62	94%
1350	Chatfield COE	58	12:40	62	94%
1400	Upper Sloan Det.	58	12:23	62	94%
1800	Sand Creek Park	58	12:37	62	94%
2250	Rosedale	58	12:41	62	94%
2360	Indian Hills	58	12:39	62	94%
2810	Pine Cliff Road	58	12:40	62	94%
4030	Red Garden	58	12:13	62	94%
4060	Lakeshore	58	11:58	62	94%
4080	Twin Sisters	58	12:41	62	94%

4300	Big Elk Park	58	12:27	62	94%
4350	Conifer Hill	58	12:40	62	94%
4550	Boulder Jail	58	12:23	62	94%
4810	Shanahan Ridge	58	12:34	62	94%
4840	SBC@S Boulder Ditch	58	12:10	62	94%
120	West Woods	59	12:10	62	95%
210	Leyden Confluence	59	12:10	62	95%
310	Guy Hill Ranch	59	12:23	62	95%
510	Virginia Court	59	12:13	62	95%
610	Harvard @ Jackson	59	12:09	62	95%
630	Temple Pond at DTC	59	11:34	62	95%
720	Confluence Pond	59	12:23	62	95%
940	Sampson Gulch	59	12:10	62	95%
1100	Louisville Rec Ctr	59	12:24	62	95%
1420	Wx-Diamond Hill	59	12:25	62	95%
1500	Powers Park	59	11:57	62	95%
1700	Cherry Cr @ Champa	59	12:25	62	95%
2190	Wx-Squaw Mountain	59	12:14	62	95%
2350	Idledale	59	12:23	62	95%
2370	Red Rocks Park	59	12:23	62	95%
2890	Spruce Mt - Douglas	59	12:13	62	95%
2920	West Cherry Head-Douglas Cnty	59	12:13	62	95%
2930	Wx-Spring Valley Rd-DougCnty	59	12:13	62	95%
2980	Dakan Rd	59	12:13	62	95%
4010	Crescent	59	12:11	62	95%
4020	Rio Grande	59	11:57	62	95%
4040	Martin Gulch	59	12:08	62	95%
4070	Bear Peak	59	12:11	62	95%
4090	Magnolia	59	12:12	62	95%
4140	Logan Mill	59	12:25	62	95%
4200	Lazy Acres	59	12:26	62	95%
4220	Fling's	59	12:26	62	95%
4310	Johnny Park	59	12:10	62	95%
4360	Justice Center	59	12:10	62	95%
4570	St. Antons	59	12:11	62	95%
4710	Wx-Ward C-1	59	12:30	62	95%
4750	Wx-Louisville Lake	59	12:25	62	95%
150	Nott Creek	60	12:11	62	97%
430	Utah Park	60	11:56	62	97%
520	Jewell Detention	60	12:10	62	97%
600	Harvard Gulch Park	60	12:10	62	97%
640	Goldsmith @ Eastman	60	11:57	62	97%
710	Horseshoe Park Drop	60	12:12	62	97%
820	ETG @ Buckley	60	12:10	62	97%
1060	Heritage Square	60	12:11	62	97%
1200	Broomfield 3207	60	12:10	62	97%
1300	Hidden Lake	60	12:11	62	97%
1320	SPR at 3rd Ave	60	12:10	62	97%
1370	West Metro FS13	60	11:57	62	97%
1440	Wx-Elbert	60	12:12	62	97%
1620	Slaughterhouse Glch	60	12:10	62	97%
1720	Cherry Cr @ Steele	60	12:10	62	97%
1810	Sand Creek at mouth	60	12:10	62	97%
2210	Wx-Hiwan G.C.	60	12:00	62	97%
2330	Morrison	60	12:10	62	97%
2340	El Rancho	60	12:10	62	97%
2850	Cherry Cr bl Bayou Glch	60	12:09	62	97%
2860	CC at Stroh Rd	60	11:57	62	97%
2910	East Cherry Cr-Douglas	60	12:00	62	97%

2950	DC Public Works	60	12:13	62	97%
2960	Indian Creek	60	12:12	62	97%
2970	Rampart Range Rd-Satellite	60	12:13	62	97%
3020	Wx-West Creek WX	60	12:15	62	97%
3030	WX-Bingham Lake Park	60	12:00	62	97%
3060	Fire Sta 47	60	12:12	62	97%
3070	Newlin Gulch	60	12:00	62	97%
4230	Golden Age	60	11:57	62	97%
4260	Taylor Mountain	60	12:05	62	97%
4770	Wx-Cal-Wood Ranch	60	12:00	62	97%
4790	Wx-Button Rock	60	12:12	62	97%
4830	SBC @ San Souci	60	12:10	62	97%
4880	Whispering Pines	60	12:10	62	97%
140	Wx-Blue Mountain	61	12:00	62	98%
200	Leyden Reservoir	61	12:10	62	98%
220	Upper Leyden	61	12:05	62	98%
320	Sports Complex	61	11:57	62	98%
440	Fire Station #7	61	12:10	62	98%
530	Fire Station #19	61	11:57	62	98%
650	Iliff Pond	61	11:57	62	98%
700	Toll Gate @ 6th	61	12:00	62	98%
730	No Name @ Quincy	61	11:57	62	98%
830	Side Creek Park	61	12:10	62	98%
860	Sand Cr at Colfax	61	12:00	62	98%
950	Piney at Liverpool	61	11:58	62	98%
1000	Maple Grove Resv.	61	12:10	62	98%
1010	Denver West	61	11:57	62	98%
1030	NREL/S. Table Mtn.	61	11:58	62	98%
1040	Lena @ U.S. Hwy 6	61	11:59	62	98%
1330	Roslyn	61	12:00	62	98%
1360	Denver Zoo	61	12:12	62	98%
1460	Wx-Urban Farm	61	12:00	62	98%
1480	Third Creek at DIA	61	11:58	62	98%
1520	Wx-Marston Lake North	61	12:00	62	98%
1550	Lakewood CC	61	12:10	62	98%
1920	Wx-Brighton	61	12:00	62	98%
2260	Brook Forest	61	11:58	62	98%
2310	Genesee Village	61	12:10	62	98%
2710	Wx-Highlands Ranch WTP	61	12:00	62	98%
2730	Wx-Salisbury Park	61	11:51	62	98%
2750	Wx-Castle Rock	61	12:00	62	98%
2800	Columbine Open Space	61	11:51	62	98%
2870	Cottonwood (Apache)	61	12:00	62	98%
2990	Wx-Tomah Rd-DougCnty	61	12:00	62	98%
3040	CC @ Prairie Canyon Ranch	61	12:00	62	98%
4050	Walker Ranch	61	11:57	62	98%
4110	Betasso	61	11:59	62	98%
4250	Geer Canyon	61	12:10	62	98%
4320	Lee Hill Rain 2012	61	11:58	62	98%
4820	Doudy Draw	61	11:53	62	98%
420	Expo Park	62	11:58	62	100%
760	Mission Viejo Park	62	11:57	62	100%
800	Sable Ditch @ 18th	62	11:45	62	100%
810	Granby Ditch @ 6th	62	11:57	62	100%
1050	Jeffco Fairgrounds	62	11:57	62	100%
1310	LDC at 64th	62	11:58	62	100%
1570	Wx-Brighton Ditch	62	11:47	62	100%
1600	Englewood Dam	62	11:58	62	100%
1900	Niver Detention	62	11:57	62	100%

3080	Tallman Gulch	62	11:48	62	100%
4160	Sunshine	62	11:58	62	100%
4340	Riverside	62	11:58	62	100%
4730	Wx-Sugarloaf	62	12:00	62	100%
300	Van Bibber Park	63	11:58	62	102%
750	Wx-Quincy Reservoir	63	11:45	62	102%
920	Wx-Aurora Town Hall	63	11:35	62	102%
970	Pump Sta 3	64	11:24	62	103%
4520	Eagle Ridge	65	11:30	62	105%
4100	Filter Plant	71	10:12	62	115%
900	Wx-Aurora Reservoir	72	10:00	62	116%
5720	Four Mile Creek	29	22:21	62	47%
5730	West Creek	63	11:33	62	102%
5740	Trail Creek	59	12:15	62	95%
5810	Stump Bump	62	12:00	62	100%
5860	Cedar Mountain	60	11:56	62	97%
5880	Hackett Mountain	61	12:00	62	98%
5900	Horse Creek-Satellite	707		62	
5940	Log Jumper	61	11:59	62	98%

2012 Monthly ALERT Radio Traffic Summary

