

# Memo



**Date:** April 3, 2007  
**To:** Kevin Stewart and Chad Kudym  
**From:** Markus Ritsch  
**Subject:** March 2007 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 Nova Star 4.0 base station (ALERT 2) were analyzed for the period March 1 through March 31, 2007.

## II. General System Analysis Summary

A total of 191,094 individual data records were analyzed. Meteorological sensors accounted for 75 percent, water level sensors 11 percent and rain sensors 6 percent of the total monthly transmissions.

Ninety-eight percent of the received data reports were flagged as "good" by the Nova Star validation process. Roughly 4,421 reports were flagged as "bad". Of these "bad" reports, 3,666 originated from the wind sensor (ID 2189 and 2187) at Squaw Mountain.

The system-wide radio traffic loading this month was 6,164 reports per day with an average hourly loading of 257 reports. The peak hourly traffic load was 679 reports, which occurred on March 24<sup>th</sup> between 11:00 AM and 12:00 PM. A plot of monthly average and peak hourly traffic loading is provided.

A total of zero (0) reports were received from the Hayman gages this month. The Hayman gages were winterized toward the end of October, 2006 and they will be activated again in the spring 2007.

The sensors reporting most frequently this month include:

1. Salisbury Park (ID 2727) with 3,976 reports,
2. Stapleton (ID 1461) with 3,307 reports
3. Quincy Reservoir (ID 747) with 3,164 reports
4. Stapleton (IDs 1464 and 1466) with 2,901, and 2,871 reports respectively.

The reports from the above sensors are distributed evenly throughout the month.

Of interest this month are several sensors that reported infrequently including:

1. Stapleton (ID 1463 – Barometric Pressure) with 4 reports,
2. Stapleton (ID 1469 – Solar) with 1 report, and
3. Cal-Wood Ranch (ID 4767) with 1 report.

### III. Rain Sensor Timer Reporting Summary

The following analysis assumes that each rain sensor has a 12-hour timer reporting interval. System-wide the ALERT 2 base station received approximately 74 percent of the non-incrementing timer reports. The 5 worst-performing rain sensors for the month are summarized (Table 1).

**Table 1. Monthly Summary of Sensors with Poor Timer Performance**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
750	1330	2310									
4470	1460	1710									
4560	2330	2350									
4240	4170	2240									
4510	4470	2250									

Genessee Village (2310), Shop Creek (1710), Idledale (2350), Cold Sprg Glch Conf (2240), and Rosedale (2250)

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.

*The month of March is a period when the District places rain gages back into service after being stored indoors during the winter. Many rain gages, including those in Table 1 have only a partial-month record of timer reports. This partial record skews the performance computation which is based upon the expected number of timer reports received for a complete month.*

The non-incrementing count series was manually inspected for those sensors with a timer reporting percentage of less than 80% (Because the month of March has so many gages that contain only a partial-month of data, the worst performing sensors from the month of February are therefore analyzed below). A brief description of the results from the manual inspection is provided below.

#### 1. Roslyn (ID 1330)

This sensor had a timer reporting percentage of 90% in March.

#### 2. Stapleton (ID 1460)

This sensor had a timer reporting percentage of 48% in March. The timer reports received from this sensor are indicative of a 24-hour reporting interval rather than a 12-hour timer reporting interval.

#### 3. Morrison (ID 2330)

This sensor had a timer reporting percentage of 87% with missing timer reports located sporadically throughout the month.

#### 4. Little Narrows (ID 4470)

This sensor had a timer reporting percentage of 84% with missing timer reports located sporadically throughout the month.

#### 5. Lyons Diversion NSV (ID 4560)

This sensor had a timer reporting percentage of 81% with missing timer reports located sporadically throughout the month.

## IV. Rain Sensor Event Reporting Summary

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

The incrementing reports from all 1-mm rain sensors that reported for the entire month were analyzed to quantify the District-wide statistical total monthly tip summary (Table 2).

**Table 2. March District-Wide Total Tip/Count Statistical Summary**

Statistical Parameter	Value	Comments
Mean	29.75	Only the 1-mm rain sensors were included in the analysis
Median	29	Only the 1-mm rain sensors were included in the analysis
Standard deviation	12.01	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	65.8	Several sensors for the month are outside the Mean +/- 3 Std Dev
Minimum total count	3	Several sensors
Maximum total count	57	Chatfield COE (ID 1350)

A monthly summary of the District-wide mean total tip/count is presented (Table 3).

**Table 3. 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										

The average precipitation experienced district-wide in March was considerably more than February. The precipitation experienced in March of 2007 was more than that experienced in the same month in 2006.

There were no sensors this month that experienced a change in tip count exceeding the system-wide mean plus three standard deviations.

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

Four rain sensors experienced a jump in their sequential tip count of more than 6 this month. The tip count series for these sensors was manually inspected and explored in the following paragraphs.

#### 1. Parker/Mississippi (ID 540)

A timer report on 3/28/2007 at 3:01:02 AM was received with a count value of 23. On 3/30/2007 at 2:50:39 PM another timer report was received with a count value of 30. There were no incrementing reports received from this sensor between 3/28/2007 at 3:01:02 AM and 3/30/2007 at 2:50:39 PM. A total jump in count of 7 was validated by the base station.

#### 2. West Metro FS13 (ID 1370)

On March 6 at around 1:00 PM the count value for this sensor jumped from 1082 to 1121. This jump is most likely due to field maintenance performed at the station.

#### 3. Shop Creek (ID 1710)

On March 29 at around 3:00 PM the count value for this sensor jumped from 0 to 2047. This jump is most likely due to field maintenance performed at the station. There is no data for this sensor prior to March 29<sup>th</sup> so we can assume that spring turn-on was performed on March 29<sup>th</sup>. The sensor reports normally for the remainder of the month.

#### 4. Salisbury Park (ID 2730)

On March 19 from 12:47:27 PM to 12:52:39 PM the count value for this sensor jumped from 952 to 973. Again, this jump is most likely due to field work performed on the sensor.

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

The system-wide reception rate of incrementing, 1-mm, tip reports for the month was approximately 92 percent. A total of 4,080 incrementing reports were received and a total of 4,461 were expected. The total loss of incrementing reports for the month was approximately 8.54 percent. Those sensors with the worst rain event transmission characteristics are summarized (Table 4).

**Table 4. Monthly Summary of Sensors with the Most Missed Tips**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2320	1330	540									
2190	4080	310									
4710	1640	4470									
4090	4050	850									
4820	4180	4570									

\*Parker/Mississippi (540), Guy Hill Ranch (310), Little Narrows (4470), Flying J (850), St. Antons (4570)

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 incrementing count series was manually inspected for those sensors with an event performance of less than 80%. A brief description of the results from the manual inspection is provided below.

### 1. Parker/Mississippi (ID 540)

This sensor was active for the entire month. A timer report on 3/28/2007 at 3:01:02 AM was received with a count value of 23. On 3/30/2007 at 2:50:39 PM another timer report was received with a count value of 30. There were no incrementing reports received from this sensor between 3/28/2007 at 3:01:02 AM and 3/30/2007 at 2:50:39 PM. A series of 7 incrementing reports were missed at the base station during this period.

### 2. Guy Hill Ranch (ID 310)

This sensor was activated on March 6, 2007. The sensor missed many single incrementing tips between 3/24/2007 through 3/30/2007. Also, several bit-flip data reports were observed in the data record on the base station. The performance of this sensor should be observed in the coming months.

### 3. Little Narrows (ID 4470)

This sensor was active for the entire month. The rain counter was reset on 3/22/2007. The sensor missed many single incrementing tips between 3/24/2007 through 3/30/2007. Also, several bit-flip data reports were observed in the data record on the base station. The performance of this sensor should be observed in the coming months.

### 4. Flying J (ID 850)

This sensor was activated on March 8, 2007. The sensor missed many single incrementing tips between 3/10/2007 through 3/30/2007. The performance of this sensor should be observed in the coming months.

### 5. St. Antons (ID 4570)

This sensor was active for the entire month. The sensor missed many single incrementing tips between 3/10/2007 through 3/30/2007. The performance of this sensor should be observed in the coming months.

## V. Heavy Radio Traffic Hour Analysis

Beginning in 2007 every hour exceeding 600 messages will be analyzed independently. The heavy hour analysis will attempt to identify rain gage sequences where 2, 3, or more, sequential messages are lost. The loss of 3 or more sequential data reports forms a limit of data degradation that causes a serious problem in the evaluation of alarm threshold conditions to support the flood mitigation needs of emergency responders within the District.

There was one occurrence of hourly traffic exceeding 600 messages this month.

The peak hour of radio traffic loading occurred on 3/24/2007 between 11:00 AM and 12:00 PM when 679 reports were received. The data for this period was examined more closely to characterize the distribution of sensor traffic (Table 5). During this hour the radio traffic was dominated by rain and water level reports.

**Table 5. Peak Traffic Hour Sensor Report Distribution**

Sensor Group	Reports	Percent
Precipitation	245	36.08
Water Level PT	253	37.28
Wind Gust	28	4.12
Precipitation - Mean	21	3.09
Temperature	21	3.09
Wind Direction	20	2.95
Water Level Float	18	2.65
Battery Voltage HSE	18	2.65
Wind Speed Ave & Azimuth	16	2.36
Wind Speed Average	11	1.62
Relative Humidity	9	1.33
Solar Radiation	4	0.59
Barometric Pressure	3	0.44
Handar 585 Alarm Status	2	0.29
Fuel Temp/Moisture	4	0.58
Battery Voltage Digital/Analog	4	0.58
Repeater Pass List/12 Hr Status	2	0.30
<b>Total</b>	<b>679</b>	<b>100%</b>

During the peak hour, several rain sensors experienced double-tips. These were transmissions that jumped 1 incrementing count between sequential reports.

There were no rain gage sequences where 2, 3, or more, sequential reports were lost during the peak hour of radio traffic.

A summary of the past peak radio traffic hours that exceeded 600 reports is presented (Table 6).

**Table 6. Peak Traffic Hour Rain Reporting Summary – Annual Reporting**

Heavy Traffic Period	Traffic Msgs/hr	Rain reports expected	Rain reports received	Loss of reports	Loss of 2, 3, or more reports
3/24/07 11:00 AM – 12:00 PM	679	143	131	8.39%	No
9/21/06 3:00 AM – 4:00 AM	620	117	114	2.56%	No
8/13/06 9:00 PM – 10:00 PM	1,107	346	286	17.34%	--

The table above will be used to track the heavy (greater than 600 reports) hour radio traffic analysis for each month so that over a period of time a correlation can be developed between peak hour loading and loss of single increment reports. In addition, during each heavy radio traffic hour, an attempt will be made to quantify the loading handled by each radio repeater.

## A. Repeater Loading During Heavy Traffic Hour

The sensor reports contained in the NovaStar database for the peak hour were correlated to the repeater path taken by each sensor to arrive at the base station (Table 7).

**Table 7. Radio Traffic Handled by Each Radio Repeater**

Radio Repeater Path	Sensor Reports Routed
Blue Mountain	246
Smokey Hill	221
Lee Hill	76
Blue Mtn., Chokecherry	52
Base Direct (Bear Creek/Lena Basin Mean Precipitation)	21
Smokey Hill, Chokecherry	19
Lee Hill, Eagle Ridge	15
Gold Hill	12
Lee Hill, Louisville	5
N/A	12
<b>Total</b>	<b>679</b>

The majority of sensor reports during the peak hour came through Blue Mountain and Smokey Hill repeaters.

## 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 systems. 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)	159
Total reports from unknown IDs	1,830
Unknown IDs with only a single received report (potential noise)	73
Total reports from active “known” IDs	191,094
Unknown reports as a fraction of total active “known” reports	0.96%

The total reports from unknown sensor IDs is small relative to the total reports received for the month from the active sensors.

A number of “unknown” sensors had multiple reports (highlighted in yellow) 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 including the number of reports received by each are quantified (Table 9).

**Table 9. Reports Received by Unknown IDs**

Unknown Sensor ID	Number of Reports
119	2
121	1
187	1
209	2
219	1
309	2
319	2
409	1
411	1
419	2
439	3
458	1
499	3
509	1
514	1
519	1
529	2
609	1
709	2
719	16
721	131
722	134
726	117
727	121
728	108
729	4
759	2
799	2
809	2
819	2
829	1
831	2
862	1
881	2
892	2
1001	1
1009	1
1019	3
1022	1
1029	1
1039	2
1041	5
1042	4
1044	4
1046	4
1047	5
1048	4
1049	4
1059	1
1099	1
1104	1
1105	21
1108	1
1299	2
1309	3
1319	30
1332	1
1390	1
1399	2
1432	1
1433	1
1443	3
1449	2
1453	2
1457	1
1458	1
1470	22
1487	1
1499	4
1502	2
1506	4
1529	6
1532	1
1627	1
1628	1
1631	1
1635	1
1639	1

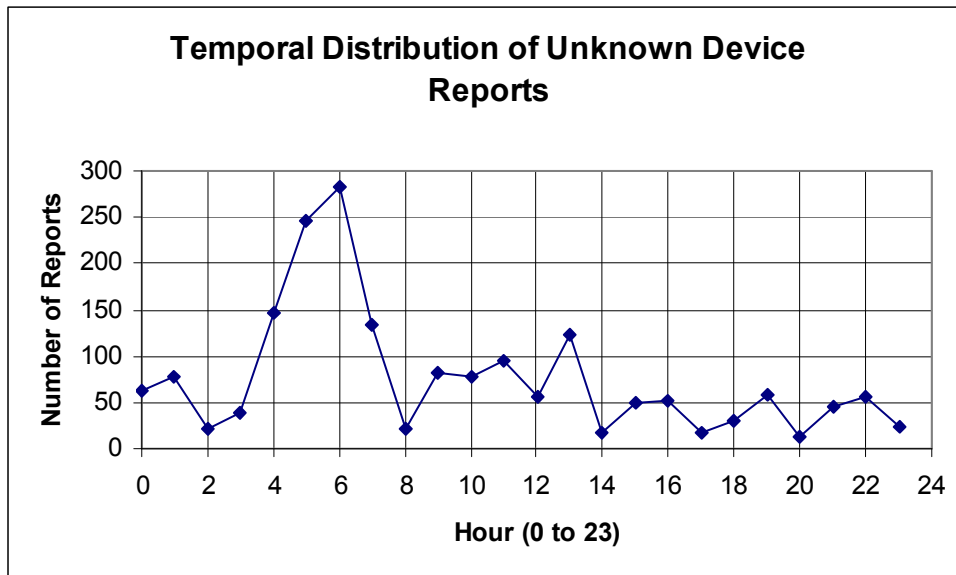
1641	1
1647	3
1801	8
1802	8
1804	8
1812	1
1919	1
1976	1
2196	2
2200	2
2218	1
2219	5
2221	4
2224	1
2232	1
2235	2
2238	1
2239	16
2252	1
2255	1
2271	1
2285	1
2339	4
2367	2
2734	1
2748	1
2749	3
2754	494
2765	1
2809	4
2818	1
2819	2
2828	1
2839	2
2847	1
3776	1
3927	1
4013	64
4029	3
4043	1
4047	1
4093	1
4131	1
4132	1
4222	1
4362	1
4379	3
4389	3
4399	3
4409	2
4419	2
4429	1
4464	1
4469	1
4522	1
4546	1
4580	1
4598	1
4603	1
4643	3
4644	3
4646	2
4736	2
4739	6
4740	10
4742	4
4743	1
4746	1
4755	1
4768	4
4769	3
4775	2
4776	2
4793	251
4809	2
4819	3
4829	3
4836	1
4839	3
5518	2
5815	1

The “unknown” device reports are analyzed temporally to understand when they were received during the day (Table 10). 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 10. Temporal Distribution of Unknown Reports**

Hour (AM)	Reports	Hour (PM)	Reports
0:00-12:59	62	12:00-12:59	57
1:00-1:59	78	1:00-1:59	124
2:00-2:59	22	2:00-2:59	18
3:00-3:59	39	3:00-3:59	49
4:00-4:59	146	4:00-4:59	51
5:00-5:59	245	5:00-5:59	17
6:00-6:59	283	6:00-6:59	31
7:00-7:59	133	7:00-7:59	59
8:00-8:59	22	8:00-8:59	14
9:00-9:59	82	9:00-9:59	46
10:00-10:59	77	10:00-10:59	56
11:00-11:59	95	11:00-11:59	24

Unknown reports were received during each hour and their distribution throughout the day is shown (Figure 1). The hours between 4:00 AM and 8:00 AM experienced more unknown device reports than other periods of the day.



**Figure 1. Daily Distribution of Unknown Device Reports**



## VII. Issues Continued from Previous Month

The following issues were identified last month.

1. **Justice Center (ID 4360):** This sensor reported the second highest tip count accumulation for the month. This was the third month in a row that this sensor experienced the highest or nearly the highest tip count. The series for this sensor should continue to be watched in upcoming months.
2. **Lyons Diversion, (ID 4560):** This sensor had a 79% timer reporting percentage in January and improved slightly to 86% in February. Its timer reporting percentage in March was 81%. The sensor did not have a single incrementing rain report in March. The sensor continues to report marginally.
3. **Little Narrows (ID 4470):** This sensor had 74% timer reporting percentage in January and improved slightly to 82% in February. Its timer reporting percentage in March was 84% and its rain event performance in March was 78%. This sensor continues to report marginally.
4. The **Stapleton rain gage (ID 1460)** had a timer reporting interval of 24 hours instead of 12 hours.

## VIII. Issues Identified this Month

Further investigation into the following issues is recommended:

1. The barometric pressure sensor at Stapleton (ID 1463) reported only 4 times and the solar sensor (ID 1469) reported only once during the month.
2. The ALERT wind sensor at Cal-Wood Ranch (ID 4767) reported only one time during the month.
3. **Upper Leyden (ID 220):** This sensor transmitted a timer report each hour during the beginning of the month. This was corrected on March 5<sup>th</sup>. The sensor timer reporting was observed to be at the normal 12-hour interval after March 5<sup>th</sup>.
4. **Parker/Mississippi (ID 540):** A timer report on 3/28/2007 at 3:01:02 AM was received with a count value of 23. On 3/30/2007 at 2:50:39 PM another timer report was received with a count value of 30. There were no incrementing reports received from this sensor between 3/28/2007 at 3:01:02 AM and 3/30/2007 at 2:50:39 PM. A total jump in count of 7 was validated by the base station.
5. **Guy Hill Ranch (ID 310):** This sensor had poor event performance. This sensor was activated on March 6, 2007. The sensor missed many single incrementing tips between 3/24/2007 through 3/30/2007. The performance of this sensor should be observed in the coming months.
6. **Little Narrows (ID 4470):** This sensor had poor event performance. This sensor was activated on March 6, 2007. The sensor missed many single incrementing tips between 3/24/2007 through 3/30/2007. The performance of this sensor should be observed in the coming months.
7. Reception of “unknown” IDs peaked in the early morning hours between 4:00 AM and 7:00AM. Investigate possible interference from noise during this period.

8. The following unknown sensor IDs had multiple reports for the month (these may be active ALERT transmitters deployed in the field that are configured incorrectly or these are active IDs that should be defined on the ALERT2 base station):
  - a. A series of nearly sequential IDs from 719 - 729 (631 reports for the month)
  - b. 1105 (21 reports for the month)
  - c. 1319 (30 reports for the month)
  - d. 1470 (22 reports for the month)
  - e. A series of IDs from 1801 – 1804 (24 reports for the month)
  - f. 2239 (16 reports for the month)
  - g. 2754 (494 reports for the month)
  - h. 4013 (64 reports for the month)
  - i. A series of IDs from 4739 – 4740 (16 reports for the month)
  - j. 4793 (252 reports for the month)

# General System Analysis

**Database Name** P:\A207-UDFCD-Data-Analysis\2007\_Mar\Novastar\_extract\_2007Mar.mdb

<b>First Date in Database</b>	3/1/07 12:00 AM	<b>Total Days</b>	31.0
<b>Last Date in Database</b>	3/31/07 11:59 PM	<b>Total Hours</b>	744.0

**Total Records Analyzed** 191094

## Records by Group

Wind Gust	32692	17%
Relative Humidity	30101	16%
Temperature	27019	14%
Wind Speed Average & Azimuth	21263	11%
Water Level PT-HSE	15882	8%
Wind Direction	15510	8%
Precipitation	11749	6%
Wind Speed Average	11121	6%
Battery Voltage HSE	5591	3%
Solar Radiation	3252	2%
Battery Voltage Digital	3140	2%
Water Level Float	2398	1%
Barometric Pressure	2215	1%
Water Level PT	1955	1%
Fuel Moisture	1479	1%
Fuel Temperature	1474	1%
Precipitation - Mean	1091	1%
Repeater Pass List	615	0%
Battery Voltage Analog	596	0%
Handar 585 ALARM Status	475	0%
Precipitation - Test	246	0%
12Hr Status Report	172	0%
Longmont Flow Gage	133	0%
Battery	116	0%
Soil Moisture	74	0%
Longmont Water Level PT	53	0%
Solar Power	1	0%
<b>Total</b>	<b>190413</b>	

## Records by Major Group

Meteorologic Sensors	143173	75%
Water Level Sensors	20421	11%
Rain Sensors	11749	6%
Sensor Status Transmissions	10590	6%
Soil and Fuel Sensors	3027	2%
<b>Total</b>	<b>188960</b>	

## Records by Validation Type

Good	0	186673	98%
Questionable	1	4421	2%
<b>Total</b>		<b>191094</b>	

## Sensors With Most Invalid Data

Description	Sensor	Reports
Squaw Mountain	2189	2801
Squaw Mountain	2187	865
Elbert	1439	97
Blue Mountain	139	34
Louisville Lake	4744	33

## Traffic Loading Summary

Alert Reports	191094	
Average Daily Traffic	6164	
Average Hourly Traffic	257	
Median Hourly Traffic	246	hour beginning
Peak Hourly Traffic	679	3/24/07 11:00 AM

# Rain Timer Performance

Analyze Rain Sensors

systemwide average (days)  
0.5194

Systemwide Average  
74%

Rain Sensors	Description	Received	Average Timer Interval	Expected Reports	Performance
220	Upper Leyden	142		62.00	
2310	Genesee Village	4		62.00	6%
1710	Shop Creek	6	12:00	62.00	10%
2350	Idledale	7	12:00	62.00	11%
2240	Cold Sprg Glch conf	8	12:00	62.00	13%
2250	Rosedale	8	12:00	62.00	13%
2260	Brook Forest	8	12:00	62.00	13%
2340	El Rancho	8	13:57	62.00	13%
2370	Red Rocks Park	8	12:00	62.00	13%
2270	Cub Cr below Blue	9	9:37	62.00	15%
2280	Kinney Peak	9	11:57	62.00	15%
1720	Cherry Cr @ Steele	10	4:48	62.00	16%
2230	Bear Cr below Cub	10	12:00	62.00	16%
2360	Indian Hills	10	10:00	62.00	16%
1100	Louisville Rec Ctr	14	11:59	62.00	23%
1110	Gunbarrel	14	15:36	62.00	23%
1020	Lena @ Nolte Pond	19	13:19	62.00	31%
410	Kelly Dam	20	11:58	62.00	32%
2840	Sulphur Gulch	22	13:29	62.00	35%
2810	Pine Cliff Road	25	11:21	62.00	40%
630	Temple Pond at DTC	26	13:09	62.00	42%
1340	Sanderson at Xavier	26	16:34	62.00	42%
620	Quincy/Highline	27	14:10	62.00	44%
600	Harvard Gulch Park	29	12:27	62.00	47%
610	Harvard @ Jackson	29	12:28	62.00	47%
1620	Slaughterhouse Glch	29	12:30	62.00	47%
1900	Niver Detention	29	12:55	62.00	47%
1360	Denver Zoo	30	12:55	62.00	48%
1460	Stapleton	30	0:02	62.00	48%
640	Goldsmith @ Eastman	32	12:27	62.00	52%
1200	Broomfield 3207	32	12:51	62.00	52%
500	Havana Park	33	11:30	62.00	53%
650	Iliff Pond	33	11:58	62.00	53%
1500	Powers Park	33	15:13	62.00	53%
1400	Upper Sloan Det.	34	12:49	62.00	55%
1810	Sand Creek at mouth	36	19:12	62.00	58%
310	Guy Hill Ranch	37	14:51	62.00	60%
420	Expo Park	37	12:22	62.00	60%
860	Sand Cr at Colfax	37	10:18	62.00	60%
1530	Bear Creek @ Lowell	37	11:09	62.00	60%
1600	Englewood Dam	37	11:58	62.00	60%
540	Parker/Mississippi	38	17:12	62.00	61%
1610	Holly Dam	38	12:36	62.00	61%
710	Horseshoe Park Drop	39	11:57	62.00	63%
850	Flying J	39	14:24	62.00	63%
870	Murphy Creek GC	39	12:21	62.00	63%
400	Montview Park	41	10:54	62.00	66%
800	Sable Ditch @ 18th	42	12:40	62.00	68%
730	No Name @ Quincy	44	11:39	62.00	71%
120	West Woods	45	12:54	62.00	73%
1300	Hidden Lake	45	12:36	62.00	73%
1350	Chatfield COE	45	13:37	62.00	73%
150	Nott Creek	46	13:42	62.00	74%
810	Granby Ditch @ 6th	46	11:59	62.00	74%
100	Carr Street	47	12:17	62.00	76%
200	Leyden Reservoir	47	12:16	62.00	76%
820	ETG @ Buckley	47	11:59	62.00	76%
1320	SPR at 3rd Ave	47	9:01	62.00	76%
1370	West Metro FS13	47	12:54	62.00	76%
110	Ralston Reservoir	48	12:33	62.00	77%
1030	NREL/S. Table Mtn.	48	12:33	62.00	77%
1050	Jeffco Fairgrounds	48	12:22	62.00	77%
1310	LDC at 64th	48	11:59	62.00	77%
320	Sports Complex	49	12:17	62.00	79%
1060	Heritage Square	49	12:50	62.00	79%
4180	Gold Lake	49	14:53	62.00	79%
510	Virginia Court	50	13:19	62.00	81%
720	Confluence Pond	50	8:35	62.00	81%
4560	Lyons Diversion NSV	50	14:42	62.00	81%
4090	Magnolia	51	13:56	62.00	82%
4850	Porphory Mtn	51	13:59	62.00	82%
440	Fire Station #7	52	13:04	62.00	84%
4010	Crescent	52	14:14	62.00	84%
4470	Little Narrows	52	12:47	62.00	84%

330	Van Bibber @ Hwy 93	53	11:12	62.00	85%
520	Jewell Detention	53	13:17	62.00	85%
830	Side Creek Park	53	13:14	62.00	85%
4170	Pine Brook	53	13:08	62.00	85%
4510	Pinewood Springs	53	12:34	62.00	85%
2330	Morrison	54	13:19	62.00	87%
4150	Gold Hill	54	13:19	62.00	87%
4220	Fling's	54	12:49	62.00	87%
4570	St. Antons	54	12:33	62.00	87%
4860	Fairview Peak	54	12:47	62.00	87%
1640	SPR at Union Ave.	55	13:18	62.00	89%
4140	Logan Mill	55	13:01	62.00	89%
4490	Apple Valley	55	13:25	62.00	89%
4730	Sugarloaf	55	12:32	62.00	89%
530	Fire Station #19	56	12:42	62.00	90%
1330	Roslyn	56	13:13	62.00	90%
2190	Squaw Mountain	56	12:15	62.00	90%
2820	Haskins Gulch Conf	56	12:29	62.00	90%
4060	Lakeshore	56	12:29	62.00	90%
4100	Filter Plant	56	12:29	62.00	90%
4360	Justice Center	56	12:56	62.00	90%
4710	Ward C-1	56	12:16	62.00	90%
1040	Lena @ U.S. Hwy 6	57	12:45	62.00	92%
4110	Betasso	57	12:30	62.00	92%
4130	Swiss Peaks	57	12:44	62.00	92%
4240	Sunset	57	12:41	62.00	92%
4270	Cannon Mountain	57	12:56	62.00	92%
4340	Riverside	57	12:13	62.00	92%
4350	Conifer Hill	57	13:01	62.00	92%
4520	Eagle Ridge	57	12:57	62.00	92%
4530	Winiger Ridge	57	11:58	62.00	92%
4750	Louisville Lake	57	12:39	62.00	92%
210	Leyden Confluence	58	12:27	62.00	94%
700	Toll Gate @ 6th	58	12:30	62.00	94%
760	Mission Viejo Park	58	12:12	62.00	94%
4020	Rio Grande	58	12:13	62.00	94%
4040	Martin Gulch	58	12:13	62.00	94%
4080	Twin Sisters	58	12:13	62.00	94%
4190	Slaughterhouse	58	11:58	62.00	94%
4200	Lazy Acres	58	12:47	62.00	94%
4230	Golden Age	58	11:59	62.00	94%
4260	Taylor Mountain	58	12:29	62.00	94%
4290	Red Hill	58	12:42	62.00	94%
4330	Indian Ruins	58	12:30	62.00	94%
4790	Button Rock	58	12:28	62.00	94%
4820	Doudy Draw	58	12:20	62.00	94%
140	Blue Mountain	59	12:14	62.00	95%
1010	Denver West	59	12:27	62.00	95%
1440	Elbert	59	11:46	62.00	95%
1480	Third Creek at DIA	59	12:28	62.00	95%
1540	Sanderson at Xavier	59	12:26	62.00	95%
1700	Cherry Cr @ Champa	59	12:30	62.00	95%
2210	Hiwan G.C.	59	12:29	62.00	95%
4160	Sunshine	59	12:28	62.00	95%
4250	Geer Canyon	59	12:27	62.00	95%
4810	Shanahan Ridge	59	12:19	62.00	95%
740	Smoky Hill	60	12:14	62.00	97%
900	Aurora Reservoir	60	11:50	62.00	97%
1660	SPR at Henderson	60	12:22	62.00	97%
4070	Bear Peak	60	12:26	62.00	97%
4300	Big Elk Park	60	12:12	62.00	97%
4770	Cal-Wood Ranch	60	12:14	62.00	97%
4830	SBC @ San Souci	60	12:04	62.00	97%
750	Quincy Reservoir	61	12:01	62.00	98%
1520	Marston Lake North	61	11:04	62.00	98%
1800	Sand Creek Park	61	8:59	62.00	98%
1920	Brighton	61	12:06	62.00	98%
2220	Evergreen Lake	61	12:10	62.00	98%
2750	Castle Rock	61	11:58	62.00	98%
4030	Red Garden	61	11:35	62.00	98%
4050	Walker Ranch	61	11:58	62.00	98%
4310	Johnny Park	61	11:59	62.00	98%
300	Van Bibber Park	62	11:59	62.00	100%
2730	Salisbury Park	62	11:53	62.00	100%
4840	SBC@S Boulder Ditch	62	11:48	62.00	100%
2710	Highlands Ranch WTP	64	11:48	62.00	103%
1420	Diamond Hill	66	11:09	62.00	106%
1000	Maple Grove Resv.	70	9:56	62.00	113%

Rain Event Performance		Reports Received	4080	Analyze Rain Sensors										
	Systemwide Avg	Total Tips	4461											
	92%	Data Loss	8.54%											
Rain Sensor	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Rcvd	Expected	Missed	Hold-off	Bucket	
540	69%	18	2	0	0	0	0	1	20	29	9	0	0.0393701	
310	70%	10	5	1	0	0	0	0	16	23	7	0	0.0393701	
4470	78%	28	7	0	1	0	0	0	36	46	10	0	0.0393701	
850	79%	18	2	2	0	0	0	0	22	28	6	0	0.0393701	
4570	79%	31	4	3	0	0	0	0	38	48	10	0	0.0393701	
2320	81%	18	3	1	0	0	0	0	22	27	5	0	0.0393701	
4240	81%	17	5	0	0	0	0	0	22	27	5	0	0.0393701	
4010	82%	26	5	1	0	0	0	0	32	39	7	0	0.0393701	
1030	83%	16	2	1	0	0	0	0	19	23	4	0	0.0393701	
4820	83%	34	2	1	0	1	0	0	38	46	8	0	0.0393701	
4080	83%	28	5	1	0	0	0	0	34	41	7	0	0.0393701	
860	83%	13	1	1	0	0	0	0	15	18	3	0	0.0393701	
2280	83%	4	1	0	0	0	0	0	5	6	1	1	0.0393701	
4510	84%	33	8	0	0	0	0	0	41	49	8	0	0.0393701	
1110	84%	27	4	1	0	0	0	0	32	38	6	1	0.0393701	
700	84%	22	5	0	0	0	0	0	27	32	5	1	0.0393701	
1320	85%	18	4	0	0	0	0	0	22	26	4	0	0.0393701	
510	85%	23	5	0	0	0	0	0	28	33	5	0	0.0393701	
1360	85%	26	0	1	1	0	0	0	28	33	5	0	0.0393701	
1660	85%	14	3	0	0	0	0	0	17	20	3	0	0.0393701	
620	85%	19	4	0	0	0	0	0	23	27	4	0	0.0393701	
4490	85%	24	5	0	0	0	0	0	29	34	5	0	0.0393701	
4730	85%	25	3	1	0	0	0	0	29	34	5	0	0.0393701	
4090	85%	32	0	3	0	0	0	0	35	41	6	0	0.0393701	
400	86%	16	1	1	0	0	0	0	18	21	3	0	0.0393701	
410	86%	15	3	0	0	0	0	0	18	21	3	0	0.0393701	
650	86%	16	1	1	0	0	0	0	18	21	3	0	0.0393701	
1100	86%	20	4	0	0	0	0	0	24	28	4	0	0.0393701	
4290	86%	33	3	0	1	0	0	0	37	43	6	0	0.0393701	
4830	86%	32	4	1	0	0	0	0	37	43	6	0	0.0393701	
4060	87%	40	3	2	0	0	0	0	45	52	7	0	0.0393701	
2330	87%	22	4	0	0	0	0	0	26	30	4	0	0.0393701	
870	87%	18	1	1	0	0	0	0	20	23	3	0	0.0393701	
530	87%	24	2	1	0	0	0	0	27	31	4	0	0.0393701	
1340	87%	24	2	1	0	0	0	0	27	31	4	0	0.0393701	
4170	87%	29	5	0	0	0	0	0	34	39	5	0	0.0393701	
420	88%	18	3	0	0	0	0	0	21	24	3	0	0.0393701	
1050	88%	20	0	0	1	0	0	0	21	24	3	0	0.0393701	
1400	88%	18	3	0	0	0	0	0	21	24	3	0	0.0393701	
1900	88%	12	2	0	0	0	0	0	14	16	2	0	0.0393701	
1350	88%	44	5	1	0	0	0	0	50	57	7	0	0.0393701	
810	88%	25	4	0	0	0	0	0	29	33	4	0	0.0393701	
1000	88%	25	4	0	0	0	0	0	29	33	4	0	0.0393701	
1810	88%	20	3	0	0	0	0	0	23	26	3	0	0.0393701	
1440	89%	14	2	0	0	0	0	0	16	18	2	0	0.0393701	
1460	89%	21	3	0	0	0	0	0	24	27	3	0	0.0393701	
1480	89%	14	2	0	0	0	0	0	16	18	2	0	0.0393701	
1600	89%	15	0	1	0	0	0	0	16	18	2	0	0.0393701	
2370	89%	7	1	0	0	0	0	0	8	9	1	1	0.0393701	
110	89%	23	1	1	0	0	0	0	25	28	3	0	0.0393701	
1500	89%	22	3	0	0	0	0	0	25	28	3	0	0.0393701	
4530	90%	39	5	0	0	0	0	0	44	49	5	0	0.0393701	
1200	90%	24	3	0	0	0	0	0	27	30	3	0	0.0393701	
1420	90%	33	4	0	0	0	0	0	37	41	4	0	0.0393701	
1010	90%	25	3	0	0	0	0	0	28	31	3	0	0.0393701	
710	90%	17	2	0	0	0	0	0	19	21	2	0	0.0393701	
4220	91%	35	4	0	0	0	0	0	39	43	4	0	0.0393701	
100	91%	36	4	0	0	0	0	0	40	44	4	0	0.0393701	
1920	91%	18	2	0	0	0	0	0	20	22	2	0	0.0393701	
2260	91%	9	1	0	0	0	0	0	10	11	1	0	0.0393701	
610	91%	19	2	0	0	0	0	0	21	23	2	0	0.0393701	
640	91%	19	2	0	0	0	0	0	21	23	2	0	0.0393701	
4100	91%	29	3	0	0	0	0	0	32	35	3	0	0.0393701	
4750	91%	29	3	0	0	0	0	0	32	35	3	0	0.0393701	
4790	91%	29	3	0	0	0	0	0	32	35	3	0	0.0393701	
4360	91%	39	4	0	0	0	0	0	43	47	4	0	0.0393701	
300	92%	20	2	0	0	0	0	0	22	24	2	0	0.0393701	
820	92%	20	2	0	0	0	0	0	22	24	2	0	0.0393701	
830	92%	20	2	0	0	0	0	0	22	24	2	0	0.0393701	
2730	92%	20	2	0	0	0	0	1	22	24	2	0	0.0393701	
800	92%	21	2	0	0	0	0	0	23	25	2	0	0.0393701	
2810	92%	21	2	0	0	0	0	0	23	25	2	0	0.0393701	
4840	92%	42	4	0	0	0	0	0	46	50	4	0	0.0393701	
4110	92%	32	3	0	0	0	0	0	35	38	3	0	0.0393701	

500	92%	22	2	0	0	0	0	0	24	26	2	0	0.0393701
1530	92%	22	2	0	0	0	0	0	24	26	2	0	0.0393701
4130	93%	34	3	0	0	0	0	0	37	40	3	0	0.0393701
900	93%	23	2	0	0	0	0	0	25	27	2	0	0.0393699
1300	93%	23	2	0	0	0	0	0	25	27	2	1	0.0393701
760	93%	24	2	0	0	0	0	0	26	28	2	0	0.0393701
4140	93%	37	3	0	0	0	0	0	40	43	3	0	0.0393701
320	93%	25	2	0	0	0	0	0	27	29	2	0	0.0393701
1620	93%	26	0	1	0	0	0	0	27	29	2	0	0.0393701
330	93%	26	2	0	0	0	0	0	28	30	2	1	0.0393701
630	93%	26	2	0	0	0	0	0	28	30	2	0	0.0393701
1640	94%	27	2	0	0	0	0	0	29	31	2	0	0.0393701
4150	94%	41	3	0	0	0	0	0	44	47	3	0	0.0393701
4230	94%	28	2	0	0	0	0	0	30	32	2	0	0.0393701
1800	94%	30	2	0	0	0	0	0	32	34	2	0	0.0393701
2190	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
4710	94%	30	2	0	0	0	0	0	32	34	2	0	0.0393701
4810	94%	47	1	1	0	0	0	0	49	52	3	0	0.0393701
220	94%	32	2	0	0	0	0	0	34	36	2	0	0.0393701
1520	94%	32	2	0	0	0	0	0	34	36	2	0	0.0393701
4050	94%	32	2	0	0	0	0	0	34	36	2	0	0.0393701
4270	95%	34	2	0	0	0	0	0	36	38	2	0	0.0393701
4520	95%	34	2	0	0	0	0	0	36	38	2	0	0.0393701
4020	95%	37	2	0	0	0	0	0	39	41	2	0	0.0393701
750	95%	19	1	0	0	0	0	0	20	21	1	1	0.0393701
1370	100%	19	1	0	0	0	0	1	20	20	1	0	0.0393701
740	95%	39	2	0	0	0	0	0	41	43	2	0	0.0393701
4180	95%	40	2	0	0	0	0	0	42	44	2	0	0.0393701
4190	95%	40	2	0	0	0	0	0	42	44	2	0	0.0393701
730	96%	21	1	0	0	0	0	0	22	23	1	0	0.0393701
4350	96%	43	2	0	0	0	0	0	45	47	2	0	0.0393701
4030	96%	44	2	0	0	0	0	0	46	48	2	0	0.0393701
4250	96%	45	2	0	0	0	0	0	47	49	2	0	0.0393701
2750	96%	23	1	0	0	0	0	0	24	25	1	0	0.0393701
4040	96%	46	2	0	0	0	0	0	48	50	2	0	0.0393701
1040	96%	24	1	0	0	0	0	0	25	26	1	0	0.0393701
1700	96%	24	1	0	0	0	0	0	25	26	1	0	0.0393701
200	96%	25	1	0	0	0	0	0	26	27	1	0	0.0393701
1310	96%	25	1	0	0	0	0	0	26	27	1	0	0.0393701
210	96%	26	1	0	0	0	0	0	27	28	1	0	0.0393701
2710	96%	26	1	0	0	0	0	0	27	28	1	0	0.0393701
440	97%	27	1	0	0	0	0	0	28	29	1	0	0.0393701
1330	97%	27	1	0	0	0	0	0	28	29	1	0	0.0393701
140	97%	29	1	0	0	0	0	0	30	31	1	0	0.0393701
2820	97%	33	1	0	0	0	0	0	34	35	1	0	0.0393701
1540	97%	35	1	0	0	0	0	0	36	37	1	0	0.0393701
4310	98%	40	1	0	0	0	0	0	41	42	1	0	0.0393701
4330	98%	48	1	0	0	0	0	0	49	50	1	0	0.0393701
4070	98%	49	1	0	0	0	0	0	50	51	1	0	0.0393701
120	100%	29	0	0	0	0	0	0	29	29	0	0	0.0393701
150	100%	35	0	0	0	0	0	0	35	35	0	1	0.0393701
520	100%	31	0	0	0	0	0	0	31	31	0	0	0.0393701
600	100%	22	0	0	0	0	0	0	22	22	0	0	0.0393701
720	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
1060	100%	23	0	0	0	0	0	0	23	23	0	0	0.0393701
1710	100%	3	0	0	0	0	0	1	3	3	0	0	0.0393701
1720	100%	12	0	0	0	0	0	0	12	12	0	1	0.0393701
2210	100%	32	0	0	0	0	0	0	32	32	0	1	0.0393701
2230	100%	5	0	0	0	0	0	0	5	5	0	1	0.0393701
2240	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
2250	100%	8	0	0	0	0	0	0	8	8	0	1	0.0393701
2270	100%	9	0	0	0	0	0	0	9	9	0	1	0.0393701
2310	100%	8	0	0	0	0	0	0	8	8	0	1	0.0393701
2340	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
2350	100%	7	0	0	0	0	0	0	7	7	0	1	0.0393701
2360	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
2840	100%	23	0	0	0	0	0	0	23	23	0	0	0.0393701
4160	100%	45	0	0	0	0	0	0	45	45	0	0	0.0393701
4200	100%	42	0	0	0	0	0	0	42	42	0	0	0.0393701
4260	100%	42	0	0	0	0	0	0	42	42	0	0	0.0393701
4300	100%	34	0	0	0	0	0	0	34	34	0	0	0.0393701
4340	100%	36	0	0	0	0	0	0	36	36	0	0	0.0393701
4770	100%	37	0	0	0	0	0	0	37	37	0	0	0.0393701
	Total Tips	3747	297	31	4	1	0	4	4080	4461			

# Radio Traffic Plot

