Memo

Water & Earth Technologies, Inc.
Water Resources and Environmental Consulting

Date: July 3, 2009
To: Kevin Stewart and Chad Kudym
From: Markus Ritsch
Subject: **June 2009 ALERT Data Analysis**

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 June 1 through June 30, 2009.

II. General System Analysis Summary

A total of 315,331 ALERT data reports were analyzed from the ALERT 2 base station. Meteorological sensors account for 71 percent, water level sensors 12 percent, and rain sensors 6 percent of the total monthly records.

The system-wide radio traffic loading was 10,511 reports per day with an average hourly loading of 438 reports. The peak hourly traffic loading was 1,138 reports, which occurred on June 2, between 5:00 AM and 6:00 AM. A plot of monthly average and peak hourly traffic loading is provided.

A. Specific Issues Identified this Month

The performance of the following sensors was unacceptable due to either poor timer performance, poor event performance, or due to the large number of invalid reports received.

Table 1. Rain Sensors with Unacceptable Performance Characteristics

ID	Description	Timer	Event	Invalid	Recommendations
2900	Russelville Gulch-Douglas	15	48.28	0	Install new high-gain radio antenna in July.
2970	Rampart Range Rd	23.33	66.67	0	Installed on June 19, continue to monitor for another month.
1700	Cherry Cr @ Champa	18.33	75	0	
2860	CC at Stroh Rd	40	61.4	0	Re-program radio to go through West Creek.
2850	Cherry Cr bl Bayou Glch	40	66.18	1	Install new antenna system.
2810	Pine Cliff Road	56.67	53.09	15	Install new antenna system and program radio to West Creek.
4330	Indian Ruins	20	92.31	0	
2270	Cub Cr below Blue	16.67	96	0	
110	Ralston Reservoir	53.33	64.86	0	
430	Utah Park	20	100	0	
4400	Orodell	95	25	0	
700	Toll Gate @ 6th	38.33	82.35	1	
540	Parker/Mississippi	63.33	60.53	2	
1360	Denver Zoo	51.67	73.68	0	
1460	Urban Farm	43.33	83.87	0	
3020	West Creek WX – Douglas	36.67	91.67	0	Installed on June 19, continue to monitor for another month.
1350	Chatfield COE	65	65.67	2	
1810	Sand Creek at mouth	60	75.29	0	
2960	Indian Creek – Douglas	48.33	88.24	0	Installed on June 19, continue to monitor for another month.
1660	SPR at Henderson	55	83.78	0	
2980	Dakan Rd – Douglas	40	100	0	Installed on June 19, continue to monitor for another month.
2280	Kinney Peak	70	70.27	2	
2210	Hiwan G.C.	86.67	87.50	21	Performance seems good, why so many invalid reports????
2230	Bear Cr below Cub	71.67	76.81	9	

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 84 percent of the non-incrementing timer reports. The worst performing rain sensors for the month are summarized (Table 1).

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

Jan*	Feb*	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2850	4030	2840	1360	1350	2900						
1650	4200	1020	1640	2850	2270						
1810	4490	1040	2270	2270	2850						
4250	4520	1720	1600	410	410						
4790	4790	1030	2850	540	540						
4300	4020	1550	1350	2320	1350						

***-Timer statistics are skewed in these months because system start-up occurs and the Blue Mountain repeater was down. The network is operational by April 1.**

Sensor ID 1460 and 700 have a 24-hour timer-reporting interval and Sensor ID 1810 has an 18-hour timer-reporting interval.

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	68	Only the 1-mm rain sensors were included in the analysis
Median	67	Only the 1-mm rain sensors were included in the analysis
Standard deviation	25.4	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	144.4	Only the 1-mm rain sensors were included in the analysis
Minimum total count	12	Rampart Range Road (ID 2970) – newly installed on June 19
Maximum total count	164	Expo Park (ID 420) – Influenced by Lawn Irrigation

B. High Rain Totals

Four sensors reported more than the mean plus three standard deviations and these sensors were 420, 920, 1310 and 630. Of these, only sensors 920 and 1310 are not influenced by irrigation. Note that the following rain gages are influenced by lawn irrigation.

420 Expo Park	510 Virginia Court	720 Confluence Pond
430 Utah Park	630 Temple Pond at DTC	750 Quincy Reservoir
500 Havana Park	640 Goldsmith @ Eastman	830 Side Creek Park
1500 Powers Park		

a. Aurora Town Hall Weather (ID 920)

This station was operational for the entire month. Anomalies in the sequential data series were not noted in the manual inspection of the ALERT reports received from this sensor.

b. LDC at 64th (ID 1310)

This station was operational for the entire month. Anomalies in the sequential data series were not noted in the manual inspection of the ALERT reports received from this sensor.

C. 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							

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

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

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

Sensor Description	Sensor ID	Comment
SPR at Henderson	1660	Large jumps in tip count occur on June 2 and June 12, 2009.
Flying J	850	Large jumps in tip count occur on June 12 and June 22, 2009.
Sand Creek at Mouth	1810	Large jumps in tip count occur on June 1 and June 11, 2009.
Parker/Mississippi	540	Large jumps in tip count occur on June 1, June 12, and June 25, 2009.

E. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing, 1-mm tip reports for the month was approximately 84.6 percent. A total of 9,573 incrementing reports were received and a total of 11,320 were expected. The total loss of incrementing reports for the month was approximately 15.43 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
140	4030	860	860	110	2900						
4490	4470	840	840	1350	540						
1420	4490	700	1640	2320	2320						
4040	4110	2840	2850	2850	110						
4160	4510	1340	700	540	1350						
4470	4790	920	1350	1810	2350						

**** - Event statistics are poor in February and March due to system start-up.***

*****- Poor event performance is evident at every station because the ALERT2 base station was unable to receive data for part of this month.***

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 identify rain tip sequences where three (3) or more, sequential messages are lost.

A. The Heaviest Hourly Traffic Periods This Month

The hours of highest radio traffic this month include:

Peak Traffic Periods	Reports/hour	Hour Beginning
Peak Hourly Traffic	1,138	6/2/09 5:00 AM
2nd Max	1,041	6/23/09 4:00 PM
3rd Max	965	6/25/09 6:00 PM
4th Max	963	6/2/09 4:00 AM
5th Max	950	6/2/09 6:00 AM

B. June 2, 2009

The heaviest period of radio traffic occurred on June 2, between 5:00 AM and 6:00 AM. Incrementing rain records from the 1-mm gages for the heavy radio traffic period were examined to characterize the loss of sequential incrementing tip transmissions (Table 7). During the heavy traffic period, a total of 1,854 reports were expected and 1,435 were received yielding a loss of approximately **22.60%** of the incrementing transmissions.

Table 7. Peak Traffic Analysis - Loss of Incrementing Tip Reports

	Occurrences of lost sequential tip reports during period			
Heavy Traffic Period (June 2)	**Loss of 3 sequential tips**	**Loss of 4 sequential tips**	**Loss of 5 sequential tips**	**Loss of 6 or more sequential tips**
2:00 AM to 8:00 AM	17	6	4	0

C. June 23, 2009

The second heaviest period of radio traffic occurred on June 23, between 4:00 PM and 7:00 PM. Incrementing rain records from the 1-mm gages for the heavy radio traffic period were examined to characterize the loss of sequential incrementing tip transmissions (Table 8). During the heavy traffic period, a total of 468 reports were expected and 415 were received yielding a loss of approximately **11.32%** of the incrementing transmissions.

Table 8. Peak Traffic Analysis - Loss of Incrementing Tip Reports

	Occurrences of lost sequential tip reports during period			
Heavy Traffic Period (June 23)	**Loss of 3 sequential tips**	**Loss of 4 sequential tips**	**Loss of 5 sequential tips**	**Loss of 6 or more sequential tips**
3:00 PM to 8:00 PM	0	0	0	0

It is interesting to note that both June 2 and June 23 experienced periods of heavy radio traffic. The lost data reports on June 23 were exclusively single and double increment reports. There were no recorded losses of three or more sequential reports on June 23.

The loss of data due to contention is a function of the type of storm (intensity and spatial extent) and the location of the storm within the District. It is hypothesized that certain parts of the District are more susceptible to data loss than other parts.

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 9).

Table 9. Summary of Unknown IDs

Description	Quantity
Total number of unknown IDs (IDs without a device definition)	395
Total reports from unknown IDs	846
Unknown IDs with only a single received report (potential noise)	286
Total reports from all IDs – RecData Log entire month	315,331
Unknown reports as a fraction of total reports	0.27%

The total number of reports from unknown sensors is very small relative to the total reports received for the month.

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 10. Reports Received by Unknown IDs

Unknown Sensor ID	Reports
2215	33
2224	27
2216	18
2239	16
2272	16
2861	16
2227	15
2275	14
2228	13
2271	13
4666	13
4031	11
5000	11
1705	10
2869	10
409	9
4786	9
1815	8
2222	8
2229	8
4094	8
2219	7
2221	7
2859	7
698	6
1657	6
2217	6
2849	6
4047	6
4282	6
1631	5
2232	5
2819	5
4039	5
4087	5
739	4
911	4
1102	4
2277	4
2736	4
2749	4
2753	4
2809	4
4043	4
4063	4
4093	4
4829	4
4839	4
111	3
1663	3
2176	3
2237	3
2238	3
2754	3
2811	3
2852	3
4053	3
4399	3
4449	3
4606	3
4664	3
4775	3
4831	3
5716	3
6308	3

The “unknown” device reports are analyzed temporally to understand when they are received during the day (Table 11). 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 11. Temporal Distribution of Unknown Reports

Hour (AM)	Reports	Hour (PM)	Reports
0:00-00:59	19	12:00-12:59	44
1:00-1:59	33	1:00-1:59	46
2:00-2:59	30	2:00-2:59	49
3:00-3:59	28	3:00-3:59	43
4:00-4:59	24	4:00-4:59	38
5:00-5:59	23	5:00-5:59	30
6:00-6:59	31	6:00-6:59	34
7:00-7:59	26	7:00-7:59	35
8:00-8:59	34	8:00-8:59	32
9:00-9:59	41	9:00-9:59	53
10:00-10:59	46	10:00-10:59	39
11:00-11:59	42	11:00-11:59	26

VII. Reporting Issues Identified this Month

Precipitation sensors with a large number of invalid reports (bit flip/contention errors/random decode):

Sensor ID	Description	Reports
2210	Hiwan G.C.	21
2810	Pine Cliff Road	15
5770	Lazy Gulch	12
2230	Bear Cr below Cub	9
640	Goldsmith @ Eastman	7
610	Harvard @ Jackson	6
2820	Haskins Gulch Conf	4
4030	Red Garden	4
860	Sand Cr at Colfax	4
2710	Highlands Ranch WTP	3
2320	Choke Cherry Resvr	3
330	Van Bibber @ Hwy 93	3

Sensors reporting frequently (over reporting):

Description	Sensor Group	Sensor ID	Reports
Quincy Reservoir	Wind Gust	749	5021
SPR at 3rd Ave	Water Level PT-HSE	1323	3255
Spring Valley Road	Wind Speed Average & Azimuth	2927	2916
Blue Mountain	Fuel Temperature	144	2835
Blue Mountain	Fuel Moisture	143	2833
Cal-Wood Ranch	Barometric Pressure	4774	2832
Blue Mountain	Wind Speed Average	137	2832
Cal-Wood Ranch	Temperature	4772	2829
Blue Mountain	Relative Humidity	141	2827
Blue Mountain	Wind Direction	138	2826
Cal-Wood Ranch	Relative Humidity	4771	2825
Blue Mountain	Wind Gust	139	2824
Castle Rock	Relative Humidity	2751	2822
Castle Rock	Temperature	2752	2815

Sensors reporting infrequently (under reporting):

Description	Group	Sensor ID	Reports
Coffintop	Precipitation	4500	1
Sugarloaf	Barometric Pressure	4734	1
Red Rocks Park	Handar 585 ALARM Status	2366	1
Chatfield COE	Battery Voltage Digital	1358	1
Castle Oaks Road	Battery Voltage HSE	2835	1
Simms Street	Handar 585 ALARM Status	126	1
Urban Farm	Barometric Pressure	1463	2
Brook Forest	Handar 585 ALARM Status	2256	2
Bear Cr below Cub	Handar 585 ALARM Status	2226	3
Cold Sprg Glch conf	Handar 585 ALARM Status	2236	8
Kinney Peak	Handar 585 ALARM Status	2276	11
Utah Park	Battery Voltage HSE	435	12
Indian Ruins	Battery Voltage HSE	4335	15
Iliff Pond	Water Level PT-HSE	654	20
Gunbarrel	Water Level PT	1113	22

VIII. Rainfall Alarms and Intensity Analysis

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

Urban Drainage and Flood Control District
ALERT Web Server

<<<<<<<<<<<<<<<<<<<<<<<<<< RAINFALL RATE ALARMS >>>>>>>>>>>>>>>>>>>>>>>>>
Historical alarm log: All alarm actions

TYPE and cause	ID/Tag	Name	Date	Time
Rainfall rate alarm	4150	Gold Hill	06/26/2009	14:07:47
Rainfall rate alarm	510	Virginia Court	06/25/2009	14:34:32
Rainfall rate alarm	510	Virginia Court	06/25/2009	14:27:06
Rainfall rate alarm	540	Parker/Mississi	06/25/2009	14:24:27
Rainfall rate alarm	530	Fire Station #1	06/25/2009	14:20:22
Rainfall rate alarm	650	Iliff Pond	06/25/2009	14:16:07
Rainfall rate alarm	540	Parker/Mississi	06/25/2009	14:14:40
Rainfall rate alarm	1530	Bear Creek @ Lo	06/25/2009	13:51:14
Rainfall rate alarm	1520	Marston Lake No	06/25/2009	13:51:11
Rainfall rate alarm	1310	LDC at 64th	06/24/2009	17:54:08
Rainfall rate alarm	1310	LDC at 64th	06/24/2009	17:52:31
Rainfall rate alarm	1310	LDC at 64th	06/24/2009	17:45:09
Rainfall rate alarm	1310	LDC at 64th	06/24/2009	17:41:45
Rainfall rate alarm	1480	Third Creek at	06/23/2009	16:38:51
Rainfall rate alarm	2730	Salisbury Park	06/23/2009	16:31:28
Rainfall rate alarm	2730	Salisbury Park	06/23/2009	16:31:28
Rainfall rate alarm	2810	Pine Cliff Road	06/23/2009	16:27:59
Rainfall rate alarm	2840	Sulphur Gulch	06/23/2009	16:26:11
Rainfall rate alarm	2840	Sulphur Gulch	06/23/2009	16:26:11
Rainfall rate alarm	870	Murphy Creek GC	06/23/2009	16:25:02
Rainfall rate alarm	2840	Sulphur Gulch	06/23/2009	16:22:31
Rainfall rate alarm	2730	Salisbury Park	06/23/2009	16:22:12
Rainfall rate alarm	1400	Upper Sloan Det	06/14/2009	15:07:32
Rainfall rate alarm	1050	Jeffco Fairgrou	06/14/2009	15:03:50
Rainfall rate alarm	1300	Hidden Lake	06/14/2009	15:00:51
Rainfall rate alarm	1400	Upper Sloan Det	06/14/2009	15:00:07
Rainfall rate alarm	1010	Denver West	06/14/2009	14:56:49
Rainfall rate alarm	1300	Hidden Lake	06/14/2009	14:55:49
Rainfall rate alarm	1050	Jeffco Fairgrou	06/14/2009	14:47:58
Rainfall rate alarm	1010	Denver West	06/14/2009	14:46:12
Rainfall rate alarm	1300	Hidden Lake	06/14/2009	14:42:57
Rainfall rate alarm	1440	Elbert	06/13/2009	19:17:52
Rainfall rate alarm	1440	Elbert	06/13/2009	19:17:52
Rainfall rate alarm	1460	Urban Farm	06/11/2009	22:45:05
Rainfall rate alarm	1810	Sand Creek at m	06/11/2009	22:30:12
Rainfall rate alarm	2840	Sulphur Gulch	06/11/2009	13:41:38
Rainfall rate alarm	2840	Sulphur Gulch	06/11/2009	13:34:15
Rainfall rate alarm	2810	Pine Cliff Road	06/11/2009	13:15:20
Rainfall rate alarm	1660	SPR at Henderso	06/02/2009	08:06:23

The following rainfall intensity summary is presented to corroborate the rainfall rate alarms.

10 Minute Peak Intensities

Station	Date	Tips	Inches	in/hr
4150	6/26/2009 2:12:43 PM	15	0.591	3.543
5720	6/25/2009 5:37:08 PM	16	0.630	3.780
5820	6/25/2009 5:19:44 PM	13	0.512	3.071
510	6/25/2009 2:31:34 PM	18	0.709	4.252
540	6/25/2009 2:24:26 PM	23	0.906	5.433
530	6/25/2009 2:22:21 PM	15	0.591	3.543
650	6/25/2009 2:16:49 PM	14	0.551	3.307
1530	6/25/2009 1:51:34 PM	14	0.551	3.307
1520	6/25/2009 1:51:11 PM	13	0.512	3.071
1310	6/24/2009 5:43:23 PM	15	0.591	3.543
1480	6/23/2009 4:38:49 PM	14	0.551	3.307
2840	6/23/2009 4:27:04 PM	15	0.591	3.543
870	6/23/2009 4:25:00 PM	13	0.512	3.071
2730	6/23/2009 4:24:46 PM	15	0.591	3.543
1400	6/14/2009 3:03:03 PM	19	0.748	4.488
1010	6/14/2009 2:54:00 PM	18	0.709	4.252
1050	6/14/2009 2:47:56 PM	13	0.512	3.071
1300	6/14/2009 2:46:31 PM	18	0.709	4.252
1440	6/13/2009 7:17:50 PM	13	0.512	3.071
2920	6/13/2009 6:46:33 PM	15	0.591	3.543
1460	6/11/2009 10:46:19 PM	14	0.551	3.307
1810	6/11/2009 10:33:09 PM	19	0.748	4.488
2840	6/11/2009 1:36:30 PM	16	0.630	3.780

1 Hour Peak Intensities

Station	Date	Tips	Inches
5820	6/25/2009 5:41:36 PM	31	1.220
510	6/25/2009 2:39:03 PM	28	1.102
540	6/25/2009 2:26:02 PM	35	1.378
1310	6/24/2009 6:01:30 PM	34	1.339
2730	6/23/2009 5:09:00 PM	40	1.575
2840	6/23/2009 4:57:00 PM	47	1.850
1300	6/14/2009 3:19:22 PM	38	1.496
1400	6/14/2009 3:07:30 PM	26	1.024
1050	6/14/2009 3:03:48 PM	26	1.024
1010	6/14/2009 3:01:45 PM	29	1.142
1440	6/13/2009 7:26:46 PM	29	1.142

General System Analysis

Database Name P:\A207-UDFCD-Data-Analysis\2009\06-2009\Novastar_extract_2009Jun.mdb

First Date in Database	6/1/09 12:00 AM	**Total Days**	30.0
Last Date in Database	6/30/09 11:59 PM	**Total Hours**	720.0

Total Records Analyzed 315331

Records by Group

Wind Gust	50,195	16%
Relative Humidity	48,319	15%
Temperature	47,196	15%
Water Level PT-HSE	30,019	10%
Precipitation	20,357	6%
Wind Direction	19,482	6%
Barometric Pressure	19,136	6%
Wind Speed Average	15,951	5%
Wind Speed Average & Azimuth	15,695	5%
Solar Radiation	8,961	3%
Battery Voltage HSE	7,256	2%
Water Level Float	5,022	2%
Water Level PT	3,903	1%
Battery Voltage Digital	3,737	1%
Fuel Temperature	3,569	1%
Fuel Moisture	3,558	1%
Battery Voltage Analog	3,549	1%
Soil Moisture	2,789	1%
Repeater Status Report	1,478	0%
Battery	1,395	0%
Wing Gust	683	0%
12Hr Status Report	586	0%
Repeater Pass List	577	0%
Hayman Battery	576	0%
Battery Voltage	250	0%
Hayman Stage	115	0%
Handar 585 ALARM Status	83	0%
Water Level	48	0%
Unknown IDs	846	0%
Total	315,331	

Records by Major Group

Meteorologic Sensors	224,935	71%
Water Level Sensors	38,944	12%
Rain Sensors	20,357	6%
Sensor Status Transmissions	17,266	5%
Soil and Fuel Sensors	9,916	3%
Total	311,418	

Traffic Loading Summary

Alert Reports	315,331	
Average Daily Traffic	10,511	
Average Hourly Traffic	438	
Median Hourly Traffic	421	hour beginning
Peak Hourly Traffic	1,138	6/2/09 5:00 AM
2nd Max	1,041	6/23/09 4:00 PM
3rd Max	965	6/25/09 6:00 PM
4th Max	963	6/2/09 4:00 AM
5th Max	950	6/2/09 6:00 AM

Rain Timer Performance

Analyze Rain Sensors

n Timer Performance

		52	12:33	83%	0.829698582
Rain ID	**Description**	**Rcv**	**Timer Interval**	**Exp**	**Performance**
2900	Russelville Gulch-Douglas	9	0:00	60.00	15%
2270	Cub Cr below Blue	10	5:54	60.00	17%
1700	Cherry Cr @ Champa	11	15:00	60.00	18%
430	Utah Park	12	11:58	60.00	20%
4330	Indian Ruins	12	13:17	60.00	20%
2970	Rampart Range Rd	14	15:16	60.00	23%
5780	Monument Gulch	20	19:30	60.00	33%
3020	West Creek WX	22	12:35	60.00	37%
700	Toll Gate @ 6th	23	0:00	60.00	38%
2850	Cherry Cr bl Bayou Glch	24	11:59	60.00	40%
2860	CC at Stroh Rd	24	10:42	60.00	40%
2980	Dakan Rd	24	13:15	60.00	40%
1460	Urban Farm	26	3:58	60.00	43%
2960	Indian Creek	29	11:59	60.00	48%
410	Kelly Dam	30	9:35	60.00	50%
1360	Denver Zoo	31	13:42	60.00	52%
110	Ralston Reservoir	32	13:51	60.00	53%
1660	SPR at Henderson	33	11:25	60.00	55%
2810	Pine Cliff Road	34	18:01	60.00	57%
5760	Cheeseman	35	17:08	60.00	58%
1810	Sand Creek at mouth	36	16:09	60.00	60%
540	Parker/Mississippi	38	15:22	60.00	63%
1350	Chatfield COE	39	14:37	60.00	65%
2340	El Rancho	41	14:51	60.00	68%
2280	Kinney Peak	42	13:40	60.00	70%
2910	East Cherry Cr-Douglas	42	12:00	60.00	70%
1570	Brighton Ditch Wx	43	13:55	60.00	72%
2230	Bear Cr below Cub	43	13:09	60.00	72%
2250	Rosedale	43	13:20	60.00	72%
4010	Cresent	43	13:00	60.00	72%
920	Aurora Town Hall Wx	44	12:27	60.00	73%
4560	Lyons Diversion NSV	44	15:37	60.00	73%
4570	St. Antons	44	14:08	60.00	73%
5770	Lazy Gulch	46	14:20	60.00	77%
150	Nott Creek	47	12:20	60.00	78%
300	Van Bibber Park	47	13:34	60.00	78%
1300	Hidden Lake	47	12:56	60.00	78%
1480	Third Creek at DIA	47	13:20	60.00	78%
1550	Lakewood CC	47	12:58	60.00	78%
2370	Red Rocks Park	47	13:40	60.00	78%
2950	DC Public Works	47	11:41	60.00	78%
4170	Pine Brook	47	14:19	60.00	78%
4750	Louisville Lake	47	12:43	60.00	78%
330	Van Bibber @ Hwy 93	48	12:40	60.00	80%
830	Side Creek Park	48	13:13	60.00	80%
1400	Upper Sloan Det.	48	13:49	60.00	80%
1500	Powers Park	48	12:19	60.00	80%
1710	Shop Creek	48	13:45	60.00	80%
2330	Morrison	48	12:32	60.00	80%
4860	Fairview Peak	48	12:22	60.00	80%
640	Goldsmith @ Eastman	49	12:37	60.00	82%
2260	Brook Forest	49	12:16	60.00	82%
4150	Gold Hill	49	12:23	60.00	82%
210	Leyden Confluence	50	13:37	60.00	83%

420	Expo Park	50	12:20	60.00	83%
440	Fire Station #7	50	12:33	60.00	83%
510	Virginia Court	50	11:57	60.00	83%
530	Fire Station #19	50	12:16	60.00	83%
630	Temple Pond at DTC	50	11:57	60.00	83%
760	Mission Viejo Park	50	11:57	60.00	83%
840	Fire Station 12	50	12:34	60.00	83%
1030	NREL/S. Table Mtn.	50	13:37	60.00	83%
1320	SPR at 3rd Ave	50	13:15	60.00	83%
1520	Marston Lake North	50	12:33	60.00	83%
1530	Bear Creek @ Lowell	50	13:29	60.00	83%
2820	Haskins Gulch Conf	50	13:21	60.00	83%
4080	Twin Sisters	50	12:59	60.00	83%
4240	Sunset	50	13:25	60.00	83%
4470	Little Narrows	50	12:59	60.00	83%
4530	Winiger Ridge	50	13:17	60.00	83%
5740	Trail Creek	50	13:34	60.00	83%
610	Harvard @ Jackson	51	13:12	60.00	85%
650	Iliff Pond	51	12:52	60.00	85%
720	Confluence Pond	51	12:31	60.00	85%
800	Sable Ditch @ 18th	51	12:15	60.00	85%
870	Murphy Creek GC	51	13:25	60.00	85%
1310	LDC at 64th	51	12:16	60.00	85%
2360	Indian Hills	51	12:38	60.00	85%
4130	Swiss Peaks	51	13:21	60.00	85%
4140	Logan Mill	51	13:45	60.00	85%
4220	Fling's	51	12:37	60.00	85%
5810	Stump Bump	51	12:18	60.00	85%
400	Montview Park	52	12:15	60.00	87%
620	Quincy/Highline	52	12:14	60.00	87%
710	Horseshoe Park Drop	52	12:32	60.00	87%
810	Granby Ditch @ 6th	52	11:57	60.00	87%
820	ETG @ Buckley	52	12:32	60.00	87%
950	Lookout One	52	12:46	60.00	87%
1000	Maple Grove Resv.	52	12:36	60.00	87%
1040	Lena @ U.S. Hwy 6	52	13:17	60.00	87%
1440	Elbert	52	13:05	60.00	87%
1620	Slaughterhouse Glch	52	12:33	60.00	87%
1800	Sand Creek Park	52	11:58	60.00	87%
2190	Squaw Mountain	52	13:01	60.00	87%
2210	Hiwan G.C.	52	12:00	60.00	87%
2220	Evergreen Lake	52	13:36	60.00	87%
2920	West Cherry Head-Douglas Cnty	52	12:18	60.00	87%
2930	Spring Valley Rd - DougCnty	52	12:48	60.00	87%
4020	Rio Grande	52	12:19	60.00	87%
4070	Bear Peak	52	12:42	60.00	87%
4090	Magnolia	52	12:19	60.00	87%
4190	Slaughterhouse	52	12:40	60.00	87%
4830	SBC @ San Souci	52	12:36	60.00	87%
4850	Porphory Mtn	52	12:14	60.00	87%
5800	Goose Creek	52	12:52	60.00	87%
100	Carr Street	53	12:56	60.00	88%
130	Simms Street	53	13:20	60.00	88%
140	Blue Mountain	53	12:20	60.00	88%
500	Havana Park	53	11:57	60.00	88%
600	Harvard Gulch Park	53	12:48	60.00	88%
1020	Lena @ Nolte Pond	53	13:20	60.00	88%
1050	Jeffco Fairgrounds	53	12:15	60.00	88%
1340	Sanderson at Xavier	53	12:53	60.00	88%

1420	Diamond Hill	53	12:00	60.00	88%
2240	Cold Sprg Glch conf	53	12:16	60.00	88%
2940	Willow Creek - DougCnty	53	12:35	60.00	88%
4510	Pinewood Springs	53	12:34	60.00	88%
4820	Doudy Draw	53	12:57	60.00	88%
120	West Woods	54	12:54	60.00	90%
220	Upper Leyden	54	12:37	60.00	90%
310	Guy Hill Ranch	54	12:17	60.00	90%
320	Sports Complex	54	11:57	60.00	90%
520	Jewell Detention	54	12:15	60.00	90%
730	No Name @ Quincy	54	11:58	60.00	90%
850	Flying J	54	12:08	60.00	90%
940	Sampson Gulch	54	11:57	60.00	90%
1010	Denver West	54	12:34	60.00	90%
1600	Englewood Dam	54	13:17	60.00	90%
1720	Cherry Cr @ Steele	54	12:14	60.00	90%
1900	Niver Detention	54	12:15	60.00	90%
2310	Genesee Village	54	12:37	60.00	90%
2840	Sulphur Gulch	54	13:02	60.00	90%
4060	Lakeshore	54	12:18	60.00	90%
4180	Gold Lake	54	13:35	60.00	90%
4360	Justice Center	54	12:14	60.00	90%
4840	SBC@S Boulder Ditch	54	12:36	60.00	90%
5730	West Creek	54	12:33	60.00	90%
5820	Corral Creek	54	12:49	60.00	90%
750	Quincy Reservoir	55	11:57	60.00	92%
1060	Heritage Square	55	12:15	60.00	92%
1330	Roslyn	55	12:18	60.00	92%
1370	West Metro FS13	55	13:03	60.00	92%
1630	SPR at Dartmouth	55	12:50	60.00	92%
1920	Brighton	55	12:00	60.00	92%
2350	Idledale	55	12:33	60.00	92%
2990	Tomah Rd-Douglas Cnty	55	13:05	60.00	92%
4710	Ward C-1	55	12:00	60.00	92%
5790	Flying G	55	12:00	60.00	92%
200	Leyden Reservoir	56	12:21	60.00	93%
970	Pump Sta 3	56	12:00	60.00	93%
4030	Red Garden	56	12:19	60.00	93%
4200	Lazy Acres	56	12:36	60.00	93%
4250	Geer Canyon	56	12:32	60.00	93%
4260	Taylor Mountain	56	12:15	60.00	93%
4340	Riverside	56	12:50	60.00	93%
4730	Sugarloaf	56	12:18	60.00	93%
5860	Cedar Mountain	56	12:15	60.00	93%
1610	Holly Dam	57	12:23	60.00	95%
4050	Walker Ranch	57	11:58	60.00	95%
4110	Betasso	57	11:40	60.00	95%
4230	Golden Age	57	11:57	60.00	95%
4300	Big Elk Park	57	11:47	60.00	95%
4400	Orodell	57	12:24	60.00	95%
4790	Button Rock	57	12:00	60.00	95%
5880	Hackett Mountain	57	12:15	60.00	95%
900	Aurora Reservoir	58	11:30	60.00	97%
1100	Louisville Rec Ctr	58	12:16	60.00	97%
2730	Salisbury Park	58	11:08	60.00	97%
4160	Sunshine	58	12:34	60.00	97%
4270	Cannon Mountain	58	11:57	60.00	97%
4310	Johnny Park	58	12:15	60.00	97%
4350	Conifer Hill	58	11:58	60.00	97%

4520	Eagle Ridge	58	12:00	60.00	97%
4810	Shanahan Ridge	58	12:16	60.00	97%
5720	Four Mile Creek	58	12:32	60.00	97%
1110	Gunbarrel	59	11:58	60.00	98%
1200	Broomfield 3207	59	11:58	60.00	98%
4040	Martin Gulch	59	11:57	60.00	98%
4290	Red Hill	59	12:14	60.00	98%
4490	Apple Valley	59	11:58	60.00	98%
4550	Boulder Jail	59	11:42	60.00	98%
4770	Cal-Wood Ranch	59	12:00	60.00	98%
4100	Filter Plant	60	11:48	60.00	100%
2710	Highlands Ranch WTP	61	10:38	60.00	102%
2750	Castle Rock	61	11:05	60.00	102%
860	Sand Cr at Colfax	63	7:17	60.00	105%
5930	Long Hollow	100	7:08	60.00	167%
2320	Choke Cherry Resvr	136		60.00	227%

Rain Event Performance

		Reports Received	9,573	Analyze Rain Sensors
	Systemwide Avg	Total Tips	11,320	
	84.6%	Data Loss	15.43%	

Rain ID	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Rcv	Exp	Miss	Hold	Bucket
2900	48%	8	1	2	2	1	0	1	14	29	15	0	0.0393701
2810	53%	22	13	3	3	0	2	2	43	81	38	0	0.0393701
540	61%	31	8	3	1	2	1	2	46	76	30	0	0.0393701
2860	61%	22	8	3	1	0	1	0	35	57	22	0	0.0393701
2320	64%	33	7	1	3	2	0	1	46	72	26	0	0.0393701
110	65%	19	1	2	1	0	1	2	24	37	13	0	0.0393701
1350	66%	29	10	3	1	1	0	1	44	67	23	0	0.0393701
2850	66%	38	1	1	2	1	2	1	45	68	23	0	0.0393701
2970	67%	5	2	1	0	0	0	0	8	12	4	0	0.0393701
2350	67%	35	5	3	4	0	0	0	47	70	23	0	0.0393701
2280	70%	58	10	8	1	1	0	0	78	111	33	0	0.0393701
1010	72%	53	12	4	1	1	0	0	71	98	27	0	0.0393701
1360	74%	22	3	2	1	0	0	0	28	38	10	0	0.0393701
860	74%	51	8	1	1	1	1	0	63	85	22	0	0.0393701
1530	74%	40	12	2	1	0	0	0	55	74	19	0	0.0393701
1520	75%	36	9	2	1	0	0	1	48	64	16	1	0.0393701
1700	75%	9	2	1	0	0	0	0	12	16	4	0	0.0393701
1810	75%	51	8	3	1	1	0	2	64	85	21	0	0.0393701
2710	75%	34	7	1	0	0	1	0	43	57	14	0	0.0393701
2840	76%	68	19	5	0	0	0	1	92	121	29	0	0.0393701
640	76%	42	9	4	0	0	0	0	55	72	17	0	0.0393701
210	77%	45	10	4	0	0	0	0	59	77	18	0	0.0393701
2230	77%	43	7	1	1	1	0	0	53	69	16	0	0.0393701
150	77%	48	12	2	1	0	0	0	63	82	19	0	0.0393701
820	77%	50	10	1	1	1	0	0	63	82	19	0	0.0393701
1040	77%	46	12	3	0	0	0	0	61	79	18	0	0.0393701
2750	77%	33	4	4	0	0	0	0	41	53	12	0	0.0393701
1480	77%	58	19	2	0	0	0	0	79	102	23	0	0.0393701
2820	78%	52	14	3	0	0	0	0	69	89	20	0	0.0393701
4470	78%	54	12	1	2	0	0	0	69	89	20	0	0.0393701
320	78%	53	11	4	0	0	0	0	68	87	19	0	0.0393701
1310	78%	92	17	6	1	0	0	0	116	148	32	0	0.0393701
4820	78%	42	5	3	1	0	0	0	51	65	14	0	0.0393701
2310	78%	50	8	3	1	0	0	0	62	79	17	0	0.0393701
100	79%	59	10	5	0	0	0	0	74	94	20	0	0.0393701
1050	79%	56	11	4	0	0	0	0	71	90	19	0	0.0393701
4570	79%	34	10	1	0	0	0	0	45	57	12	0	0.0393701
4130	79%	43	9	1	1	0	0	0	54	68	14	0	0.0393701
1400	80%	63	11	3	1	0	0	0	78	98	20	0	0.0393701
4750	80%	37	8	2	0	0	0	0	47	59	12	0	0.0393701
1000	80%	50	13	0	1	0	0	0	64	80	16	0	0.0393701
720	80%	46	2	3	0	0	1	0	52	65	13	0	0.0393701
760	80%	47	9	0	0	0	1	0	57	71	14	0	0.0393701
120	81%	38	7	0	0	1	0	0	46	57	11	0	0.0393701
1570	81%	68	10	3	1	0	0	0	82	101	19	1	0.0393701
940	81%	66	9	1	1	1	0	0	78	96	18	0	0.0393699
1060	81%	52	6	2	0	1	0	0	61	75	14	0	0.0393701
4090	81%	40	6	1	1	0	0	0	48	59	11	0	0.0393701
2360	81%	48	6	2	1	0	0	0	57	70	13	0	0.0393701
1370	82%	47	9	2	0	0	0	0	58	71	13	0	0.0393701
1440	82%	52	9	1	1	0	0	0	63	77	14	0	0.0393701
4840	82%	45	8	2	0	0	0	0	55	67	12	1	0.0393701
4180	82%	43	6	1	1	0	0	0	51	62	11	0	0.0393701
700	82%	72	9	2	0	0	1	0	84	102	18	1	0.0393701
2340	82%	38	8	1	0	0	0	1	47	57	10	0	0.0393701
140	83%	70	12	3	0	0	0	0	85	103	18	0	0.0393701
220	83%	52	7	3	0	0	0	0	62	75	13	1	0.0393701
1330	83%	55	4	2	0	0	1	0	62	75	13	0	0.0393701
1500	83%	56	8	3	0	0	0	0	67	81	14	0	0.0393701
1550	83%	43	4	0	2	0	0	0	49	59	10	0	0.0393701
1420	83%	56	6	2	1	0	0	0	65	78	13	0	0.0393701
830	83%	53	5	1	0	0	1	0	60	72	12	0	0.0393701
4080	83%	42	7	0	1	0	0	0	50	60	10	1	0.0393701
1340	84%	45	11	0	0	0	0	0	56	67	11	0	0.0393701
4150	84%	47	7	2	0	0	0	0	56	67	11	0	0.0393701
920	84%	112	12	2	0	1	1	0	128	153	25	0	0.0393701
1660	84%	27	2	2	0	0	0	3	31	37	6	1	0.0393701
1460	84%	67	8	2	1	0	0	0	78	93	15	0	0.0393701
300	84%	43	8	1	0	0	0	0	52	62	10	0	0.0393701
4140	84%	43	8	1	0	0	0	0	52	62	10	0	0.0393701
4730	84%	39	7	1	0	0	0	0	47	56	9	0	0.0393701
730	84%	51	4	2	1	0	0	0	58	69	11	0	0.0393701
1920	84%	50	6	1	1	0	0	0	58	69	11	0	0.0393701

2370	84%	50	6	1	1	0	0	0	58	69	11	0	0.0393701
750	84%	43	2	2	1	0	0	0	48	57	9	0	0.0393701
600	84%	47	5	1	1	0	0	0	54	64	10	0	0.0393701
1800	85%	60	9	2	0	0	0	1	71	84	13	0	0.0393701
2730	85%	82	6	4	1	0	0	0	93	110	17	0	0.0393701
1320	85%	44	4	1	1	0	0	0	50	59	9	0	0.0393701
710	85%	53	8	0	1	0	0	0	62	73	11	0	0.0393701
310	85%	68	10	2	0	0	0	0	80	94	14	0	0.0393701
900	86%	71	11	0	1	0	0	0	83	97	14	0	0.0393699
530	86%	65	6	1	0	1	0	0	73	85	12	0	0.0393701
510	86%	90	13	0	0	1	0	0	104	121	17	0	0.0393701
1030	86%	50	5	0	0	1	0	0	56	65	9	0	0.0393701
610	86%	54	8	1	0	0	0	0	63	73	10	0	0.0393701
840	86%	56	6	2	0	0	0	1	64	74	10	0	0.0393701
2950	86%	28	3	1	0	0	0	0	32	37	5	0	0.0393701
4790	86%	29	2	0	1	0	0	0	32	37	5	0	0.0393701
2260	87%	39	5	1	0	0	0	0	45	52	7	0	0.0393701
330	87%	47	3	1	1	0	0	0	52	60	8	0	0.0393701
2240	87%	57	8	1	0	0	0	0	66	76	10	0	0.0393701
2920	87%	66	7	2	0	0	0	0	75	86	11	0	0.0393701
1710	87%	47	8	0	0	0	0	1	55	63	8	0	0.0393701
2330	87%	53	9	0	0	0	0	1	62	71	9	1	0.0393701
2210	88%	50	4	2	0	0	0	1	56	64	8	0	0.0393701
4240	88%	43	5	1	0	0	0	0	49	56	7	0	0.0393701
4250	88%	45	1	3	0	0	0	0	49	56	7	0	0.0393701
2960	88%	13	2	0	0	0	0	0	15	17	2	0	0.0393701
1300	88%	101	11	2	0	0	0	0	114	129	15	0	0.0393701
4710	89%	55	6	1	0	0	0	0	62	70	8	0	0.0393701
400	89%	60	4	2	0	0	0	1	66	74	8	0	0.0393701
1620	89%	37	5	0	0	0	0	0	42	47	5	0	0.0393701
800	89%	52	7	0	0	0	0	1	59	66	7	0	0.0393701
650	89%	61	6	1	0	0	0	1	68	76	8	0	0.0393701
4170	90%	31	4	0	0	0	0	0	35	39	4	0	0.0393701
4520	90%	47	6	0	0	0	0	0	53	59	6	0	0.0393701
620	90%	51	1	1	1	0	0	0	54	60	6	0	0.0393701
1600	90%	49	4	1	0	0	0	0	54	60	6	0	0.0393701
630	90%	119	9	0	0	0	1	0	129	143	14	0	0.0393701
2990	90%	67	6	1	0	0	0	0	74	82	8	0	0.0393701
520	91%	70	6	1	0	0	0	1	77	85	8	0	0.0393701
4010	91%	53	4	1	0	0	0	0	58	64	6	0	0.0393701
4530	91%	35	4	0	0	0	0	0	39	43	4	0	0.0393701
4770	91%	54	6	0	0	0	0	0	60	66	6	0	0.0393701
970	91%	57	3	0	1	0	0	1	61	67	6	0	0.0393701
440	91%	68	2	1	1	0	0	0	72	79	7	0	0.0393701
4060	91%	58	6	0	0	0	0	0	64	70	6	0	0.0393701
4510	91%	39	4	0	0	0	0	0	43	47	4	0	0.0393701
810	92%	72	4	0	1	0	0	0	77	84	7	0	0.0393701
3020	92%	20	2	0	0	0	0	0	22	24	2	0	0.0393701
4350	92%	51	5	0	0	0	0	0	56	61	5	0	0.0393701
2940	92%	52	5	0	0	0	0	0	57	62	5	0	0.0393701
4160	92%	52	5	0	0	0	0	0	57	62	5	0	0.0393701
4830	92%	53	3	1	0	0	0	0	57	62	5	0	0.0393701
2250	92%	43	2	1	0	0	0	1	46	50	4	0	0.0393701
2910	92%	42	4	0	0	0	0	0	46	50	4	0	0.0393701
4220	92%	42	4	0	0	0	0	0	46	50	4	0	0.0393701
1720	92%	53	5	0	0	0	0	0	58	63	5	0	0.0393701
420	92%	141	9	0	0	1	0	0	151	164	13	0	0.0393701
4330	92%	11	1	0	0	0	0	0	12	13	1	0	0.0393701
4030	92%	68	4	1	0	0	0	0	73	79	6	0	0.0393701
4110	92%	45	4	0	0	0	0	0	49	53	4	1	0.0393701
4360	93%	47	4	0	0	0	0	0	51	55	4	0	0.0393701
950	93%	71	6	0	0	0	0	0	77	83	6	0	0.0393701
200	93%	38	1	1	0	0	0	0	40	43	3	0	0.0393701
1200	93%	38	1	1	0	0	0	0	40	43	3	0	0.0393701
4810	93%	64	3	1	0	0	0	0	68	73	5	0	0.0393701
4550	93%	39	1	1	0	0	0	0	41	44	3	0	0.0393701
870	94%	81	6	0	0	0	0	1	87	93	6	0	0.0393701
500	94%	98	5	1	0	0	0	0	104	111	7	0	0.0393701
850	95%	83	3	1	0	0	0	2	87	92	5	0	0.0393701
4190	95%	50	3	0	0	0	0	0	53	56	3	0	0.0393701
4070	95%	69	4	0	0	0	0	0	73	77	4	0	0.0393701
1900	95%	53	3	0	0	0	0	1	56	59	3	0	0.0393701
4340	95%	36	2	0	0	0	0	0	38	40	2	0	0.0393701
4200	96%	41	2	0	0	0	0	0	43	45	2	0	0.0393701
4040	96%	90	4	0	0	0	0	0	94	98	4	0	0.0393701
2190	96%	46	2	0	0	0	0	0	48	50	2	0	0.0393701
2270	96%	23	1	0	0	0	0	0	24	25	1	0	0.0393701

4290	96%	52	2	0	0	0	0	0	54	56	2	0	0.0393701
4050	96%	53	2	0	0	0	0	0	55	57	2	0	0.0393701
4300	97%	55	2	0	0	0	0	0	57	59	2	0	0.0393701
1110	97%	33	1	0	0	0	0	0	34	35	1	0	0.0393701
4230	97%	34	1	0	0	0	0	0	35	36	1	0	0.0393701
1100	97%	70	2	0	0	0	0	0	72	74	2	0	0.0393701
4270	97%	35	1	0	0	0	0	0	36	37	1	0	0.0393701
4020	97%	74	2	0	0	0	0	0	76	78	2	0	0.0393701
4310	98%	38	1	0	0	0	0	0	39	40	1	0	0.0393701
2930	98%	42	1	0	0	0	0	0	43	44	1	0	0.0393701
4100	98%	45	1	0	0	0	0	0	46	47	1	1	0.0393701
4260	98%	52	1	0	0	0	0	0	53	54	1	0	0.0393701
4490	100%	50	0	0	0	0	0	0	50	50	0	0	0.0393701
410	100%	23	0	0	0	0	0	0	23	23	0	0	0.0393701
2980	100%	18	0	0	0	0	0	0	18	18	0	0	0.0393701
430	100%	17	0	0	0	0	0	0	17	17	0	0	0.0393701
	Total Tips	**8,284**	**983**	**207**	**62**	**21**	**16**	**33**	**9,573**	**11,320**	**1,747**	**10**	

Monthly Traffic Loading