

December 21, 1999

Mr. Kevin Stewart
Urban Drainage and Flood Control District
2480 W. 26th Avenue, Suite 156B
Denver, Colorado 80211

Dear Kevin:

Maintenance work on the ALERT Gauging Network for 1999 has been completed under Agreement 99-01.16. During the 1999 operating season, DIAD generated 718 maintenance reports for the combined UDFCD/Boulder County network. Of these, 92 (12.8%) were unscheduled service calls, while the remainder documented standard maintenance activities.

Overall, vandalism declined in the UDFCD network in 1999 compared to the 1998 season. Niver Detention was vandalized in March. The mast had been torn down, damaging the antenna and antenna cable. The site was repaired concurrent with the PT housing upgrade and PT replacement. The Johnny Park site was vandalized in early September. The mast, solar panel and antenna were missing, and the solar and antenna cables had been severed. The site was brought back to operational status in October. A steel strap was welded between the replacement mast box and mast to make it more difficult to pull the mast off from the top of the mast box. In more minor incidents, the antenna was found missing at the South St. Vrain at Berry Ridge site, the solar panel was shot to bits at Big Elk Park, and ground planes were found bent at the Lyons Diversion site.

During the end of season inspection, the ceiling at Shop Creek was found to have collapsed. Vandalism is a possibility; another possibility is that the rotting shingle roof leaked into the top of the ceiling and it took on water. No damage was found with regards to the ALERT equipment. You will recall that during one of last year's inspections, the door was found open with the hasp for the exterior lock broken; again, no equipment was stolen or damaged. The current state of disrepair of the building is a major concern. This site needs extensive repairs and should be secured before it is restocked with ALERT equipment. A better solution might be to install a standpipe with a standard 1 mm tipping bucket here and abandon the structure altogether.

Site damage not related to vandalism occurred to a relatively minor degree, with the exception of Englewood Dam. The site took a direct lightning strike, vaporizing the antenna, frying the signal conditioning board, and popping some circuitry off of the

transmitter logic board. Not surprisingly, the PT died as well. All equipment was replaced and the site was restored to operational status. Flood related damage occurred at Bear Creek at Cub, where the horizontal intake for the PT had been bent downstream and was no longer anchored to the bed of the channel. The intake was replaced and re-anchored. The transmitter enclosure at Evergreen Lake needs to be replaced. One of the two hinges has rusted away. We believe that for long-term durability, a stainless steel enclosure should be acquired to replace the old steel enclosure. The PT housing and conduit at Nolte Pond was re-anchored after new concrete work had been performed there. The receive antenna cable at the UDFCD base was compromised after old, brittle cable ties had weathered off and allowed the loose cable to scrape and breach against the concrete edge of the antenna mast mount/base. The cable was repaired and secured. Mast brackets at the Eagle Ridge site were upgraded with beefier units, and the Smokey Hill mast brackets were also replaced.

At Goldsmith-Eastman, engineered structural improvements on the channel were completed towards the end of the summer. This will eliminate further bank collapse and channel widening, and thus ensure adequate protection of the PT housing. At Cold Spring Gulch, new bridge construction nears completion. Construction activity has not(!) resulted in any damage to the standpipe or PT housing. Major reconstruction of the detention pond at Expo Park has recently begun. The old site has been abandoned, and all available parts and equipment were salvaged from the site. Because construction activity is expected to continue well into next year, this site will not be active during the 2000 flood season. After construction is completed at Expo Park, the site will be reinstalled, likely with just one stage sensor. 6th and Tollgate was outfitted with a new PT housing, 5 psi PT and an 11 bit A/D transmitter. The housing consists of a 12 inch diameter PVC stilling well to increase resolution of year-round stage data, thus enhancing water quality measurement/analysis capabilities.

As documented earlier this year, South Platte River "piggyback" installations at the Union Avenue, Sand Creek at Burlington Ditch, and Cherry Creek at Champa Street sites continued to lose operational status concurrent with site visits by USGS personnel. Since our meeting with USGS personnel, performance has changed for the better. The sites have consistently reported, indicating that the procedural changes that were identified by DIAD Inc. and subsequently adopted by the USGS are working well.

RF path problems persist at the Pine Cliff site in Douglas County. Transmit power output was increased to 25 watts via a power amplifier installation June 22, but the site still reports less consistently than desired. Shifting the directionality of repeater antenna elements might result in improved performance from Pine Cliff, but this would likely degrade site performance at other sites within the system. The next step to take here should be to install a directional antenna in place of the omni.

Other sites with possible RF issues include Guy Hill and Van Bibber Park. Both of these sites are completely free of any line-of-sight interference, so amplification of the transmit signals should be unnecessary. In addition, the RF performances as defined by recent VSWR measurements are reasonable, which suggest that the antenna and cabling are OK. However, even "reasonable" VSWR measurements do not absolutely guarantee that an antenna system is in excellent working order. Replacing the antenna and antenna cable is probably the next logical step at these sites if marginal performance persists.

Repeater/Controller issues still need to be resolved. We learned that the "spare" Controller will remotely switch Blue Mountain to pass-all (from normal) and to normal (from pass-all) modes from the roof at Diamond Hill. (The spare Controller can also switch Smokey Hill to "pass-all" mode from Blue Mountain.) The UDFCD Controller at Diamond Hill fails to remotely switch either the Smokey Hill or the Blue Mountain repeater into pass-all mode. The "known-good-from-the-roof" spare controller was hooked up to the UDFCD base station on the first floor, but failed to work from there. The UDFCD RNET transmitter on the roof was benched, but this effected no change in the behavior of either controller from the base station. The cable run from the base station to the roof was measured as having a resistance of 12.6 ohms, which may be a problem if the switching signal is being delayed or chopped due to excessive resistance. When attempting to hook up the UDFCD Controller directly to the RNET on the roof, hard rain commenced and troubleshooting had to be suspended. The next obvious steps are to 1) test the UDFCD Controller to see that it still works and 2) find out whether or not the long cable run is inhibiting UDFCD Controller functionality. This effort will likely take place before spring 2000 start-up commences.

A new Handar weather station suite was installed in June near Elbert. Shortly after the install, it was observed that wind and peak wind data were reporting instantaneous winds; an updated 555 program fixed the problem. To date, the sonic wind sensor, which is currently unique in the UDFCD system, appears to be working well. A similar suite was planned for Squaw Mountain, but the installation has been postponed until next spring, due to a serious melange of bureaucratic and physical obstacles. The current plan is to mount the sensors (and the 555F, in a NEMA enclosure) near the base of the State of Colorado telecommunications tower.

During the 1999 field season, new pressure transducers were installed at the following sites: Harvard Gulch Park, Grandby Ditch, 6th and Tollgate, Maple Grove Reservoir, Nolte Pond, Niver Detention, Englewood Dam, Morrison, and South St. Vrain at Berry Ridge (replaced with a Boulder County spare PT). However, at Harvard Gulch Park, Grandby Ditch, and 6th and Tollgate, we have experienced sensor drift of sufficient magnitude to require multiple re-calibrations during 1999. At this point, we do not know if the sensors are defective or if the signal conditioning is at fault. We did experience trouble "zeroing" some of the new signal boards while calibrating the new PT's, including these three sites. The lack of available spare HSE signal conditioning boards has prevented us from swapping the boards to see if they are defective. At Morrison, the shaft encoder was abandoned in favor of a stage sensor because of excessive drift. Data from the PT have been far more stable than that generated from the shaft encoder.

Other sites with older pressure sensors that have experienced consistent sensor drift this year include Confluence Pond (both Foxboro PT's), Temple Pond (Foxboro), Goldsmith/Eastman (Druck) and Croke Pump Station (Druck). We recommend sensor replacements for all these sites, except Goldsmith/Eastman. The sensor here is only one year old and, like the sites with newly installed PT's, the signal board may be causing the problem.

If the Temple Pond stage sensor is replaced, we suggest relocating the standpipe to the south side of Union St., rather than leaving the transmitter and signal board some 300 feet away from the stage sensor. This would greatly facilitate maintenance for this site, particularly for one person. Due to the extreme length of the run, the cost of replacing

the PT and cable in the current configuration will be comparable to relocating the standpipe. During the original installation, efforts to install the standpipe near the stage sensor were unsuccessful. As several years have passed since the original installation, we feel that this would be an appropriate time to raise the issue again. If hydraulics allow, another option would be to install a vented splice inside a secure junction box, which would decrease the length of sensor cable requiring replacement in the future. We don't recommend this option, because it is doubtful that we could safely vent without being forced to install a mast. A mast with a box mounted on it would be both unsightly (an important consideration at this location) and would be very awkward to maintain.

Another stage sensor that requires replacement is Montview Park. Although this sensor does not drift, its offset is extremely large (1.6 ft.). This PT is a Keller with a 0-5 V output and has no signal conditioning. The PT at 6th and Lena should be replaced as part of the Flood District's proposed PT housing redesign. Stage data at this site mysteriously disappeared for several days last summer (replacing the transmitter and signal conditioning board with spares failed to fix the problem), then mysteriously reappeared. The current PT here is a Foxboro.

The Lee Hill repeater remains a single point of failure for the Boulder County system. Radio testing was conducted at "Neon" (the current location of the Boulder Watershed's repeater) to determine whether or not the site is a suitable candidate for a backup repeater location. Data were collected from October 15 to October 18 at 169.500 MHz. Although comprehensive data analysis is incomplete, preliminary results clearly indicate that Boulder County sites north of Sunshine Canyon do not reliably report directly to Neon. A broad ridge oriented to the NE of Neon interferes with RF paths from these sites.

The following encapsulates other problems of note in the UDFCD system during 1999:

--Working spare Sierra-Misco signal conditioning boards became a rare enough commodity that we were forced to install boards that were stuffed for different stage ranges at Expo Park and at Temple Pond late in the season in order to successfully recalibrate stage sensors and maintain stage data. We have since been able to repair four spare boards on the bench. This is a problem that will recur as long as Foxboro PT's are maintained in the system, because the signal conditioning boards have a shorter life-span than the sensors. However, if PT replacements are performed as planned next year, 5 of the remaining 16 Foxboro's will be removed from the network, which will help to temporarily fix this problem.

--The same problem will very likely crop up for the newer generation of signal boards. Each season the population of Druck PDCR 1830 PT's in the UDFCD network increases, as they remain the sensor of choice to replace the Foxboro's and Keller's that die. We currently have no working spare HSE signal conditioning boards to use as field replacements. Several of these should be purchased as field spares.

--As happens every flood season, several Handar batteries dropped out in September, resulting in a number of unscheduled maintenance visits just prior to the end of the official maintenance schedule. DIAD plans to purchase enough spare Handar batteries to allow a swap to be performed at non-solar Handar sites as part of the mid-season inspection. This will allow the non-solar sites in the Bear Creek network (as well as some of the other odd non-solar Handar sites scattered throughout the rest of the

system) to perform with greater reliability throughout (and particularly at the terminus of) the flood season.

--The temperature sensor at Castle Rock was replaced at the beginning of the flood season, as the old sensor was generating spurious data on an intermittent basis.

--A new RH/AT housing was installed at Blue Mountain, as well as a new wind sensor.

--The Quincy weather station experienced a succession of problems, due to defective transmitters that were installed there. The transmitter installed there at the beginning of the season would experience intermittent "logic lock" episodes. The spare transmitter that was installed in its place has intermittent problems with reporting wind data. The current 585 installed here is not wired for a barometric pressure configuration, so BP data is not being reported from this site. At the District's request, this site is currently being evaluated for an "upgrade" to a programmable 555 DCP.

--Maple Grove transmitted excessive stage data after the new PT install. The event resolution for the stage sensor was changed on the transmitter logic board to report every two increments, rather than every increment.

--The effects of spiders and their webs were much more prevalent in 1999 than in 1998, resulting in a greater number of incapacitated TB's and plugged funnels.

--In addition to the two defective Handar 585's installed at Quincy Wx, a Handar 555 that had been sent back for repair in 1998 (RMA 20608, s/n 2774, the victim of the cable short at Blue Mountain) was returned to DIAD Inc., but was found to have not been completely repaired (if at all). Two EG&G transmitters died: 1) Pinewood Springs (decrements one count per bucket tip), and 2) Red Garden (dead radio). An "original" Sierra-Misco transmitter was removed from Flings due to excessive quiescent current draw. In addition to the Sierra-Misco destroyed by lightning at Englewood Dam, a spare Sierra-Misco transmitter also died (decrements one count per bucket tip, but on an intermittent basis). A bad Johnson radio was found on a HSE 3206 at Castle Oaks. Another bad radio (RNET) was found in the 5096 at Sugarloaf; this transmitter was replaced with a Boulder County spare. DIAD believes that the two dead radios may be repairable. Total casualties: 3 Handars (two 585's plus one 555 from 1998), 2 EG&G's, 3 S-M 5050's, 1 HSE 3206, and 1 Hydrolynx 5096.

DIAD would like to remind the District that the system is required to be FCC compliant with narrow banding (although compliance shall be complaint enforced) by 2005. A substantial portion of the network runs with transmitters that will violate this stipulation in just five more years. Several sites (13) in the shared network with Boulder County are still supported with transmitters that are 20 years old. The majority of sites in the rest of the UDFCD use Sierra-Misco transmitters that are already over 10 years old. We believe that now is the time to consider initiating an ongoing commitment to replacing these transmitters so that the system will be up to snuff with FCC regulations. A general strategy might be to initially budget to replace S-M 5050 stage sites with HSE 3206's. The displaced 5050's could then be installed at sites that use the very oldest equipment. Later phases of upgrades could then finish stage sites, saving rain-only upgrades for last.

Kevin, DIAD would like to thank you for your professionalism, and we hope to be able to continue to work with you and support the UDFCD during the next flood season.

Sincerely,

Robert Cress
DIAD Inc.