Urban Drainage and Flood Control District

2001 ALERT Maintenance

Summary Report

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Overview

Maintenance activities on the ALERT Gauging Network for 2001 have been completed under Agreement 00-01.15. During the 2001 operating season, DIAD generated 702 maintenance reports for the combined UDFCD/Boulder County network. Of these, a total of 67 (9.5%) service calls were generated: 35 (5.0%) were unscheduled District service calls and 32 (4.5%) were unscheduled DIAD Incorporated service calls; the remainder documented standard maintenance activities. The overall percentage of service calls increased during the 2001 field season compared to the year 2000. This is primarily attributable to increased efforts at monitoring the District's ALERT system from DIAD's base station in Longmont and taking a more proactive role in addressing problems in as timely, efficient a manner as possible. "DIAD service calls" simply differentiate the source of the service request. These activities are intended to supplement the District's efforts at locating problems within the system.

Given the relative "spike" in the number of service calls compared to last year, it is also instructive to examine sites that required multiple visits. Site 1810 (Sand Creek Mouth) required 11 unscheduled visits, sites 4440 (James Creek) and 1700 (Cherry Creek @ Champa) required 4, and sites 1440 (Elbert) and 1420 (Diamond Hill) required 3 apiece. The cumulative visits to these 5 sites accounted for 37% of all 2001 service calls; site 1810 alone accounted for 16.4%. Site 1810 has been troublesome from a maintenance standpoint since its inception, for reasons that have been articulated ad nauseum in the past. The majority of the service calls here again required performing the "handshaking" operation with the Tiny Basic program to enable ALERT data transmission from the serial transmitter. The USGS also replaced a power supply in the Sutron datalogger at this site, which prevented data transfer for several days this summer. DIAD would like to encourage the District to consider reconfiguring the sites that are shared with the USGS such that each agency terminates any interdependence on the other to maintain their respective data streams. This is not an indictment of the USGS, it is a realization that the current interdependent nature of the site configurations is not in the mutual best interests of either agency. The 4 service calls to James Creek had to do with an ongoing RF problem that was ultimately caused by a marginal squelch condition at the Lee Hill receiver, not by an RF problem at James Creek. Squelch again drifted into the open state at Lee Hill at the end of the season and the receiver was replaced with a spare unit.

Damaged equipment and site removals

During the 2001 season, the combined UDFCD/Boulder County network experienced a relative decrease in damages resulting from vandalism or "unintended destruction". Vandalism that did occur was of a very minor nature (e.g., bent ground planes). However, on June 20, the Gunbarrel standpipe was found damaged to an extent that prevented removal of the transmitter for standard maintenance. The standpipe was apparently "sideswiped" by some sort of motor vehicle, creating a 5" deep crease in its side. The site remained in operational status until the end of the season, whereupon the standpipe was excavated and sawed open to retrieve the equipment; all components were salvaged except the standpipe. At site 810 (Grandby Ditch, rain and stage), irrigation crews accidentally bent the buried ½" GRC conduit housing the PT cable while trenching; fortunately, the damage was superficial and did not impact site operation. Three other sites were physically removed due to forthcoming development: site 1050 (Jefferson County Fairgrounds, rain only), site 200 (Leyden Reservoir, rain and stage) and site 1010 (Denver West, rain only). These 3 sites are tentatively scheduled to be (re)installed after construction activities are completed. "Act of God" events resulted in the complete destruction of electrical equipment at site 1610 (Holly Dam, stage only) and possibly caused PT and transmitter failure at site 410 (Kelly Dam). Kelly Dam was returned to operational status this year, Holly Dam will return to operational status next spring. Two sites that were removed during the 2000 field season were reinstalled this year: site 760 (Mission Viejo, rain only) and Expo Park (rain and stage).

Site additions

Four new sites were added to the District's system during 2001: site 1300 (Hidden Lake, rain and stage), site 1310 (Little Dry Creek @ 64th, rain and stage), site 1460 (Urban Farm, rain, barometric pressure, RHAT, wind speed and direction, solar radiation, soil moisture) and site 1480 (DIA @ Third Creek, rain and 2 stage sensors).

The Urban Farm site incorporates an alternative structural design for a weather suite configuration (see Figures 1 and 2) that required more sensors than the "traditional" ALERT weather suite. In large part, the design was derived by DIAD to be able to accommodate the use of a Campbell Scientific CR10X datalogger in conjunction with a High Sierra Electronics 3210 serial transmitter to broadcast ALERT data. The CR10X has an external, detachable wiring panel that includes screw terminals for sensor connections, and therefore is unsuitable for pulling up or dropping down a standpipe, hence the inclusion of the weatherproof enclosure with dropdown door. The CR10X is a mature, stable product that lends itself extremely well to applications that require more sensor inputs than a typical ALERT transmitter can handle with a standard standpipe configuration.

Figure 1. Site 1460, Urban Farm Weather Suite

Figure 2. Urban Farm enclosure interior

The CR10X was also chosen for the DIA @ Third Creek installation (see Figure 3), not only because it provides the necessary flexibility to be able to add numerous other sensors in the future, but it also provides superior control capabilities to respond to specific site conditions (e.g., automatically collecting water samples based on specific water depth or discharge thresholds), features that are very important for the DIA Environmental Services Group.

Figure 3. Site 1480, DIA @ Third Creek

PT Replacements

New Druck pressure transducers were installed at sites 100 (Carr St.), 430 (Utah Park) 610 (Harvard/Jackson) and 1620 (Slaughterhouse), replacing dead or drifting Foxboros. Poorly designed stage configurations at Carr St. and Harvard/Jackson resulted in far more effort to replace PT's than is normally the case. The designs were not poor in terms of collecting stage data, but rather in terms of long-term maintenance. At these sites the entry of the PT cables occurred in the base of the vertical riser, preventing the PT from being pulled without excavating the riser itself, as well as the conduit attaching to the base of the riser. What should have been simple pressure transducer replacements became nearly as labor-intensive as site installations in these cases. Needless

to say, the old configurations were replaced with (what have become) “normal” configurations that have the cables coming in near the tops of their respective risers. Such configurations will allow future PT replacements at these sites to be far more straightforward.

A number of additional stage sites required new PT’s, chiefly to replace drifting Druck PDCR 1830’s. The following list is a site-by-site description of these replacements.

--The Druck at site 700 (6th and Tollgate) died shortly after startup this year. This PT gave slightly more than 2 years of service. We had left this stage site active over the past two winters but decided to begin pulling the PT up to eliminate potential freeze/thaw exposure. We have discovered that the stilling well here is not sufficiently deep to avoid freezing in the interior; exposure to freeze/thaw cycles may have caused the PT to expire prematurely.

--The PT at site 810 (Grandby Ditch) continued to experience problems related to long-term drift (i.e., requiring recalibrations at nearly every inspection) and was replaced in July. The PT that was pulled was sent to Druck for failure analysis (see “Discussion” below). This PT has recently been reinstalled in site 1480 (DIA @ Third Creek) and will be monitored closely for reliability. The replacement PT at site 810 appears to be stable.

--At site 420 (Expo Park), the pressure transducer that was initially put into service as part of the reinstallation shortly began to report way too frequently, indicating excessive short-term drift. The problem was verified by DIAD in the field and the PT was replaced. This PT was also returned to the manufacturer for failure analysis (see “Discussion” below).

--The pressure transducer at site 630 (Temple Pond) was in service for just over one year. The frequency of sensor reports became excessive in August with the sensor out of the water (zero pressure). The PT output was found to drift from 10-15 mV at constant 5 psi. The sensor had been stable since installation prior to this time.

--Site 410 (Kelly Dam) presumably lost both the pressure transducer and the transmitter simultaneously, at some time prior to 5/14/01. Electrical surge may have caused the failure, but there was no physical evidence that supported this view. A “lower-level” surge could have occurred without frying chips or melting wires that would still be sufficient to damage the electronics.

--At site 120 (Croke Pump Station), problems with stage data drift were complicated by a flaky signal conditioning board. The PT was drifting to an extent that we determined replacement was necessary. However, the replacement PT’s output was only 12.5 mv at 10 psi. The signal conditioning board was discovered to be inhibiting the +12V return to th PT to only about 1 volt. After installing a spare signal board, the new PT functioned properly. The

PT that was removed was kept as a system spare, but was subsequently discovered to have a problem nonetheless (see “Discussion” below).

--At site 4470 (Little Narrows) a Druck PDCR 940 pressure transducer died late in the season after 4.5 years of service. Another Druck PDCR 940 at site 4380 (Eldorado Springs) also expired at the end of this season after 4.5 years of service, suggesting that the remaining PDCR 940 series of transducers in Boulder County stage sites may be nearing fallout.

Discussion of PT problems

As was initially pointed out in the 2000 end-of-year report, we have been experiencing what we feel is a larger than normal fallout of Druck PDCR 1830 pressure transducers. This trend continued in 2001. Recent developments might (with emphasis on “might”) help explain some of the overall drifting we have observed with recently installed Druck PT’s. Some of the Druck PDCR 1830 PT’s show instabilities with regard to resistance measurements taken between the shield conductor in the cable and the body of the PT. A proper bond should essentially result in a dead short between the two materials. We measured changing resistances by simply applying a slight pressure to the polyurethane of the PT cable/body junction. Such an unstable bond likely results in the induction of noise in the returned signal from the PT. This would produce inconsistencies in pressure readings, because any induced noise cannot be bled off to a proper ground due to the unstable connection/bond between cable shield and body. We suspect this condition might well account for a good portion of the sensor drift that has been observed with a number of new Druck PDCR 1830 PT’s that have been installed in the District’s early flood warning system during the past couple of years. A disturbing aspect of this condition is the concurrent reduction in common ground bonding between the electronic equipment and the water in which the PT is submerged, resulting in compromised lightning/surge protection. Earlier this flood season, we did indeed lose a transmitter concurrently with a Druck PDCR 1830 at site 410 (Kelly Dam). We certainly cannot prove that a poor bond between the shield in the cable and the body of the PT caused our transmitter failure, we simply emphasize that this problem increases that possibility.

We recently sent back the 3 PDCR 1830 pressure transducers with the problem described above to Druck for failure analysis. One of these was a new PT installed (and immediately pulled) at DIA @ Third Creek, one was a new system spare, and the other was a PT that has required a total of 5 recalibrations in the 18 month period that it was in service at site 120 (Croke Pump Station). We are hopeful that Druck can verify that there is a problem and take corrective action as needed.

Earlier this year, we sent two PT’s back to Druck for failure analysis; both PT’s suffered from unacceptable magnitudes of drift in the field. (At the times these PT’s were sent back, we were unaware of the variable-resistance problems

noted above.) The first return was the first PT installed at Expo Park in July this year (see site 420 above). Their response was that they found a dent in the PT membrane and the problem was therefore "customer-induced". Not having any evidence to the contrary, we were unable to argue with their findings; it is possible that the problem was customer-induced. However, it is extremely interesting that the behavior of the Expo PT mirrored that of the new PT that we recently installed at DIA and pulled for the very same reason (and, nay, we found no dents with our magnifying glasses). The second PT we sent in was the PT that was pulled for excessive drift in the long-term (see site 810 above). After monitoring the PT for 96 hours, Druck's FA found no problems and the PT was returned to DIAD. The earlier transactions with Druck have therefore not led to any information that helps us to diagnose or correct performance of the sensors in question.

In a practical sense, the long-term (let's call this up to +/- 2% change from previous calibration) drift that we see with pressure transducers is a certainly a liability in terms of the accuracy of real-time stage data, but not to a degree that critically endangers the District's ability to monitor stage data for flooding or high discharges. We replace these sensors because we (the District and DIAD) have agreed to particular thresholds of drift (1% or less from the previous calibration) that are acceptable. Based on historical performance, these thresholds are not unreasonable. The problem is a significant nuisance in terms of replacement parts and labor costs as well as decreased efficiency in maintaining the system.

Druck's response (or lack thereof) to the problems discussed above will be an important factor on maintenance decisions with regard to stage sensor alternatives in the District's system. As noted last year, there is no comfortable, obvious alternative to this particular vendor. The only other vendor in the same price range is KPSI (Pressure Systems, a.k.a. Keller). The primary disadvantage of Keller PT's is that the 0-5 V output signal is not conditioned, and therefore cannot be "tweaked" to compensate for changing calibration offsets resulting from drift. A number of Keller PT's were installed in the District's system years ago, 5 or 6 of them remain in service. Other vendors exist, but are far more expensive.

Proposed system-wide repeater upgrade

DIAD is finalizing a proposal to upgrade the District's repeater network. An upgrade to the overall system, which could begin with the installation of a new Boulder County backup repeater, would include installing new PC programmable, remotely controllable repeaters at the three existing sites. An additional repeater in the Boulder County portion of the system would provide backup to the Lee Hill repeater in the same fashion that the two Denver area ALERT repeaters back each other up. An additional benefit to a backup repeater in Boulder County would be that the ALERT radio traffic could be distributed over four repeaters instead of three. This would decrease the traffic loading on the three existing

repeaters and either allow for expansion of the system, or improved performance under the existing traffic load.

A site has been located in the area of Gold Hill in Boulder County that meets the requirements of a backup repeater for Lee Hill. This site lends itself to sharing some of the load with sensors in the Denver portion of the system. The site was tested by placing a temporary repeater at the site and collecting data for about two days. Subsequent evaluation of the data confirmed the suitability of this location for a repeater.

Providing the UDFCD system with an additional repeater and requiring all primary repeaters to be PC programmable and remotely controllable will improve the reliability of the system and help ensure that real time ALERT data is available to emergency managers at all times. This would provide for faster, automatic switching of repeater function when one of the other repeaters fails.

Miscellaneous activity of note

--At site 1720 (Cherry Creek @ Steele), the original (rotting and disfigured) 15' extension from the channel bank was replaced with a new, shorter intake, which now extends only 6' beyond the bank. The intake was shortened to minimize the possibility of another high discharge event transporting debris that could hang up on the intake/anchor in the channel and produce sufficient moment to bend the conduit downstream. In terms of stage measurements, there is no disadvantage in having a shorter intake because the braided channel at this site is of uniform depth from bank to bank, a result of the coarse sediment regime and associated unstable, dynamic bed; scour or deposition of sediment at higher discharges inevitably result in a reasonably uniform datum across the channel bed.

--The Handar RHAT sensor at site 750 (Quincy Reservoir) was replaced shortly after startup due to consistently high dew point readings observed in the past.

--Deteriorating bearings caused the wind vane at site 1420 (Diamond Hill) to bind during light or moderate winds. The vane was returned to the manufacturer for refurbishment and calibration and was replaced with a system spare.

--A 5-element YAGI (transmit) antenna installation was performed at site 740 (Smoky Hill), after repeater data began to hiccup for a 4-day period. The old 3-element YAGI, in combination with the old antenna cable was producing poor RF and both components were replaced.

--At sites 2340 (El Rancho) and site 2710 (Highlands Ranch), YAGI antennas were installed to replace omnidirectional antennas in an effort to improve the reliability of each site. Reliability has improved as a result, but to a lesser degree at El Rancho. The remaining alternative is to install power amps. The problem at El Rancho is vexing, given its close proximity to the Chokecherry repeater.

--The Boulder County narrowbanding upgrade effort stalled in 2001. The only site in the shared portion of the UDFCD/Boulder County network that does not currently have a 3206 transmitter is Magnolia, site 4090. Budgetary constraints prevented Boulder County from purchasing any additional hardware for the upgrade effort during 2001, so six sites in the "unshared" portion of the network remain ASCII sites: Johnny Park (4310), Big Elk Park (4300), Red Hill (4290), Cannon Mountain (4270), Taylor Mountain (4260) and Indian Ruins (4330). We attempted to plug in a 3206 without a PA at Indian Ruins, but reliability took a severe hit and we were forced to reinstall an EG&G w/PA. If the proposed repeater upgrade becomes reality, all remaining ASCII format transmitters will need to be replaced in the Boulder County network, as the current translation "feature" at Lee Hill (receiving 2-digit ASCII ID's and re-transmitting as 4-digit ID's) will no longer be supported. Boulder County narrowbanding upgrades should take precedence over all other transmitter upgrades in the District's system due to this situation. If budgets allow, District stage sites should then be next in line for transmitter replacement. A total of 13 District stage sites are still using Sierra-Misco 5050 transmitters. After Boulder County, these sites should take the highest priority in terms of continuing narrowband upgrades. Fifteen more S-M 5050's are still employed at rain only sites, leaving a total of 28 S-M 5050's that will require replacement with 3206's.

--Several old solar panels were replaced with brand new smaller units that better fit the power budget requirements associated with the new Boulder County site configurations using 3206 transmitters and their associated smaller batteries. During 2001, we retrofitted five sites during normal inspection rounds, leaving seven more that require solar panel retrofits. Most of the remaining seven still have power-sucking ASCII transmitters that require the large solar panels to maintain battery charge and stay alive over the winter. When these are replaced, the retrofits can proceed.

--A cooperative effort between DIAD and the District resulted in the resolution of various database discrepancies between the two agencies that had built up over time with regard to site reference levels as well as PT calibration coefficients and dates.

DIAD Incorporated would like to thank the District's ALERT administrator, Kevin Stewart, for his continued assistance, and we hope to again have the opportunity to support the UDFCD during the next flood season.