



# UDFCD ALERT Gauging System Maintenance 2013 Annual Report

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## Executive Summary

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### Introduction

The purpose of this report is to summarize the ALERT system maintenance activities completed by OneRain in 2013 on behalf of the Urban Drainage and Flood Control District (UDFCD) under our current contract.

We believe that maintenance for the 2013 season was successful. The increased number of service calls is a direct result of the September flooding. We are excited about the continued implementation of the ALERT2™ protocol and the positive impact it may 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 <sup>1</sup>	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) <sup>2</sup>	180	43%
2012	692	67 (53/14) <sup>2</sup>	176	38%
2013	635	97(87/10)	177	55%

<sup>1</sup> This total number of sites includes repeaters and base stations.

<sup>2</sup> Count does not include 'administrative' maintenance records which document battery disposal

## System Performance

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We had a total of 635 maintenance records; there were 87 service calls initiated by OneRain, and 10 service calls initiated by others. In addition, there were 5 installations, and 2 repairs. These records were gathered between January 1, 2013 and December 12, 2013.

### Service Calls

Of the eighty-seven service calls initiated by OneRain, they are broken down as follows:

- 28 Stage Issues
- 22 Transmitter/RF issues
- 12 Power related issues
- 11 September flood related issues
- 7 Tipping Bucket issues
- 4 Infrastructure issues
- 3 Weather Station related issues

Of the ten service calls not initiated by OneRain the break out is as follows:

- 5 Stage issues
- 4 Tipping Bucket issues
- 1 Infrastructure

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

- **Transmitter/RF issues** – Transmitter related issues continue to constitute a large percentage of service call visits. 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 33 Pressure Transducer service calls, 17 were due to PT failures/replacements, 4 were due to SDI-12 sniffer installation/troubleshooting, and 2 service calls were for signal conditioning calibration and replacement. The remaining service calls were calibration adjustments and miscellaneous repairs.
- **Flood Issues** – After the September flooding high priority stage locations were inspected for damage.

## **Pressure Transducer Failures and Replacements**

PT failures were higher than previous years. This is mainly due to an aging fleet of pressure transducers. In addition, a new stage gauge was installed which had an out of box failure, along with the re-location of Carr St and conduit replacement at Maple Grove. Overall, 60 pressure transducer calibrations were performed. This number is lower than previous years, although we had higher replacement numbers. This shows that calibrations are steady for the existing fleet. Specific details of pressure transducer activity are as follows:

New pressure transducers were installed at the following sites:

- ETG @ Hampden (10011) – installed 5/3/2013
- ETG @ Hampden (10011) – out of box failure, replaced 5/15/2013

Pressure transducers were replaced at the following sites:

- Ralston Res. (110) – replaced 3/20/2013
- Sports Complex (320) – replaced 3/20/2013
- Iliff Pond (650) – replaced 4/24/2013
- No Name at Quincy (730) – replaced 9/5/2013
- Aurora Regional Pond (940) – replaced 3/21/2013
- DIA at 3<sup>rd</sup>. Creek (1480) – replaced 8/8/2013
- Englewood Dam (1600) – replaced 7/18/2013
- Sand Creek Park (1800) – replaced 3/28/2013
- Boulder Falls (4390) – replaced 4/29/2013
- Fourmile (4410) – replaced 4/2/2013
- James Creek (4440) – replaced 7/26/2013
- S. St. Vrain at Berry Ridge (4460) – replaced 6/6/2013
- Little Narrows (4470) – replaced 4/29/2013
- Carr St. (10012) – replaced 5/30/2013
- Maple Grove Res. (10013) – replaced 5/17/2013

## **Damaged Equipment/Other Replacements**

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### **Ralston Reservoir (110)**

The pressure transducer at Ralston Reservoir had poor access at high water. The PT could only be calibrated when the water was at low levels. On February 5, 2013 new conduit was installed, along with an access port for servicing the PT during higher water elevations.

### **No Name at Quincy (730)**

Over the years dirt around the standpipe had eroded away and the standpipe had begun to lean. This incline had made the tipping bucket no longer capable of being leveled. On August 21, 2013 the standpipe was excavated and re-leveled with concrete anchoring.

### **DIA at 3<sup>rd</sup> Creek (1480)**

On July 5, 2013 DIA at 3<sup>rd</sup> creek was vandalized. The solar panel, transmitter, and stream pressure transducer were destroyed. On August 8, 2013 OneRain replaced all damaged sensors and secured the site location.

### **SPR @ Henderson (1660)**

This site is owned and operated by the Colorado Division of Water Resources (CDWR). In the past sensor data was collected with a High Sierra 3306 transmitter via SDI-12. The polling of this transmitter would interfere with the CDWR's system. On June 21, 2013 a SDI-12 sniffer was installed allowing unabated access to stage data.

### **Brighton (1929)**

On August 21, 2013 it was discovered that the solar panel had failed, and no longer was producing an acceptable charging current. The panel was replaced on September 6, with a new 110mA unit.

### **Hiwan (2210)**

On July 9, 2013 OneRain replaced the anemometer at Hiwan due to bad bearings which inhibited the sensor from rotating freely.

### **Choke Cherry Repeater (2320)**

The repeater at Choke Cherry was previously listening and transmitting on 169.525 MHz. With the addition of the ALERT2 repeaters the frequency was changed to 169.500. On April 4, 2013 a crystal filter was installed on the receive antenna for the new frequency of 169.500.

### **Lee Hill Repeater (4210)**

The Lee Hill Repeater started to report intermittently in early April. After several visits the repeater was replaced and the site was brought back online to a full operational status.



### **Eldorado Springs (4380)**

This site is owned and operated by the Colorado Division of Water Resources (CDWR). In the past sensor data was collected with a High Sierra 3306 transmitter via SDI-12. The polling of this transmitter would interfere with the CDWR's system. On June 22, 2013 a SDI-12 sniffer was installed allowing unabated access to stage data.

### **CalWood Ranch (4770)**

On November 13, 2013 during fall shut down, it was discovered that the SWR was below acceptable levels. After further inspection it was determined that the antenna, cabling, and polyphaser were aging and not performing to standard. This equipment was ordered and installed on December 14, 2013

### **Cannon Ditch (4840)**

The pressure transducer intake had rusted and clogged requiring replacement. On February 13, 2013 the previous intake was excavated and replaced with new galvanized ridged conduit (GRC).

### **Gold Hill Repeater (8015)**

With the addition of the ALERT2 repeater, maintenance accessibility had become difficult at the repeater location. On September 3, 2013 the standpipe was removed and replaced with a NEMA 4X stainless steel enclosure. The new enclosure allows easy access to both repeaters while still securing all antennas.

### **Carr St. (10012)**

On October 11, 2011 Carr St. was removed for park reconstruction. The site was re-installed on May 30, 2013 as an ALERT2 location.

### **Maple Grove Res. (10013)**

The anchors holding the PT riser to the concrete wall were damaged and failed. On May 17<sup>th</sup>, 2013 a new riser was installed along with conduit. Furthermore, an ALERT2 transmitter was added along with a GPS sensor.

## New Site Installations

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### **ETG @ Hampden (10011)**

A new site was installed along a newly constructed detention pond located on Hampden Avenue, Latitude 39.6527270°, Longitude -104.7274610. Installation was complete on 5/03/2013. ETG @ Hampden utilizes ALERT2 technology and is powered with a High Sierra 3306 ALERT2 transmitter. It is currently configured for rain and stage.



**Figure 1: ETG @ Hampden**

### **Blackstone (10010)**

A new site was installed along the newly constructed Blackstone golf course, Latitude 39.5783830°, Longitude -104.6614240. Installation was complete on 3/29/2013. Blackstone utilizes ALERT2 technology and is powered with a Campbell Scientific ALERT2 transmitter. It is currently configured for rain only.



**Figure 2: Blackstone**

### **Justice Center (4360)**

Justice Center was re-located from the roof of the Justice Center on 1/22/2013. The new infrastructure is located at Latitude 40.01400°, Longitude -105.28800°. It is currently configured for rain only.



**Figure 3: Justice Center**

### **Carr St. (10012)**

Carr Street was re-located after park construction on 5/30/2013. The new infrastructure is located at Latitude 39.80500°, Longitude -105.09100°. Carr Street utilizes ALERT2 technology and is powered with a Campbell Scientific ALERT2 transmitter. It is currently configured for rain and stage.



**Figure 4: Carr St.**

## 2014 Upgrades, Rehabilitations, and Relocations

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The following items are currently submitted for approval or under contract and will be completed in early 2014:

### **Van Bibber @ 93 (330)**

The captive nuts which secure the top section of the standpipe to the base have failed. During spring startup, new captive nuts will be installed, securing the top section in place.

### **Parker and Mississippi (540)**

The captive nuts which secure the top section of the standpipe to the base have failed. During spring startup, new captive nuts will be installed, securing the top section in place.

### **Iloff Pond (650)**

The captive nuts which secure the top section of the standpipe to the base have failed. During spring startup, new captive nuts will be installed, securing the top section in place. Furthermore, the hydraulic contact of the stream side pressure transducer is poor. New hydraulic ports will be drilled into the riser, assuring hydraulic contact.

### **Flying J (850)**

The pressure transducer riser has ceased and is no longer accessible for maintenance. Furthermore, the conduit has failed at multiple locations. On November, 13 the pressure transducer and riser were removed for repair at OneRain. All infrastructure and sensors will be replaced in the spring.

### **Nolte Pond (1020)**

The Flex conduit has separated from the PT riser. Furthermore, the flex conduit is now exposed from the riser to the standpipe. To properly fix this site it is recommended that galvanized rigid conduit be installed replacing all flex lines.



**Figure 5: Nolte Pond**

### **Roslyn (1330)**

Roslyn was removed on 12/06/2012 due to parking lot re-construction. We are currently awaiting a new install location from the UDFCD.

### **Diamond Hill Wx (1420)**

The anemometer at Diamond Hill has failed. After several site visits, transmitter replacement, and bench tests of the sensor on an oscilloscope, the problem still persists. Next steps will include bringing additional troubleshooting equipment to the roof at Diamond Hill to further investigate the problem.

### **Slaughter House (1620)**

The conduit fittings attaching the riser to upstream conduit run have been damaged. Replacement of the fittings will be completed in spring.

### **Niver Detention (1900)**

The concrete anchors holding the riser and conduit to the detention outlet structure are damaged and have begun to show signs of age. New riser anchors and conduit will be installed in the spring to replace the damaged infrastructure.



**Figure 6: Niver Detention**

### **Squaw (2190)**

Squaw mountain weather station was removed on September 21, 2012 due to tower reconstruction. The site currently has not been re-installed. OneRain recommends that the site not be re-located on the new tower due to access concerns. Negotiations have stalled with USFS regarding permitting issues. A new location will be needed if this site is to be re-installed.

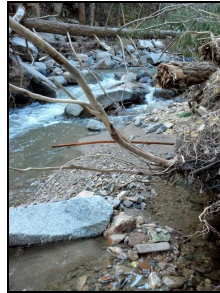
## Flood Related Activity

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The following section details sites affected by the September 2013 flooding:

### **Fourmile (4410)**

During the flooding the creek channel scoured two feet into the bedrock, thus exposing our intake and destroying it. Furthermore, the riser was completely inundated clogging the pipe with debris. A trench will need to be dug to the new channel level where the new riser and intake will be installed.



**Figure 7: Fourmile**

### **Broadway (4580)**

During the flooding immense amounts of transported boulders and sediment were piled against the retaining wall which the pressure transducer is mounted on. The sensor is no longer accessible. OneRain contacted the city of Boulder, whom will notify OneRain once they bring machinery in to remove the debris. Currently the sensor still appears to be working.



**Figure 8: Broadway**

### **Cold Spring Gulch (2240)**

Flood waters destroyed both the intake and riser at this location. Luckily, there was no erosion to the channel. A new riser and intake will need installed.

### **SBC @ Cannon Ditch (4840)**

The pressure transducer infrastructure was completely destroyed at Cannon Ditch. The stream channel has re-located and transported large boulders, making re-installation unfeasible. The transmitter was altered for rain only. It is recommended that this site be re-located.



**Figure 9: Cannon Ditch**

### **Bridge (4420)**

During the high waters the conduit fitting attached to the riser was damaged. This fitting will be replaced in spring.



**Figure 10: Bridge**

### **Expo Park (420)**

The Expo Park standpipe was flooded during the event. It appears that a lawnmower had hit the standpipe puncturing the metal. This allowed floodwaters to infiltrate. The transmitter floated during this event, however further testing needs to be completed. The site was pumped out and a spare transmitter was installed. Mud and debris has accumulated around the riser. This debris was dug out and the riser was pumped clear.

### **Cherry Creek at Steele (1720)**

During the flood event the intake pipe was damaged and severed. The current intake will need to be excavated and a new one will be installed.

### **Sand Creek Park (1800)**

The riser has been torn free from the concrete bridge. During this process multiple conduit fittings were damaged. The riser and fittings will be replaced in spring.

### **Nott Creek (150)**

The access to Nott Creek was washed out during the flood event. The site now requires a significant walk in. The park service does not know when the access road will be repaired. OneRain accessed the site and replaced the battery. The transmitter and tipping bucket were left in for the winter due to the poor access.

### **Sand Creek Mouth (1810)**

The entire pressure transducer conduit was completely destroyed by the September flooding. Excessive bank erosion makes re-installing at this location impossible. Compacted with the current security access issues, all electronics have been removed from the site and abandoned. OneRain is currently in contact with the USGS to re-locate the site across the stream.

### **Boulder County Flood Issues**

The following sites were affected by flooding in Boulder County:

#### **Rowena (4430)**

The intake, riser, and pressure transducer were destroyed at this location.

#### **Little Narrows (4470)**

The intake, riser, and pressure transducer were destroyed at this location.

#### **Lyons Diversion (4560)**

This site was a complete loss.

#### **S. St. Vrain at Berry Ridge (4460)**

This site was a complete loss.

#### **James Creek (4440)**

This site was a complete loss.

#### **Lower Lefthand (4450)**

This site was a complete loss.



The following sites are not accessible due to road wash outs:

**Geer Canyon (4250)**

**Hansen (4330)**

**Red Hill (4290)**

**Button Rock (4790)**

## Miscellaneous Activity

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### **Diamond Hill ALERT2 Receiver**

In late summer the total number of ALERT2 reports began to diminish at the Diamond Hill location. As a result on September 19, 2013, after thorough testing, the receive radio was replaced. Immediately after the radio was installed performance increased. A new radio was ordered for spares.

### **Blue Mountain Repeater**

Early in 2010, the Blue Mountain Repeater began to experience temperature related loss of signal on the 169.500 MHz frequency, typically at temperatures less than 20° F. After discussion and analysis with the manufacturer, the audio mixer/combiner was replaced on 5/21/10. Unfortunately, the site is still experiencing issues at low temperatures.

This issue is currently seen only on the standard ALERT channel and has not impacted the ALERT2™ channel. With the full switch to ALERT2, this issue will no longer be present.

### **FCC Licensing**

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

### **SDI-12 Sniffer**

With the success of the SDI-12 Sniffer at SPR @ Henderson and Eldorado Springs, other sites should be considered for implementation. SPR @ Union Avenue would be the next location where to implement this technology.

## Future Areas of Interest

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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**

This spring all primary repeaters were updated to receive ALERT2 transmissions. Since the update four sites have been deployed using that technology.

- Carr Street (Campbell Transmitter)
- Maple Grove Reservoir (Campbell Transmitter)
- East Toll Gate at Hampden (HSE Transmitter)
- Blackstone (HSE Transmitter)

### **ALERT2™ Transmitters**

During the first implementation of a Campbell Scientific AL200 ALERT2 transmitter certain firmware glitches were discovered. During a rain event the pressure transducer did not transmit on the set change in delta. As a result OneRain increased the timed transmissions to every 15 minutes. This had no impact on the system, since each ALERT2 site transmits on its own interval. The manufacturer was contacted and a new firmware release resolved the issue. Since the latest firmware upgrades, all Campbell ALERT2 transmitters have transmitted reliably.

### **Recommended Pressure Transducer Replacements**

OneRain recommends that the following pressure transducers be replaced due to slipping performance and constant re-calibrations during maintenance visits. Spare equipment will need to be purchased to complete this work. Pricing for equipment to replace these sensors is included in the spare equipment table below.

- DIA at Third Creek (1480), 60ft
- Harvard/Jackson (610), 50ft.
- Horseshoe Park (710), 120ft.
- Murphy Creek (870), 130ft.

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 City Hall 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 Contrail.

## **Metadata Consistency**

OneRain will continue to work with WET and other agencies to integrate database metadata ensuring accuracy and consistency. An agreement between WET and UDFCD in the fall will provide OneRain with all metadata regarding important thresholds .

## Spare Equipment Recommendations for Upcoming Season

**Table 2: Spare Equipment Recommendations**

Manufacturer	Model	Cost	Quantity	Total	Notes
Campbell	RPD120-DO-M2-RD	\$1,500	5	\$7,500	ALERT2 TXR
Campbell	GPS	\$30	5	\$150	ALERT2 GPS Antenna
Campbell	CM235	\$40	5	\$200	GPS Mount
Campbell	DTX-145	\$468	1	\$468	ALERT2 Spare Radio
Ritron	SD-125EV2	\$201	3	\$603	ALERT Spare Radio
Ritron	DTX-142	\$468	1	\$468	ALERT Repeater Spare
High Sierra	4005-02	\$85	5	\$425	Signal Conditioning
High Sierra	5301-03	\$112	5	\$560	Solar Panels
High Sierra*	Repair	\$85	8	\$680	HSE 3206 TXR Repair
Hydrolynx*	Repair	\$125	4	\$500	Hydrolynx Repeater Repair
Druck	PDCR1830	\$786	4	\$3,144	60 ft PT
Druck	PDCR1830	\$876	3	\$2,628	120 ft PT
Druck	PDCR1830	\$956	1	\$956	160 ft PT
BWD	B2010	\$5,235	1	\$5,235	ALERT2 BaseStation Receiver
			<b>Total</b>	<b>\$23,517</b>	

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

## **Appendix A: Spares on Hand**

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**Per separate PDF accompanying this document**

## **Appendix B: Maintenance Records**

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**Per separate PDF accompanying this document**

## Appendix C: PT Calibration Log

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**Per separate PDF accompanying this document**