Memo

Date: January 13, 2015
To: Kevin Stewart
From: Markus Ritsch
Subject: **2014 December ALERT Data Analysis Report**

I. ALERT Data Source

Raw ALERT data records extracted from the Urban Drainage and Flood Control District's NovaStar 5 base station were analyzed for the period January 1 through December 31, 2014.

II. General System Analysis Summary

In 2014 data was received at the District through both the legacy ALERT channel and through the ALERT2 (concentrator plus A2 self-reports) channel. The following (Table 1) quantifies the data reception through each telemetry source. The West Creek repeater in Douglas County processes both incoming legacy and ALERT2 but passes on only concentrator ALERT2 format messages to Diamond Hill. All other repeaters in the system send data on both legacy and ALERT2 channels.

Table 1. Reception of A1/A2 Data at Diamond Hill

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Legacy	320,303	214,698	279,782	293,137	351,946	318,434	308,775	282,598	271,188	276,732	246,901	248,002
Concentrator	508,306	370,222	495,874	515,526	537,996	430,118	475,605	453,331	440,796	431,441	415,746	418,059
ALERT2	129,855	86,506	110,086	107,478	113,674	109,244	130,087	354,119	354,822	218,687	210,943	208,261
TOTAL	**958,464**	**671,426**	**885,742**	**916,141**	**1,003,616**	**857,796**	**914,467**	**1,090,048**	**1,066,806**	**926,860**	**873,590**	**874,322**
Conc+A2	638,161	456,728	605,960	623,004	651,670	539,362	605,692	807,450	795,618	650,120	626,689	626,320
Conc/Leg	1.59	1.72	1.77	1.76	1.53	1.35	1.54	1.60	1.63	1.56	1.68	1.68
DataChron	498,846	444,211	599,923	630,962	663,576	583,568	654,910	705,565	694,923	610,674	589,452	594,231

The District operates two redundant NovaStar5 base stations: a primary base station (ns5a) at Diamond Hill and a redundant base (ns5b) at Green House Data. Additional analyses are conducted on the data received by these two base stations (Table 2).

Table 2. Comparison of Data Reception by Diamond Hill (ns5a) and Green House (ns5b)

NS5A (Diamond Hill)	**Apr***	**May***	**Jun**	**Jul**	**Aug**	**Sep**	**Total (Jun–Sep)**
Legacy	293,137	351,946	318,434	298,562	282,598	271,188	1,170,782
Concentrator	515,525	537,996	430,118	461,794	453,331	440,796	1,786,039
ALERT2	107,478	113,674	109,244	123,982	354,119	354,822	942,167
NS5B (Green House)							
Legacy	282,737	192,514	318,341	298,416	282,357	271,193	1,170,307
Concentrator	497,679	288,132	430,703	462,334	454,017	442,822	1,789,876
ALERT2	104,180	59,261	110,843	124,595	356,665	359,423	951,526
Diff (ns5a-ns5b)							
Legacy	10,400	159,432	93	146	241	- 5	475
Concentrator	17,846	249,864	- 585	- 540	- 686	-2,026	-3,837
ALERT2	3,298	54,413	-1,599	- 613	-2,546	-4,601	-9,359

*-Incomplete data sets from ns5b for these months

Except for the months of April and May, the reception of legacy reports is consistent between the Diamond Hill server (ns5a) and the Green House server (ns5b). Incomplete data sets from ns5b prohibit the comparison of received data for the months of April and May.

The reception of concentrator and ALERT2 reports between ns5a and ns5b is NOT consistent. The server at Green House Data (ns5b) generally receives more reports than does the server at Diamond Hill (ns5a). In particular the Green House server seems to receive more ALERT2 direct reports. An effort to quantify the difference for an ALERT2 self-reporting site, Sand Creek at Colfax (10016) is provided (Table 3).

Table 3. ALERT2 Reports Received at Each Server from Sand Creek at Colfax (10016) – September 2014

Sensor	Diamond Hill (ns5a)	Green House (ns5b)	Difference (ns5a-ns5b)	Comments
100160	2,503	2,714	-211	Total reports for September
100167	2,364	2,562	-198	
100168	2,289	2,478	-189	

Pass-filtering does not exist on the ALERT2 repeaters so the data from an ALERT2 self-reporting site is received and re-broadcast by multiple repeaters. A single report from the Sand Creek at Colfax location is received four times at the base through the following repeaters: Smoky Hill (source address 6502), Blue Mountain (6503), Lee Hill (6505) and Gold Hill (6506). The quantification of ALERT2 reports received through each repeater from sensor 100160 is provided (Table 4).

Table 4. ALERT2 Reports Received at Each Server from Sensor 100160 Through Each Repeater

Source Repeater	Diamond Hill (ns5a)	Green House (ns5b)	Difference (ns5a-ns5b)	Comments
6502 – Smoky	681	687	-6	
6503 – Blue Mt.	472	669	-197	The majority difference is from SA 6503
6505 – Lee Hill	667	688	-21	
6506 – Gold Hill	683	670	13	
TOTAL	**2,503**	**2,714**	**- 211**	

An attempt to confirm this finding among all the concentrator reports received in September is provided (Table 5).

Table 5. Concentrator Reports Received Through Each Repeater – September, 2014

Source Repeater	Diamond Hill (ns5a)	Green House (ns5b)	Difference (ns5a-ns5b)	Comments
6001 – West Creek	158,060	158,038	22	
6502 – Smoky	87,868	87,969	-103	
6503 – Blue Mt.	112,245	114,056	-1,811	The majority difference is from SA 6503
6505 – Lee Hill	26,904	26,961	-58	
6506 – Gold Hill	55,719	55,798	-76	
TOTAL	**440,796**	**442,822**	**-2,026**	

An interesting finding when looking through all the reports received at both Diamond Hill and Green House Data is that the inconsistency in received concentrator and ALERT2 reports is linked to the Blue Mountain repeater. Approximately 90 percent of the difference in received reports between the two servers can be traced to reports received through Blue Mountain on source address 6503.

The daily ratio of total concentrator reports received versus total legacy ALERT reports received is shown (Figure 1).

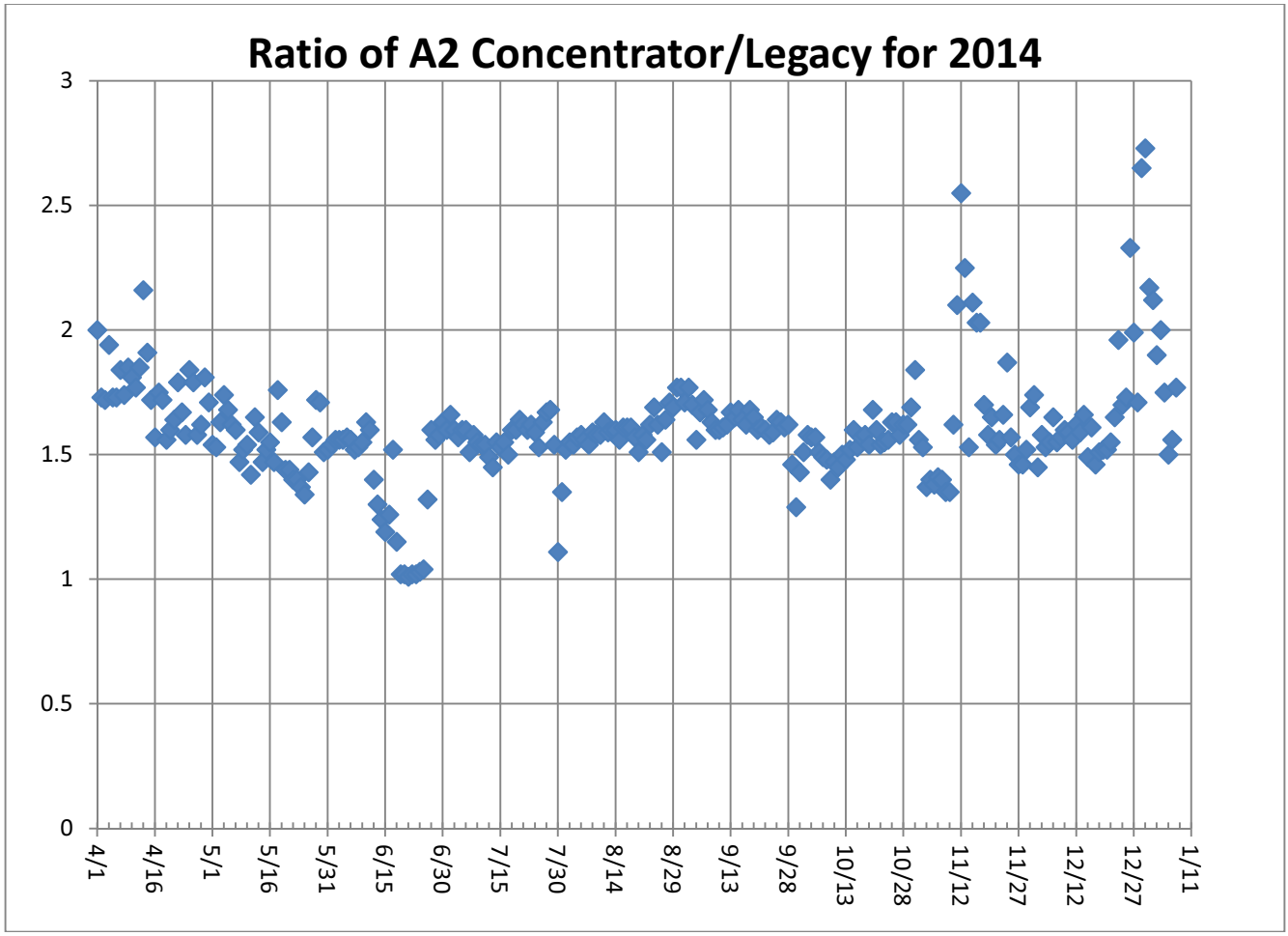


Figure 1. Daily Ratio of Concentrator Reports to Legacy Reports

A ratio in the neighborhood of 1.5 indicates the system is functioning as expected. The ratio is higher than one due to the fact that one repeater in the system (West Creek in Douglas County) forwards only the concentrated reports to Diamond Hill. If the West Creek repeater sent both the concentrated and legacy reports the system-wide ratio would be near one. Of importance are periods where the ratio drops significantly below 1.5. Days when the ratio increases, specifically those days when the ratio exceeds 2.0 are very cold days when the legacy feed from the Blue Mountain repeater is significantly degraded.

June 12 – 26

On Friday, June 13, Markus and Rob traveled to the Douglas County West Creek repeater to troubleshoot and found the repeater was working just fine. On Saturday, June 14, Markus returned to the West Creek repeater to enable the legacy ALERT reporting from West Creek for the Douglas County system. In the evening of June 14, legacy ALERT data reports were being decoded in the parking lot of the Diamond Hill complex using a field decoder and laptop. The legacy ALERT reports however were not being received by the Diamond Hill base station. The evening of June 14, an email was sent from Markus to Kevin Stewart and OneRain indicating there may be a problem with the receiving equipment at Diamond Hill. On Monday, June 16, Kevin Stewart called OneRain to request a service visit to Diamond Hill where it was discovered the receiving antenna had been taken down from the roof and was lying flat on the roof. It turns out that the dismantled antenna was still able to receive data reports from the nearby repeaters and only the furthest repeater, West Creek had a low enough fade margin where its reports were no longer being received. A new antenna was installed by OneRain and full data reception returned on Wednesday, June 18. On Thursday, June 26, WET returned to West Creek to disable the legacy ALERT reporting and enable the concentrator and A2 channel to Diamond Hill.

July 30 – 31
Intermittent reception of concentrator and A2 reports was identified on July 30, 2014. OneRain traced the intermittent data problem to the A2 decoder and the network IP feed to both District base stations as well as the OneRain base station in Longmont.

As of July 31, the exact problem has not been determined. According to OneRain, the source of the problem is likely one of the following:

- The linux board on the A2 decoder
- The cat5 cable from the A2 decoder on the roof to the server room is damaged
- The network at Diamond Hill has latency issues

Both OneRain and WET have implemented alarm criteria to notify when the latency issues are again observed. Another rain event is likely needed to reproduce the latency issue to pin-point the problem.

On July 31 data reception issues were also identified on the legacy ALERT feed to ns5a and ns5b. The legacy ALERT feed also employs an IP routing device but it is completely separate from the A2 IP routing mechanism. Since problems were noticed on both the A2 and legacy data channels a problem with the network may have played a role in the data interruption experienced on July 30 and 31.

September 30
On September 30th the ratio of concentrator to legacy reports decreases significantly. Intermittent latency from the ALERT2 decoder was identified as the problem. On October 1, the following email was received from OneRain.

"We have isolated the problem to the B2010 receiver/decoder. The B2010 is getting hung up with writing logs to the internal SD card and outputting data to our servers. We have been in contact with BWD and they will be further looking into the situation and possibly applying diagnostic tools."

November 3 - 8
Several days in early November experienced latency on the concentrator channel at Diamond Hill. As of December 19, 2014, this issue has not been resolved and OneRain has since involved Blue Water Design to investigate. On November 7, the following email was received from OneRain.

"BWD has been taking lead on this. They implemented some monitoring software in the B2010. We have not heard back of what they have discovered or the next course of action."

December 5
In early December an inquiry was made to Blue Water Design (BWD) regarding resolution to the latency issue. The following email was received from BWD on December 5.

"I'm a bit taken by surprise by this thread of messages. I haven't been copied on this thread and I'm unaware of the evidence for Scott's assertion that "We have isolated the problem to the B2010 receiver/decoder." David Van Wie developed software to log some timing data on the B2010 to try and isolate the problem, but AFAIK there has not be an latency occurrence since it was installed. And it wasn't clear the logging would definitively isolate the problem anyway. One theory that has been proposed is that the Ethernet cable to the B2010 on the roof is failing in heavy rain since the failures have occurred only in those condition. To diagnose the source of the problem I proposed to OneRain implementing a separate logging of the serial and IP output from the B2010 with time tagging actually inside the NEMA box on the roof at Diamond Hill. Scott has never replied to my request to borrow a CSI data logger for that testing. I've also suggested that the installation of UDFCD's second B2010 at a backup location with a different Ethernet network may also provide evidence of whether it is or is not a directly a B2010 issue. Since it appears that OneRain has decided that it is no longer a joint problem, when I return from vacation, BWD will investigate further and attempt to find a way to do the external logging I proposed back at the end of October, or at least setup a B2010 at BWD and begin time tagging IP output at computer to see if the problem can be recreated in a different network environment."

A. ALERT2 Concentrator Reception vs Legacy

The reception of both concentrator and legacy reports for three sensors is presented for the entire operational (April through October) year: Aurora Town Hall Relative Humidity (921), Marston Lake North Wind (1525) and Blue Mountain Air Temperature (142). A one-to-one relationship is expected when comparing the concentrated reports against the legacy reports for these three sensors on any of the three District base stations (Diamond Hill – ns5a, Green House Data – ns5b, OneRain Contrail).

Server	Sensor	Source	April	May	June	July	Aug	Sep	Oct
Diamond Hill (ns5a)	921	Legacy	707	726	422	659	548	95	152
	921	Concentrator	716	743	722	703	724	715	733
		Ratio	*1.01*	*1.02*	*1.71*	*1.07*	*1.32*	*7.53*	*4.82*
	1525	Legacy	2,724	2,878	1,434	2,719	2,652	2,111	2,164
	1525	Concentrator	2,811	2,928	1,437	2,840	2,856	2,493	2,497
		Ratio	*1.03*	*1.02*	*1.00*	*1.05*	*1.08*	*1.19*	*1.15*
	142	Legacy	2,792	2,853	2,837	2,900	2,901	2,799	2,940
	142	Concentrator	2,917	2,978	2,875	2,934	2,957	2,545	2,772
		Ratio	*1.05*	*1.01*	*1.01*	*1.01*	*1.02*	*0.91*	*0.94*
OneRain Contrail Base in Longmont	921	Legacy	655	691	352	582	455	29	68
	921	Concentrator	714	741	724	698	723	719	736
		Ratio	*1.09*	*1.07*	*2.06*	*1.20*	*1.59*	*24.79*	*10.82*
	1525	Legacy	2,682	1,775	622	2,831	2,644	2,250	2457
	1525	Concentrator	2,737	1,771	621	2,804	2,657	2,252	2414
		Ratio	*1.02*	*1.00*	*1.00*	*1.00*	*1.01*	*1.00*	*0.98*
	142	Legacy	2,805	2,903	2,864	2,953	2,804	2,726	2,955
	142	Concentrator	2,872	2,942	2,872	2,952	2,962	2,840	2,940
		Ratio	*1.02*	*1.01*	*1.00*	*1.00*	*1.06*	*1.04*	*0.99*
Green House (ns5b)	921	Legacy	685	381	422	656	548	95	151
	921	Concentrator	694	387	722	700	725	716	736
		Ratio	*1.01*	*1.01*	*1.71*	*1.07*	*1.32*	*7.53*	*4.87*
	1525	Legacy	2,634	1,506	1,433	2,708	2,650	2,111	2,157
	1525	Concentrator	2,722	1,521	1,444	2,847	2,864	2,498	2,520
		Ratio	*1.03*	*1.01*	*1.01*	*1.05*	*1.08*	*1.18*	*1.17*
	142	Legacy	2,704	1,507	2,836	2,888	2,895	2,799	2,931
	142	Concentrator	2,826	1,553	2,874	2,933	2,961	2,801	2,909
		Ratio	*1.05*	*1.03*	*1.01*	*1.02*	*1.02*	*1.00*	*0.99*

In general the reception of concentrator reports throughout the year is better than the reception of legacy reports which is to be expected. This is evidenced by the fact that the ratios are typically greater than one. Of interest are periods when the ratio greatly exceeds one which may indicate degradation of the legacy channel and periods when the ratio is less than one which may indicate degradation on the concentrator channel. Two such periods are evident.

In September and October the ratio for Aurora Town Hall (921) greatly exceeds one. A review of the data shows a marked decrease in the received legacy reports on all three base stations. The reason for this decrease is not known.

In September and October the ratio for Blue Mt. Air Temp (142) drops below one. A review of the data shows a decrease in the number of received reports on the concentrator channel. The Blue Mt. Air Temp (142) sensor reports every 15 minutes resulting in 96 reports per day. A plot showing the daily reports from both legacy and concentrator channels is provided for the entire year (Figure 2). The problem with the concentrator feed begins September 13 and seems to be resolved by the end of October.

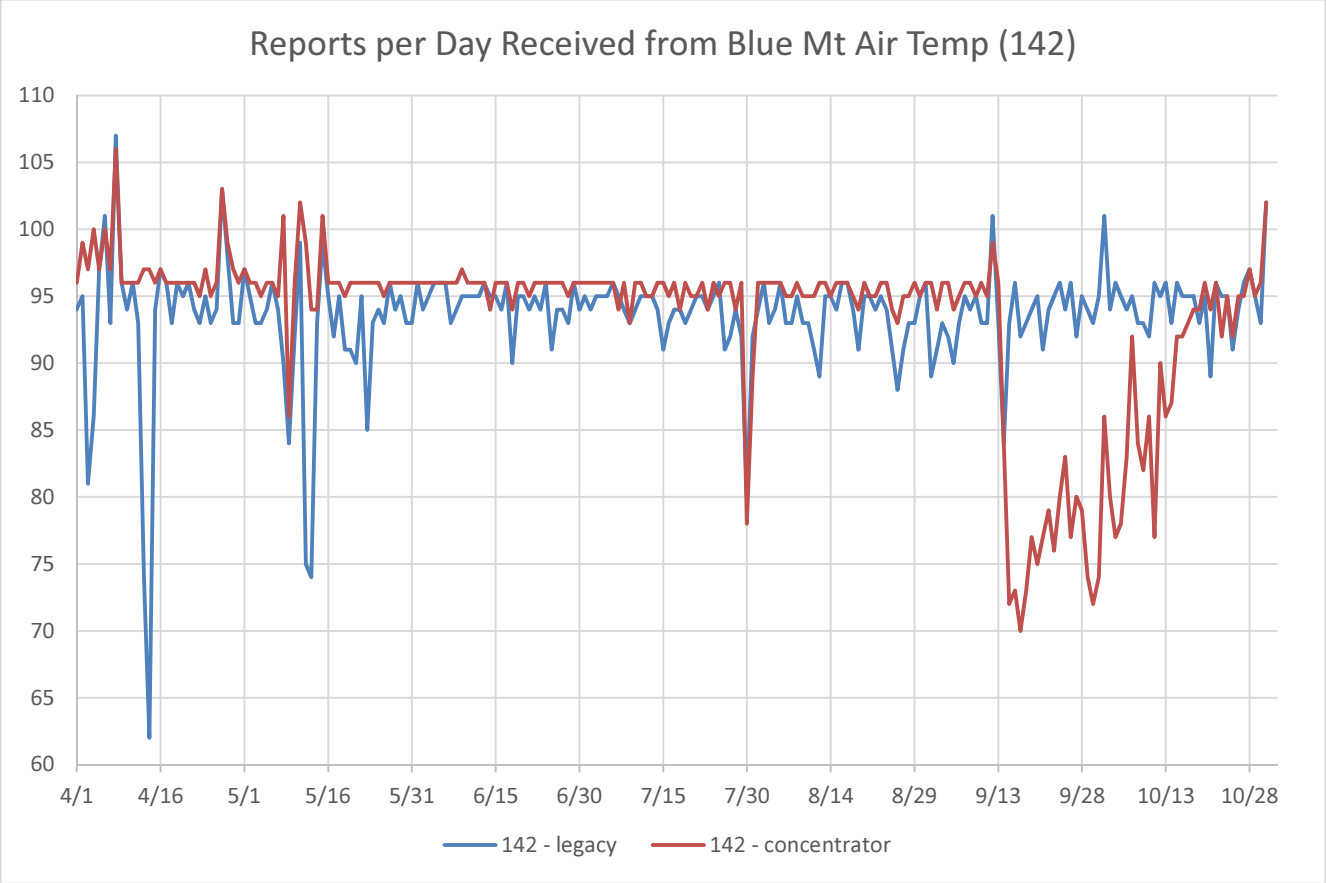


Figure 2. Daily Reports from Blue Mt. Air Temp (142) on Legacy and Concentrator Channels

B. Continuous Operation of Base Receiver/Decoder

The NS5 base stations were NOT in continuous operation for the entire year. Intermittent reception of concentrator and A2 reports was identified on several occasions during 2014. The intermittent data may be linked to an issue with the A2 decoder and/or the network IP feed to both District base stations as well as the OneRain base station in Longmont.

C. 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 6).

Table 6. Monthly Summary of Sensors with Poor Timer Performance (Sensor ID)

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*
4470	2710	2790	2810	1700	2810	4330	4330	4770	4220	2750	2330
2710	4470	2710	2330	4330	100150	2360	2360	2360	4850	2330	4240
2330	2730	4470	2360	2330	100140	1660	1660	4330	2710	4470	4470
4870	4550	4870	420	1710	2750	2330	3090	2330	2750	4330	4870
920	3010	3010	1700	940	4330	2280	540	2790	4330	4870	4330
3010	4330	4330	1710	100150	2330	100150	2330	1710	2790	4220	2320

***- 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.

Two sites show poor performance characteristics throughout the year: Morrison (ID 2330) and Hansen (4330).

III. 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 7). 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 7. District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	8.11	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	6.5	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	27.69	Only the 1-mm rain sensors were included in the analysis
Mean minus two standard deviations	0	Only the 1-mm rain sensors were included in the analysis
Minimum total count	1	Several sites
Maximum total count	24	Justice Center (4360)
Sensors showing **NO** rain for the month	4	IDs 2980, 4730, 4060, 1570
Sensors greater than 3 SD (over reporting)		None
Sensors less than 2 SD (under reporting)		None

B. Monthly Average Tip/Count Summary

A monthly summary of the District-wide mean total tip/count is presented (Table 8).

Table 8. 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	48.81	22.32	2.98	4.18	22.66
2013	2.96	14.31	21.86	35.96	45.87	16.39	52.33	50.63	229.74	29.64	5.86	4.00	42.46
2014	6.88	11.86	25.91	29.30	77.30	29.16	99.73	43.59	50.96	29.26	13.36	8.11	35.54

***- 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 9).

Table 9. Sensors with a Jump of 6 or More in Sequential Count

Sensor Description	Sensor ID	Comment
None		None this month

D. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 97 percent. A total of 608 incrementing reports were received and a total of 625 reports were expected. The total loss of incrementing reports for the month was approximately 3 percent. Those sensors with the worst event transmission performance are summarized (Table 10).

Table 10. Monthly Summary of Sensors with the Worst Performance

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov*	Dec*
4520	2730	2790	2980	4330	5940	650	3090	2330	4470	4490	4240
4010	4330	4790	2230	100150	310	4470	2360	2360	4520	140	4870
4170	4200	4530	4510	4470	2980	2320	2980	4470	4570	4510	4820
3030	4240	4510	3050	2980	1620	2970	2800	2970	4840	4330	4470
1460	4870	4240	2330	2330	2790	2360	310	1660	4870	4080	4790
1700	4470	4870	100150	5900	4470	2980	2330	4330	4490	2730	2320

***-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.

The sensors showing the worst performance for the year include: Little Narrows (4470) and Morrison (2330).

IV. Heavy Radio Traffic Analysis

Periods exceeding 1,000 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 11). The five heaviest hours of radio traffic are analyzed to quantify the number of missing rain reports for that hour.

Table 11. Periods of Heavy Radio Traffic (total load includes Concentrator and A2 and Legacy reports)

Day	Hour	Expected	Received	Total Load	Loss
23	12	5	4	1646	20.00%
23	14	1	1	1633	0.00%
23	11	5	5	1602	0.00%
23	13	1	1	1596	0.00%
23	10	1	1	1557	0.00%

V. 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 12).

Table 12. Summary of Unknown IDs

Description	Concentrator	Legacy
Total number of unknown IDs (IDs without a device definition)	218	255
Total reports from unknown IDs	1,099	1,135
Unknown IDs with only a single received report (potential noise)	113	156
Total reports from all IDs – RecData Log entire month	418,059	248,002
Unknown reports as a fraction of total reports	0.26%	0.46%

The total number of reports from unknown sensors is very small relative to the total reports received for the month. Shown below (Table 13) are the total reports received from unknown sensor IDs for each month of the year.

Table 13. Monthly Summary of Total Reports from Unknown IDs (Concentrator)

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	774	2,657	3,854	5,466
2013	4,265	994	1,100	2,589	3,623	6,973	5,230	1,070	4,429	781	13,459	1,213
2014	870	4,284	2,399	2,104	25,746	1,832	3,983	268	369	448	470	1,099

The fraction of reports from unknown sensors relative to the total number of reports is shown below (Table 14).

Table 14. Monthly Percent of Unknown Sensor Reports (Concentrator)

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%	0.20%	0.72%	1.15%	1.62%
2013	1.40%	0.31%	0.29%	0.60%	0.37%	0.61%	0.82%	0.21%	0.96%	0.31%	5.37%	0.23%
2014	0.14%	0.94%	0.40%	0.34%	3.95%	0.34%	0.66%	0.03%	0.03%	0.07%	0.11%	0.26%

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 15).

Table 15. Reports Received by Unknown IDs

Concentrator		Legacy ALERT		
Unknown ID	**Reports**	**Unknown ID**	**Reports**	**Comment**
207	130	207	134	May be emanating from Leyden Reservoir (ID 200)
206	123	206	130	May be emanating from Leyden Reservoir (ID 200)
208	121	208	123	May be emanating from Leyden Reservoir (ID 200)
202	99	202	107	May be emanating from Leyden Reservoir (ID 200)
201	82	201	86	May be emanating from Leyden Reservoir (ID 200)
1470	23	1470	24	
2239	11	2239	11	

VI.Sensors with Invalid Reports

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

Sensor ID	Description	Invalid Reports	Comments
2810	Pine Cliff Road	3	This site is out of service
1420	WX-Diamond Hill	2	Random decodes
1530	Bear Creek at Lowell	9	This site is out of service
140	WX-Blue Mt	2	Random decodes
2320	Choke Cherry Res	2	Random decodes
4060	Lakeshore	2	Random decodes
4200	Lazy Acres	2	Random decodes

VII. Rainfall Alarms and Intensity Analysis

The following rainfall rate alarms from the Urban Drainage and Flood Control District NovaStar 5.0 Web Server were identified this month.

No alarms this month.

ID	Description	Alarm Description	Date/Time	Threshold (in)	Total Rain (in)

General System Analysis

Database Name	P:\A207-UDFCD-Data-Analysis\2014\12-2014\Novastar_extract_2014Dec.mdb

First Date in Database	11/30/14 11:59 PM	**Total Days**	31.0
Last Date in Database	12/31/14 11:59 PM	**Total Hours**	744.0

Total Records Analyzed 418,058

Records by Group	**Concentrator**	**Percent**	**Legacy**	**Percent**
Wind Data	175,290	42%	95,582	39%
Temperature	71,635	17%	37,585	15%
Relative Humidity	64,666	15%	38,299	15%
Barometric Pressure	36,351	9%	22,013	9%
Battery Voltage	18,348	4%	9,319	4%
Water Level	12,443	3%	11,193	5%
Solar Radiation	10,802	3%	10,382	4%
Fuel Moisture	5,839	1%	5,453	2%
Fuel Temperature	5,824	1%	5,458	2%
Precipitation	5,509	1%	4,691	2%
Wind Direction	3,970	1%	0	0%
Soil Moisture	2,815	1%	2,508	1%
Repeater Status Report	2,340	1%	2,839	1%
Unknown	1,099	0%	1,135	0%
ET-Hourly	732	0%	728	0%
12Hr Status Report	194	0%	174	0%
Repeater Pass List	70	0%	552	0%
Not Used	54	0%	53	0%
GPS Lock	32	0%	0	0%
ET-Daily	31	0%	22	0%
Solar Power	10	0%	11	0%
Handar 585 ALARM Status	4	0%	4	0%
Total	**418,058**	**100%**	**248,001**	**100%**

Traffic Loading Summary	**Concentrator**		**Legacy**	
Alert Reports	418,058		248,001	
Average Daily Traffic	13,064		8,000	
Average Hourly Traffic	544		333	
Median Hourly Traffic	555	hour beginning	345	hour beginning
Peak Hourly Traffic	909	Dec 23, 11:00 AM	540	Dec 15, 9:00 AM
2nd Max	907	Dec 23, 12:00 PM	482	Dec 15, 11:00 AM
3rd Max	894	Dec 23, 10:00 AM	477	Dec 23, 2:00 PM
4th Max	880	Dec 23, 2:00 PM	464	Dec 23, 12:00 PM
5th Max	870	Dec 23, 1:00 PM	455	Dec 1, 11:00 PM

Rain Timer Performance

Analyze Rain Sensors

Rain Sensors	Description	Rcv	Timer	Exp	Performance	Comment
2330	Morrison	27	21:48	62	44%	
4240	Sunset	28	17:43	62	45%	
4470	Little Narrows	36	14:40	62	58%	
4870	SBC @ SB Road	36	18:24	62	58%	
4330	Hansen Rain	44	16:09	62	71%	
2320	Choke Cherry Resvr	48	13:05	62	77%	
4270	Cannon Mountain	50	13:44	62	81%	
1660	SPR at Henderson	52	14:12	62	84%	
2750	Wx-Castle Rock	52	12:00	62	84%	
700	Toll Gate @ 6th	53	12:30	62	85%	
4510	Pinewood Springs	53	13:17	62	85%	
2980	Dakan Rd	55	13:19	62	89%	
2710	Wx-Highlands Ranch WTP	56	12:28	62	90%	
4190	Slaughterhouse	56	13:04	62	90%	
3010	WX-EPC at Hwy 105	57	12:00	62	92%	
4490	Apple Valley	57	12:12	62	92%	
1440	Wx-Elbert	58	12:25	62	94%	
1460	Wx-Urban Farm	58	12:41	62	94%	
1640	SPR at Union Ave.	58	12:12	62	94%	
2730	Wx-Salisbury Park	58	12:40	62	94%	
2790	Wx-W. Cherry Creek	58	12:27	62	94%	
4010	Cresent	58	12:37	62	94%	
4070	Bear Peak	58	12:36	62	94%	
3030	WX-Bingham Lake Park	59	12:00	62	95%	
4050	Walker Ranch	59	12:10	62	95%	
4060	Lakeshore	59	12:22	62	95%	
4180	Gold Lake	59	12:23	62	95%	
4200	Lazy Acres	59	12:27	62	95%	
4250	Geer Canyon	59	12:25	62	95%	
4340	Riverside	59	12:22	62	95%	
4530	Winiger Ridge	59	12:10	62	95%	
4810	Shanahan Ridge	59	12:24	62	95%	
4820	Doudy Draw	59	12:11	62	95%	
900	Wx-Aurora Reservoir	60	12:00	62	97%	
1420	Wx-Diamond Hill	60	12:13	62	97%	
1570	Wx-Brighton Ditch	60	12:12	62	97%	
1700	Cherry Cr @ Champa	60	11:59	62	97%	
2210	Wx-Hiwan G.C.	60	12:13	62	97%	
3020	Wx-West Creek WX	60	12:00	62	97%	
4030	Red Garden	60	11:59	62	97%	
4080	Twin Sisters	60	11:58	62	97%	
4090	Magnolia	60	12:11	62	97%	
4100	Filter Plant	60	12:13	62	97%	
4110	Betasso	60	12:14	62	97%	
4220	Fling's	60	12:10	62	97%	
4290	Red Hill	60	12:10	62	97%	
4300	Big Elk Park	60	12:10	62	97%	
4310	Johnny Park	60	12:11	62	97%	
4320	Lee Hill Rain 2012	60	12:11	62	97%	
4360	Justice Center	60	12:11	62	97%	
4520	Eagle Ridge	60	12:13	62	97%	
4550	Boulder Jail	60	12:11	62	97%	
4730	Wx-Sugarloaf	60	12:12	62	97%	
4790	Wx-Button Rock	60	12:13	62	97%	

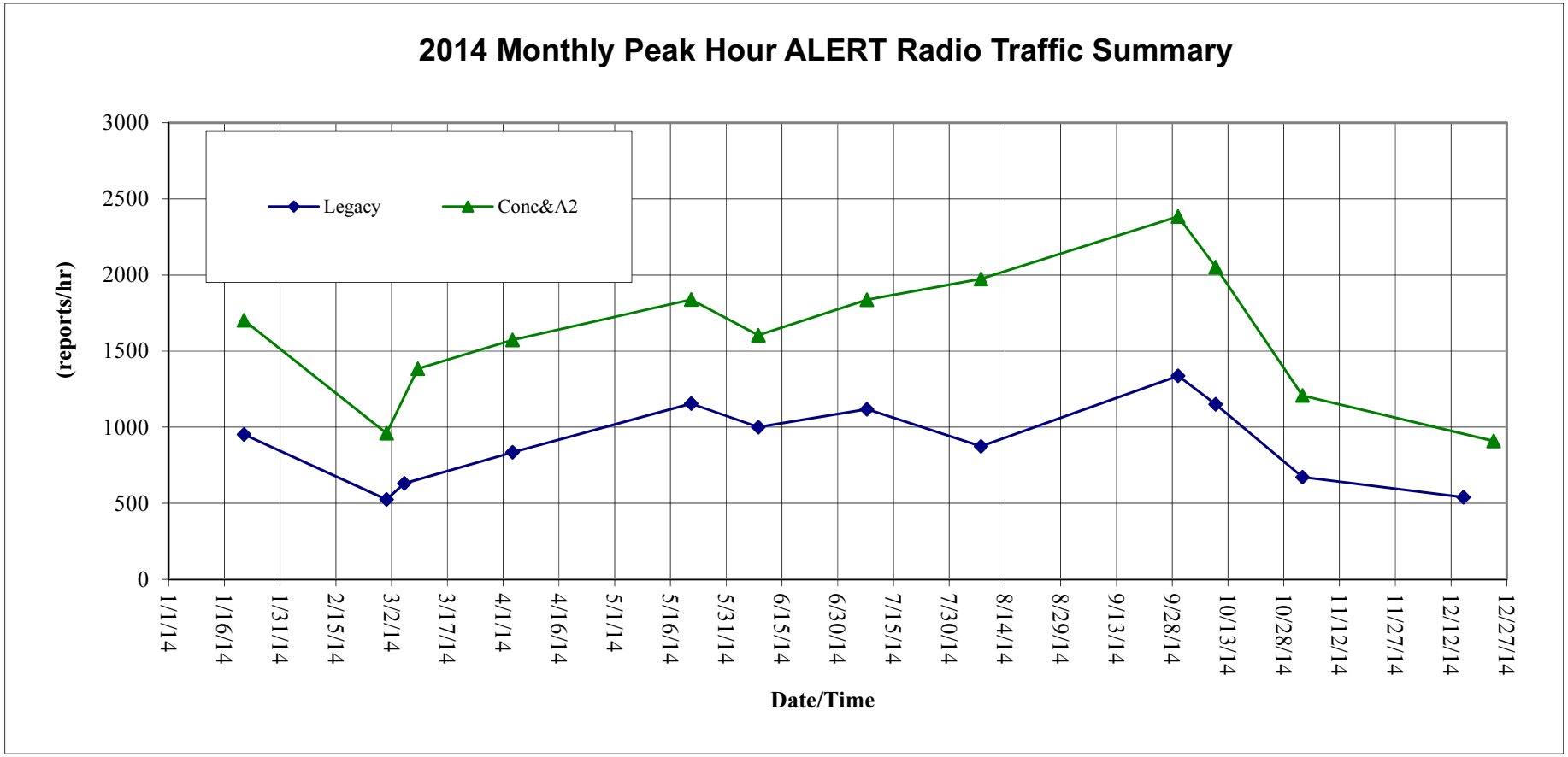
4830	SBC @ San Souci	60	12:11	62	97%
140	Wx-Blue Mountain	61	12:00	62	98%
750	Wx-Quincy Reservoir	61	11:57	62	98%
920	Wx-Aurora Town Hall	61	12:00	62	98%
970	Pump Sta 3	61	12:00	62	98%
1520	Wx-Marston Lake North	61	12:00	62	98%
1920	Wx-Brighton	61	12:00	62	98%
2930	Wx-Spring Valley Rd-DougCnty	61	12:00	62	98%
2990	Wx-Tomah Rd-DougCnty	61	12:00	62	98%
4020	Rio Grande	61	11:57	62	98%
4040	Martin Gulch	61	11:58	62	98%
4130	Swiss Peaks	61	11:59	62	98%
4140	Logan Mill	61	11:58	62	98%
4150	Gold Hill	61	11:58	62	98%
4160	Sunshine	61	11:58	62	98%
4170	Pine Brook	61	11:57	62	98%
4260	Taylor Mountain	61	11:58	62	98%
4350	Conifer Hill	61	11:58	62	98%
4570	St. Antons	61	11:59	62	98%
4710	Wx-Ward C-1	61	12:00	62	98%
4750	Wx-Louisville Lake	61	12:00	62	98%
4770	Wx-Cal-Wood Ranch	61	12:00	62	98%
4840	SBC@S Boulder Ditch	61	11:57	62	98%
4860	Fairview Peak	61	12:00	62	98%
4880	Whispering Pines	61	11:57	62	98%
4230	Golden Age	62	11:57	62	100%
200	Leyden Reservoir	64	11:19	62	103%
870	A2-Murphy Creek GC	207	out of service	62	
1000	A2-Maple Grove Resv.	249	out of service	62	

Rain Event Performance

Analyze Rain Sensors

		Reports Received	608													
	Systemwide Avg	Total Tips	625													
	97.28%	Data Loss	2.72%													
Description	**Sensor**	**Performance**	**1-tips**	**2-tips**	**3-tips**	**4-tips**	**5-tips**	**6-tips**	**>6-tips**	**Rcv**	**Exp**	**Miss**	**Hold**	**Bucket**		
Sunset	4240	50%	0	1	0	0	0	0	0	1	2	1	0	0.03937		
SBC @ SB Road	4870	80%	13	2	1	0	0	0	0	16	20	4	0	0.03937	Mean	8.1169
Doudy Draw	4820	85%	10	0	1	0	0	0	0	11	13	2	0	0.03937	Median	6
Little Narrows	4470	86%	5	1	0	0	0	0	0	6	7	1	0	0.03937	St. Dev	6.5252
Wx-Button Rock	4790	86%	5	1	0	0	0	0	0	6	7	1	0	0.03937	Mean plus 3 SD	27.692
Choke Cherry Resvr	2320	88%	6	1	0	0	0	0	0	7	8	1	0	0.03937	Min	1
Morrison	2330	91%	9	1	0	0	0	0	0	10	11	1	0	0.03937	Max	36
Wx-Tomah Rd-DougCnty	2990	91%	19	2	0	0	0	0	0	21	23	2	0	0.03937		
Lazy Acres	4200	92%	11	1	0	0	0	0	0	12	13	1	0	0.03937		
Red Garden	4030	95%	18	1	0	0	0	0	0	19	20	1	0	0.03937		
Betasso	4110	95%	20	1	0	0	0	0	0	21	22	1	0	0.03937		
WX-EPC at Hwy 105	3010	97%	34	1	0	0	0	0	0	35	36	1	0	0.01		
Wx-Blue Mountain	140	100%	4	0	0	0	0	0	0	4	4	0	0	0.03937		
Leyden Reservoir	200	100%	12	0	0	0	0	0	0	12	12	0	0	0.03937		
Toll Gate @ 6th	700	100%	7	0	0	0	0	0	0	7	7	0	0	0.03937		
Wx-Quincy Reservoir	750	100%	5	0	0	0	0	0	0	5	5	0	0	0.03937		
Wx-Aurora Reservoir	900	100%	4	0	0	0	0	0	0	4	4	0	0	0.03937		
Wx-Aurora Town Hall	920	100%	4	0	0	0	0	0	0	4	4	0	0	0.03937		
Pump Sta 3	970	100%	3	0	0	0	0	0	0	3	3	0	0	0.03937		
Wx-Diamond Hill	1420	100%	16	0	0	0	0	0	0	16	16	0	0	0.03937		
Wx-Elbert	1440	100%	1	0	0	0	0	0	0	1	1	0	0	0.03937		
Wx-Urban Farm	1460	100%	5	0	0	0	0	0	0	5	5	0	0	0.03937		
Wx-Marston Lake North	1520	100%	15	0	0	0	0	0	0	15	15	0	0	0.03937		
SPR at Union Ave.	1640	100%	13	0	0	0	0	0	0	13	13	0	0	0.03937		
SPR at Henderson	1660	100%	3	0	0	0	0	0	0	3	3	0	0	0.03937		
Cherry Cr @ Champa	1700	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937		
Wx-Brighton	1920	100%	2	0	0	0	0	0	0	2	2	0	0	0.03937		
Wx-Hiwan G.C.	2210	100%	5	0	0	0	0	0	0	5	5	0	0	0.03937		
Wx-Highlands Ranch WTP	2710	100%	7	0	0	0	0	0	0	7	7	0	0	0.03937		
Wx-Salisbury Park	2730	100%	4	0	0	0	0	0	0	4	4	0	0	0.03937		
Wx-Castle Rock	2750	100%	2	0	0	0	0	0	0	2	2	0	0	0.03937		
Wx-W. Cherry Creek	2790	100%	6	0	0	0	0	0	0	6	6	0	0	0.03937		
Wx-Spring Valley Rd-DougCnty	2930	100%	2	0	0	0	0	0	0	2	2	0	0	0.03937		
Wx-West Creek WX	3020	100%	14	0	0	0	0	0	0	14	14	0	0	0.03937		
WX-Bingham Lake Park	3030	100%	18	0	0	0	0	0	0	18	18	0	0	0.03937		
Cresent	4010	100%	2	0	0	0	0	0	0	2	2	0	0	0.03937		
Rio Grande	4020	100%	2	0	0	0	0	0	0	2	2	0	0	0.03937		
Martin Gulch	4040	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937		
Walker Ranch	4050	100%	2	0	0	0	0	0	0	2	2	0	0	0.03937		
Bear Peak	4070	100%	4	0	0	0	0	0	0	4	4	0	0	0.03937		
Twin Sisters	4080	100%	3	0	0	0	0	0	0	3	3	0	0	0.03937		
Magnolia	4090	100%	4	0	0	0	0	0	0	4	4	0	0	0.03937		
Filter Plant	4100	100%	14	0	0	0	0	0	0	14	14	0	0	0.03937		
Swiss Peaks	4130	100%	4	0	0	0	0	0	0	4	4	0	0	0.03937		
Logan Mill	4140	100%	4	0	0	0	0	0	0	4	4	0	0	0.03937		
Gold Hill	4150	100%	3	0	0	0	0	0	0	3	3	0	0	0.03937		
Sunshine	4160	100%	1	0	0	0	0	0	0	1	1	0	0	0.03937		
Pine Brook	4170	100%	3	0	0	0	0	0	0	3	3	0	0	0.03937		
Gold Lake	4180	100%	2	0	0	0	0	0	0	2	2	0	0	0.03937		
Slaughterhouse	4190	100%	4	0	0	0	0	0	0	4	4	0	0	0.03937		
Fling's	4220	100%	10	0	0	0	0	0	0	10	10	0	0	0.03937		
Golden Age	4230	100%	1	0	0	0	0	0	0	1	1	0	0	0.03937		

Geer Canyon	4250	100%	14	0	0	0	0	0	0	14	14	0	0	0.03937		
Taylor Mountain	4260	100%	8	0	0	0	0	0	0	8	8	0	0	0.03937		
Cannon Mountain	4270	100%	3	0	0	0	0	0	0	3	3	0	0	0.03937		
Red Hill	4290	100%	6	0	0	0	0	0	0	6	6	0	0	0.03937		
Big Elk Park	4300	100%	5	0	0	0	0	0	0	5	5	0	0	0.03937		
Johnny Park	4310	100%	17	0	0	0	0	0	0	17	17	0	0	0.03937		
Lee Hill Rain 2012	4320	100%	12	0	0	0	0	0	0	12	12	0	0	0.03937		
Hansen Rain	4330	100%	5	0	0	0	0	0	0	5	5	0	0	0.03937		
Riverside	4340	100%	6	0	0	0	0	0	0	6	6	0	0	0.03937		
Conifer Hill	4350	100%	3	0	0	0	0	0	0	3	3	0	0	0.03937		
Justice Center	4360	100%	24	0	0	0	0	0	0	24	24	0	0	0.03937		
Apple Valley	4490	100%	8	0	0	0	0	0	0	8	8	0	0	0.03937		
Pinewood Springs	4510	100%	8	0	0	0	0	0	0	8	8	0	0	0.03937		
Eagle Ridge	4520	100%	8	0	0	0	0	0	0	8	8	0	0	0.03937		
Winiger Ridge	4530	100%	3	0	0	0	0	0	0	3	3	0	0	0.03937		
Boulder Jail	4550	100%	11	0	0	0	0	0	0	11	11	0	0	0.03937		
St. Antons	4570	100%	1	0	0	0	0	0	0	1	1	0	0	0.03937		
Wx-Ward C-1	4710	100%	7	0	0	0	0	0	0	7	7	0	0	0.03937		
Wx-Louisville Lake	4750	100%	7	0	0	0	0	0	0	7	7	0	0	0.03937		
Wx-Cal-Wood Ranch	4770	100%	7	0	0	0	0	0	0	7	7	0	0	0.03937		
Shanahan Ridge	4810	100%	6	0	0	0	0	0	0	6	6	0	0	0.03937		
SBC @ San Souci	4830	100%	9	0	0	0	0	0	0	9	9	0	0	0.03937		
SBC@S Boulder Ditch	4840	100%	12	0	0	0	0	0	0	12	12	0	0	0.03937		
Fairview Peak	4860	100%	5	0	0	0	0	0	0	5	5	0	0	0.01		
Whispering Pines	4880	100%	13	0	0	0	0	0	0	13	13	0	0	0.03937		
		Total Tips	593	13	2	0	0	0	0	608	625	17	0			


2014 Monthly Peak Hour ALERT Radio Traffic Summary
(reports/hr)
3000
2500
2000
1500
1000
500
0
Legacy
Conc&A2
1/1/14
1/16/14
1/31/14
2/15/14
3/2/14
3/17/14
4/1/14
4/16/14
5/1/14
5/16/14
5/31/14
6/15/14
6/30/14
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7/30/14
8/14/14
8/29/14
9/13/14
9/28/14
10/13/14
10/28/14
11/12/14
11/27/14
12/12/14
12/27/14
Date/Time