

December 15, 2009

Kevin Stewart, P.E.
Urban Drainage and Flood Control District
Suite 156-B
2480 West 26th Avenue
Denver, CO 80211

Re: ALERT Gaging System Maintenance Program - FINAL End of Year Report

Dear Kevin,

OneRain is pleased to present you with the accompanying ALERT Gaging System 2009 End of Year Report. The purpose of the Report is to summarize the ALERT system maintenance activities completed by OneRain in 2009 on behalf of the Urban Drainage and Flood Control District (UDFCD) per our contract.

Although there was an increase in service calls from the previous year, we believe that maintenance for the 2009 season was successful. A number of major obstacles were overcome this year including the damage and replacement of the Blue Mountain repeater infrastructure and the implementation of the Digital TV conversion.

We are also excited about the continued implementation of the ALERT2® protocol and the positive impact it may have on more reliable data collection.

The accompanying Report includes a description of the overall system performance and problems encountered, recommendations for the upcoming 2010 season, and copies of our last round of maintenance records.

We want to thank you for allowing us to be your maintenance service provider for 2009. It is truly a pleasure to work with an owner who appreciates and understands the value of their flood warning system. We hope you are pleased with our service, and we look forward to our continued collaboration with the UDFCD. Please contact me with any questions.

Sincerely,



Mike Zucosky
Manager, Field Integration



HEADQUARTERS
1531 Skyway Drive
Unit D
Longmont, CO 80504

800-758-RAIN
303.774.2033
Fax: 303.774.2037
www.onerain.com
information@onerain.com

UDFCD ALERT Gaging System Maintenance

**Annual Report
December 15, 2009**

**Presented To
Kevin Stewart
Urban Drainage and Flood Control District
Denver, Colorado**

**By
OneRain Incorporated
1531 Skyway Drive, Unit D
Longmont, Colorado 80504
303.774.2033
www.onerain.com**

TABLE OF CONTENTS

Executive Summary	1
System Performance	2
Service calls	2
Pressure Transducer Failures and Replacements	4
Damaged Equipment/Other Replacements	5
Site Additions and Re-installations	6
USGS SatLink-2 Conversion	10
Blue Mountain Repeater	11
Digital TV Conversion	14
Miscellaneous Activity of Note	16
FCC Licensing	16
ALERT-2	16
2009 Summary	16
2010 Plans	17
Future Areas of Interest	18
Pressure Transducer Replacement	18
Shared USGS Sites	18
Frequency Splitting	18
CommEngine Modifications	18
CR 10X Data Logger Sites	19
Spare Equipment Recommendations for Upcoming Season	20
Appendix A: Spares on Hand	21
Appendix B: Maintenance Records (per separate pdf accompanying this document)	22
Appendix C: PT Calibration Log (per separate pdf accompanying this document)	22
Appendix D: Inventory (per separate pdf accompanying this document)	22

EXECUTIVE SUMMARY

The purpose of this report is to summarize the ALERT system maintenance activities completed by OneRain in 2009 on behalf of the Urban Drainage and Flood Control District (UDFCD) under our current contract.

Although there was an increase in service calls from the previous year, we believe that maintenance for the 2009 season was successful. A number of major obstacles were overcome this year including the damage and replacement of the Blue Mountain repeater infrastructure and the implementation of the Digital TV conversion.

We are also excited about the continued implementation of the ALERT2™ protocol and the positive impact it may have on more reliable data collection.

As in 2008, OneRain and the District modified the maintenance schedule slightly from previous years by including an interim trip to all rain gage sites. Table 1 below summarizes the maintenance activity over the course of the last nine 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

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 ²	107(93/14)	179 ³	60%

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

² There have been 670 scheduled maintenance visits to date, with an additional 45 visits yet to be completed in Boulder County, with no problems anticipated.

³ This total Includes Cottonwood Park and Stroh Rd sites, which were installed by OneRain this year, but are not maintained under this contract. Previous years total included Douglas Co. and Aurora sites that are not maintained under this contract.

SYSTEM PERFORMANCE

We had a total of seven hundred fifteen maintenance records; 670 scheduled visits to date, and an additional 41 visits to sites in Boulder County and 4 visits to UDFCD sites that are scheduled in the next few weeks, with no anticipated problems. There were ninety-three service calls initiated by OneRain, and fourteen service calls requested by the District.

Service calls

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

- ◆ 22 Transmitter Related issues
- ◆ 21 Pressure Transducer issues
- ◆ 16 Digital TV issues
- ◆ 15 Power issues
- ◆ 8 USGS Sutron Conversion
- ◆ 4 Damaged Sites
- ◆ 4 ALERT2 issues
- ◆ 3 Base Station issues


Of the fourteen service calls requested by the District, they are broken down as follows:

- ◆ 3 Blue Mountain Tower Repair
- ◆ 2 Power issues
- ◆ 2 Program Corruption (5096 & CommEngine)
- ◆ 2 Tipping Bucket issues
- ◆ 2 Non-Reporting (Digital TV Related)
- ◆ 1 USGS Sutron Conversion
- ◆ 1 “Bad Observations”
- ◆ 1 Base Station Failure

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

Transmitter issues – Service calls due to transmitter related issues were lower than the previous year and on par with other prior years. Transmitter related issues encompass a wide array of on site issues from dead radios and program corruptions to transmitter failures.

Digital TV Transition – A large number of service calls and missing reports was due to the digital TV transition which occurred this year. A detailed discussion of this item is included below.

	Urban Drainage and Flood Control District	
	ALERT System Maintenance 2009 End of Year Report	December 15, 2009

Power issues – Due to an aging battery fleet and unusually high rainfall this spring, a number of batteries did not survive the interval between standard preventative maintenance visits.

USGS Sutron Conversion – With the generous donation of the Sutron 8200 units from the USGS, we were able to successfully re-install USGS co-operative sites. However, due to the new SatLink-2 equipment, a number of service calls were required to complete the transition.

Pressure Transducers – Out of the 21 Pressure Transducer service calls, 13 were due to PT failure. 4 were due to signal conditioning failures and the remainders were calibration adjustments and miscellaneous repairs.

Pressure Transducer Failures and Replacements

PT failures were consistent with previous maintenance years. Specific details of pressure transducer activity are as follows:

We performed thirty-six pressure transducer calibrations.

Pressure transducers were newly installed at the following three sites:

- ◆ Stroh Rd (2863)
- ◆ Cottonwood Park (2873)
- ◆ Sand Creek Mouth (1813) – Replacement of USGS Shaft Encoder

Pressure transducers were relocated at the following two sites:

- ◆ Utah Park (433)
- ◆ Grandby Ditch (813)

Pressure transducers were replaced at the following thirteen sites:

- ◆ Ralston Reservoir (113)
- ◆ Montview Park (403)
- ◆ Kelly Dam (413) – Lightning Damage
- ◆ Expo Park (423)
- ◆ No-Name at Quincy (733)
- ◆ Aurora Regional Pond (943) – Vandalism
- ◆ Maple Grove Reservoir (1003)
- ◆ Little Dry Creek at 64th (1313)
- ◆ Platte River at 3rd Ave. (1323)
- ◆ Marston Reservoir (1523)
- ◆ Englewood Dam (1603)
- ◆ Sand Creek Park (1803)
- ◆ South Boulder Creek below Four Mile (4423)

Multiple re-calibrations of the pressure transducer were required at the following sites:

- ◆ Broadway at Canyon (4583): Druck, 5 psi unit – recommend replacement
- ◆ Powers Park (1503): KPSI, 10 psi unit – recommend replacement
- ◆ Cherry Creek at Steele (1723): Druck, 4-20mA, 10 psi unit – recommend replacement

Damaged Equipment/Other Replacements

We replaced two Vaisala sonic wind sensors: Aurora Reservoir (900) due to high wind damage and at Blue Mountain (140) due to damage when the tower failed.

Four Maxon radios failed and were replaced during the course of the maintenance year:

- ◆ Stapleton (1460)
- ◆ SPR at Henderson (1660) – two radios failed at this location
- ◆ Choke Cherry Repeater (2340) – transmit radio

Four Signal Conditioning units also failed and were replaced:

- ◆ Leyden Reservoir (200)
- ◆ No-Name at Quincy (730) – installed due to new PT, previous unit did not require signal conditioning
- ◆ Hidden Lake (1300)
- ◆ Sanderson Gulch (1340)

Site Additions and Re-installations

Seven sites were installed. Two sites are new, with the remainder being relocated sites or Pressure Transducers

Upon installation, we provided District staff the details on each site, as identified below, so they could immediately update their database. The new sites are as follows:

- ◆ Stroh Road. This site is identified as site # 2860, and consists of both rain and stage sensors. The site is located at Latitude 39.479, Longitude -104.769, Elevation 5903 feet. This site reports via the Smoky Hill Repeater. A site picture follows:



Figure 1: Stroh Road

- ◆ Cottonwood Park. This site is identified as site # 2870, and consists of both rain and stage sensors. The site is located at Latitude 39.5578, Longitude -104.786, Elevation 5728 feet. This site reports via the Smoky Hill Repeater. A site picture follows:



Figure 2: Cottonwood Park

- ◆ Sand Creek Mouth. This site is identified as site # 1810, and consists of both rain and stage sensors. The site is located at Latitude 39.806, Longitude -104.941, Elevation 5150 feet. This site reports via the Blue Mountain Repeater.

The USGS abandoned this site. A PT was installed in lieu of maintaining the existing stilling well. The serial transmitter at this site was replaced by a HSE 3206 transmitter to accommodate the new PT and existing tipping bucket. A site picture follows:



Figure 3: Sand Creek Mouth

- ◆ Utah Park. This site is identified as site # 430, and consists of both rain and stage sensors. The site is located at Latitude 39.685, Longitude -104.844, Elevation 5536 feet. This site reports via the Smokey Hill Repeater.

This site was a re-installation with a new standpipe and PT due to a complete re-structuring of the park lake and outflow structure. A site picture follows:



Figure 4: Utah Park

- ◆ Grandby Ditch. This site is identified as site # 810, and consists of both rain and stage sensors. The site is located at Latitude 39.725, Longitude -104.797, Elevation 5455 feet. This site reports via the Smokey Hill Repeater.

This site was a re-installation of the PT due to a complete re-structuring of the outflow structure. A site picture follows:



Figure 5: Grandby Ditch

- Denver Zoo. This site is identified as site # 1360, and consists of a rain sensor. The site is located at Latitude 39.751, Longitude -104.954, Elevation 5266 feet. This site reports via the Blue Mountain Repeater.

This site was a re-installation of the standpipe due to scheduled zoo construction. A site picture follows:



Figure 6: Denver Zoo

- Hansen. This site is identified as site # 4330, and consists of a rain sensor. The site is located at Latitude 40.1686, Longitude -105.329, Elevation 7325 feet. This site reports via the Lee Hill Repeater.

This site was formerly Indian Ruins and was relocated due to loss of lease on private property. A site picture follows:



Figure 7: Hansen

USGS SatLink-2 Conversion

The co-operative sites located at SPR at Union and Cherry Creek at Champa were re-configured in conjunction with the USGS conversion to Sutron SatLink-2 transmitters. For these sites, the USGS provided two Sutron 8200 units which allowed the re-use of the existing serial transmitters located at these sites. The 8200 units provide parallel access to the USGS stage sensors on the SDI-12 data line.

A number of service calls involving the USGS were performed in order to maximize the amount of data we could collect while minimizing the impact the UDFCD equipment had on the USGS measurements.

Blue Mountain Repeater

In January of this year, the Rohn 25G tower at Blue Mountain was damaged due to high winds which separated the tower from its base. On February 12th, the equipment was removed from the downed tower for testing and evaluation.



Figure 8: Damaged tower

After your approval to install a much heavier duty replacement Rohn 55G tower, the tower was ordered and the infrastructure work scheduled with contractors. Unfortunately, the tower arrived damaged and was unusable. On April 3rd, the repeater was temporarily placed at the site in a pick-up truck to support the flood warning system operation while the replacement tower was on order, and the contractors were rescheduled.



Figure 9: Temporary Repeater Installation

The tower infrastructure was re-installed on April 8th. By April 14th, the repeater and weather station electronics and sensors had been re-installed and were functional. The Rohn 55G tower will provide a stronger, more permanent installation.

Restoration of the area was arranged to repair the deep ruts caused by the cement truck in the soft ground.



Figure 10: Current Blue Mountain Installation

Digital TV Conversion

In July of this year, the impact of Digital TV going full power on Look Out Mountain was observed at the Choke Cherry Repeater. Initially, the Choke Cherry Repeater was not passing a few gages. The pass list and input receiver were evaluated and found to be functioning properly. At this time, a large amount of RF interference was discovered at the site and found to be keeping the repeater in open squelch. We inquired with the FCC as to the source of the interference and possible solutions. It was determined through research with the FCC that the new digital TV broadcasts were the source of the interference and that the broadcast was within FCC specifications.


The repeater vendor, HydroLynx, recommended upgrading the modem board of the Choke Cherry repeater to a new design that uses ALERT tone as well as carrier detect. In addition, we changed the radio to a Ritron unit that is better at rejecting interfering signals, and allows the squelch to be adjusted on-site. In addition, we installed a tuned cavity filter on the antenna feed line (this will be replaced by a custom crystal filter that is still on order). Subsequently, we converted the repeater to a duplex mode on a single frequency. This enabled us to separate the cavity filter from the output/transmit antenna. These upgrades increased the reliability of sites reporting thru the Choke Cherry Repeater, however, additional work may be required for optimum efficiency at the transmitter sites.

The Blue Mountain repeater was also impacted by the conversion; however, due to its distance from the Digital TV source, its reliability was degraded to a less noticeable degree than Choke Cherry. The existing radios were also changed to Ritrons, and a cavity filter was installed on the receive line. The existing repeater was already equipped with the newer modem board.


The Smoky Hill repeater, which has all of the above noted upgrades, did not appear to be impacted by the Digital TV conversion.

The Blue and Smoky repeaters can now also be adjusted on-site (the Ritron receivers allow this), in addition to including monitor speakers. This gives much improved maintainability, and the ability to monitor and adjust for minimum interference from DTV and other troublesome signals.

The cavity filter at Choke Cherry will be replaced with a crystal filter in the spring. The cavity filters at Blue and Smoky will remain because they are tuned to pass both 169.500 and 169.525. Crystal filters will be considered only if the existing filtering is insufficient.

	Urban Drainage and Flood Control District	
	ALERT System Maintenance 2009 End of Year Report	December 15, 2009

After the above changes were implemented, sites utilizing CommEngines often lost the last message in a transmission. We are currently investigating this issue, and suspect it may be related to the change to the new modems, and faster responding receivers. We have learned that some transmitter manufacturers include transmit tails (keeping the transmitter on after the last message), that are not specified in the ALERT protocol. This allows their modems to finish decoding all messages. CommEngines have not done this in the past, to maximize channel capacity. Blue Water Design is adding this capability, to allow tuning the system to work reliably with repeaters from different manufacturers.

	Urban Drainage and Flood Control District	
	ALERT System Maintenance 2009 End of Year Report	December 15, 2009

Miscellaneous Activity of Note

FCC Licensing

To date, OneRain has received confirmation for renewed or extended licensing on all sites and call signs. As new sites are installed OneRain will keep the licenses up to date.

In 2010, it will be necessary to re-license approximately half of the sites in the UDFCD system.

ALERT2™

2009 Summary


The repeaters at Smoky Hill and Blue Mountain were upgraded to include dual frequency (receive both 169.500 and 169.525) and summing to transmit both ALERT and ALERT2. Additional filtering and the receiver changes were discussed in the DTV section.

At this time, there is no spare repeater to replace either Smoky or Blue. Should the Blue dual-summing repeater go out, two spare repeaters may be able to temporarily replace it by adding an additional temporary ALERT transmit antenna (e.g. a mag-mount). This is not possible at Smoky. In that case, two temporary repeaters may be able to be used if the power amp there is still good and we use a High Power Combiner, at a cost of approximately \$100.

Our recommended long term solution is to acquire a spare dual frequency summing repeater, and spare ALERT2 concentrator. This would allow it to replace either the Blue or Smoky repeater, as they are now identical units. Until we have these complete spares, it may be appropriate to acquire a combiner as described above before the start of next season's flood season.

ALERT2 receiver decoders were installed at both Diamond Hill and OneRain. Blue Water Design redesigned, built, and tested a new ALERT2 receiver that incorporates a single board computer, eliminating the need to do Forward Error Correction decoding in a separate PC. The new receiver incorporates the capabilities required by the specification developed through the NHWC Standards Committee.

BWD & Telos Services installed and tested the new receiver at Diamond Hill. This required new enclosures, new cabling from UDFCD offices to the roof and a new power supply. The output connections were completed to the HydroLynx application as well as to OneRain's servers via IP. OneRain established the ability to ingest ALERT2 data and make it available on Conrail Web.


	Urban Drainage and Flood Control District	
	ALERT System Maintenance 2009 End of Year Report	December 15, 2009

Blue Water Design developed a new version of the encoder (Concentrator) that is compliant with the NHWC standards of spring 2009. A new PC board layout was generated and redesigned units were produced. The new encoder has been installed at Smoky Hill, with installations at Blue Mountain and West Creek anticipated before the end of 2009.

2010 Plans

Next year the redistribution of gages across the two input frequencies will be continued during spring startup. This will affect the Denver area gages, and will distribute loading across two input channels (169.500 & 169.525) that are recombined in the summing repeaters at Smoky Hill and Blue Mountain.

Additionally, the goal is to complete the deployment of encoders at the remaining output repeaters in the system: Gold Hill and Lee Hill. Data analysis begun in 2009 will be completed, allowing us to compare the actual performance of ALERT and ALERT2. After the analysis is complete, and when confidence in ALERT2 has been gained, the system may be shifted to use ALERT2 as the production system, perhaps in late 2010.

	Urban Drainage and Flood Control District	
	ALERT System Maintenance 2009 End of Year Report	December 15, 2009

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.

Pressure Transducer Replacement

Due to multiple calibrations required this year, we recommend PT replacements for the following sites:

- ◆ Broadway at Canyon (4583)
- ◆ Powers Park (1503)
- ◆ Cherry Creek at Steele (1723)

Shared USGS Sites

The USGS change to Sutron SatLink-2 (SDI-12) equipment impacted two sites: Cherry Creek @ Champa (1700) and SPR @ Union (1640). Due to the instability of the Sutron 8200 units that are currently being utilized other means of data collection should be considered. In the event of 8200 failures, upgrading these sites to Campbell Scientific data loggers would provide a more stable system.

Frequency Splitting

In order to reduce contention on the input repeater channels for both ALERT and ALERT2, the output frequency of approximately 50 sites in the system will be changed. In addition to making the physical changes required in the radios, this will also require the updating of FCC licensing.

CommEngine Modifications

Due to the necessary changes to the repeater locations, sites utilizing CommEngines have experienced data loss through the repeater. Research has shown that when multiple messages are sent from a CommEngine site, the last message from the site is lost (and sometimes single messages are also lost). The repeater modem boards appear to require a carrier tone tail to remain active. The CommEngine was designed to provide an efficient message packet by limiting its transmission duration.

Blue Water Design is currently working on a patch that may require upgrading CommEngines by removing them from the site. Research into this issue is ongoing and we will inform the District prior to implementing any changes.

CR 10X Data Logger Sites

The CR 10X is obsolete, and no longer supported by the manufacturer. We will continue to make recommendations to upgrade the remaining sites where the 10X is still in use.

SPARE EQUIPMENT RECOMMENDATIONS FOR UPCOMING SEASON

1. Transmitter
 - a. High Sierra 3206 – recommend purchasing 5
Cost at (5) x \$2,243 each = \$11,215
 - b. HydroLynx 5096-81 – recommend purchasing 2
Cost at (2) x \$2,915 each = \$5,830
 - c. HydroLynx 50386 Modem Board
Cost = \$360
2. Wind Sensor
 - a. Spare sonic wind sensor
Cost = \$1,837
3. Radio
 - a. Spare Maxon Radio - recommend purchasing 2
Cost at (2) x \$211 each = \$422
 - b. Spare Ritron Radio - recommend purchasing 1
Cost = \$350
4. Pressure Transducer
 - a. Druck PDCR 1830: 100mV, 10psi - 60' (For Cherry Creek at Steele)
Cost = \$725
 - b. Druck PDCR 1830: 100mV, 10psi - 120' (For Powers Park)
Cost = \$828
 - c. Druck PDCR 1830: 100mV, 5psi - 50' (For Broadway at Canyon)
Cost = \$707

Total cost = \$22,274

APPENDIX A: SPARES ON HAND

Sensors

RH/AT Sensors – Vaisala HMP 45A	5 each
Anemometer – Wind Speed Hydrolynx	1 each
Wind Vane – Wind Direction Hydrolynx	1 each
Handar sensors (removed from Quincy (used)):	
Wind Speed	1 each
Wind Direction	1 each
Air Temperature and Humidity	1 each

Solar Panels

110mA	3 each
5W	1 each

Pressure Transducers

Druck PDCR 1830 10psi 100mV 100 feet	3 each
KPSI 4-20mA (Sand Cr @ Colfax) 180 feet	1 each

Repeaters

Hydrolynx 50386 dual frequency	2 each
--------------------------------	--------

Transmitters

Hydrolynx 5096	2 each
Hydrolynx 5096-81 Wx (Questionable Performance)	1 each
High Sierra 3206 (combined UDFCD/BoCo)	2 each

Antennae


DB222 (UDD)	1 each
Yagi (UDD)	1 each
Omni (BoCo)	1 each
Yagi (BoCo)	1 each

Radios

Maxon	3 each
-------	--------

Misc.

20 Watt Power Amp	1 each
Signal Conditioning Module	5 each

	Urban Drainage and Flood Control District	
	ALERT System Maintenance 2009 End of Year Report	December 15, 2009

APPENDIX B: MAINTENANCE RECORDS (PER SEPARATE PDF ACCOMPANYING THIS DOCUMENT)

APPENDIX C: PT CALIBRATION LOG (PER SEPERATE PDF ACCOMPANYING THIS DOCUMENT)

APPENDIX D: INVENTORY (PER SEPARATE PDF ACCOMPANYING THIS DOCUMENT)