



UDFCD ALERT Gauging System Maintenance 2014 Annual Report

Kevin Stewart
Urban Drainage and Flood Control District
Denver, Colorado

Prepared By
OneRain Incorporated
1531 Skyway Drive, Unit D
Longmont, Colorado 80504

Report Date: December 31, 2014

Table of Contents

Executive Summary	4
Introduction.....	4
System Performance	5
Service Calls.....	5
Pressure Transducer Failures and Replacements.....	5
Damaged Equipment/Other Replacements.....	7
Sports Complex (320)	7
Van Bibber @ 93 (330)	7
Parker at Mississippi (540)	7
Harvard Jackson (610)	7
Confluence Pond (720).....	7
Flying J (850).....	7
Aurora Reservoir (900).....	7
Aurora Regional Pond (940).....	7
Louisville Dwy D (1100).....	8
Ferril Lake (1380)	8
Urban Farm (1460)	8
Third Creek at DIA (1480).....	8
Cherry Creek @ Champa (1700).....	8
Idledale (2350).....	8
Walker Ranch (4050)	8
Orodell (4400).....	8
SBC @ Canon Ditch (4840)	9
Maple Grove Res. (10013).....	9
New Site Installations.....	10
Havana Pond (10023)	10
Westerly Creek Dam (10024)	10
2014 Site Reconstructions, Relocations and Upgrades.....	11
Diamond Hill Wx (1420).....	11

Cherry Creek at Steele (1720).....	11
Fourmile (4410).....	11
Bridge (4420).....	12
SBC @ South Boulder Road (4870).....	12
Sand Creek @ Colfax (10016).....	12
Murphy Creek (10019).....	12
Nolte Pond (10025).....	13
Boulder County Activity.....	14
Rowena (4430).....	14
Little Narrows (4470).....	14
Eagle Ridge (4520).....	14
Lyons Diversion (4560).....	14
James Creek (10017).....	15
Lower Lefthand (10018).....	15
S. St. Vrain @ Berry Ridge (10021).....	15
Miscellaneous Activity	16
FCC Licensing.....	16
ALERT2™ Transmitters.....	16
Diamond Hill Base Station Issues.....	17
Future Areas of Interest	18
ALERT2™ Upgrade.....	18
Recommended Pressure Transducer Replacements.....	18
Secondary ALERT2 Base Station at Westminster.....	18
Metadata Consistency.....	19
Spare Equipment Recommendations for Upcoming Season.....	20
Additional Site Recommendations	21
Appendix A: Spares on Hand	22
Per separate PDF accompanying this document.....	22
Appendix B: Maintenance Records.....	23
Per separate PDF accompanying this document.....	23

Appendix C: PT Calibration Log.....24

Per separate PDF accompanying this document..... 24

Executive Summary

Introduction

The purpose of this report is to summarize the ALERT system maintenance activities completed by OneRain in 2014 on behalf of the Urban Drainage and Flood Control District (UDFCD) under our current contract.

We believe that maintenance for the 2014 season was successful. There was quite a bit of work done throughout the year to recover from last years September flooding, which mainly consisted of relocating sites that were affected and restoring conduit. 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 eleven 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) ²	180	43%
2012	692	67 (53/14) ²	176	38%
2013	635	97(87/10)	177	55%
2014	624	64(64/0)	178	36%

¹ This total number of sites includes repeaters and base stations.

² Count does not include 'administrative' maintenance records which document battery disposal

System Performance

We had a total of 624 maintenance records; there were 64 service calls initiated by OneRain. These records were gathered between January 1, 2014 and December 8, 2014.

Service Calls

The 64 service calls initiated by OneRain are broken down as follows:

- 15 Transmitter/RF issues
- 12 Power related issues
- 23 Stage Issue
- 8 Tipping Bucket issues
- 6 Infrastructure issues

Key factors of the unscheduled visits can be attributed to the following:

- **Transmitter/RF issues** – Transmitter related issues encompass a wide array of on site issues from dead radios and program corruptions to transmitter failures.
- **Power issues** – Due to a continuing aging battery fleet, a number of batteries did not survive the interval between standard preventative maintenance visits.
- **Stage Issues** – Out of the 23 stage service calls, 18 were due to PT failures/replacements. 5 service calls were for signal conditioning calibration and miscellaneous repairs such as flushing the PT riser.
- **Tipping Bucket issues** – Typically most issues for Tipping buckets arise from being clogged whether it be by vegetation or animal activity.
- **Infrastructure issues** – Most problems are from breakages in PT conduit, many of which were affected from last years flood.

Pressure Transducer Failures and Replacements

There were more PT failures compared to last year, due to damage during the September 2013 flood and an aging fleet of pressure transducers. 65 pressure transducer calibrations were performed, which is slightly higher than last year. This year we have started transissioning to the Keller pressure transducer after seeing high failures and poor lead time on the Druck units. Specific details of pressure transducer replacements after failures is shown below.

Pressure transducers were replaced at the following sites:

- Maple Grove Res (10013) – Replaced 3/14/2014
- Aurora Regional Pond (940) – Replaced 3/24/2014

- Iliff pond (650) – Replaced 3/24/2014
- Kelly Dam (410) – Replaced 3/24/2014
- Bear Creek @ Cub (2230) – Replaced 3/25/14
- Rosedale (2250) – Replaced 3/25/2014
- Leyden Confluence (210) – Replaced 5/1/2014
- Holly Dam (1610) – Replaced 5/2/2014
- Rowena (4430) – Replaced 5/5/2014
- Little Narrows (4470) – Replaced 5/9/2014
- Leyden Reservoir (200) – Replaced 5/13/2014
- Sand Creek Park (1800) – Replaced 5/20/2014
- Lower Lefthand (4450) – Replaced 5/23/2014
- Goldsmith/Eman (640) – Replaced 6/4/2014
- DIA @ Third Creek (1480) – Replaced 7/15/2014
- Cold Spring Gulch (2240) – Replaced 7/17/14
- Murphy Creek (10019) – Replaced 7/28/2014
- Marston Lake (1520) – Replaced 11/10/2014

Damaged Equipment/Other Replacements

Sports Complex (320)

Heavy sediment was deposited in the channel during an event in 2014 creating poor hydraulic contact for the sensor. OneRain met with Darren Bradshaw on October 29 to point out the pressure transducer. Work was to begin the next week to clean out the channel.

Van Bibber @ 93 (330)

After the September 2013 flooding the stream channel shifted covering the riser in sediment. The riser was dug out and retrofitted for the 2014 season. The site will continue to be monitored. If the channel shifts or the riser continues to clog the conduit will need to be moved and replaced to a new location.

Parker at Mississippi (540)

It appears that this site was hit by a lawnmower damaging the bottom portion of the standpipe. After a rain event water was discovered at the bottom of the pipe. All water was pumped out along with the holes patched and sealed. OneRain would recommend that this standpipe be replaced.

Harvard Jackson (610)

After showing poor hydraulic performance the intake pipe was flushed on 7/28/2014 resolving all issues.

Confluence Pond (720)

During start up it was noticed that the site had poor SWR. The antenna was replaced on March 21, 2014.

Flying J (850)

Flying J quit reporting on April 2, 2014. On April 4, 2014 a site visit discovered the radio had failed. The unit was replaced. Furthermore, the stage sensor at this site was destroyed. There is currently no plans of replacing the sensor and the site has been converted to rain only.

Aurora Reservoir (900)

On June 13, 2014 the sonic wind sensor was replaced due to sensor failure.

Aurora Regional Pond (940)

The site was displaying signs of poor performance. The transmitter was found unresponsive to test transmissions along with corrosion on the board. The transmitter was replaced on May 23, 2014. There were no visible signs of how water had entered the canister.

Louisville Dwy D (1100)

The intake pipe which protrudes through the concrete to the drainage channel has been damaged. In the current state the intake is prone to clogging. Every visit this year required the intake to be pumped out. Once pumped, the site has good hydraulic contact, however, after a small event the pipe tends to become clogged. It is recommended that the intake and PT riser be dug up and replaced.

Ferril Lake (1380)

The bubbler at Ferril Lake has failed. OneRain recommended to the City of Denver that the unit be replaced with a freeze proof pressure transducer. Currently there is a lack of funds to pay for the upgrade. As this site is stage only, it will most likely be decommissioned until repairs can be funded.

Urban Farm (1460)

On 7/15/2014 it was discovered that the pyronometer had fallen off the mast and was transmitting bad readings. The sensor was re-mounted to the mast. The sensors and transmitter at this site have been in service for many years. The transmitter is no longer manufactured or supported. OneRain recommends upgrading this site to an ALERT2 weather station and replacing sensors that can no longer be calibrated.

Third Creek at DIA (1480)

During take out it was noticed that the solar panel at the site was vandalized and destroyed. The panel will be replaced during spring start up. This site has been vandalized several times in the past and has a severe mouse infestation. OneRain has initiated talks with DIA to re-locate the site to a standpipe. Permitting is quite complex for this site and talks of relocation have stalled.

Cherry Creek @ Champa (1700)

The USGS replaced their datalogger which disabled our data feed. A SDI-12 sniffer was installed on May 22, 2014 to re-establish stage readings.

Idledale (2350)

Since the site installation a tree has grown next to the standpipe resulting in a poor rain catch. Every spring the tree is trimmed to allow the best possible catch. The tree is located on private property and OneRain does not have permission to remove the tree.

Walker Ranch (4050)

The solar panel was found unresponsive at Walker Ranch on March 27, 2014. The panel was replaced with a spare unit.

Orodell (4400)

On August 19, 2014 the transmitter was found not responding to PT changes or test button pushes. The transmitter was replaced with a spare.

SBC @ Canon Ditch (4840)

During the September flooding the stream channel at Canon Ditch had altered and destroyed all conduit. Currently the City of Boulder does not have funds to repair the site. The site has been changed to a rain only station.



Maple Grove Res. (10013)

With the site upgraded to ALERT2 and transmitting hourly data, a solar panel was installed on February 24, 2014 to keep the battery charged.

New Site Installations

Havana Pond (10023)

<i>Latitude</i>	<i>Longitude</i>	<i>Site ID</i>
39.8056800°	-104.8590800°	10023



Installation was completed on 10/21/2014. Havana Pond utilizes ALERT2 technology and is powered with a Campbell Scientific ALERT2 transmitter. It is currently configured for rain and stage.

Westerly Creek Dam (10024)

<i>Latitude</i>	<i>Longitude</i>	<i>Site ID</i>
39.717691°	-104.881467°	10024



Installation was completed on 11/5/2014. Westerly Creek Dam is powered with a Campbell Scientific ALERT2 transmitter. It is currently configured for rain and stage.

2014 Site Reconstructions, Relocations and Upgrades

Diamond Hill Wx (1420)

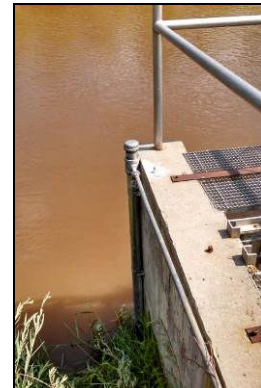
After several site visits, transmitter replacements, and bench tests of failed sensors, a new weather station with a CR1000 data logger, ultrasonic anemometer, and HMP45A RH/AT sensor was installed.

Cherry Creek at Steele (1720)

The intake for this site was destroyed in the 2013 flooding. The intake was dug up through the bank to the riser. New conduit was layed in place on 5/7/2014. This site is notorious for sediment build up. A fabric screen was placed over the intake to help reduce sediment build up.

Cold Spring Gulch (2240)

A new PT Riser and intake was reinstalled on July 17, 2014 after being destroyed from the September 2013 flood. Conduit was run to the standpipe and a new pressure transducer was installed.



Fourmile (4410)

A new PT Riser and intake was reinstalled on May 6, 2014 after being destroyed from the September 2013 flood. The original pressure transducer survived the flooding.



Bridge (4420)

After the September 2013 flood, the riser attached to the concrete wall was knocked off its anchors and sections of conduit were destroyed. The pressure transducer was unharmed and is in working order. On 4/20/2014 all conduit was repaired and the riser was remounted to the wall.



SBC @ South Boulder Road (4870)

After the September 2013 flooding the channel had moved and the intake was destroyed. On 3/14/2014, OneRain technicians re-installed the intake securing it in the new channel.

Sand Creek @ Colfax (10016)

During Startup the CR200 was unresponsive. The old datalogger was scrapped and the site was upgraded to ALERT2. Currently there is heavy construction in the area associated with the Colfax bridge replacement project. OneRain has talked with the contractor and the site should not be in any danger during the construction. OneRain will monitor the site as the construction continues.

Murphy Creek (10019)

Murphy Creek pressure transducer failed early in the spring. With the aging CR10X, it was decided to upgrade the site to ALERT2. An AL200 was installed along with GPS antenna and solar panel.

Nolte Pond (10025)

Nolte Pond was relocated to a more accessible location on the south side of the pond on 10/24/2014. Pelco infrastructure was installed along with an ALERT2 transmitter. Rigid conduit was run to the pond.



Boulder County Activity

Rowena (4430)

A new PT riser and intake was reinstalled on May 5, 2014 after being destroyed during the September 2013 flood. A new pressure transducer was installed.

Little Narrows (4470)

A new PT riser and intake was reinstalled on May 9, 2014 after being destroyed during the September 2013 flood. A new pressure transducer was installed.



Eagle Ridge (4520)

Eagle Ridge failed in early January. It was discovered that the solar panel was removed and thrown close to the site. The panel was still in working condition. The batteries were replaced and the solar panel was re-mounted.

Lyons Diversion (4560)

Lyons Diversion was moved upstream to the Highway 80 bridge. with coordinates: Latitude 40.2429083°, Longitude -105.3136444°. A radar and an enclosure were installed on the upstream side of the bridge for measuring stage. Excessive moisture was found inside the NEMA enclosure. Moisture is intruding from condensation build up in the conduit. All access ports were completely sealed off and additional desiccant was added.



James Creek (10017)

After being completely destroyed in the 2013 September flooding, James Creek was relocated upstream and installed in downtown Jamestown on 5/5/2014. The new GPS coordinates are Latitude 40.1149180°, Longitude - 105.3859350°. The site was also upgraded to the ALERT2 protocol.



Lower Lefthand (10018)

The site was converted to ALERT2 on 5/16/14 with a new mast for a GPS antenna and solar panel.

S. St. Vrain @ Berry Ridge (10021)

On 8/13/14 South St. Vrain @ Berry Ridge was relocated and installed after being destroyed in the September 2013 flooding. Its new location is Latitude 40.16765500°, Longitude - 104.8814670°. It is an ALERT2 site with a standpipe and door, solar panel, Campbell Scientific AL200 and RDP-120 transmitter installed. Conduit was run and installed with a riser which houses a Keller PT. This is a stage only site.



Miscellaneous Activity

FCC Licensing

OneRain is currently in process of updating all licenses and renewing if applicable.

Dimond Hill Antenna Install

In mid-September it was found that Diamond Hill was not receiving ALERT data reliably. Upon inspection it was found that Building Maintenance had taken down the original antenna that had been in operation for 20+ years. OneRain installed a new, more robust, antenna on September 10, 2014. During the installation all aging RF cables were replaced with new cable and connectors.



ALERT2™ Transmitters

Over the year, OneRain has been working closely with Campbell Scientific diagnosing and troubleshooting issues with the AL200 ALERT2 encoder and transmitter. A re-setting issue was discovered with the transmitter at multiple locations. These resets caused the site to overreport and in some cases cease transmitting. OneRain monitored these sites very closely and no down time was experienced during the flood season. Dataloggers were added to select sites after the flood season to monitor the AL200 output. It was discovered that a leaky diode was causing the sites to reset. Furthermore, the GPS chip would lose clock sync at low temperatures. Campbell issued a fix and all AL200 owned by the UDFCD are currently being repaired by Campbell. OneRain will continue to test these units once they are received back from Campbell.

Diamond Hill Base Station Issues

Starting in October latency issues were discovered from the Diamond Hill Base Station. Data was not being received at both collection platforms (Conrail and Novastar). Logging code was implemented into the B2010. However, since the code was implemented there has not been an outage. This issue has not been pinpointed to either the B2010 or network cables that run from the decoder to the network room. Currently, we are awaiting another latency outage to determine where exactly the problem exists.

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 we want to make you aware of.

ALERT2™ Upgrade

Below is a complete list of sites that have been upgraded to ALERT2:

- 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
- Sand Creek at Colfax
- Westerly Creek Dam

Recommended Pressure Transducer Replacements

OneRain recommends that the following pressure transducers be replaced due to slipping performance and constant re-calibrations during maintenance visits. These sensors will be replaced with equipment from spares.

- Leyden Reservoir (200), 160ft.
- Montview Park (400) , 50 ft.
- Temple Pond (630), 75ft.

As always, all sensors will be tested and evaluated during spring start-up.

Secondary ALERT2 Base Station at Westminster

To ensure reliable data reception, a redundant ALERT2 data receive location will be installed at the City of Westminster Public Safety building. Data will be collected using a DB224 antenna and Blue Water Designs B2010 Base Station Receiver/Demodulator. The serial output will then be transmitted to OneRain's secure data storage center via TCP/IP for display in Conrail. With the ongoing latency issue, it is critical to have the secondary base station operational by April 1.

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
Campbell	RPD120-D8-M2-C6	\$2,500	1	\$2,500	ALERT2 Weather Station
Campbell	GPS and Mount	\$179	1	\$179	ALERT2 GPS Antenna & cable
Campbell	DTX-145	\$475	1	\$475	ALERT2 Spare Radio
Ritron	SD-125EV2	\$201	2	\$402	ALERT Spare Radio
Campbell	RM Young	\$1,000	1	\$1,000	Annemometer
Campbell	CS106	\$600	1	\$600	BP Sensor
High Sierra	5301-03	\$115	3	\$345	Solar Panels
Hydrolynx*	Repair	\$500	1	\$500	Hydrolynx Repeater Repair
Keller	Acculevel	\$740	2	\$1,480	120 ft PT
Keller	Acculevel	\$830	2	\$1,660	180 ft PT
Talley	MBS150	\$125	2	\$250	Spare Antenna
-			Total	\$9,391	

*These repair costs are estimated and will be determined by the manufacturer

Additional Site Recommendations

The following are additional site recommendations not associated with spares.

- Standpipe replacement at Parker @ Mississippi
 - Equipment \$1,888
 - Labor \$1,520
 - Total **\$3,408**
- Replace top section at Powers Park
 - Equipment **\$580**
- Upgrade Urban Farm to ALERT2
 - Equipment \$3,831 (includes all new sensors, price may be adjusted by using spares or existing sensors)
 - Labor \$1,520
 - Total **\$5,351**

Appendix A: Spares on Hand

Per separate PDF accompanying this document

Appendix B: Maintenance Records

Per separate PDF accompanying this document

Appendix C: PT Calibration Log

Per separate PDF accompanying this document