Memo

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

Date: October 6, 2006

To: Kevin Stewart, Chad Kudym

From: Markus Ritsch

Subject: **September 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 September 1 through September 30, 2006.

II. General System Analysis Summary

A total of 189,640 individual data records were analyzed. Meteorological sensors account for 70 percent, water level sensors 13 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 4,085 reports were flagged as "bad". Of these "bad" reports, 3,601 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 6,321 reports per day with an average hourly loading of 263 reports. The peak hourly traffic loading was 620 reports, which occurred on September 21 between three and four in the morning. 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 1,869 rain reports were received from the Hayman gages this month. After quantification of 2 months of data, the Hayman gages account for approximately 1 percent of the monthly radio traffic.

The sensors reporting most frequently this month include:

1. Marston Lake North (IDs 1521 and 1526) reported 2,797 and 2,769 times respectively, and

2. Urban Farm (IDs 1464, 1465, 1466, 1467) reported every 15 minutes.

3. Green Ditch (ID 4593) and Boulder Creek at Broadway (ID 4583) are stage sensors that both had over 2,700 reports which is about 1 report every 15 minutes.

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

III. Rain Sensors Reporting This Month

Approximately 171 rain sensors reported incrementing tips this month. This includes the Douglas County Hayman gages.

Timer reports were received from 155 sensors and incrementing reports were received from 151 sensors. Rain sensors with timer reports but no incrementing tip reports include:

1. Lena at Nolte Pond (ID 1020), Holly Dam (ID 1610), Evergreen Lake (2220), Lyons Diversion NSV (ID 4560) – These stations all report a 12-hour status report on the rain ID but no rain gage is installed.

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 90 percent of the non-incrementing timer reports. Those rain sensors with the worst timer reporting performances 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
1010	1460	1460	2340	1460	1460	1460	1440	1540/320			
1460	1660	4820	1460	1330	4820	1440	1460	1460			
1640	4240	4570	1330	540	4830	110	2340	4820			
--	--	--	1610	1600	1600	4820	4820	1440			
			1600	4820	2350	4220		110			

Sanderson at Xavier (1540), Sports Complex (320), Stapleton "Urban Farm" (1460), Doudy Draw (4820), Elbert (1440), Ralston Reservoir (110)

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 its timer performance value is actually better than reported here (see data analysis report for May, 2006).

1. Sanderson at Xavier (1540) and Sports Complex (320)

The count series for these sensors is incomplete for the month of September. For 1540, data was received only for the period 9/27/2006 at 2:34:28 PM through 9/30/2006 at 2:26:30 PM. For 320, data was received only for the period 9/13/2006 at 11:36:41 AM through 9/30/2006 at 10:36:46 PM. The incomplete series for these sensors results in their poor timer performance metrics.

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 2).

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

Statistical Parameter	Value	Comments
Mean	24.17	Only the 1-mm rain sensors were included in the analysis
Median	22	Only the 1-mm rain sensors were included in the analysis
Standard deviation	12.58	Only the 1-mm rain sensors were included in the analysis
Mean plus three standard deviations	62	Several sensors for the month are outside the Mean +/- 3 Std Dev
Minimum total count	5	Sanderson at Xavier (ID 1540)
Maximum total count	95	Temple Pond at DTC (ID 630)

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

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	24.17			

The average rainfall experienced district-wide was decreased from the prior months of July and August. One sensor experienced a tip count that exceeded the system-wide mean plus three standard deviations for the month. That sensor was Temple Pond at DTC (630). This sensor also exceeded the mean plus three standard deviations in the month August. The data records for these sensors were further inspected.

1. Temple Pond at DTC (630)

The rain tip count series for the month looks odd for Temple Pond at DTC. The count series increases several counts each day, at the exactly the same time of day (Figure 1). A comparison is made to a nearby gage, sensor 620, Quincy/Highline (Figure 2).
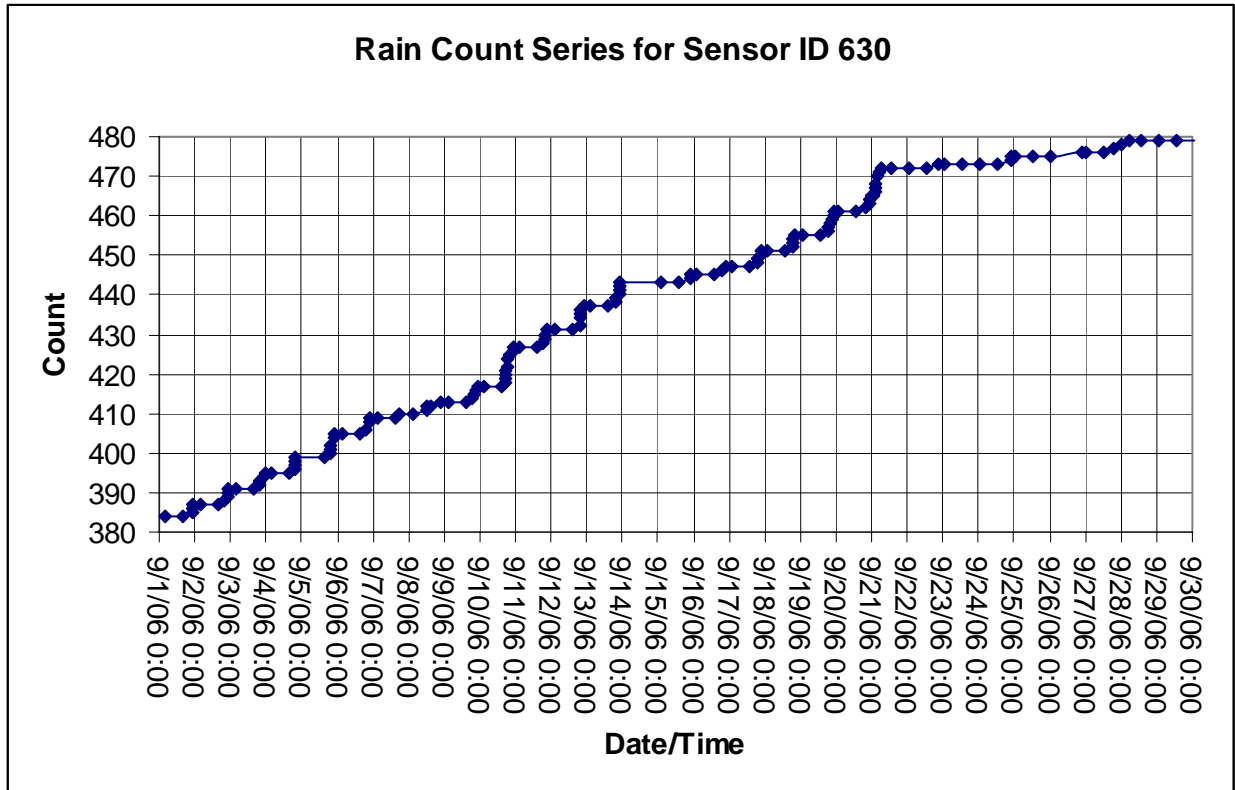

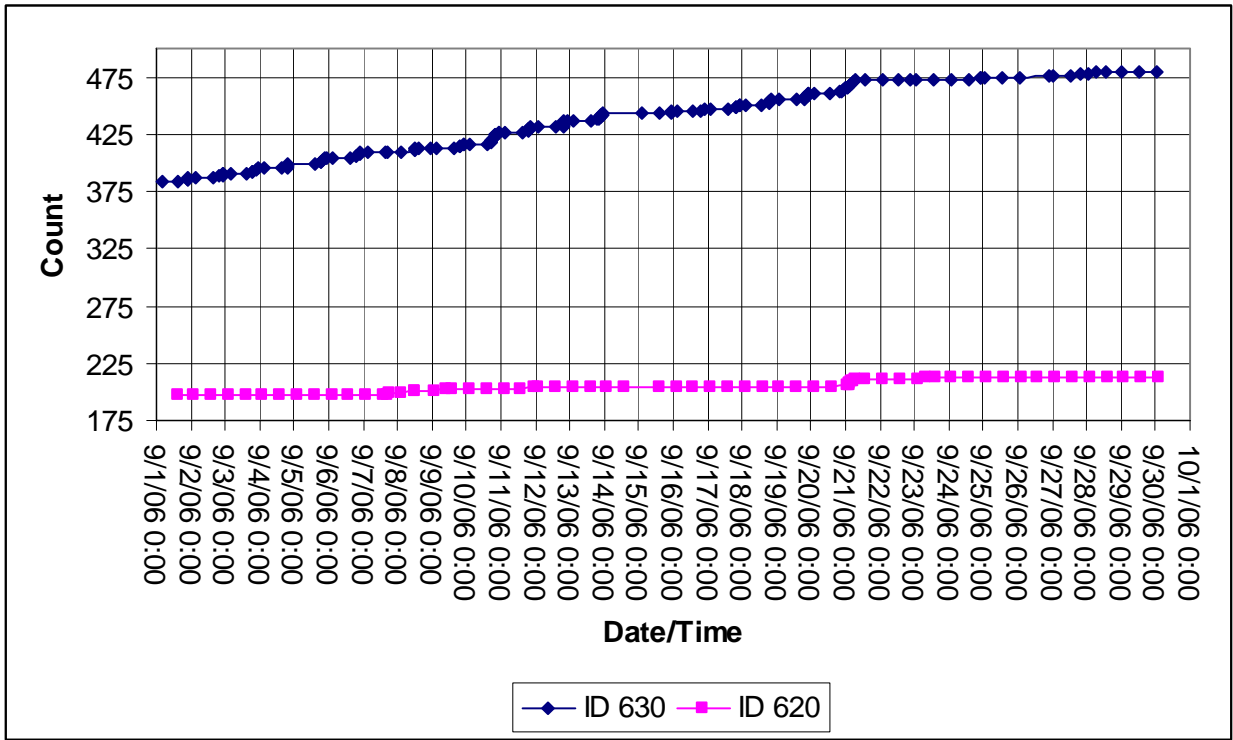**Figure 1. Tip Count Series for Temple Pond at DTC (ID 630)**

Figure 2. Comparison of Rain Tip Count for Temple Pond (ID 630) and Quincy/Highline (620)

The count series for sensor 620 does not exhibit the daily jump in count value as does sensor 630. The accumulation of rainfall at sensor 630 is artificial in nature, probably due to irrigation. The UDFCD Web page (http://www.udfcd.org/FWP/alertstatus.html) identifies sensor 630 as a sensor that may be influenced by lawn irrigation.

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

There were no sensors this month that experienced a jump in their sequential tip count of more than 6.

C. Sensor-by-Sensor Incrementing Count Summary

A total of 149 rain sensors had incrementing reports in the database.

The system-wide reception rate of incrementing rain tip reports for the month was approximately 94 percent. A total of 3,380 incrementing reports were received and a total of 3,605 were expected. The total loss of incrementing reports for the month was approximately 6.24 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
640	4010	4530	2190	540	4820	4820	2370	1200			
1640	4080	4170	310	1400	1350	2350	2310	4820			
4490	4170	4820	4820	1100	4790	2310	220	2340			
-----	-----	-----	-----	4820	2340	750	4060	1530			
-----	-----	-----	-----	1420	2350	150	4180	110			

* Broomfield (1200), Doudy Draw (4820), El Rancho (2340), Bear Cr at Lowell (1530), Ralston Reservoir (110).

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.

D. Peak Traffic Hour Analysis

The peak hour of radio traffic occurred on 9/21/2006 between 3:00 AM and 4:00 AM. The data for this period was examined more closely to characterize the distribution of sensor transmissions during times of heavy loading (Table 5). During this hour the radio traffic was dominated by water level and precipitation sensor reports.

Table 5. Peak Traffic Hour Sensor Report Distribution

Sensor Group	Total Reports	Percent
Precipitation	165	26.6
Water Level PT-HSE	128	20.7
Hayman Precipitation	72	11.6
Wind Gust	58	9.4
Precipitation - Mean	42	6.8
Wind Speed Average & Azimuth	33	5.3
Wind Direction	25	4.0
Relative Humidity	20	3.2
Wind Speed Average	16	2.6
Temperature	15	2.4
Water Level Float	12	1.9
Battery Voltage HSE	9	1.5
Battery Voltage Digital	7	1.1
Water Level PT	4	0.7
Solar Radiation	4	0.7
Barometric Pressure	3	0.5
Handar 585 ALARM Status	2	0.3
Fuel Temperature	2	0.3
Fuel Moisture	2	0.3
Battery Voltage Analog	1	0.1
Total	**620**	100%

The accuracy of rain data for the peak hour was further analyzed (Table 6) for the District's 1-mm rain sensors. The Hayman gages are not included in the following analysis. Less than 3 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 6. Peak Traffic Hour Rain Reporting Summary – Annual Reporting

Heavy Traffic Period	Traffic Msgs/hr	Rain reports expected	Rain reports received	Loss of reports	Accurate rain totals
9/21/06 3:00 AM – 4:00 AM	620	117	114	2.56%	Yes
8/13/06 9:00 PM – 10:00 PM	1,107	346	286	17.34%	Yes

The table above will be used to track the peak hour summary for each month so that over a period of time a correlation can be developed between hour loading and loss or single increment reports.

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. Elbert (1440) continues to exhibit poor timer performance.

3. Marston Lake North (ID 1521 and 1526) continues to report frequently, every 15 minutes.

4. 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. Green Ditch (ID 4593) and Boulder Creek at Broadway (ID 4583) each reported over 2,700 times or about 1 report every 15 minutes.

2. Poor timer performance was observed at Elbert (1440), Doudy Draw (4820), and Ralston Reservoir (110).

3. Poor event performance was observed at Broomfield (1200), Doudy Draw (4820), El Rancho (2340), Bear Creek at Lowell (1530), and Ralston Reservoir (110).

General System Analysis

Database Name	P:\A207-UDFCD-Data-Analysis\2006_Sep\Novastar_extract_2006Sep.mdb		

First Date in Database	9/1/06 12:00 AM	**Total Days**	30.0
Last Date in Database	9/30/06 11:59 PM	**Total Hours**	720.0

Total Records Analyzed   189640

Records by Group

Description	Records	Percent
Wind Gust	32044	17%
Relative Humidity	27586	15%
Temperature	25465	13%
Water Level PT-HSE	17766	9%
Wind Direction	16977	9%
Wind Speed Average & Azimuth	14317	8%
Precipitation	12234	6%
Wind Speed Average	10853	6%
Battery Voltage HSE	5936	3%
Battery Voltage Digital	4223	2%
Water Level PT	4099	2%
Solar Radiation	4058	2%
Water Level Float	2405	1%
Barometric Pressure	2034	1%
Precipitation - Mean	1900	1%
Hayman Precipitation	1869	1%
Fuel Moisture	1405	1%
Fuel Temperature	1372	1%
Repeater Pass List	942	0%
Handar 585 ALARM Status	900	0%
Battery Voltage Analog	545	0%
Precipitation - Test	236	0%
12Hr Status Report	226	0%
Longmont Flow Gage	121	0%
Soil Moisture	59	0%
Longmont Water Level PT	57	0%
Precipitation-ASCII	10	0%
Repeater Status Report	1	0%
Total	**189640**	

Records by Major Group

Description	Records	Percent
Meteorologic Sensors	133334	70%
Water Level Sensors	24448	13%
Sensor Status Transmissions	12773	7%
Rain Sensors	12244	6%
Soil and Fuel Sensors	2836	1%
Total	**185635**	

Records by Validation Type

Description	Value	Records	Percent
Good	0	185555	98%
Questionable	1	4085	2%
	Total	**189640**	

Sensors With Most Invalid Data

Description	Sensor	Reports
Squaw Mountain	2189	2732
Squaw Mountain	2187	869
Quincy Reservoir	753	68
Cal-Wood Ranch	4774	35
Highlands Ranch WTP	2704	27

Traffic Loading Summary

Alert Reports	189640	
Average Daily Traffic	6321	
Average Hourly Traffic	263	
Median Hourly Traffic	258	hour beginning
Peak Hourly Traffic	620	9/21/06 3:00 AM

Total Number of Sensors Defined	**Total Number of Sensors Reporting**
806	541

Reports per Sensor

Description	Sensor	Reports	Fraction of Total
Urban Farm	1464	2802	1%
Marston Lake North	1521	2797	1%
Marston Lake North	1526	2769	1%
Squaw Mountain	2189	2756	1%
Urban Farm	1466	2732	1%
Green Ditch	4593	2731	1%
Boulder Cr at Broadway	4583	2727	1%
Urban Farm	1465	2718	1%
Urban Farm	1467	2660	1%
Squaw Mountain	2187	2571	1%
Elbert	1439	2534	1%
Hiwan G.C.	2208	2529	1%
Castle Rock	2744	2480	1%
Salisbury Park	2727	2477	1%
Salisbury Park	2724	2475	1%
Blue Mountain	138	2473	1%
Squaw Mountain	2188	2393	1%
Sugarloaf	4724	2389	1%
Elbert	1438	2280	1%
Quincy Reservoir	751	2176	1%
Louisville Lake	4744	2176	1%
Diamond Hill	1421	2174	1%
SPR at Union Ave.	1643	2121	1%
Ward C-1	4704	2024	1%
Salisbury Park	2732	2002	1%

Rain Timer Performance

			systemwide average (days) 0.5206	Analyze Rain Sensors	Systemwide Average 90%
Rain Sensor ID	Description	Received	Average Timer Interval	Expected	Performance
100	Carr Street	56	12:29	60.00	93%
110	Ralston Reservoir	42	16:40	60.00	70%
120	West Woods	54	13:00	60.00	90%
140	Blue Mountain	52	13:06	60.00	87%
150	Nott Creek	54	13:07	60.00	90%
200	Leyden Reservoir	56	12:28	60.00	93%
210	Leyden Confluence	56	12:42	60.00	93%
220	Upper Leyden	55	13:02	60.00	92%
300	Van Bibber Park	54	12:43	60.00	90%
310	Guy Hill Ranch	51	12:44	60.00	85%
320	Sports Complex	35	12:21	60.00	58%
330	Van Bibber @ Hwy 93	55	12:15	60.00	92%
400	Montview Park	55	11:58	60.00	92%
410	Kelly Dam	54	11:58	60.00	90%
420	Expo Park	57	12:34	60.00	95%
430	Utah Park	58	12:20	60.00	97%
440	Fire Station #7	50	13:33	60.00	83%
500	Havana Park	57	12:16	60.00	95%
510	Virginia Court	58	12:17	60.00	97%
520	Jewell Detention	58	12:27	60.00	97%
530	Fire Station #19	56	12:28	60.00	93%
540	Parker/Mississippi	49	13:38	60.00	82%
600	Harvard Gulch Park	58	12:25	60.00	97%
610	Harvard @ Jackson	56	12:27	60.00	93%
620	Quincy/Highline	55	12:15	60.00	92%
630	Temple Pond at DTC	53	11:57	60.00	88%
640	Goldsmith @ Eastman	58	11:57	60.00	97%
650	Iliff Pond	58	12:12	60.00	97%
700	Toll Gate @ 6th	52	13:49	60.00	87%
710	Horseshoe Park Drop	59	12:11	60.00	98%
720	Confluence Pond	55	12:30	60.00	92%
730	No Name @ Quincy	53	12:45	60.00	88%
740	Smoky Hill	58	12:14	60.00	97%
750	Quincy Reservoir	54	13:13	60.00	90%
760	Mission Viejo Park	57	11:57	60.00	95%
800	Sable Ditch @ 18th	53	13:01	60.00	88%
810	Granby Ditch @ 6th	58	12:12	60.00	97%
820	ETG @ Buckley	58	11:57	60.00	97%
830	Side Creek Park	55	13:00	60.00	92%
840	Fire Station 12	57	12:15	60.00	95%
850	Flying J	54	12:45	60.00	90%
860	Sand Cr at Colfax	102	6:22	60.00	170%
870	Murphy Creek GC	58	12:00	60.00	97%
900	Aurora Reservoir	53	12:32	60.00	88%
1000	Maple Grove Resv.	54	12:29	60.00	90%
1010	Denver West	58	12:12	60.00	97%
1020	Lena @ Nolte Pond	56	12:39	60.00	93%
1030	NREL/S. Table Mtn.	57	12:26	60.00	95%
1040	Lena @ U.S. Hwy 6	56	12:13	60.00	93%
1050	Jeffco Fairgrounds	56	12:41	60.00	93%
1060	Heritage Square	56	12:27	60.00	93%
1100	Louisville Rec Ctr	53	13:00	60.00	88%
1110	Gunbarrel	54	12:44	60.00	90%
1200	Broomfield 3207	53	12:59	60.00	88%
1300	Hidden Lake	57	12:12	60.00	95%
1310	LDC at 64th	55	12:44	60.00	92%
1320	SPR at 3rd Ave	55	12:57	60.00	92%
1330	Roslyn	59	12:00	60.00	98%
1340	Sanderson at Xavier	54	12:45	60.00	90%
1350	Chatfield COE	55	12:15	60.00	92%
1360	Denver Zoo	59	12:00	60.00	98%
1370	West Metro FS13	54	12:15	60.00	90%
1400	Upper Sloan Det.	55	13:12	60.00	92%
1420	Diamond Hill	56	12:45	60.00	93%
1440	Elbert	36	12:48	60.00	60%
1460	Urban Farm	27	1:15	60.00	45%
1480	Third Creek at DIA	55	12:30	60.00	92%
1500	Powers Park	55	12:18	60.00	92%
1520	Marston Lake North	57	12:00	60.00	95%
1530	Bear Creek @ Lowell	55	12:54	60.00	92%
1540	Sanderson at Xavier	5	11:57	60.00	8%
1600	Englewood Dam	56	12:41	60.00	93%
1610	Holly Dam	59	11:58	60.00	98%
1620	Slaughterhouse Glch	56	12:41	60.00	93%
1640	SPR at Union Ave.	59	12:00	60.00	98%

1660	SPR at Henderson	59	12:00	60.00	98%
1700	Cherry Cr @ Champa	58	12:00	60.00	97%
1710	Shop Creek	56	12:29	60.00	93%
1720	Cherry Cr @ Steele	50	13:33	60.00	83%
1800	Sand Creek Park	55	12:42	60.00	92%
1810	Sand Creek at mouth	49	11:50	60.00	82%
1900	Niver Detention	59	11:57	60.00	98%
1920	Brighton	58	12:00	60.00	97%
2190	Squaw Mountain	54	13:04	60.00	90%
2210	Hiwan G.C.	55	12:16	60.00	92%
2220	Evergreen Lake	56	12:37	60.00	93%
2230	Bear Cr below Cub	55	12:31	60.00	92%
2240	Cold Sprg Glch conf	59	12:00	60.00	98%
2250	Rosedale	55	12:32	60.00	92%
2260	Brook Forest	57	12:16	60.00	95%
2270	Cub Cr below Blue	56	12:00	60.00	93%
2280	Kinney Peak	52	13:30	60.00	87%
2310	Genesee Village	58	12:00	60.00	97%
2330	Morrison	60	11:58	60.00	100%
2340	El Rancho	54	12:42	60.00	90%
2350	Idledale	59	12:00	60.00	98%
2360	Indian Hills	56	12:00	60.00	93%
2370	Red Rocks Park	57	12:30	60.00	95%
2710	Highlands Ranch WTP	57	12:14	60.00	95%
2730	Salisbury Park	58	12:00	60.00	97%
2750	Castle Rock	61	12:00	60.00	102%
2810	Pine Cliff Road	57	12:15	60.00	95%
2820	Haskins Gulch Conf	53	12:29	60.00	88%
2840	Sulphur Gulch	53	13:00	60.00	88%
4010	Cresent	55	12:56	60.00	92%
4020	Rio Grande	59	11:57	60.00	98%
4030	Red Garden	57	12:14	60.00	95%
4040	Martin Gulch	53	12:29	60.00	88%
4050	Walker Ranch	59	11:58	60.00	98%
4060	Lakeshore	53	13:21	60.00	88%
4070	Bear Peak	57	12:12	60.00	95%
4080	Twin Sisters	56	12:14	60.00	93%
4090	Magnolia	49	14:26	60.00	82%
4100	Filter Plant	58	12:14	60.00	97%
4110	Betasso	57	12:15	60.00	95%
4130	Swiss Peaks	54	13:06	60.00	90%
4140	Logan Mill	53	13:21	60.00	88%
4150	Gold Hill	51	12:33	60.00	85%
4160	Sunshine	57	12:13	60.00	95%
4170	Pine Brook	53	12:45	60.00	88%
4180	Gold Lake	53	13:21	60.00	88%
4190	Slaughterhouse	53	12:33	60.00	88%
4200	Lazy Acres	57	12:29	60.00	95%
4220	Fling's	55	11:57	60.00	92%
4230	Golden Age	57	12:12	60.00	95%
4240	Sunset	51	13:40	60.00	85%
4250	Geer Canyon	59	12:12	60.00	98%
4260	Taylor Mountain	54	12:47	60.00	90%
4270	Cannon Mountain	56	11:57	60.00	93%
4290	Red Hill	57	12:26	60.00	95%
4300	Big Elk Park	57	12:29	60.00	95%
4310	Johnny Park	58	12:13	60.00	97%
4330	Indian Ruins	59	11:57	60.00	98%
4340	Riverside	56	12:47	60.00	93%
4350	Conifer Hill	59	12:11	60.00	98%
4360	Justice Center	57	12:12	60.00	95%
4470	Little Narrows	54	12:56	60.00	90%
4490	Apple Valley	56	12:40	60.00	93%
4510	Pinewood Springs	51	14:04	60.00	85%
4520	Eagle Ridge	57	12:15	60.00	95%
4530	Winiger Ridge	54	12:44	60.00	90%
4560	Lyons Diversion NSV	47	15:07	60.00	78%
4570	St. Antons	50	13:11	60.00	83%
4710	Ward C-1	52	13:00	60.00	87%
4730	Sugarloaf	57	12:15	60.00	95%
4750	Louisville Lake	54	12:31	60.00	90%
4770	Cal-Wood Ranch	48	13:53	60.00	80%
4790	Button Rock	58	12:14	60.00	97%
4810	Shanahan Ridge	51	13:23	60.00	85%
4820	Doudy Draw	44	13:32	60.00	73%
4830	SBC @ San Souci	50	13:23	60.00	83%
4840	SBC@S Boulder Ditch	57	12:13	60.00	95%
4850	Porphory Mtn	47	14:28	60.00	78%
4860	Fairview Peak	49	14:23	60.00	82%

Rain Event Performance

		Reports Received	3380		Analyze Rain Sensors								
	Systemwide Avg	Total Tips	3605										
	94%	Data Loss	6.24%										

Sensor ID	Performance	1-tips	2-tips	3-tips	4-tips	5-tips	6-tips	>6-tips	Tips received	Tips expected	missed tips	Hold-of TX	Bucket size
100	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
110	75%	10	1	0	1	0	0	0	12	16	4	0	0.0393701
120	95%	19	1	0	0	0	0	0	20	21	1	0	0.0393701
140	100%	31	0	0	0	0	0	0	31	31	0	0	0.0393701
150	94%	32	2	0	0	0	0	0	34	36	2	0	0.0393701
200	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
210	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
220	100%	21	0	0	0	0	0	0	21	21	0	0	0.0393701
300	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
310	82%	11	3	0	0	0	0	0	14	17	3	0	0.0393701
320	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701
330	91%	19	2	0	0	0	0	0	21	23	2	5	0.0393701
400	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
410	91%	19	2	0	0	0	0	0	21	23	2	0	0.0393701
420	98%	55	1	0	0	0	0	0	56	57	1	0	0.0393701
430	96%	47	2	0	0	0	0	0	49	51	2	0	0.0393701
440	92%	11	1	0	0	0	0	0	12	13	1	0	0.0393701
500	91%	27	3	0	0	0	0	0	30	33	3	0	0.0393701
510	100%	34	0	0	0	0	0	0	34	34	0	0	0.0393701
520	84%	13	3	0	0	0	0	0	16	19	3	0	0.0393701
530	88%	13	2	0	0	0	0	0	15	17	2	0	0.0393701
540	100%	13	0	0	0	0	0	0	13	13	0	0	0.0393701
600	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
610	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
620	93%	13	1	0	0	0	0	0	14	15	1	0	0.0393701
630	95%	85	5	0	0	0	0	0	90	95	5	0	0.0393701
640	98%	41	1	0	0	0	0	0	42	43	1	0	0.0393701
650	79%	10	0	0	1	0	0	0	11	14	3	0	0.0393701
700	91%	9	1	0	0	0	0	0	10	11	1	0	0.0393701
710	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
720	91%	18	2	0	0	0	0	0	20	22	2	0	0.0393701
730	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
740	93%	37	3	0	0	0	0	0	40	43	3	0	0.0393701
750	77%	8	1	1	0	0	0	0	10	13	3	0	0.0393701
760	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
800	100%	13	0	0	0	0	0	0	13	13	0	0	0.0393701
810	88%	13	2	0	0	0	0	0	15	17	2	0	0.0393701
820	92%	11	1	0	0	0	0	0	12	13	1	0	0.0393701
830	98%	39	1	0	0	0	0	0	40	41	1	0	0.0393701
840	95%	18	1	0	0	0	0	0	19	20	1	0	0.0393701
850	95%	17	1	0	0	0	0	0	18	19	1	0	0.0393701
860	79%	13	1	0	1	0	0	0	15	19	4	0	0.0393701
870	89%	22	3	0	0	0	0	0	25	28	3	0	0.0393701
900	97%	27	1	0	0	0	0	0	28	29	1	0	0.0393699
1000	96%	26	1	0	0	0	0	0	27	28	1	0	0.0393701
1010	87%	11	2	0	0	0	0	0	13	15	2	0	0.0393701
1030	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
1040	94%	15	1	0	0	0	0	0	16	17	1	0	0.0393701
1050	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
1060	100%	18	0	0	0	0	0	0	18	18	0	0	0.0393701
1100	80%	7	0	1	0	0	0	0	8	10	2	0	0.0393701
1110	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
1200	71%	7	2	1	0	0	0	0	10	14	4	0	0.0393701
1300	100%	13	0	0	0	0	0	0	13	13	0	0	0.0393701
1310	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
1320	91%	9	1	0	0	0	0	0	10	11	1	0	0.0393701
1330	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
1340	100%	15	0	0	0	0	0	0	15	15	0	0	0.0393701
1350	81%	23	5	1	0	0	0	0	29	36	7	0	0.0393701
1360	100%	17	0	0	0	0	0	0	17	17	0	0	0.0393701
1370	100%	32	0	0	0	0	0	0	32	32	0	0	0.0393701
1400	100%	14	0	0	0	0	0	0	14	14	0	0	0.0393701
1420	100%	17	0	0	0	0	0	0	17	17	0	0	0.0393701
1440	97%	33	1	0	0	0	0	0	34	35	1	0	0.0393701
1460	100%	17	0	0	0	0	0	0	17	17	0	0	0.0393701
1480	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
1500	98%	49	1	0	0	0	0	0	50	51	1	0	0.0393701
1520	94%	14	1	0	0	0	0	0	15	16	1	0	0.0393701
1530	75%	8	4	0	0	0	0	0	12	16	4	0	0.0393701
1540	100%	5	0	0	0	0	0	0	5	5	0	0	0.0393701
1545	50%	1	0	1	0	0	0	0	2	4	2	0	0.0393701
1600	88%	12	2	0	0	0	0	0	14	16	2	0	0.0393701
1620	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
1640	100%	12	0	0	0	0	0	0	12	12	0	0	0.0393701
1660	100%	6	0	0	0	0	0	0	6	6	0	0	0.0393701
1700	100%	10	0	0	0	0	0	0	10	10	0	0	0.0393701
1710	83%	12	3	0	0	0	0	0	15	18	3	0	0.0393701
1720	93%	12	1	0	0	0	0	0	13	14	1	5	0.0393701
1800	85%	9	2	0	0	0	0	0	11	13	2	0	0.0393701
1810	89%	7	1	0	0	0	0	0	8	9	1	0	0.0393701
1900	100%	9	0	0	0	0	0	0	9	9	0	0	0.0393701
1920	100%	8	0	0	0	0	0	0	8	8	0	0	0.0393701
2190	100%	23	0	0	0	0	0	0	23	23	0	0	0.0393701

2210	95%	51	3	0	0	0	0	0	54	57	3	0	0.0393701
2230	100%	35	0	0	0	0	0	0	35	35	0	0	0.0393701
2240	93%	34	3	0	0	0	0	0	37	40	3	0	0.0393701
2250	100%	45	0	0	0	0	0	0	45	45	0	0	0.0393701
2260	95%	39	2	0	0	0	0	0	41	43	2	0	0.0393701
2270	89%	35	5	0	0	0	0	0	40	45	5	0	0.0393701
2280	89%	34	5	0	0	0	0	0	39	44	5	0	0.0393701
2310	85%	26	2	0	1	0	0	0	29	34	5	0	0.0393701
2320	94%	28	2	0	0	0	0	0	30	32	2	0	0.0393701
2330	93%	26	2	0	0	0	0	0	28	30	2	0	0.0393701
2340	73%	16	2	0	0	0	1	0	19	26	7	0	0.0393701
2350	97%	35	1	0	0	0	0	0	36	37	1	0	0.0393701
2360	100%	31	0	0	0	0	0	0	31	31	0	0	0.0393701
2370	96%	23	1	0	0	0	0	0	24	25	1	0	0.0393701
2710	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
2730	90%	34	2	1	0	0	0	0	37	41	4	0	0.0393701
2750	91%	36	4	0	0	0	0	0	40	44	4	0	0.0393701
2810	97%	30	1	0	0	0	0	0	31	32	1	0	0.0393701
2820	89%	23	1	1	0	0	0	0	25	28	3	0	0.0393701
2840	96%	25	1	0	0	0	0	0	26	27	1	0	0.0393701
4010	100%	7	0	0	0	0	0	0	7	7	0	0	0.0393701
4020	100%	37	0	0	0	0	0	0	37	37	0	0	0.0393701
4030	100%	32	0	0	0	0	0	0	32	32	0	0	0.0393701
4040	96%	24	1	0	0	0	0	0	25	26	1	0	0.0393701
4050	96%	24	1	0	0	0	0	0	25	26	1	0	0.0393701
4060	89%	22	3	0	0	0	0	0	25	28	3	0	0.0393701
4070	100%	32	0	0	0	0	0	0	32	32	0	0	0.0393701
4080	96%	22	1	0	0	0	0	0	23	24	1	0	0.0393701
4090	90%	23	3	0	0	0	0	0	26	29	3	0	0.0393701
4100	96%	24	1	0	0	0	0	0	25	26	1	0	0.0393701
4110	100%	26	0	0	0	0	0	0	26	26	0	0	0.0393701
4130	78%	17	3	0	1	0	0	0	21	27	6	0	0.0393701
4140	96%	23	1	0	0	0	0	0	24	25	1	0	0.0393701
4150	90%	32	4	0	0	0	0	0	36	40	4	0	0.0393701
4160	92%	33	3	0	0	0	0	0	36	39	3	0	0.0393701
4170	100%	18	0	0	0	0	0	0	18	18	0	0	0.0393701
4180	94%	27	2	0	0	0	0	0	29	31	2	0	0.0393701
4190	97%	30	1	0	0	0	0	0	31	32	1	0	0.0393701
4200	96%	22	1	0	0	0	0	0	23	24	1	0	0.0393701
4220	89%	27	4	0	0	0	0	0	31	35	4	0	0.0393701
4230	100%	23	0	0	0	0	0	0	23	23	0	0	0.0393701
4240	95%	19	1	0	0	0	0	0	20	21	1	0	0.0393701
4250	100%	24	0	0	0	0	0	0	24	24	0	0	0.0393701
4260	100%	25	0	0	0	0	0	0	25	25	0	0	0.0393701
4270	100%	31	0	0	0	0	0	0	31	31	0	0	0.0393701
4290	96%	25	1	0	0	0	0	0	26	27	1	0	0.0393701
4300	97%	28	1	0	0	0	0	0	29	30	1	0	0.0393701
4310	100%	23	0	0	0	0	0	0	23	23	0	0	0.0393701
4330	94%	29	2	0	0	0	0	0	31	33	2	0	0.0393701
4340	92%	21	2	0	0	0	0	0	23	25	2	0	0.0393701
4350	96%	23	1	0	0	0	0	0	24	25	1	0	0.0393701
4360	95%	18	1	0	0	0	0	0	19	20	1	0	0.0393701
4470	82%	11	3	0	0	0	0	0	14	17	3	0	0.0393701
4490	100%	11	0	0	0	0	0	0	11	11	0	0	0.0393701
4510	82%	11	3	0	0	0	0	0	14	17	3	0	0.0393701
4520	90%	17	2	0	0	0	0	0	19	21	2	0	0.0393701
4530	100%	23	0	0	0	0	0	0	23	23	0	0	0.0393701
4570	94%	29	2	0	0	0	0	0	31	33	2	0	0.0393701
4710	89%	42	6	0	0	0	0	0	48	54	6	0	0.0393701
4730	90%	23	3	0	0	0	0	0	26	29	3	0	0.0393701
4750	93%	12	1	0	0	0	0	0	13	14	1	0	0.0393701
4770	96%	25	1	0	0	0	0	0	26	27	1	0	0.0393701
4790	86%	15	3	0	0	0	0	0	18	21	3	0	0.0393701
4810	93%	25	2	0	0	0	0	0	27	29	2	0	0.0393701
4820	72%	13	4	0	1	0	0	0	18	25	7	0	0.0393701
4830	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
4840	100%	16	0	0	0	0	0	0	16	16	0	0	0.0393701
	Total Tips	3178	188	7	6	0	1	0	3380	3605			

	Compute Statistics		

Sensor ID	(mm of rain measured) Measured Bucket Tips	Outliers Removed	Bucket Tip Data Analysis	
100	15	15	Mean	24.16779
110	16	16	Median	22
120	21	21	Std Deviation	12.58023
140	31	31	Mean + 3 st dev	61.90848
150	36	36	Mean - 3 st dev	-13.57291
200	14	14	Min	5
210	14	14	Max	95
220	21	21		
300	16	16		
310	17	17		
320	9	9		
330	23	23		
400	19	19		
410	23	23		
420	57	57		
430	51	51		
440	13	13		
500	33	33		
510	34	34		
520	19	19		
530	17	17		
540	13	13		
600	11	11		
610	15	15		
620	15	15		
630	95	95		
640	43	43		
650	14	14		
700	11	11		
710	10	10		
720	22	22		
730	17	17		
740	43	43		
750	13	13		
760	19	19		
800	13	13		
810	17	17		
820	13	13		
830	41	41		
840	20	20		
850	19	19		
860	19	19		
870	28	28		
900	29	29		
1000	28	28		
1010	15	15		
1030	14	14		
1040	17	17		
1050	12	12		
1060	18	18		
1100	10	10		
1110	14	14		
1200	14	14		
1300	13	13		
1310	16	16		
1320	11	11		

1330	11	11
1340	15	15
1350	36	36
1360	17	17
1370	32	32
1400	14	14
1420	17	17
1440	35	35
1460	17	17
1480	10	10
1500	51	51
1520	16	16
1530	16	16
1540	5	5
1600	16	16
1620	14	14
1640	12	12
1660	6	6
1700	10	10
1710	18	18
1720	14	14
1800	13	13
1810	9	9
1900	9	9
1920	8	8
2190	23	23
2210	57	57
2230	35	35
2240	40	40
2250	45	45
2260	43	43
2270	45	45
2280	44	44
2310	34	34
2320	32	32
2330	30	30
2340	26	26
2350	37	37
2360	31	31
2370	25	25
2710	16	16
2730	41	41
2750	44	44
2810	32	32
2820	28	28
2840	27	27
4010	7	7
4020	37	37
4030	32	32
4040	26	26
4050	26	26
4060	28	28
4070	32	32
4080	24	24
4090	29	29
4100	26	26
4110	26	26
4130	27	27
4140	25	25
4150	40	40
4160	39	39

4170	18	18
4180	31	31
4190	32	32
4200	24	24
4220	35	35
4230	23	23
4240	21	21
4250	24	24
4260	25	25
4270	31	31
4290	27	27
4300	30	30
4310	23	23
4330	33	33
4340	25	25
4350	25	25
4360	20	20
4470	17	17
4490	11	11
4510	17	17
4520	21	21
4530	23	23
4570	33	33
4710	54	54
4730	29	29
4750	14	14
4770	27	27
4790	21	21
4810	29	29
4820	25	25
4830	16	16
4840	16	16