



UDFCD ALERT Gauging System Maintenance 2017 Annual Report

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Executive Summary

Introduction

The purpose of this report is to summarize the ALERT system maintenance activities completed by OneRain in 2017 on behalf of the Urban Drainage and Flood Control District (UDFCD) under our current contract.

We believe that maintenance for the 2017 season was successful. We are excited about the continued implementation of the ALERT2™ protocol and the positive impact it will have on more reliable data collection.

Beginning in the 2008 maintenance season, OneRain and the District modified the maintenance schedule slightly from previous years by including an interim trip to all rain gauge sites. Table 1 below summarizes the maintenance activity over the course of the last sixteen years. The “Service Rate” column is the ratio (%) of service calls to sites in the combined UDFCD/Boulder System.

Table 1: Recent Maintenance Activity Statistics for UDFCD & Boulder Co.

Year	Total # of Visits	Service Calls OneRain/District	Number of Sites ¹	Service Rate
2001	701	66 (30/36)	152	43%
2002	723	59 (45/14)	161	37%
2003	794	110 (86/24)	171	64%
2004	790	78 (51/27)	173	45%
2005	810	97 (76/21)	174	56%
2006	696	97 (78/19)	182	53%
2007	653	58 (49/9)	183	32%
2008	715	94 (62/32)	194	48%
2009	715	107 (93/14)	179	60%
2010	744	82 (81/1)	180	45%
2011	680	78 (69/9)	180	43%
2012	692	67 (53/14)	176	38%
2013	635	97(87/10)	177	55%
2014	624	64(64/0)	178	36%
2015	598	73(63/10)	175	42%
2016 ²	529	50	177	28%
2017	634	44	178	25%

¹ Includes repeaters and base stations.

² In 2016 OneRain began using new Inventory Maintenance software.

System Performance

A total of 634 maintenance records were collected between January 1 – November 17, 2017, including 44 service calls initiated by OneRain.

Service Calls

The 44 total service calls included the following:

- 9 stage issues
- 5 power-related issues
- 5 tipping bucket issues
- 15 transmitter/RF issues
- 10 infrastructure issues

The unscheduled visits can be attributed to the following:

- Transmitter/RF issues – Transmitter-related issues encompass a wide array of onsite issues including dead radios, program corruptions, transmitter failures, and antenna failures.
- Power issues – Due to an aging battery fleet, a number of batteries did not survive the interval between standard preventative maintenance visits. Batteries are subjected to a dynamic discharge testing at our office. If the battery underperforms it is scrapped and replaced.
- Stage issues – Out of the 9 stage service calls, 2 were due to PT failures/replacements. The other service calls were for signal conditioning and calibration.
- Tipping bucket issues – Typically most issues for tipping buckets are due to clogging of the funnel by debris.
- Infrastructure issues – Most issues were due to damage to sites resulting from construction activities.

Pressure Transducer Failures and Replacements

There were significantly less PT failures compared to last year. Over the past few years PT replacements have been high as the aging fleet is upgraded. This year 21 pressure transducer calibrations were performed. This number falls in line with preceding years. Over the last few years the older Druck units have been replaced with Keller Accuvue units. Specific pressure transducer replacements for 2017 are listed below.

- Maple Grove Reservoir (10013) – Replaced February 2
- Ralston Reservoir (110) – Replaced March 23

Damaged Equipment/Other Replacements

Shop Creek (1710)

During startup it was discovered that data was only intermittently displayed in Contrail. The problem was remedied by replacing the radio.

Aurora FS # 12 (840)

During startup it was discovered that data was only intermittently displayed in Contrail. Further inspection revealed that the antenna cable was in poor condition. The problem was resolved by replacing the antenna cable.

Denver Zoo (1360)

Shortly after startup, the site began reporting intermittently. The old Hydrolynx 5096 transmitter was replaced with a spare High Sierra 3206 ALERT unit in mid-March.

Marston (1520)

During startup in mid-March, it was determined that the ultrasonic wind sensor was malfunctioning. This sensor was subsequently “turned off” in the datalogger program to prevent it from reporting erroneous data until it could be replaced. On April 4 the old wind sensor was replaced with a new RM Young unit (Figure 1). This unit has reported reliably since that time.



Figure 1: Marston RM Young Wind Sensor

DIA @ 3rd Creek (1480)

The PT located inside the well began to over report and send erroneous data after startup at the beginning of April. It was decided to abandon this sensor. In addition, the signal conditioning box and MS connector to the transmitter were replaced due to significant damage caused by mice. The well PT was lifted and coiled up. It is still available as a pull string if it is decided a new sensor should be installed.

SPR @ Union (4090)

This site stopped reporting shortly after startup at the beginning of April. The issue was resolved by replacing the radio.

Van Bibber @ 93 (330)

This site stopped reporting shortly after startup at the beginning of April. The radio, antenna, and antenna cable were all replaced.

Gold Hill Repeater (8015)

OneRain was informed by a local resident that the antenna appeared to be leaning to one side. A site visit in mid-April revealed that the strut clamps securing the antenna were loose, likely resulting from high winds. The antenna was realigned and the strut clamps were tightened.

Lee Hill Repeater (4210)

The encoder board failed after a lightning strike in mid-May. A spare repeater was installed. The original repeater (canister enclosure) was sent to Blue Water Design for repair. The repeater was reconfigured to a rack mount unit, thus standardizing all repeater inventory. It is currently available as a spare.

Grandby Ditch (810)

The top section had been extremely difficult to remove during maintenance for some time. A new top section was installed on May 18.

Aurora Town Hall (920)

In late June the WXT520 weather sensor (Figure 2) at Aurora Town Hall malfunctioned. Diagnostic tests performed during a site visit in early July proved inconclusive and the sensor was brought back to the OneRain shop for further testing where it was determined that the sensor cable had been damaged. The sensor was returned to the site with a new cable on July 14 and the sensor has reported reliably since then.



Figure 2: Aurora Town Hall WXT520 Weather Sensor

The reservoir of the ET gauge ran empty at the end of August (Figure 3). While it is not unusual for this sensor's reservoir to require refilling during the summer, in order to minimize the sensor's downtime between fillings in the future, OneRain created a Contrail alarm that will alert its field personnel when the sensor has failed to "tip" for 24 hours.



Figure 3: Aurora Town Hall ET Gauge

Expo Park (430)

This site began reporting intermittently in mid-July. Diagnostic tests performed at the site revealed a defective transmitter. A spare ALERT transmitter was used to replace the original on July 28.

Lville Dwy (1100)

In mid-August this site erroneously reported 9.8" of rain in a 24-hour period. It was found that the tipping bucket was shorting out the transmitter. The tipping bucket was replaced with a spare.

South Boulder Creek at South Boulder Road (4870)

On December 19, the damaged section of the PT intake pipe was removed. The intake pipe was flushed, and a perforated plastic cap was placed on the end of the pipe (Figure 4). The PT now has good hydraulic contact.



Figure 4: SBC @ SBR PT Intake Pipe

South Boulder Creek at Sans Sou (4830)

On December 20, a new 10' section of 1/2" pipe was coupled to the existing intake pipe emerging from the channel bank, replacing the old, rusted, damaged section (Figure 5 and Figure 6). A perforated plastic cap was placed on the end of the intake, and the PT now has good hydraulic contact.



Figure 5: New PT Intake Pipe at Sans Sou



Figure 6: New PT Intake Pipe at Sans Sou (Covered with Rocks)

Lakeshore (4060)

A large tree has grown in the vicinity of the rain gauge. It is obscuring the rain catch and solar panel. This site is on private property and we cannot trim or remove the tree. This site should be relocated to an area on Denver Water property with adequate rain catch.

2017 Site Reconstructions, Relocations, and Upgrades

Maple Grove Reservoir (10013)

Historically, PTs installed at Maple Grove have been periodically damaged by ice. This is a high priority, year-round site. Accordingly, on February 9, in order to combat potential ice damage in the future, the PT was replaced with a freeze-resistant OTT PLS unit and the riser pipe was lowered 1' ¼" (5 ¾" from the channel bottom) in order to ensure that the PT resides below the ice layer that typically forms on top of the water during the winter months (Figure 7). The PT reference was adjusted in Contrail.



Figure 7: Maple Grove Reservoir Riser Pipe

Flying J (10043)

During startup it was found that data was only being received locally via field decoder – no data was being displayed in Contrail. The backplane consisted of aged equipment, and the antenna cable was in very poor condition. The site was upgraded to ALERT2 on March 20 and a new antenna cable and solar panel were installed.

Filter Plant (10046)

The startup visit revealed that the standpipe had been knocked over during recent construction activities. The site was upgraded to ALERT2 and reinstalled with a Pelco pole and a High Sierra cabinet (Figure 8).



Figure 8: New Site Infrastructure at Filter Plant

Quincy Reservoir (10047)

Sometime during the summer, the standpipe at Quincy Reservoir was severely damaged by construction activities taking place in the area (Figure 9).



Figure 9: Damaged Standpipe at Quincy Reservoir

On September 13 the site was relocated to the northeast corner of the property. The site was upgraded to ALERT2 (High Sierra A2 3306 transmitter) and a new standpipe was installed (Figure 10). In addition, the tipping bucket, solar panel, RM Young wind sensor, and relative humidity/air temperature sensor were replaced with new units. The pyranometer from the old site was found to be operating correctly so it is still in use at the new site. The barometric pressure sensor was irreparably damaged by the construction activities and no replacement was installed at the new site.



Figure 10: Quincy Reservoir ALERT2 Upgrade

Diamond Hill (10028)

On October 17 the Diamond Hill weather station was relocated to the penthouse roof (Figure 11). All equipment and components that were present at the former location are still in use at the new location. The weather station is mounted to the angle iron structure on the penthouse roof, and no portion of the station is in contact with the roof surface, which should obviate any conflicts in the future if repairs to the roof are required.



Figure 11: Diamond Hill Site Relocation to Penthouse Roof

Green Ditch (10048)

The City of Boulder performed stream reconstruction in the vicinity of the original location of this site. The site was relocated with new infrastructure and upgraded to ALERT2 (Figure 12). The newly installed site became operational December 14th, 2017.



Figure 12: Green Ditch Relocation

Standpipe Door Installations

Doors were installed at Upper Sloan, Grandby Ditch, Confluence Pond, Maple Grove Reservoir and Horseshoe Park. Doors allow for maintenance to be performed in a more efficient and safe manner. These sites were chosen due to being located on steep topography where ladder use is problematic and unsafe. Additional doors should be installed annually to increase maintenance efficiency and safety.

Boulder County Activity

There were no major issues in Boulder County this year. A separate report will be delivered to the County with additional recommendations and upgrades.

Golden Age (4230)

This site stopped reporting in mid-April. A site visit revealed that the antenna mast had been sheared off, destroying the solar panel. The mast was successfully re-attached albeit a foot shorter than it was originally. The original transmitter was also replaced since it had been reporting erroneous battery voltage for some time. The site is now in good working condition.

Lyons Diversion (4560)

In early August the solar panel was replaced with a unit taken from spares.

Riverside (4340)

This site stopped reporting at the beginning of September. Testing performed in the field on September 9 revealed the radio had failed. The radio was replaced with a spare unit.

Miscellaneous Activity

FCC Licensing

OneRain is currently in the process of updating and renewing all applicable licenses. Currently all sites are associated with a FCC license and are not due for renewal until 2025.

Alarming

Rainfall alarms were added to all sites in Contrail. Alarming is triggered by the following events:

- 0.5 Inches in 10 Minutes
- 1.0 inches in 1 hour
- 3.0 inches in 2 hours
- 5.0 Inches in 5 hours

Deliveries are set up for e-mail and/or text message. When a site is in the alarm state, the icon in the user interface will reflect this.

Secondary ALERT2 Base Station at Westminster

On December 19th, a redundant ALERT2 data receive location was installed at the City of Westminster Public Safety building. Data is received using a DB224 antenna and Blue Water Design B2010 Base Station Receiver/Demodulator (this was UDFCD's spare). Westminster required a minimum visual impact to the north, so the antenna needed to be mounted on the steel structure on the south side of the brickwork. To minimize interference from the steel framework, and maximize reception to the northwest for Lee Hill, it was mounted on standoffs to the south. Pictures show the mounting, and the view to the northwest (Figure 13). The antenna, including feedline and lightning protection, performance was swept with an antenna analyzer and a good match was confirmed.



Figure 13: Looking NW

The cavity filter ordered for the project had not yet arrived at the time of installation, so a spare cavity was retuned and temporarily installed in the radio room.

Data was transmitted to OneRain's secure data storage center via TCP/IP for display in Contrail. Work will need to be continued with Westminster's IT department to arrange remote login access, access by NovaStar to retrieve data, and confirmation that an adequate firewall is in place. The device is not on the City network, but instead on an independent network that the investigators use. Accordingly, it is believed that network does not currently have a robust firewall in place. It may be necessary for UDFCD to acquire a basic firewall to protect the B2010, since B2010s have been corrupted by being installed without a firewall, and Blue Water Design specifies that a firewall is needed to protect the processor. Accordingly, the B2010 at Westminster was disconnected from the internet, until the details could be resolved.

ALERT/ALERT2 Concentrator

UDFCD purchased an ALERT/ALERT2 Concentrator for installation at Diamond Hill. This device will log and queue all data reports. In the event of internet outage (which has plagued the feed from Diamond Hill, since it switches between ISPs, and the B2010 takes some time to recover during which time data is lost). All data collected is stored and transmitted when internet connectivity is restored. The Concentrator is scheduled to be installed in January.

Future Areas of Interest

The sections below outline areas that the District and OneRain have been tracking through our monthly meetings, or areas of future concern worthy of note.

ALERT2™ Upgrade

Below is a complete list of sites that have been upgraded to ALERT2 (23 Total):

- Carr Street
- Maple Grove Reservoir
- East Toll Gate at Hampden
- Blackstone
- Havana Pond
- James Creek at Jamestown
- Lower Lefthand
- Murphy Creek
- Nolte Pond
- South St. Vrain at Berry
- Quincy Reservoir
- Flying J
- Sand Creek at Colfax
- Westerly Creek Dam
- Coal Creek at McCaslin
- Diamond Hill Wx
- Sanderson Gulch
- Side Creek Park
- Little Dry Creek @ 64th
- Broadway
- Porphyry
- Montview
- Filter Plant

Metadata Consistency

OneRain will continue to work with WET and other agencies to integrate database metadata ensuring accuracy and consistency.

Spare Equipment Recommendations for Upcoming Season

Table 2: Spare Equipment Recommendations

Manufacturer	Model	Cost	Quantity	Total	Notes
High Sierra	3306-02	\$3,000	2	\$6,000	ALERT2 Transmitter
High Sierra	5301-03	\$198	2	\$396	Solar Panel
High Sierra	7135-11	\$388	2	\$776	GPS Antenna / Cable
Keller	Acculevel	\$1,462	1	\$1,462	160 ft. PT
RM Young	05103	\$1,202	2	\$2,404	Wind Sensor
Maxon	SD-125	\$500	4	\$2,000	TXR Radio
Talley	VHF Omni Antenna	\$266	2	\$532	Antenna / Cable set
			TOTAL	\$13,570	

Additional Site Recommendations

The following are additional site recommendations not associated with spares. A detailed proposal can be provided upon request.

Standpipe Door Retrofit Implementation

For the last two seasons OneRain has been retrofitting old standpipes with doors using the High Sierra door kit. Currently there are still many sites that lack a door, and are therefore difficult to access the electronics inside. We propose purchasing at least 5 retrofit kits for installation during the spring of 2018. The installation of doors improves both maintenance safety and efficiency. The cost of **\$495** per retrofit includes hardware and labor. The list below contains sites that would benefit most greatly from the upgrade:

- Lena Gulch at HWY 6
- Cherry Ck / Steele
- Iliff Pond
- Hidden Lake
- ETG @ Buckley

Van Bibber ALERT2 Upgrade and Relocation

Since the flooding of 2013, maintaining hydraulic contact at the current PT riser location has been an ongoing challenge. The channel has shifted greatly and a substantial layer of rocks and sediment has been deposited in the vicinity of the PT. In addition, the standpipe top section is in disrepair and access is difficult in its current location due to the sloping topography.

The site will likely be relocated to the bridge on Crestone Street (Figure 14). We recommend replacing the PT with a non-contact radar unit mounted to the bridge, similar to Coal Creek at McCaslin. The site will also be upgraded to ALERT2 prior to installation.

The Crestone Street location is attractive because the radar sensor, enclosure/cabinet, tipping bucket, and antenna could all be mounted to the bridge's concrete structure. The installation could be done safely and will allow for safe and efficient maintenance in the future.

Conversely, the cabinet, tipping bucket, and antenna could also be mounted to a pole off the bridge in the nearby grassy area (as was done for Coal Creek at McCaslin) should it be necessary.



Figure 14: Proposed New Location for Van Bibber at Crestone Street Bridge

Maple Grove Reservoir Real-Time Gate Height Monitoring

Currently, OneRain is in the process of scheduling a site visit with Consolidated Mutual Water Company personnel (CMWC) to determine the feasibility of outfitting the two gates at Maple Grove Reservoir with inclinometers or other sensors capable of monitoring the gate heights in real-time. OneRain's intent is to integrate the gate height sensors with the Maple Grove Reservoir ALERT2 site. Doing so will likely require the addition of a CR1000X datalogger to the site.

ALERT2 Site Upgrades

Currently, sites are only upgraded to ALERT2 when the previous transmitter fails or a new site is installed. We would like to implement an ALERT2 upgrade plan, in which a specific number of sites are upgraded each year. By upgrading, we increase the quality of data and preemptively reduce the chances of transmitter failure. The price to upgrade a site to ALERT2 includes hardware, labor, and configuration of Contrail.

- \$3,712 per location

ALERT2 SDI-12 Sniffer

High Sierra Electronics has combined a SDI-12 sniffer feature with their new ALERT2 transmitters. We currently have 2 ALERT sites where SDI-12 sniffers are in place. We can easily upgrade these locations to ALERT2 while eliminating the SDI-12 sniffer hardware.

- \$3,712 New 3306 ALERT2 Transmitter with Solar Panel and GPS

ETG @ Hampden (10011)

During 2016 takeout, it was discovered that the standpipe was leaning to one side, and evidence that it had been struck by a large (construction?) vehicle was apparent (Figure 15). The site is functioning correctly, and while the standpipe does not appear to be in imminent danger of toppling over, it should be repaired when possible.



Figure 15: Damage to ETG @ Hampden

- \$1,860 Labor and supplies to realign the standpipe

Appendix A: Spares on Hand

Per separate PDF accompanying this document 

**2018 Spare Equipment
Urban Drainage and Flood Control District
OneRain Incorporated**

Serial Number	Category	Model	Manufacturer
1042	ALERT 2 Canister	RDP120	Campbell Scientific, inc
1051	ALERT 2 Canister	RDP120	Campbell Scientific, inc
NSN 1	Antenna	MBS150	PCTEL
NSN 2	Antenna	MBS150	PCTEL
40159	Antenna	Bullet GPS Antenna	Campbell Scientific, inc
55079	Antenna	Bullet GPS Antenna	Campbell Scientific, inc
149366	Antenna	Bullet GPS Antenna	Campbell Scientific, inc
149366	Antenna	Bullet GPS Antenna	Campbell Scientific, inc
30350293	Antenna	Bullet GPS Antenna	Trimble
L0740697	Barometric Pressure	PTB110	Vaisala
34437	Datalogger	CR 800	Campbell Scientific, inc
105450	Pressure Transducer	Acculevel	Keller
133805	Pressure Transducer	Acculevel	Keller
133834	Pressure Transducer	Acculevel	Keller
143670	Pressure Transducer	Acculevel	Keller
143674	Pressure Transducer	Acculevel	Keller
143675	Pressure Transducer	Acculevel	Keller
113306	Pressure Transducer	Acculevel	Keller
113308	Pressure Transducer	Acculevel	Keller
113342	Pressure Transducer	Acculevel	Keller
113346	Pressure Transducer	Acculevel	Keller
143673	Pressure Transducer	Acculevel	Keller
133859	Pressure Transducer	Acculevel	Keller
A 2270	Radio	DTX-145	Ritron
A13893	Radio	DTX-145	Ritron
A13936	Radio	DTX-145	Ritron
A15971	Radio	DTX-145	Ritron
10448466	Radio	SD-125E V2	Maxon
50211272	Radio	SD-125E V2	Maxon
50613029	Radio	SD-125E V2	Maxon
50614531	Radio	SD-125E V2	Maxon
2340	Repeater	50386	HydroLynx
2069	Repeater	50386	HydroLynx
2314	Repeater	50386	HydroLynx
C0220034	RH/AT Sensor	HMP 45A	Vaisala
C0220033	RH/AT Sensor	HMP 45A	Vaisala
C0220036	RH/AT Sensor	HMP 45A	Vaisala
B4810036	RH/AT Sensor	HMP 45A	Vaisala
23932	Solar Panel	5301-03	High Sierra
38552	Solar Panel	5301-03	High Sierra
37267	Solar Panel	5301-03	High Sierra
38750	Solar Panel	5301-03	High Sierra

23032	Solar Panel	5301-03	High Sierra
41167	Tippin Bucket	2400-03	High Sierra
41174	Tippin Bucket	2400-03	High Sierra
C058	Transmitter/RTU	Model 4	Blue water Design, LLC
F008	Transmitter/RTU	Model 4	Blue water Design, LLC
1115	Transmitter/RTU	AL200 ALERT2 Interface	Campbell Scientific, inc
1048	Transmitter/RTU	AL200 ALERT2 Interface	Campbell Scientific, inc
19663	Transmitter/RTU	3206	High Sierra
4395	Transmitter/RTU	3206	High Sierra
23970	Transmitter/RTU	3206	High Sierra
27467	Transmitter/RTU	3206	High Sierra
43101	Transmitter/RTU	3306-02	High Sierra