Urban Drainage And Flood Control District
Alert Gage Meteorological Survey And Rating
Phase II

Prepared for:

Urban Drainage and Flood Control District
2480 West 26th Avenue Suite 156B
Denver, Colorado 80211

Prepared by:

Genesis Weather Solutions, LLC
10630 Braselton Street
Highlands Ranch, Colorado 80126
303-927-6522
www.genesisweathersolutions.com

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1.0 Introduction

Genesis Weather Solutions, LLC (GWS) has been contracted by the Urban Drainage and Flood Control District (UDFCD) to survey and objectively rate ALERT (Automated Local Evaluation in Real Time) gages within its flood detection network (FDN). GWS was also tasked with creating a Metadata database that contains information about each ALERT gage surveyed. This information includes such things as the gages latitude and longitude, elevation, sensor measurements (distance above the ground), sensor obstruction measurements (distance between sensors and obstruction), potential future sensor obstructions and digital photographs.

The survey and rating was completed for eighteen (18) ALERT atmospheric variable observing gages, (weather stations) and for one hundred-twenty two (122) ALERT precipitation-observing gages, (rain gages) located within the FDN. All eighteen (18) weather stations observe rainfall in addition to other meteorological variables and therefore the weather stations were included in the rain gage ratings. Throughout the remainder of the report atmospheric variable observing gages will be referred to as weather stations and precipitation-observing gages will be referred to as rain gages.

Phase I of this project was completed by GWS Meteorologist Bryan Rappolt in January of 2003. In phase I sixteen (16) weather stations and fifteen (15) rain gages were surveyed and rated. In phase II of the project fifteen (15) of the previous sixteen (16) weather stations that were rated in phase I were re-rated against new rating criteria that was developed. The Urban Farm weather station which was surveyed and rated in phase I was moved approximately 200 yards to the east of its original location and has been renamed the Stapleton weather station (ID 1460).

For the purpose of continuity all the rain gages and weather stations that were surveyed and rated in Phase I and Phase II are included together in the rating tables (Tables 3.0 and 4.0) contained in this report.

Digital photographs were taken of all the gages that were visited and surveyed. All the photographs as well areal imagery depicting the locations of the gages can be found on a compact disk that accompanies this report. A photograph of each gage along with other information relevant to the gage can be found in the Appendix that accompanies this report.

2.0 UDFCD Flood Detection Network

The UDFCD FDN (Figure 1.0) contains one hundred sixty nine (169) ALERT gages that provide one hundred fifty two (152) real-time rain measurements (Figure 1.0), eighty (80) real-time stream and/or reservoir water levels measurements (Figure 2.0), and eighteen (18) real-time weather stations that measure atmospheric variables (Figure 3.0).


Figure 1.0: ALERT rain gage.


Figure 2.0: ALERT stream gage.


Figure 3.0: ALERT weather station.

Precipitation is measured using standard 1mm ALERT tipping buckets. The precipitation is observed in a standpipe tower by a 12-inch diameter funnel. All weather stations measure precipitation, air temperature, relative humidity, wind speed and direction and some stations measure barometric (station) pressure, and solar radiation. Stream flow and water height are observed by submersible pressure transducers and digital shaft encoders.

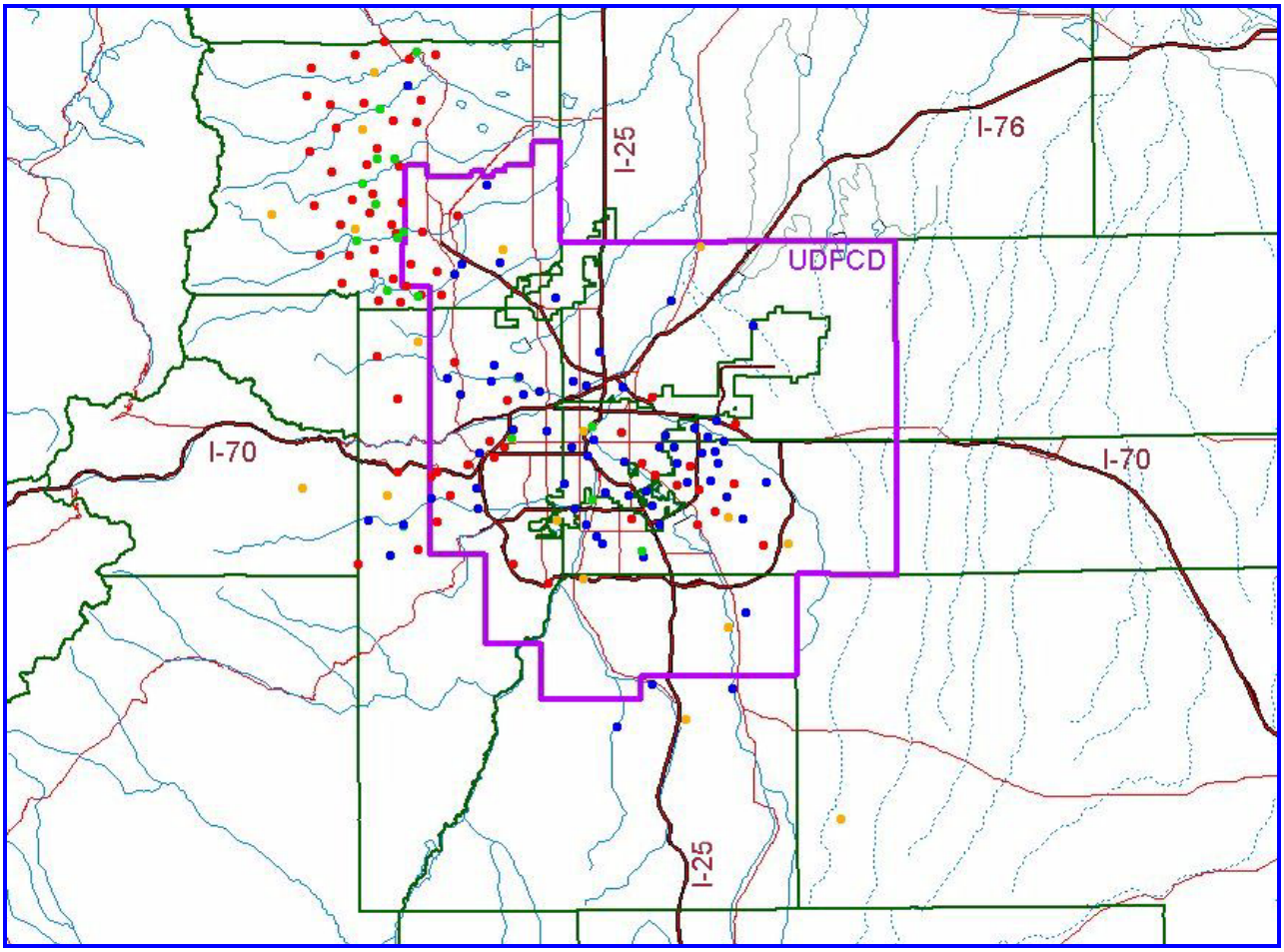

Figure 4.0. UDFCD ALERT gage network. Red = Rain Gages, Yellow = Weather Stations, Blue = Rain/Stream Gages, Green = Stream Gages. Purple = UDFCD Boundary.

The gage information is disseminated by radio frequency (RF) transmitters to radio receivers located in and around the District. The information is displayed in real-time by ALERT compatible software applications and by the Districts ALERT web site.

The FDN information is utilized for many purposes that include weather prediction, flood detection, water supply, wildfire suppression, and past weather reconstruction. The FDN, especially the weather stations are instrumental within the UDFCD's Flash Flood Prediction Program (F2P2) in assisting the Private Meteorological Service (PMS) with basin specific quantitative precipitation forecasts (QPF) and heavy rainfall notification to local governments located within the District.

3.0 Project Description

The project involved a survey that included gathering of select ALERT gage information and an objective rating of the gages. Gages that were surveyed included eighteen (18) weather stations and one hundred and thirty four (134) rain gages. The eighteen (18) weather stations all measure rainfall and were included in the rain gage rating resulting in a total rain gage rating of one hundred fifty two (152) gages.

Information was gathered through physical site visits, and included information such as instrument height above the ground surface, ground surface type, identification of vegetation, forestation and water bodies in the proximity of the instrumentation. Digital photographs were also taken of each gage. A visual inspection was performed to determine if there was any damage to the gage and if the instrumentation looked to be in good working order.

# ID	Letter ID	Station Name	Station Type	Latitude	Longitude	Elevation (ft)	Install Date
100	CRTC2	Carr Street	PS	39.804722	105.090833	5322	5/30/1988
110	RALC2	Ralston Reservoir	PS	39.822778	105.246111	6033	9/23/1988
120	CRPC2	West Woods	PS	39.820000	105.173333	5590	8/2/1989
140	BMTC2	Blue Mountain	Wx	39.870000	105.296667	8050	4/25/1991
150	NOTC2	Nott Creek	P	39.852222	105.366111	7815	4/9/1991
200	LEYC2	Leyden Reservoir	PS	39.840000	105.167222	5603	5/30/1988
210	LCNC2	Leyden Confluence	PS	39.822500	105.122778	5430	8/2/1989
220	LECC2	Upper Leyden	P	39.844444	105.233889	6000	8/14/1990
300	VABC2	Van Bibber Park	P	39.794722	105.146389	5525	9/23/1988
310	GHRC2	Guy Hill Ranch	P	39.796667	105.330833	8320	5/30/1988
320	SPOC2	Sports Complex	PS	39.801667	105.117778	5420	7/3/1989
330	VBCC2	Van Bibber @ Hwy 93	PS	39.802222	105.224167	5900	8/14/1990
400	MOVC2	Montview Park	PS	39.747222	104.879722	5303	6/9/1988
410	KELC2	Kelly Dam	PS	39.732500	104.888611	5344	9/22/1988
420	EXPC2	Expo Park	PS2	39.710833	104.859167	5458	5/21/1988
430	UTAC2	Utah Park	PS	39.685278	104.843611	5536	5/21/1988
440	ILIC2	Fire Station #7	P	39.675833	104.823056	5620	5/21/1988
500	HAVC2	Havana Park	PS	39.733056	104.864167	5375	5/26/1988
510	VICC2	Virginia Court	P	39.706667	104.838611	5550	5/21/1988
520	JWLC2	Jewell Detention	P	39.681667	104.859722	5560	5/21/1988
530	IVYC2	Fire Station #19	P	39.710556	104.920000	5420	5/21/1988
540	PAMC2	Parker/Mississippi	P	39.696111	104.897222	5460	9/22/1988
600	HGPC2	Harvard Gulch Park	PS	39.672222	104.982222	5315	7/25/1989
610	HAJC2	Harvard Gulch @ Jackson	PS	39.669167	104.942500	5410	7/25/1989
620	QUHC2	Quincy/Highline	P	39.638889	104.935833	5490	9/19/1989
630	TEMC2	Temple Pond	PS	39.631944	104.891111	5575	5/29/1987
640	GSEC2	Goldsmith @ Eastman	PS	39.656111	104.902222	5480	9/6/1989
650	ILFC2	Iliff Pond	PS2	39.673889	104.911111	5440	8/25/2004
700	TGSC2	Toll Gate @ 6th	PS	39.725000	104.818333	5400	11/7/1989
710	HPDC2	Horseshoe Park Drop	PS	39.687222	104.803056	5490	7/17/1989
720	CNPC2	Confluence Pond	PS2	39.666944	104.776944	5570	7/25/1989
730	NNCC2	No Name @ Quincy	PS	39.638333	104.748611	5710	8/13/1990

# ID	Letter ID	Station Name	Station Type	Latitude	Longitude	Elevation (ft)	Install Date
740	SMGC2	Smoky Hill	RP	39.604167	104.716389	6080	8/13/1990
750	QURC2	Quincy Reservoir	Wx	39.638889	104.768889	5750	1/8/1990
760	MVJC2	Mission Viejo Park	P	39.748611	104.796389	5660	8/3/1989
800	SADC2	Sable Ditch @ 18th	PS	39.728611	104.809722	5430	8/2/1989
810	GDIC2	Granby Ditch @ 6th	PS	39.725278	104.796667	5455	8/3/1989
820	ETGC2	E. Toll Gate @ Buckley	PS	39.711389	104.791111	5460	8/3/1989
830	SIPC2	Side Creek Park	P	39.683611	104.763056	5600	8/3/1989
840	FREC2	Fire Station 12	P	39.761944	104.761389	5433	3/30/2004
850	FLJC2	Flying J	PS	39.765833	104.792778	5387	3/30/2004
860	CFAC2	Sand Creek @ Colfax	PS	39.781140	104.781140	5423	2/1/2006
870	MURC2	Murphy Creek G.C.	PS	39.685278	104.710278	5614	3/30/2004
900	AURC2	Aurora Reservoir	Wx	39.605833	104.674167	5945	11/25/2003
1000	MGVC2	Maple Grove Reservoir	PS	39.755556	105.136667	5519	6/2/1985
1010	DVWC2	Denver West	P	39.731667	105.152222	5805	5/30/2002
1030	SERC2	NREL/South Table Mtn	P	39.740556	105.176111	6000	4/1/1985
1040	HIWC2	Lena @ U.S. Highway 6	PS	39.725278	105.192778	5920	6/2/1985
1050	FARC2	Jeffco Fairgrounds	P	39.720556	105.167778	5920	4/1/1985
1060	APEC2	Heritage Square	P	39.710000	105.212222	6420	4/1/1985
1100	LDDC2	Louisville Dwy D	PS	39.973056	105.156111	5464	5/6/1988
1110	GBLC2	Gunbarrel	PS	40.074167	105.177778	5225	12/1/1991
1200	BRFC2	Broomfield Basin 3207	PS	39.927778	105.064444	5350	3/23/1989
1300	WTMC2	Hidden Lake	PS	39.818611	105.036389	5288	8/28/2001
1310	DRCC2	Little Dry at 64th	PS	39.813056	105.013889	5204	8/29/2001
1320	THDC2	SPR at 3rd Avenue	PS	39.721667	105.010278	5210	1/28/2003
1330	RSYC2	Roslyn	P	39.797222	104.901111	5220	1/17/2003
1340	SGXC2	Sanderson at Xavier	PS	39.684444	105.050278	5410	4/2/2003
1350	CHTC2	Chatfield COE	P	39.556389	105.078889	5545	3/6/2003
1360	ZOOC2	Denver Zoo	P	39.750833	104.953889	5265	1/17/2003
1370	METC2	West Metro FS13	P	39.581111	105.137778	5853	2/26/2004
1400	USDC2	Upper Sloan Detention	PS	39.753611	105.079167	5431	5/30/1987
1420	DHPC2	Diamond Hill	Wx	39.753889	105.015833	5256	10/15/1990
1440	EBBC2	Elbert	Wx	39.245278	104.588889	6850	6/18/1999
1460	N/A	Stapleton	Wx	39.767652	104.866948	5279	12/2/2005
1480	THRC2	Third Creek at DIA	PS	39.890000	104.730000	5186	11/19/2001
1500	PWPC2	Powers Park	PS	39.616111	104.997222	5410	4/22/2002
1520	MSTC2	Marston Lake North	Wx	39.638611	105.062500	5500	9/9/2002
1530	BLWC2	Bear Creek at Lowell	PS	39.652222	105.032778	5310	10/16/2002
1600	EGAC2	Englewood Dam	PS	39.589722	104.918056	5570	6/11/1987
1620	SHGC2	Slaughterhouse Gulch	PS	39.608611	104.986111	5470	3/23/1989
1640	ENWC2	SPR at Union Avenue	PS	39.632500	105.014444	5290	5/21/1998
1660	HNDC2	SPR at Henderson	PS	39.921944	104.866667	5003	4/17/1998
1700	CCMC2	Cherry Creek at Champa	PS	39.742222	104.999444	5190	5/14/1998
1710	SHCC2	Shop Creek	P	39.630556	104.828333	5608	3/30/2004
1720	CCSC2	Cherry Creek @ Steele	PS	39.713056	104.949167	5310	4/8/1991
1800	SCPC2	Sand Creek Park	PS	39.756389	104.831111	5330	3/24/1989

# ID	Letter ID	Station Name	Station Type	Latitude	Longitude	Elevation (ft)	Install Date
1810	SCMC2	Sand Creek at mouth	PS	39.810833	104.950833	5120	5/1/1990
1900	NIVC2	Niver Detention	PS	39.857222	104.988333	5236	5/30/1987
1920	BHNC2	Brighton	Wx	39.993333	104.817222	4975	8/26/1998
2190	SQWC2	Squaw Mountain	Wx	39.681111	105.495556	11400	6/1/2000
2210	HGCC2	Hiwan Golf Club	Wx	39.672222	105.346944	7650	4/9/1991
2230	BBCC2	Bear Creek below Cub Cr	PS	39.632222	105.321111	7020	4/9/1991
2240	CGCC2	Cold Spring Gulch Conf	PS	39.666111	105.275278	6655	4/25/1991
2250	ROSC2	Rosedale	PS	39.638056	105.380556	7310	5/7/1992
2260	BRKC2	Brook Forest	P	39.581944	105.397778	8340	5/14/1992
2270	CBBC2	Cub Creek below Blue Cr	PS	39.592778	105.343889	7560	5/12/1992
2280	KIPC2	Kinney Peak	P	39.601111	105.296111	7700	11/20/1993
2310	GEVC2	Genesee Village	P	39.701944	105.263889	7360	4/9/1991
2320	CHOC2	Choke Cherry Reservoir	RP	39.696111	105.274722	7850	4/23/1992
2330	MOSC2	Bear Creek at Morrison	PS	39.653056	105.195278	5790	11/22/1993
2340	ERPC2	El Rancho	P	39.701667	105.329722	7680	10/4/1993
2350	IDLC2	Idledale	P	39.670556	105.241389	6740	5/7/1992
2360	INDC2	Indian Hills	P	39.636944	105.263611	7375	5/7/1992
2370	RRPC2	Red Rocks Park	PS	39.680278	105.197222	6090	10/27/1992
2710	HIGC2	Highlands Ranch WTP	Wx	39.561944	105.019167	5550	4/21/1998
2730	SAPC2	Salisbury Park	Wx	39.498889	104.776389	5870	4/13/1998
2750	COKC2	Castle Rock	Wx	39.375833	104.845833	6560	7/2/1998
2810	WPCC2	Pine Cliff Road	PS	39.372222	104.966111	5930	8/27/1998
2820	HSKC2	Haskins Gulch	PS	39.423056	104.904444	5960	4/10/2003
2830	CARC2	Castle Oaks Road	PS	39.416389	104.768611	6030	6/11/1998
2840	SPHC2	Sulphur Gulch	PS	39.516944	104.745833	5915	11/26/2004
4010	CREC2	Crescent	P	39.924167	105.363889	7760	1979-80
4020	RGRC2	Rio Grande	P	39.922500	105.325833	7330	1979-80
4030	REDC2	Red Garden	P	39.931944	105.292222	6360	1979-80
4040	2-Mar	Martin Gulch	P	39.942778	105.314722	6520	1979-80
4050	WLRC2	Walker Ranch	P	39.952222	105.339167	7320	1979-80
4060	LSHC2	Lakeshore	P	39.961111	105.370278	7700	1979-80
4070	BPKC2	Bear Peak	P	39.971111	105.308056	6920	1979-80
4080	TWIC2	Twin Sisters	P	39.984167	105.411944	8120	1979-80
4090	MAGC2	Magnolia	P	39.990556	105.370278	7320	1978-79
4100	FILC2	Filter Plant	P	40.011111	105.334167	6360	1978-79
4110	BETC2	Betasso	P	40.023889	105.339444	6480	1978-79
4130	SWIC2	Swiss Peaks	P	40.022778	105.428333	8600	1978-79
4140	LOGC2	Logan Mill	P	40.038333	105.378056	7200	1978-79
4150	GLHC2	Gold Hill	P	40.055278	105.407778	8120	1978-79
4160	SUNC2	Sunshine	P	40.063056	105.371944	7560	1978-79
4170	PBHC2	Pine Brook	P	40.052500	105.322222	6920	1981-82
4180	GLLC2	Gold Lake	P	40.093056	105.441667	8560	1981-82
4190	SLGC2	Slaughterhouse	P	40.101667	105.383611	7400	1981-82
4200	LFTC2	Lazy Acres	P	40.099444	105.328611	7020	1981-82
4220	FLIC2	Fling's	P	40.118056	105.478889	8590	1981-82

# ID	Letter ID	Station Name	Station Type	Latitude	Longitude	Elevation (ft)	Install Date
4230	GOAC2	Golden Age	P	40.125278	105.363056	8160	1981-82
4240	SUSC2	Sunset	P	40.048889	105.471389	8680	1981-82
4250	GEEC2	Geer Canyon	P	40.157222	105.297778	6080	1981-82
4260	TYMC2	Taylor Mountain	P	40.191111	105.485000	8425	1981-82
4270	CMTC2	Cannon Mountain	P	40.149444	105.433333	8120	1981-82
4290	RDHC2	Red Hill	P	40.185556	105.291389	6590	1981-82
4300	BEPC2	Big Elk Park	P	40.226667	105.476111	8600	1981-82
4310	JOPC2	Johnny Park	P	40.244167	105.401667	7680	1981-82
4330	INRC2	Indian Ruins	P	40.159444	105.338333	7790	1981-82
4340	RVRC2	Riverside	P	40.179722	105.443333	8340	1981-82
4350	COHC2	Conifer Hill	P	40.181944	105.388056	8120	1981-82
4360	JUCC2	Justice Center	P	40.014444	105.288056	5400	1981-82
4470	LINC2	Little Narrows	PS	40.204444	105.313611	5620	4/21/1997
4490	APLC2	Apple Valley	P	40.238333	105.310278	5920	1984-85
4510	PWSC2	Pinewood Springs	P	40.261111	105.352222	6850	1984-85
4520	ERDC2	Eagle Ridge	R/P	40.244167	105.265000	6280	6/1/1996
4530	WSWC2	Winiger Ridge	P	39.948056	105.424167	8130	1984-85
4550	BOJC2	Jail	P	40.034444	105.228611	5290	6/2/1997
4570	STAC2	St. Antons	P	39.985278	105.462778	8350	1984-85
4710	WRDC2	Ward C-1	Wx	40.035278	105.540556	9700	7/22/1997
4730	SFSC2	Sugarloaf	Wx	40.018056	105.403611	7860	6/23/1997
4750	LEWC2	Louisville Lake	Wx	39.992222	105.153333	5580	7/26/1998
4770	CALC2	Cal-Wood Ranch	Wx	40.147778	105.389722	7760	6/20/1997
4790	BTRC2	Button Rock	Wx	40.220833	105.368611	6500	5/11/1992
4810	SNHC2	Shanahan Ridge	P	39.961389	105.265278	5840	9/19/2002
4820	DDYC2	Doudy Draw	P	39.932222	105.256944	5740	9/20/2002
4830	SSOC2	SBC at Sans Souci	PS	39.957778	105.235833	5470	9/24/2002
4840	SBDC2	SBC at S. Boulder Ditch	PS	39.972500	105.223056	5400	10/9/2002
4850	PPHC2	Porphyry Mountain	P	40.119722	105.387778	7347	7/7/2004
4860	FAPC2	Fairview Peak	P	40.134444	105.348333	8260	8/11/2004

Table 1.0: Surveyed and rated ALERT gages. P = Precipitation, S = Stream Flow/Stage, Wx = Weather, R = Repeater.

The gage surveys and ratings were performed by GWS meteorologist, Bryan Rappolt during the fall of 2005 and the winter of 2005-2006. Table 1.0 depicts the gages that were surveyed and rated in Phase and Phase II of the project. A site visit was attempted for all the gages in Table 1.0 and was performed for most of them. However, some of the gages could not be accessed due to a few different reasons, which included inaccessibility due to deep snow, mud, or locked gates on the access roads leading to the gages. A total of twenty-five (25) gages (all located in the higher terrain of Boulder and Jefferson Counties) could not be accessed. A survey and rating was still performed on these gages through the use of information and digital photographs provided by Mr. Dave Pruett, a Field Technician with OneRain, Inc. OneRain performs the maintenance of the gages within the UDFCD FDN. *A special thank you goes out to OneRain, Inc. for all their assistance provided on this project.*

4.0 Weather Station Rating Criteria

Currently there are no set standards that have been established for siting ALERT weather stations. Therefore the ALERT Weather stations were surveyed rated based on criteria (criteria A, F and G) that was developed by the Oklahoma Climatological Survey, to site gages within the Oklahoma weather station network, (Oklahoma Mesonet). The Oklahoma Mesonet consists of one hundred fifty eight (158) automated weather stations located throughout the state of Oklahoma. Figure 5.0 depicts the location of the gages that comprise the Oklahoma Mesonet.

Criteria (criteria B, C, D and E) established by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, was also used in the rating process. These criteria were established to assist in the siting of official first and second order weather observing stations across the United States.

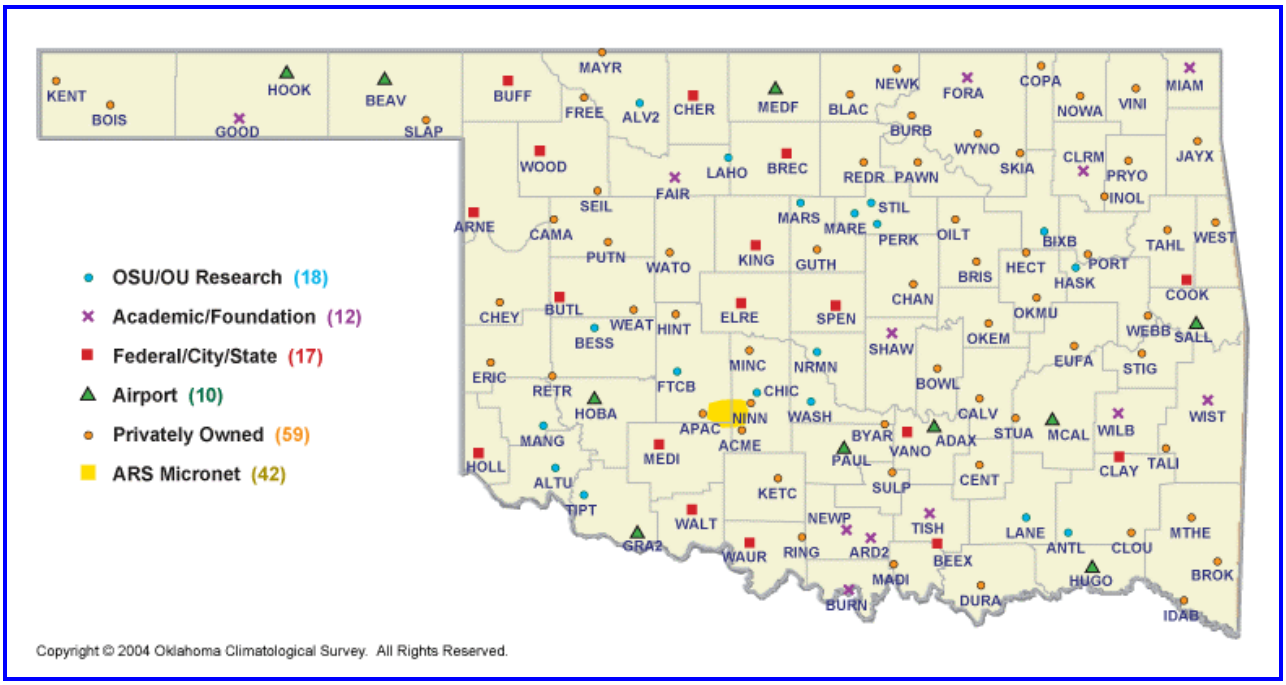

Figure 5.0. Weather stations that comprise the Oklahoma Mesonet.

Weather stations that were rated for this project are defined as any gage that observes at a minimum, the following variables: temperature, relative humidity, wind direction and wind speed. The criteria used to rate the weather stations are as follows:

A. A site should be as far away as possible from irrigated areas, lakes and forests to minimize their influence on observation variables.

B. The sensor to measure air temperature and relative humidity should be mounted ~ 5 feet above the ground. The ground below should be at least 100 feet from any extensive concrete or paved surface. For this rating air temperature and relative humidity sensors that were observed to be higher than 5 feet above the ground were assessed a lower value. For example sensor heights of 5 feet were assessed a 5, 6 to 8 feet above the ground were assessed a 4, greater than 8 feet but less than 11 feet a 3, 11 feet to 14 feet a 2, and greater than 14 feet a 1.

C. The sensor to measure wind velocity and wind direction should be mounted between 23 and 33 feet above the ground. For this rating wind velocity and direction sensors that were observed to be lower than 23 feet above the ground were assessed a lower value. For example sensor heights of 23 to 33 feet above the ground were assessed a 5; greater than 12 feet but less than 23 feet a 4, greater than 6 feet to 12 feet a 3, greater than 3 feet but less then 5 feet a 2, and 3 feet or less a 1.

D. A site should be relatively level. Small gradual slopes are acceptable but ravines, bluffs, ridges, etc., should be avoided because they can cause eddy currents and can have an effect of wind catchment.

E. There should be a minimum of obstructions that impede wind flow at the gage site. (The distance between an obstruction to the wind and the top of the gage should be at least 20 times the height of the obstruction. For example, a 30-foot tree should be no closer than 600 feet from the top of the gage.)

F. Gage sites should have uniform low-cover vegetation. Bare soil should not be visible except over the bare soil temperature measurements.

G. Accessibility by vehicles for maintenance.

Each weather station was rated based on each of the seven (7) established criteria (A-F) described above and was given a numerical value of 1 through 5. A description associated with each value can be found in Table 2.0.

Value	Description
5	**Exceptional**
4	**Excellent**
3	**Good**
2	**Fair**
1	**Poor**

Table 2.0. ALERT gage rating values and their associated description.

5.0 Rain Gage Rating Criteria

Currently there are no set standards that have been established for siting ALERT rain gages. Therefore the ALERT rain gages were rated based on criteria developed by the Oklahoma Climatological Survey (criteria C) and the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (criteria B). Research performed by Mr. Howard Frisinger on the relationship between precipitation catchment and rain gage height was used for the establishment of criteria A. Rain gages that were rated for this project are defined as any gage that observes rainfall depth. The criteria used to rate the rain gages are as follows:

A. Rain gage catchment funnel height. Research has shown that there is a direct correlation between the height of the rain gage and the observed precipitation catchment. It has been shown that precipitation catchment decreases with increased height of the rain gage (Figure 6.0) due to increased turbulent airflow around the top of the gage with height. For this rating rain gages that were observed to be higher than 5 feet above the ground (standard rain gage height as established by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration) were assessed a lower value. For example

gage heights of 5 feet were assessed a 5, greater than 5 feet to 8 feet above the ground were assessed a 4; greater than 8 feet but less than 11 feet a 3, 11 feet to 14 feet a 2, and grater than 14 feet a 1.

B. There should be a minimum of obstructions that impede precipitation catchment (Figure 7.0) in the catchment funnel. The height of any obstruction relative to the catchment funnel height should not exceed twice the distance between the gage and the obstruction. For example a 20-foot tree should be no closer than 10 feet from the gage.

C. Accessibility by vehicles for maintenance.

Each rain gage was rated on each of the three criteria (A-C) described above and was given a numerical value of 1 through 5. A description associated with each value can be found in Table 2.0.

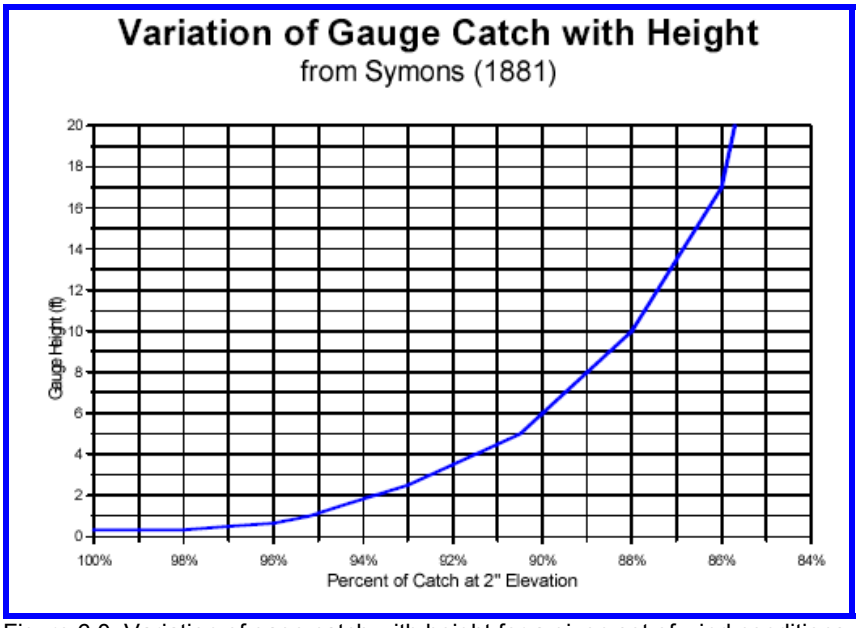

Figure 6.0: Variation of gage catch with height for a given set of wind conditions.

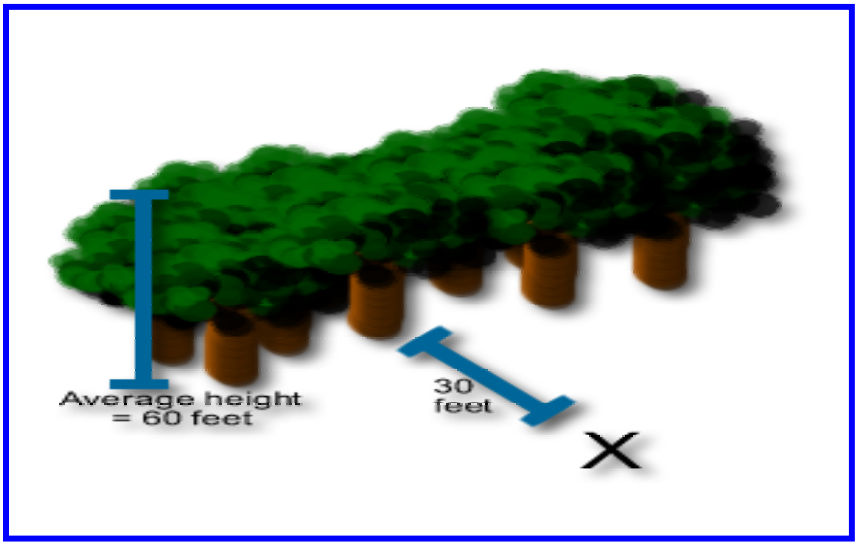

Figure 7.0. Distance relationship for rain gage obstructions.

6.0 ALERT Gage Rating Results

6.1 Weather Station Rating Results

Table 3.0 depicts the results of the weather station ratings, based on the established criteria. The results show that the Elbert weather station (ID 1440) and the Quincy Reservoir weather station (ID 750) had the highest rating, twenty-eight (28) points, and twenty-seven (27) points respectively out of a possible thirty-five (35) points. The high ratings for these two weather stations are due to the fact that they were assessed good (3 points) to exceptional (5 points) on all seven (7) of the rating criteria.

The lowest rated weather station, scoring sixteen (16) points out of a possible thirty-five (35) points was the Cal-Wood Ranch weather station (ID 4770). The low rating was due to its close proximity to an open water source and forestation, wind obstruction due to trees to the north and west, and poor accessibility by a vehicle for maintenance.

ID	Name	Sensor Type	Rating	A	B	C	D	E	F	G	Total
1440	Elbert	Wx		5	4	3	3	5	4	4	28
750	Quincy Reservoir	Wx		3	3	3	5	4	5	4	27
900	Aurora Reservoir	Wx		2	3	4	4	4	4	3	24
1460	Stapleton	Wx		4	3	4	4	2	3	4	24
2730	Salisbury Park	Wx		2	3	3	4	4	3	4	23
2710	Highlands Ranch WTP	Wx		3	3	3	4	2	4	3	22
1520	Marston Lake North	Wx		2	2	3	4	4	3	4	22
140	Blue Mountain	Wx		3	3	3	4	3	3	2	21
1920	Brighton	Wx		3	4	3	3	2	2	4	21
2750	Castle Rock	Wx		3	3	3	3	4	3	2	21
1420	Diamond Hill	Wx		4	1	4	4	2	4	1	20
4750	Louisville Lake	Wx		2	3	3	2	2	4	4	20
2190	Squaw Mountain	Wx		3	1	5	4	2	3	2	20
4730	Sugarloaf	Wx		2	3	3	4	2	3	3	20
4790	Button Rock	Wx		2	4	3	3	2	3	2	19
4710	Ward C-1	Wx		3	3	3	3	2	3	2	19
2210	Hiwan Golf Club	Wx		2	3	3	3	2	2	3	18
4770	Cal-Wood Ranch	Wx		2	3	3	2	2	2	2	16

Table 3.0: Weather station rating results. Wx = Weather

6.2 Rain Gage Rating Results

Table 4.0 depicts the results of the rain gage ratings based on the established criteria. The results show that the Elbert rain gage (ID 1440), Little Dry Creek rain gage @ 64th (ID 1310), Louisville rain gage (ID 1100), Third Creek at DIA rain gage (ID 1480) and the Van Bibber Park rain gage (ID 300) had the highest ratings with thirteen (13) points respectively out of a possible fifteen (15) points. The high ratings are due to the fact that the some of the gages are relatively low to the ground for increased rain catchment, there are no obstructions to the rain gage openings, and the gages are easily accessible by vehicles for maintenance.

ID	Name	Sensor Type	Rating	A	B	C	Total
1440	Elbert	P		4	5	4	13
1310	Little Dry Creek at 64th	P		3	5	5	13
1100	Louisville Dwy 'D'	P		4	5	4	13
1480	Third Creek at DIA	P		3	5	5	13
300	Van Bibber Park	P		3	5	5	13
2330	Bear Creek at Morrison	P		4	3	5	12
2830	Castle Oaks Road	P		3	5	4	12
420	Expo Park	P		3	5	4	12
530	Fire Station #19	P		3	4	5	12
440	Fire Station #7	P		3	4	5	12
840	Fire Station 12	P		3	4	5	12
610	Harvard Gulch @ Jackson	P		3	4	5	12
800	Sable Ditch @ 18th	P		3	4	5	12
1340	Sanderson at Xavier	P		3	4	5	12
830	Side Creek Park	P		3	4	5	12
1640	SPR at Union Avenue	P		4	4	4	12
430	Utah Park	P		3	5	4	12
2230	Bear Creek below Cub Cr	P		4	3	4	11
1920	Brighton	P		3	4	4	11
1200	Broomfield Basin	P		3	5	3	11
1350	Chatfield COE	P		3	4	4	11
2320	Choke Cherry Reservoir	P		3	4	4	11
720	Confluence Pond	P		3	4	4	11
4010	Crescent	P		3	4	4	11
1360	Denver Zoo	P		3	4	4	11
2340	El Rancho	P		3	4	4	11
1600	Englewood Dam	P		3	5	3	11
4100	Filter Plant	P		3	4	4	11
4220	Flings	P		3	4	4	11
850	Flying J	P		3	4	4	11
2310	Genesee Village	P		3	4	4	11
650	Goldsmith Gulch @ Iliff Pond	P		3	4	4	11
810	Granby Ditch @ 6th	P		3	4	4	11
1110	Gunbarrel	P		3	4	4	11
310	Guy Hill Ranch	P		3	4	4	11
600	Harvard Gulch Park	P		3	4	4	11
500	Havana Park	P		3	5	3	11
1060	Heritage Square	P		3	4	4	11
1300	Hidden Lake	P		3	4	4	11
2350	Idledale	P		3	4	4	11
2360	Indian Hills	P		3	4	4	11
4550	Jail	P		3	5	3	11
1050	Jeffco Fairgrounds	P		3	4	4	11
520	Jewell Detention	P		3	4	4	11
410	Kelly Dam	P		3	5	3	11
1040	Lena @ U.S. Highway 6	P		3	4	4	11

ID	Name	Sensor Type	Rating	A	B	C	Total
210	Leyden Confluence	P		3	5	3	11
200	Leyden Reservoir	P		3	5	3	11
4470	Little Narrows	P		3	4	4	11
760	Mission Viejo Park	P		3	4	4	11
870	Murphy Creek G.C.	P		3	4	4	11
1900	Niver Detention	P		3	4	4	11
2810	Pine Cliff Road	P		3	4	4	11
750	Quincy Reservoir	P		3	4	4	11
620	Quincy/Highline	P		3	4	4	11
110	Ralston Reservoir	P		3	5	3	11
2250	Rosedale	P		3	4	4	11
1330	Roslyn	P		3	4	4	11
1800	Sand Creek Park	P		3	4	4	11
1710	Shop Creek	P		3	5	3	11
1620	Slaughterhouse Gulch	P		3	5	3	11
740	Smoky Hill	P		3	4	4	11
1320	SPR at 3rd Avenue	P		3	4	4	11
2840	Sulphur Gulch	P		3	4	4	11
630	Temple Pond	P		3	5	3	11
700	Toll Gate @ 6th	P		3	4	4	11
220	Upper Leyden	P		3	4	4	11
510	Virginia Court	P		3	4	4	11
1370	West Metro FS13	P		3	4	4	11
4490	Apple Valley	P		3	4	3	10
900	Aurora Reservoir	P		2	5	3	10
1530	Bear Creek at Lowell	P		3	3	4	10
4110	Betasso	P		3	5	2	10
4300	Big Elk Park	P		3	4	3	10
2260	Brook Forest	P		3	4	3	10
4790	Button Rock	P		4	4	2	10
1700	Cherry Creek at Champa	P		4	3	3	10
1010	Denver West	P		3	4	3	10
4820	Doudy Draw	P		3	5	2	10
820	E. Toll Gate @ Buckley	P		3	4	3	10
4520	Eagle Ridge	P		3	4	3	10
4860	Fairview Peak	P		3	4	3	10
4180	Gold Lake	P		3	4	3	10
4230	Golden Age	P		3	4	3	10
2710	Highlands Ranch WTP	P		3	4	3	10
2210	Hiwan Golf Club	P		3	4	3	10
710	Horseshoe Park Drop	P		3	5	2	10
4750	Louisville Lake	P		3	4	3	10
1000	Maple Grove	P		3	4	3	10
1520	Marston Lake North	P		2	4	4	10
400	Montview Park	P		3	4	3	10
730	No Name @ Quincy	P		3	3	4	10
150	Nott Creek	P		3	4	3	10
1030	NREL/Table Mtn	P		3	4	3	10

ID	Name	Sensor Type	Rating	A	B	C	Total
540	Parker/Mississippi	P		3	4	3	10
4850	Porphory Mtn	P		3	4	3	10
1500	Powers Park	P		3	4	3	10
4290	Red Hill	P		3	4	3	10
2370	Red Rocks Park	P		3	4	3	10
4340	Riverside	P		3	4	3	10
2730	Salisbury Park	P		2	4	4	10
860	Sand Creek @ Colfax	P		3	4	3	10
4840	SBC @ S. Boulder Ditch	P		3	4	3	10
4810	Shanahan Ridge	P		3	4	3	10
320	Sports Complex	P		3	3	4	10
1660	SPR at Henderson	P		2	4	4	10
1460	Stapleton	P		2	4	4	10
4730	Sugarloaf	P		3	4	3	10
4260	Taylor Mountain	P		3	4	3	10
1400	Upper Sloan Detention	P		3	5	2	10
330	Van Bibber @ Hwy 93	P		2	4	4	10
120	West Woods	P		3	4	3	10
4270	Cannon Mountain	P		3	4	2	9
2750	Castle Rock	P		2	5	2	9
1720	Cherry Creek @ Steele	P		3	2	4	9
2240	Cold Spring Gulch Conf	P		3	4	2	9
4350	Conifer Hill	P		3	4	2	9
2270	Cub Creek below Blue	P		3	2	4	9
640	Goldsmith Gulch @ Eastman	P		3	2	4	9
4250	Greer Canyon	P		3	4	2	9
4330	Indian Ruins	P		3	4	2	9
4040	Martin Gulch	P		3	4	2	9
4510	Pinewood Springs	P		3	4	2	9
4830	SBC @ S. San Souci	P		3	4	2	9
4190	Slaughterhouse	P		3	4	2	9
4530	Winiger Ridge	P		3	4	2	9
4070	Bear Peak	P		3	4	1	8
4770	Cal-Wood Ranch	P		3	4	1	8
100	Carr Street	P		3	2	3	8
4150	Gold Hill	P		3	4	1	8
2820	Haskins Gulch	P		2	4	2	8
2280	Kinney Peak	P		3	4	1	8
4200	Lazy Acres	P		3	2	3	8
4140	Logan Mill	P		3	4	1	8
4090	Magnolia	P		3	4	1	8
4030	Red Garden	P		3	4	1	8
4020	Rio Grande	P		3	4	1	8
1810	Sand Creek at mouth	P		2	4	2	8
4570	St. Antons	P		3	1	4	8
4240	Sunset	P		3	4	1	8
4160	Sunshine	P		3	4	1	8
4130	Swiss Peaks	P		3	4	1	8

ID	Name	Sensor Type	Rating	A	B	C	Total
4080	Twin Sisters	P		3	4	1	8
4050	Walker Ranch	P		3	4	1	8
140	Blue Mountain	P		3	3	1	7
4060	Lakeshore	P		3	1	3	7
4710	Ward C-1	P		2	4	1	7
4310	Johnny Park	P		3	1	2	6
4360	Justice Center	P		1	4	1	6
4170	Pine Brook	P		3	2	1	6
1420	Diamond Hill	P		1	3	1	5
2190	Squaw Mountain	P		1	2	1	4

Table 4.0: Rain gage rating results. P = Precipitation

Twelve rain gages scored a total of twelve (12) points, which is considered a good score. Most of these gages would have scored higher if they were they were lower to the ground, which would lead to an increase in rain catchment.

The rain gage that was rated lowest, scoring four (4) points out of a possible fifteen (15) points, was Squaw Mountain (ID 2190). The low score is due to the fact that the gage is located in a remote location that has poor accessibility by vehicles for maintenance, it has a large obstruction (large rock) to the west of the gage, and the rain gage is located high above the ground (~33 feet) resulting in poor rain catchment. Two other rain gages, that are located on the roofs of buildings (Diamond Hill, ID 1420 and the Justice Center, ID 4360) scored low, five (5) points and six (6) points respectively due to poor rain catchment, due to the high gage height above the ground and the inaccessibility by vehicles for maintenance.

The Johnny Park (ID 4310) and Pine Brook (ID 4170) rain gages also scored low with six (6) points each due to inaccessibility by vehicles for maintenance and obstructions by trees located in the proximity of the gages resulting in poor rain catchment.

7.0 Summary

A total of one hundred-fifty two (152) ALERT gages that comprise the UDFCD's FDN were surveyed and rated by Mr. Bryan Rappolt, GWS Meteorologist. The gages were objectively rated based on criteria that were developed by the Oklahoma Climatological Survey, the U.S. Department of Commerce, National Oceanic and Atmospheric Administration and research performed by Howard H. Frisinger on rain gage catchment with respect to gage height.

The results of the weather station ratings show that Elbert received the highest score (28 points out of a possible 35 points) and Calwood Ranch the lowest score (16 points out of a possible 28 points).

The results of the rain gage ratings show that multiple (5) rain gages received the highest scores (13 points out of a possible 15 points) and the Squaw Mountain rain gage scored the lowest (4 points out of a possible 15 points).

It is recommended that the Elbert and Quincy Reservoir weather stations be used as models for future weather siting within the UDFCD's FDN. It is also recommended that the five (5) highest rated rain gages (Elbert, Little Dry Creek @ 64th, Louisville, Third Creek @ DIA and Van Bibber Park all be used as models for future rain gage siting within the UDFCD's FDN.

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