Memo

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

Date: September 4, 2006

To: Kevin Stewart, Chad Kudym

From: Markus Ritsch

Subject: **August 2006 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 August 1 through August 31, 2006.

II. General System Analysis Summary

A total of 212,475 individual data records were analyzed. Meteorological sensors account for 67 percent, water level sensors 16 percent, and rain sensors 7 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 4,250 reports were flagged as "bad". Of these "bad" reports, 3,339 originated from the wind sensor (ID 2189 and 2187) at Squaw Mountain. The reception of "bad" data reports from the Squaw Mountain sensor ID's 2189 and 2187 has been a consistent theme throughout this year.

The system-wide radio traffic loading this month was 6,854 reports per day with an average hourly loading of 286 reports. The peak hourly traffic loading was 1,107 reports, which occurred on August 13th between nine and ten in the evening. This is the highest hourly traffic rate recorded so far this year. A plot of monthly average and peak hourly traffic loading is provided.

A new radio repeater was installed by Douglas County to relay the Hayman Burn precipitation gages on the District's primary base receiving frequency of 171.875 MHz. The new Douglas County repeater was activated on July 21, 2006 and configured to re-broadcast only those gages with IDs between 5700 through 6000.

A total of 2,864 rain reports were received from the Hayman gages this month. The impact upon radio traffic from these gages will be tracked throughout the flood season.

The sensors reporting most frequently this month include:

1. Salisbury Park (ID 2727) ALERT wind sensor reported 3,174 times,

2. Marston Lake North (ID 1521) relative humidity sensor reported 2,877 times, and

3. Urban Farm (IDs 1464, 1465, 1465, 1467) reported every 15 minutes.

The reports from the above sensors are more-or-less distributed evenly throughout the month.

III. Rain Sensors Reporting This Month

Approximately 171 rain sensors had incrementing reports this month. This includes the Douglas County Hayman gages. Several rain sensors had no incrementing rain tip reports during the month (Table 1).

Table 1. Rain Sensors with No Tip Reports

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-----	-----	-----	-----	1020	520	1020	320*				
-----	-----	-----	-----	1610	540	1610	1940*				
-----	-----	-----	-----	2220	1020	2220	5920*				
-----	-----	-----	-----	4560	1610	4560	1020				

-----	-----	-----	-----	-----	2220	1610					
-----	-----	-----	-----	-----	4240	2220					
-----	-----	-----	-----	-----	4560	4560					

* Sports Complex (320), Third Creek at DIA (1940), and Hayman Vermillion Canyon (5920) have installed rain sensors but these gages only had one or two transmissions received by the ALERT2 base station. Lena at Nolte Pond (1020), Holly Dam (1610), Evergreen Lake (2220), and Lyons Diversion NSV (4560) do not have an installed rain sensor although they report the rain ID.

IV. Rain Sensor Timer Reporting Summary

The following summary assumes that all rain sensors have a 12-hour timer reporting interval. System-wide the ALERT 2 base station received 91 percent of the non-incrementing timer reports. Those rain sensors with the worst timer reporting performances are summarized (Table 2).

Table 2. Monthly Summary of Sensors with Poor Timer Performance

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1010	1460	1460	2340	1460	1460	1460	1440				
1460	1660	4820	1460	1330	4820	1440	1460				
1640	4240	4570	1330	540	4830	110	2340				
--	--	--	1610	1600	1600	4820	4820				
			1600	4820	2350	4220					

* Stapleton "Urban Farm" (1460), Elbert (1440), El Rancho (2340), Doudy Draw (4820).

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. For example, sensor 4820 consistently exhibits a poor timer performance value.

We suspect that sensor 1460 has a 24-hour timer reporting interval so it's timer performance value is actually better than reported here (see data analysis report for May, 2006).

V. 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. August District-Wide Total Tip/Count Statistical Summary

Statistical Parameter	Value	Comments
Mean	46.89	Only the 1-mm rain sensors were included in the analysis
Median	42	Only the 1-mm rain sensors were included in the analysis
Standard deviation	23.58	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	117.65	Several sensors for the month are outside the Mean +/- 3 Std Dev
Minimum total count	8	Red Hill (ID 4290)
Maximum total count	126	Upper Leyden (ID 220)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.62	5.92	18.39	20.47	19.44	13.75	74.03	46.89				

The average rainfall experienced district-wide was not as great as in July. The month of August, however, did produce some high intensity rainfall. The following sensors had a maximum monthly total tip count that exceeded the system-wide mean plus three standard deviations for the month: Upper Leyden (220) and Temple Pond at DTC (630). The data records for these sensors were further inspected.

1. Upper Leyden (220) and Temple Pond at DTC (630)

The rain tip count series for the month looks reasonable for both Upper Leyden and Temple Pond at DTC. The count series for Upper Leyden increased significantly on August 3rd when heavy rains were experienced (Figure 1). Two additional periods of significant rainfall were evident at both stations on 8/13/2006 and on 8/19/2006.
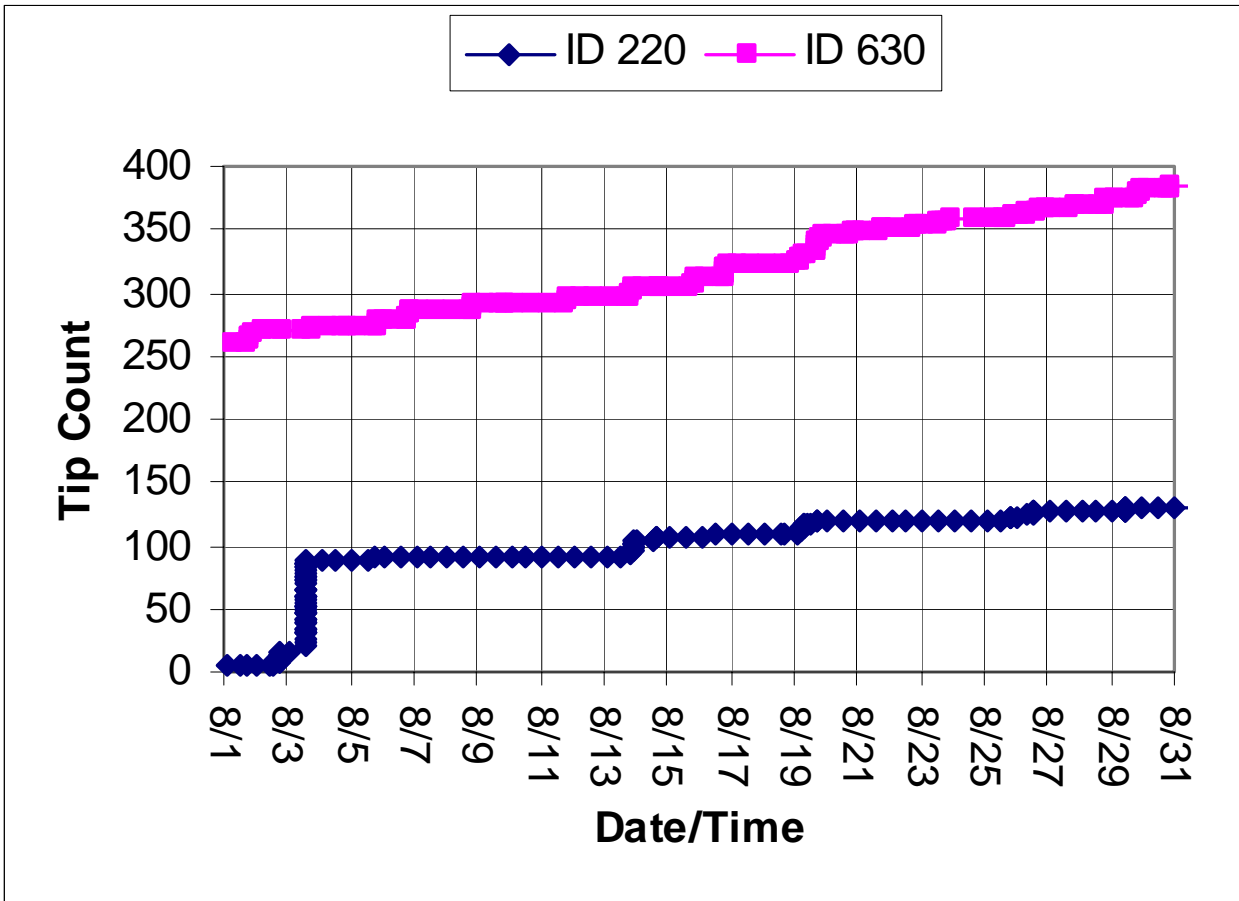

Figure 1. Tip Count Series for Upper Leyden (ID 4860) and Temple Pond at DTC (ID 630)

The heavy rain period at Upper Leyden on August 3rd is examined more closely (Figure 2).
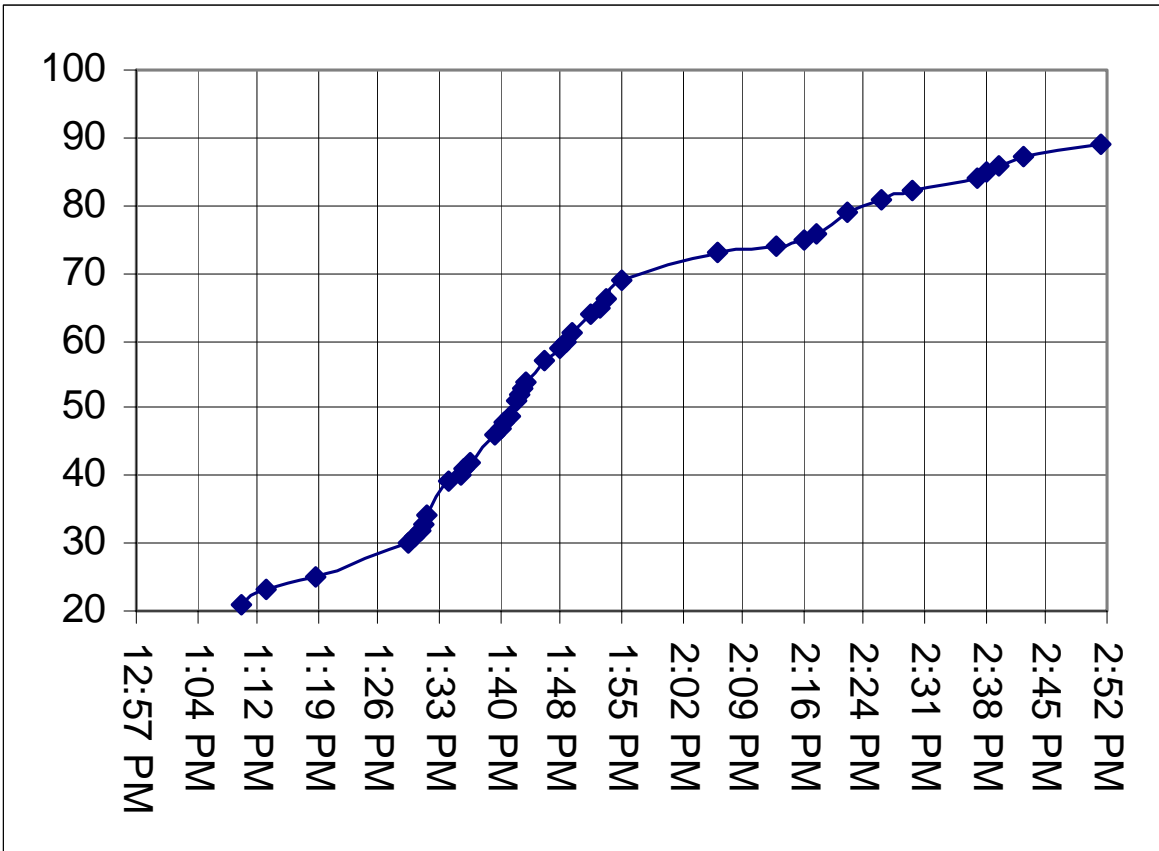
Figure 2. Heavy Rain on August 3rd at Upper Leyden (ID 220)

The early afternoon period between 1:00 PM and 3:00 PM on 8/3/06 produced almost 70 tips of rain. The highest rainfall rate occurred from approximately 1:25 PM to 1:55 PM (30 minutes) where approximately 45 tips (1.77 inches) were received at the base station.

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

The following rain sensors experienced a jump in their sequential tip count of more than 6. The data records for these sensors were further analyzed through a visually inspection of the data.

1. Fire Station 12, ID 840
2. Genesee Village, ID 2310
3. Gold Lake, ID 4180

1. Fire Station 12, ID 840

On 8/15/2006 at 10:07:16 AM the count value jumped from 40 to 2046. NovaStar validated the large jump, which occurred in a span of 10 minutes. The cause of the large jump is not clear. It is not attributable to actual rainfall.

Date/Time	Sensor ID	Count	Data Type
8/15/2006 2:54:53 AM	840	40	0
8/15/2006 9:57:06 AM	840	40	0
8/15/2006 10:07:16 AM	840	2046	0
8/15/2006 10:12:26 AM	840	2046	0
8/15/2006 10:14:09 AM	840	2046	0

2. Genesee Village, ID 2310

On 8/18/2006 the series jumped from 173 to 180. Both the last report of 173 on 8/17/06 and the first report of 180 on 8/18/06 were timer transmissions. A total of 7 incrementing reports were not received at the base station between 8/17/06 at 12:24 AM and 8/18/06 at 12:24 PM. The rain total as shown by NovaStar is accurate as the large jump was validated. The temporal distribution of the tips within the 12-hour period was, however, lost.

Date/Time	Sensor ID	Count	Data Type
8/17/2006 12:24:07 AM	2310	173	0
8/17/2006 12:24:09 PM	2310	173	0
8/18/2006 12:24:09 AM	2310	180	0
8/18/2006 12:24:11 PM	2310	180	0

3. Gold Lake, ID 4180

On 8/22/2006 the series jumped from 190 to 199. Both the last report of 190 and the first report of 199 on 8/22/06 were timer transmissions. A total of 9 incrementing reports were not received at the base station between 8/21/06 at 3:44 AM and 8/22/06 at 3:38 PM. The rain total as shown by NovaStar was accurate as the large jump was validated but the temporal occurrence of each tip was lost.

Date/Time	Sensor ID	Count	Data Type
8/20/2006 3:46:50 PM	4180	190	0
8/21/2006 3:44:46 AM	4180	190	0
8/22/2006 3:38:41 PM	4180	199	0
8/23/2006 3:36:32 AM	4180	199	0

C. Sensor-by-Sensor Incrementing Count Summary

The system-wide reception rate of incrementing rain tip reports for the month was approximately 89 percent. A total of 6,180 incrementing reports were received and a total of 6,910 were expected. The total loss of incrementing reports for the month was approximately 10.5 percent. Those sensors with the worst rain event transmission characteristics are summarized (Table 5).

Table 5. Monthly Summary of Sensors with the Most Missed Tips

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
640	4010	4530	2190	540	4820	4820	2370				
1640	4080	4170	310	1400	1350	2350	2310				
4490	4170	4820	4820	1100	4790	2310	220				
-----	-----	-----	-----	4820	2340	750	4060				
-----	-----	-----	-----	1420	2350	150	4180				

* Red Rocks Park (2370), Genesee Village (2310), Upper Leyden (220), Lakeshore (4060), Gold Lake (4180).

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 with poor rain tip performance all experienced jumps in sequential count values during the heavy rain period from 8/13/2006 through 8/14/2006.

D. Peak Traffic Hour Analysis

The peak hour of radio traffic during August occurred on 8/13/2006 between 9:00 PM and 10:00 PM. The data for this period was examined more closely to better characterize the performance of the system during times of heavy loading. The distribution of radio traffic by sensor is shown (Table 6). During this hour the radio traffic was dominated by water level and precipitation sensor reports.

Table 6. Peak Traffic Hour Sensor Report Distribution

Sensor Group	Total Reports	Percentage
Water Level PT-HSE	476	43%
Precipitation	347	31%
Water Level Float	64	6%
Relative Humidity	36	3%
Wind Gust	36	3%
Temperature	28	3%
Water Level PT	28	3%
Wind Direction	21	2%
Wind Speed Average	14	1%
Hayman Precipitation	13	1%
Wind Speed Average & Azimuth	13	1%
Battery Voltage Digital	8	1%
Battery Voltage HSE	7	1%
Barometric Pressure	5	0%
Solar Radiation	4	0%
Fuel Moisture	2	0%
Fuel Temperature	2	0%
Battery Voltage Analog	1	0%
Precipitation - Mean	1	0%
Repeater Pass List	1	0%
Total	**1107**	

The accuracy of rain data for the peak hour was further analyzed (Table 7) for the District's 1-mm rain sensors. The Hayman gages are not included in the following analysis. Seventeen percent of the single incrementing tip reports were lost during this hour. The rainfall accumulation totals as tracked by NovaStar, however, were accurate. There were no sensors that under-reported rainfall due to the loss of sequential tip counts.

Table 7. Peak Traffic Hour Rain Reporting Summary

Heavy Traffic Period	Traffic Msgs/hr	Rain reports expected	Rain reports received	Loss of reports	Accurate rain totals
8/13/06 9:00 PM – 10:00 PM	1,107	346	286	17.34%	Yes

VI. Issues Continued from Previous Month

The following issues were identified last month.

1. Doudy Draw (4820) continues to exhibits both poor timer and event transmission performance.

2. The timer reporting interval for Stapleton sensor 1460 (rain) is twenty-four (24) hours, **not** twelve (12) hours as expected. The timer reports are received each day at approximately 11:57:20 pm.

VII. Issues Identified this Month

Further investigation into the following issues is recommended:

1. Marston Lake North (ID 1521) relative humidity sensor reported 2,877 times or once every 15 minutes.

2. The rain sensors installed at the Sports Complex (320) and Third Creek at DIA (1940) reported only one or two times during the month. The ALERT2 base station received no incrementing tip reports from these sensors.

3. The rain sensor at Elbert (1440) had a poor timer performance for the second month in a row.

4. Fire Station 12 (ID 840) saw the raw count jump from a value of 40 to 2046 in a span of 10 minutes on August 15th at 10:07:16 AM. NovaStar validated the large jump, which was not actual rainfall. The cause of the large jump is not known.

5. The rain sensor at Genesee Village (2310) had a poor event performance for the second month in a row.

6. The significant and at times heavy rain experienced between August 13th and August 14th caused the loss of sequential single increment data transmissions from numerous rain sensors. The system performed very well in terms of tracking rainfall totals as no sensors were found to under-report rainfall. The temporal distribution of rainfall for some sensors may be lost due to the missing tip counts during extended periods.

General System Analysis

Database Name	P:\A207-UDFCD-Data-Analysis\2006_Aug\Novastar_extract_2006Aug.mdb		
First Date in Database	8/1/06 12:00 AM	**Total Days**	31.0
Last Date in Database	8/31/06 11:59 PM	**Total Hours**	744.0
Total Records Analyzed	212475		

Records by Group

Wind Gust	33829	16%
Relative Humidity	30127	14%
Temperature	26658	13%
Water Level PT-HSE	26554	12%
Wind Direction	17760	8%
Wind Speed Average & Azimuth	15258	7%
Precipitation	15231	7%
Wind Speed Average	11306	5%
Battery Voltage HSE	6057	3%
Battery Voltage Digital	4489	2%
Solar Radiation	4278	2%
Water Level Float	3972	2%
Water Level PT	3959	2%
Hayman Precipitation	2864	1%
Barometric Pressure	2113	1%
Precipitation - Mean	1902	1%
Fuel Moisture	1474	1%
Fuel Temperature	1456	1%
Repeater Pass List	975	0%
Handar 585 ALARM Status	869	0%
Battery Voltage Analog	552	0%
Precipitation - Test	248	0%
12Hr Status Report	234	0%
Longmont Flow Gage	172	0%
Soil Moisture	74	0%
Longmont Water Level PT	60	0%
Precipitation-ASCII	3	0%
Snow (water equiv.)	1	0%
Total	**212475**	

Records by Major Group

Meteorologic Sensors	141329	67%
Water Level Sensors	34717	16%
Rain Sensors	15234	7%
Sensor Status Transmissions	13176	6%
Soil and Fuel Sensors	3004	1%
Total	**207460**	

Records by Validation Type

Good	0	208224	98%
Questionable	1	4251	2%
	Total	**212475**	

Sensors With Most Invalid Data

Description	Sensor	Reports
Squaw Mountain	2189	2572
Squaw Mountain	2187	767
Quincy Reservoir	753	157
Holly Dam	1613	47
Highlands Ranch WTP	2704	36

Traffic Loading Summary

Alert Reports	212475	
Average Daily Traffic	6854	
Average Hourly Traffic	286	
Median Hourly Traffic	270	hour beginning
Peak Hourly Traffic	1107	8/13/06 9:00 PM

Total Number of Sensors Defined	**Total Number of Sensors Reporting**
806	540

Reports per Sensor

Description	Sensor	Reports	Fraction of Total
Salisbury Park	2727	3174	1%
Marston Lake North	1521	2877	1%
Urban Farm	1466	2866	1%
Urban Farm	1465	2831	1%
Urban Farm	1467	2817	1%
Marston Lake North	1526	2794	1%
Elbert	1439	2775	1%
Urban Farm	1464	2770	1%
Green Ditch	4593	2739	1%
Squaw Mountain	2188	2715	1%
Castle Rock	2744	2646	1%
Squaw Mountain	2187	2626	1%
Quincy Reservoir	751	2620	1%
Hiwan G.C.	2208	2599	1%
Squaw Mountain	2189	2597	1%
Elbert	1438	2515	1%
Salisbury Park	2724	2416	1%
SPR at Union Ave.	1643	2414	1%
Louisville Lake	4744	2332	1%
Sugarloaf	4724	2325	1%
Blue Mountain	138	2324	1%
Quincy Reservoir	747	2265	1%
Diamond Hill	1414	2263	1%
Highlands Ranch WTP	2704	2200	1%
Diamond Hill	1421	2182	1%
Brighton	1914	2079	1%
Castle Rock	2747	2024	1%
Castle Rock	2751	2010	1%

Rain Timer Performance

			systemwide average (days) 0.5196		Systemwide Average 91%
Rain Sensors	**Description**	**umber of Received Timer Repo**	**Average Timer Interval**	**umber of expected Timer Repo**	**Performance**
100	Carr Street	57	12:27	62.00	92%
110	Ralston Reservoir	54	12:49	62.00	87%
120	West Woods	59	12:07	62.00	95%
140	Blue Mountain	62	11:40	62.00	100%
150	Nott Creek	55	12:00	62.00	89%
200	Leyden Reservoir	58	11:58	62.00	94%
210	Leyden Confluence	60	12:12	62.00	97%
220	Upper Leyden	63	11:13	62.00	102%
300	Van Bibber Park	60	12:12	62.00	97%
310	Guy Hill Ranch	54	13:27	62.00	87%
330	Van Bibber @ Hwy 93	56	13:04	62.00	90%
400	Montview Park	58	12:28	62.00	94%
410	Kelly Dam	56	12:42	62.00	90%
420	Expo Park	57	11:57	62.00	92%
430	Utah Park	55	11:57	62.00	89%
440	Fire Station #7	57	12:27	62.00	92%
500	Havana Park	57	13:03	62.00	92%
510	Virginia Court	59	12:18	62.00	95%
520	Jewell Detention	56	12:45	62.00	90%
530	Fire Station #19	60	11:57	62.00	97%
540	Parker/Mississippi	57	12:58	62.00	92%
600	Harvard Gulch Park	59	12:27	62.00	95%
610	Harvard @ Jackson	59	11:42	62.00	95%
620	Quincy/Highline	54	12:51	62.00	87%
630	Temple Pond at DTC	58	11:57	62.00	94%
640	Goldsmith @ Eastman	58	12:40	62.00	94%
650	Iliff Pond	58	12:28	62.00	94%
700	Toll Gate @ 6th	61	12:00	62.00	98%
710	Horseshoe Park Drop	54	12:46	62.00	87%
720	Confluence Pond	55	11:58	62.00	89%
730	No Name @ Quincy	57	12:45	62.00	92%
740	Smoky Hill	60	12:15	62.00	97%
750	Quincy Reservoir	63	11:16	62.00	102%
760	Mission Viejo Park	54	12:51	62.00	87%
800	Sable Ditch @ 18th	56	12:44	62.00	90%
810	Granby Ditch @ 6th	58	12:28	62.00	94%
820	ETG @ Buckley	57	12:59	62.00	92%
830	Side Creek Park	53	12:22	62.00	85%
840	Fire Station 12	60	11:53	62.00	97%
850	Flying J	51	12:45	62.00	82%
860	Sand Cr at Colfax	110	6:39	62.00	177%
870	Murphy Creek GC	59	12:15	62.00	95%
900	Aurora Reservoir	55	11:59	62.00	89%
1000	Maple Grove Resv.	57	12:28	62.00	92%
1010	Denver West	60	11:57	62.00	97%
1020	Lena @ Nolte Pond	58	12:37	62.00	94%
1030	NREL/S. Table Mtn.	57	12:11	62.00	92%
1040	Lena @ U.S. Hwy 6	60	12:12	62.00	97%
1050	Jeffco Fairgrounds	59	12:11	62.00	95%
1060	Heritage Square	57	12:54	62.00	92%
1100	Louisville Rec Ctr	51	14:16	62.00	82%
1110	Gunbarrel	49	14:43	62.00	79%
1200	Broomfield 3207	54	13:31	62.00	87%
1300	Hidden Lake	55	12:47	62.00	89%
1310	LDC at 64th	58	11:58	62.00	94%
1320	SPR at 3rd Ave	55	12:41	62.00	89%
1330	Roslyn	55	12:44	62.00	89%
1340	Sanderson at Xavier	58	12:45	62.00	94%
1350	Chatfield COE	56	12:14	62.00	90%
1360	Denver Zoo	61	12:00	62.00	98%
1370	West Metro FS13	56	13:02	62.00	90%
1400	Upper Sloan Det.	60	12:12	62.00	97%
1420	Diamond Hill	64	11:24	62.00	103%
1440	Elbert	22	14:14	62.00	35%
1460	Urban Farm	29	2:23	62.00	47%
1480	Third Creek at DIA	57	12:45	62.00	92%
1500	Powers Park	58	12:19	62.00	94%
1520	Marston Lake North	54	13:03	62.00	87%
1530	Bear Creek @ Lowell	57	11:57	62.00	92%
1600	Englewood Dam	55	11:57	62.00	89%
1610	Holly Dam	60	12:10	62.00	97%
1620	Slaughterhouse Glch	57	12:47	62.00	92%
1640	SPR at Union Ave.	59	12:15	62.00	95%
1660	SPR at Henderson	65	11:16	62.00	105%

1700	Cherry Cr @ Champa	60	12:13	62.00	97%
1710	Shop Creek	61	12:14	62.00	98%
1720	Cherry Cr @ Steele	60	12:00	62.00	97%
1800	Sand Creek Park	53	12:31	62.00	85%
1810	Sand Creek at mouth	59	12:00	62.00	95%
1900	Niver Detention	58	11:57	62.00	94%
1920	Brighton	61	12:00	62.00	98%
2190	Squaw Mountain	60	12:00	62.00	97%
2210	Hiwan G.C.	59	12:16	62.00	95%
2220	Evergreen Lake	59	12:10	62.00	95%
2230	Bear Cr below Cub	57	12:34	62.00	92%
2240	Cold Sprg Glch conf	54	12:30	62.00	87%
2250	Rosedale	59	12:16	62.00	95%
2260	Brook Forest	53	12:21	62.00	85%
2270	Cub Cr below Blue	59	12:18	62.00	95%
2280	Kinney Peak	54	12:37	62.00	87%
2310	Genesee Village	55	12:49	62.00	89%
2320	Choke Cherry Resvr	235		62.00	
2330	Morrison	59	12:12	62.00	95%
2340	El Rancho	46	14:13	62.00	74%
2350	Idledale	60	12:00	62.00	97%
2360	Indian Hills	58	12:45	62.00	94%
2370	Red Rocks Park	56	12:31	62.00	90%
2710	Highlands Ranch WTP	61	11:47	62.00	98%
2730	Salisbury Park	60	12:14	62.00	97%
2750	Castle Rock	60	12:00	62.00	97%
2810	Pine Cliff Road	57	12:16	62.00	92%
2820	Haskins Gulch Conf	55	12:17	62.00	89%
2840	Sulphur Gulch	54	12:32	62.00	87%
4010	Cresent	53	13:11	62.00	85%
4020	Rio Grande	59	11:58	62.00	95%
4030	Red Garden	60	12:15	62.00	97%
4040	Martin Gulch	59	12:13	62.00	95%
4050	Walker Ranch	59	12:12	62.00	95%
4060	Lakeshore	53	13:27	62.00	85%
4070	Bear Peak	60	11:58	62.00	97%
4080	Twin Sisters	49	12:18	62.00	79%
4090	Magnolia	55	12:29	62.00	89%
4100	Filter Plant	60	11:59	62.00	97%
4110	Betasso	56	12:47	62.00	90%
4130	Swiss Peaks	48	14:12	62.00	77%
4140	Logan Mill	49	13:45	62.00	79%
4150	Gold Hill	52	13:15	62.00	84%
4160	Sunshine	57	12:31	62.00	92%
4170	Pine Brook	51	12:32	62.00	82%
4180	Gold Lake	56	12:14	62.00	90%
4190	Slaughterhouse	57	12:32	62.00	92%
4200	Lazy Acres	52	14:30	62.00	84%
4220	Fling's	53	12:50	62.00	85%
4230	Golden Age	59	12:28	62.00	95%
4240	Sunset	51	13:06	62.00	82%
4250	Geer Canyon	59	12:12	62.00	95%
4260	Taylor Mountain	55	12:32	62.00	89%
4270	Cannon Mountain	58	11:57	62.00	94%
4290	Red Hill	55	13:11	62.00	89%
4300	Big Elk Park	59	11:57	62.00	95%
4310	Johnny Park	58	12:29	62.00	94%
4330	Indian Ruins	51	13:25	62.00	82%
4340	Riverside	56	13:06	62.00	90%
4350	Conifer Hill	61	11:57	62.00	98%
4360	Justice Center	58	12:41	62.00	94%
4470	Little Narrows	53	13:17	62.00	85%
4490	Apple Valley	56	12:28	62.00	90%
4510	Pinewood Springs	51	14:09	62.00	82%
4520	Eagle Ridge	55	13:28	62.00	89%
4530	Winiger Ridge	50	12:18	62.00	81%
4560	Lyons Diversion NSV	51	13:54	62.00	82%
4570	St. Antons	56	13:08	62.00	90%
4710	Ward C-1	47	14:44	62.00	76%
4730	Sugarloaf	57	12:00	62.00	92%
4750	Louisville Lake	58	12:28	62.00	94%
4770	Cal-Wood Ranch	61	11:57	62.00	98%
4790	Button Rock	58	12:15	62.00	94%
4810	Shanahan Ridge	55	13:04	62.00	89%
4820	Doudy Draw	47	14:14	62.00	76%
4830	SBC @ San Souci	55	13:12	62.00	89%
4840	SBC@S Boulder Ditch	52	13:38	62.00	84%
4850	Porphory Mtn	48	12:47	62.00	77%
4860	Fairview Peak	54	12:21	62.00	87%

Rain Event Performance

		Reports Received	6180		Analyze Rain Sensors								
	Systemwide Avg	Total Tips	6910										
	90%	Data Loss	10.56%										
Rain Sensor	Total Performance	1-tip	2-tip	3-tip	4-tip	5-tip	6-tip	> 6-tip	Received	Expected	Missed	Hold-off	Bucket
100	100%	22	0	0	0	0	0	0	22	22	0	0	0.0393701
110	87%	71	10	1	0	0	0	0	82	94	12	0	0.0393701
120	90%	60	3	2	0	0	0	0	65	72	7	0	0.0393701
140	90%	59	5	1	0	0	0	0	65	72	7	1	0.0393701
150	84%	27	3	0	1	0	0	0	31	37	6	0	0.0393701
200	86%	49	7	1	0	0	0	0	57	66	9	0	0.0393701
210	93%	35	3	0	0	0	0	0	38	41	3	0	0.0393701
220	67%	63	10	5	3	2	1	0	84	126	42	0	0.0393701
300	89%	30	2	1	0	0	0	0	33	37	4	0	0.0393701
310	94%	30	0	1	0	0	0	0	31	33	2	0	0.0393701
330	82%	52	12	1	0	0	0	0	65	79	14	13	0.0393701
400	86%	52	5	1	1	0	0	0	59	69	10	0	0.0393701
410	85%	63	9	2	0	0	0	0	74	87	13	0	0.0393701
420	90%	72	5	2	0	0	0	0	79	88	9	0	0.0393701
430	89%	70	3	3	0	0	0	0	76	85	9	0	0.0393701
440	87%	30	3	1	0	0	0	0	34	39	5	0	0.0393701
500	86%	58	11	0	0	0	0	0	69	80	11	0	0.0393701
510	90%	80	8	1	0	0	0	0	89	99	10	0	0.0393701
520	84%	31	7	0	0	0	0	0	38	45	7	0	0.0393701
530	90%	48	3	0	1	0	0	0	52	58	6	0	0.0393701
540	86%	37	5	1	0	0	0	0	43	50	7	0	0.0393701
600	95%	68	4	0	0	0	0	0	72	76	4	0	0.0393701
610	91%	55	1	1	1	0	0	0	58	64	6	0	0.0393701
620	77%	52	7	3	2	0	0	0	64	83	19	0	0.0393701
630	93%	108	6	1	0	0	0	0	115	123	8	0	0.0393701
640	95%	100	4	1	0	0	0	0	105	111	6	0	0.0393701
650	86%	42	5	0	1	0	0	0	48	56	8	1	0.0393701
700	92%	42	4	0	0	0	0	0	46	50	4	0	0.0393701
710	89%	31	2	1	0	0	0	0	34	38	4	0	0.0393701
720	91%	44	5	0	0	0	0	0	49	54	5	0	0.0393701
730	90%	65	3	1	1	0	0	0	70	78	8	0	0.0393701
740	99%	75	1	0	0	0	0	0	76	77	1	0	0.0393701
750	80%	26	4	2	0	0	0	0	32	40	8	0	0.0393701
760	84%	29	7	0	0	0	0	0	36	43	7	0	0.0393701
800	89%	28	4	0	0	0	0	0	32	36	4	0	0.0393701
810	90%	39	5	0	0	0	0	0	44	49	5	0	0.0393701
820	87%	28	5	0	0	0	0	0	33	38	5	0	0.0393701
830	91%	87	8	1	0	0	0	0	96	106	10	1	0.0393701
840	87%	42	3	0	0	1	0	1	46	53	7	0	0.0393701
850	84%	39	6	0	1	0	0	0	46	55	9	0	0.0393701
860	82%	37	8	1	0	0	0	0	46	56	10	1	0.0393701
870	88%	56	9	0	0	0	0	0	65	74	9	0	0.0393701
900	92%	72	5	1	0	0	0	0	78	85	7	1	0.0393699
1000	88%	20	3	0	0	0	0	0	23	26	3	0	0.0393701
1010	97%	29	1	0	0	0	0	0	30	31	1	0	0.0393701
1030	94%	14	1	0	0	0	0	0	15	16	1	0	0.0393701
1040	89%	22	1	1	0	0	0	0	24	27	3	0	0.0393701
1050	84%	17	4	0	0	0	0	0	21	25	4	0	0.0393701
1060	97%	29	1	0	0	0	0	0	30	31	1	0	0.0393701
1100	81%	13	4	0	0	0	0	0	17	21	4	0	0.0393701
1110	93%	13	1	0	0	0	0	0	14	15	1	0	0.0393701
1200	81%	40	8	2	0	0	0	0	50	62	12	0	0.0393701
1300	89%	30	4	0	0	0	0	0	34	38	4	0	0.0393701
1310	95%	52	3	0	0	0	0	0	55	58	3	0	0.0393701
1320	86%	25	5	0	0	0	0	0	30	35	5	0	0.0393701
1330	97%	80	3	0	0	0	0	0	83	86	3	0	0.0393701
1340	93%	26	2	0	0	0	0	0	28	30	2	0	0.0393701
1350	81%	42	2	2	0	0	1	0	47	58	11	0	0.0393701
1360	95%	40	2	0	0	0	0	0	42	44	2	0	0.0393701
1370	86%	32	4	1	0	0	0	0	37	43	6	0	0.0393701
1400	93%	23	2	0	0	0	0	0	25	27	2	0	0.0393701
1420	94%	46	3	0	0	0	0	0	49	52	3	0	0.0393701
1440	97%	37	1	0	0	0	0	0	38	39	1	0	0.0393701
1460	89%	54	8	0	0	0	0	0	62	70	8	0	0.0393701
1480	92%	31	1	1	0	0	0	0	33	36	3	0	0.0393701
1500	93%	102	8	0	0	0	0	0	110	118	8	0	0.0393701
1520	95%	49	3	0	0	0	0	0	52	55	3	0	0.0393701
1530	83%	41	5	1	1	0	0	0	48	58	10	0	0.0393701
1600	90%	24	3	0	0	0	0	0	27	30	3	0	0.0393701
1620	90%	33	4	0	0	0	0	0	37	41	4	0	0.0393701
1640	89%	37	5	0	0	0	0	0	42	47	5	0	0.0393701
1660	93%	38	3	0	0	0	0	0	41	44	3	0	0.0393701
1700	79%	25	7	1	0	0	0	0	33	42	9	0	0.0393701
1710	92%	22	0	1	0	0	0	0	23	25	2	0	0.0393701
1720	85%	41	5	0	1	0	0	0	47	55	8	11	0.0393701
1800	88%	44	5	1	0	0	0	0	50	57	7	0	0.0393701
1810	91%	61	7	0	0	0	0	0	68	75	7	0	0.0393701
1900	93%	39	3	0	0	0	0	0	42	45	3	0	0.0393701
1920	87%	28	5	0	0	0	0	0	33	38	5	0	0.0393701
2190	95%	60	3	0	0	0	0	0	63	66	3	0	0.0393701
2210	98%	38	1	0	0	0	0	0	39	40	1	1	0.0393701
2230	100%	36	0	0	0	0	0	0	36	36	0	1	0.0393701
2240	100%	21	0	0	0	0	0	0	21	21	0	1	0.0393701
2250	95%	34	2	0	0	0	0	0	36	38	2	1	0.0393701
2260	93%	51	4	0	0	0	0	0	55	59	4	0	0.0393701
2270	94%	45	3	0	0	0	0	0	48	51	3	1	0.0393701
2280	92%	41	4	0	0	0	0	0	45	49	4	0	0.0393701
2310	65%	18	3	1	0	0	0	1	22	34	5	0	0.0393701
2320	93%	26	2	0	0	0	0	0	28	30	2	0	0.0393701
2330	100%	19	0	0	0	0	0	0	19	19	0	0	0.0393701
2340	78%	15	6	0	0	0	0	0	21	27	6	0	0.0393701
2350	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
2360	100%	24	0	0	0	0	0	0	24	24	0	0	0.0393701
2370	58%	11	0	1	1	0	1	0	14	24	10	2	0.0393701
2710	98%	44	1	0	0	0	0	0	45	46	1	0	0.0393701
2730	87%	35	4	1	0	0	0	0	40	46	6	0	0.0393701
2750	97%	63	2	0	0	0	0	0	65	67	2	0	0.0393701
2810	89%	38	3	1	0	0	0	0	42	47	5	0	0.0393701
2820	93%	69	4	1	0	0	0	0	74	80	6	0	0.0393701
2840	91%	56	6	0	0	0	0	0	62	68	6	0	0.0393701
4010	90%	36	1	0	1	0	0	0	38	42	4	0	0.0393701
4020	98%	41	1	0	0	0	0	0	42	43	1	0	0.0393701

4030	98%	51	1	0	0	0	0	0	52	53	1	0	0.0393701
4040	92%	32	3	0	0	0	0	0	35	38	3	0	0.0393701
4050	91%	19	2	0	0	0	0	0	21	23	2	0	0.0393701
4060	73%	5	3	0	0	0	0	0	8	11	3	0	0.0393701
4070	97%	29	1	0	0	0	0	0	30	31	1	0	0.0393701
4080	97%	36	1	0	0	0	0	0	37	38	1	0	0.0393701
4090	83%	24	6	0	0	0	0	0	30	36	6	0	0.0393701
4100	100%	29	0	0	0	0	0	0	29	29	0	0	0.0393701
4110	93%	26	2	0	0	0	0	0	28	30	2	0	0.0393701
4130	92%	44	4	0	0	0	0	0	48	52	4	0	0.0393701
4140	94%	30	2	0	0	0	0	0	32	34	2	0	0.0393701
4150	80%	47	16	0	0	0	0	0	63	79	16	0	0.0393701
4160	97%	54	2	0	0	0	0	0	56	58	2	0	0.0393701
4170	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
4180	74%	32	3	0	0	0	0	1	35	47	3	0	0.0393701
4190	96%	45	0	1	0	0	0	0	46	48	2	0	0.0393701
4200	92%	10	1	0	0	0	0	0	11	12	1	0	0.0393701
4220	85%	25	2	0	1	0	0	0	28	33	5	0	0.0393701
4230	95%	20	1	0	0	0	0	0	21	22	1	0	0.0393701
4240	93%	37	3	0	0	0	0	0	40	43	3	0	0.0393701
4250	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
4260	88%	26	4	0	0	0	0	0	30	34	4	0	0.0393701
4270	97%	37	1	0	0	0	0	0	38	39	1	0	0.0393701
4290	75%	4	2	0	0	0	0	0	6	8	2	0	0.0393701
4300	98%	40	1	0	0	0	0	0	41	42	1	0	0.0393701
4310	100%	44	0	0	0	0	0	0	44	44	0	0	0.0393701
4330	91%	19	2	0	0	0	0	0	21	23	2	0	0.0393701
4340	97%	30	1	0	0	0	0	0	31	32	1	0	0.0393701
4350	90%	35	2	1	0	0	0	0	38	42	4	0	0.0393701
4360	100%	25	0	0	0	0	0	0	25	25	0	0	0.0393701
4470	85%	9	2	0	0	0	0	0	11	13	2	0	0.0393701
4490	89%	15	0	1	0	0	0	0	16	18	2	0	0.0393701
4510	87%	23	2	1	0	0	0	0	26	30	4	0	0.0393701
4520	92%	10	1	0	0	0	0	0	11	12	1	0	0.0393701
4530	86%	35	7	0	0	0	0	0	42	49	7	0	0.0393701
4570	90%	33	2	1	0	0	0	0	36	40	4	0	0.0393701
4710	92%	31	1	1	0	0	0	0	33	36	3	0	0.0393701
4730	91%	27	3	0	0	0	0	0	30	33	3	0	0.0393701
4750	95%	19	1	0	0	0	0	0	20	21	1	0	0.0393701
4770	94%	32	2	0	0	0	0	0	34	36	2	0	0.0393701
4790	93%	26	2	0	0	0	0	0	28	30	2	0	0.0393701
4810	79%	22	4	0	1	0	0	0	27	34	7	0	0.0393701
4820	80%	29	7	1	0	0	0	0	37	46	9	0	0.0393701
4830	82%	24	7	0	0	0	0	0	31	38	7	0	0.0393701
4840	82%	24	7	0	0	0	0	0	31	38	7	1	0.0393701
	Total Tips	5583	513	60	18	3	3	3	6180	6910			

Rain Sensor	(mm of rain measured) Measured Bucket Tips	Outliers Removed	Bucket Tip Data Analysis	
100	22	22	Mean	46.89796
110	94	94	Median	42
120	72	72	Std Deviation	23.5848
140	72	72	Mean + 3 st dev	117.6524
150	37	37	Mean - 3 st dev	-23.85645
200	66	66	Min	8
210	41	41	Max	126
220	126	126		
300	37	37		
310	33	33		
330	79	79		
400	69	69		
410	87	87		
420	88	88		
430	85	85		
440	39	39		
500	80	80		
510	99	99		
520	45	45		
530	58	58		
540	50	50		
600	76	76		
610	64	64		
620	83	83		
630	123	123		
640	111	111		
650	56	56		
700	50	50		
710	38	38		
720	54	54		
730	78	78		
740	77	77		
750	40	40		
760	43	43		
800	36	36		
810	49	49		
820	38	38		
830	106	106		
840	53	53		
850	55	55		
860	56	56		
870	74	74		
900	85	85		
1000	26	26		
1010	31	31		
1030	16	16		
1040	27	27		
1050	25	25		
1060	31	31		
1100	21	21		
1110	15	15		
1200	62	62		
1300	38	38		
1310	58	58		
1320	35	35		
1330	86	86		

Compute Statistics

1340	30	30
1350	58	58
1360	44	44
1370	43	43
1400	27	27
1420	52	52
1440	39	39
1460	70	70
1480	36	36
1500	118	118
1520	55	55
1530	58	58
1600	30	30
1620	41	41
1640	47	47
1660	44	44
1700	42	42
1710	25	25
1720	55	55
1800	57	57
1810	75	75
1900	45	45
1920	38	38
2190	66	66
2210	40	40
2230	36	36
2240	21	21
2250	38	38
2260	59	59
2270	51	51
2280	49	49
2310	27	27
2320	30	30
2330	19	19
2340	27	27
2350	17	17
2360	24	24
2370	24	24
2710	46	46
2730	46	46
2750	67	67
2810	47	47
2820	80	80
2840	68	68
4010	42	42
4020	43	43
4030	53	53
4040	38	38
4050	23	23
4060	11	11
4070	31	31
4080	38	38
4090	36	36
4100	29	29
4110	30	30
4130	52	52
4140	34	34
4150	79	79
4160	58	58
4170	17	17
4180	38	38

4190	48	48
4200	12	12
4220	33	33
4230	22	22
4240	43	43
4250	15	15
4260	34	34
4270	39	39
4290	8	8
4300	42	42
4310	44	44
4330	23	23
4340	32	32
4350	42	42
4360	25	25
4470	13	13
4490	18	18
4510	30	30
4520	12	12
4530	49	49
4570	40	40
4710	36	36
4730	33	33
4750	21	21
4770	36	36
4790	30	30
4810	34	34
4820	46	46
4830	38	38
4840	38	38