EMWIN System Design Proposal

Prepared for the

Urban Drainage and Flood Control District

Prepared by

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I. Executive Summary

The Urban Drainage and Flood Control District of Denver, Colorado is committed to provide timely flood warning information to their constituents. Their service area includes 39 counties, cities, and towns.

The UDFCD has commissioned a study to develop an EMWIN (Emergency Managers Weather Information Network) rebroadcast service for the district in 2003. The service is intended to provide weather forecasts, watch and warning products for emergency managers in the Denver area. The desire is to identify a single transmitter site to serve the entire area. Equipment needed to receive the EMWIN signal is not included in this project, but is the responsibility of individual emergency management entities.

Three locations were identified for evaluation as transmitter sites. While none of the three proposed transmitter sites provides complete coverage of the service area, a downtown Denver building-top would deliver the most comprehensive service. UDFCD is looking for a site donor in the downtown area, but one has not been identified to date. The acquisition cycle for a site of this type is typically six months.

The emergency manager for the city of Westminster has offered to cooperate in providing a no-cost site for the EMWIN rebroadcast service. If Westminster provides the necessary infrastructure resources, their location would provide a reasonable start-up site – in excess of 90% of the proposed county, city and town receiver locations would be served. In addition, a governing board could be established to launch the system, while progressing on licensing and content based on user feedback. The licensing process takes months, but once a system is established, allows relocation of the transmitter within the area quickly.

II. EMWIN and Rebroadcast Services

The National Weather Service recommends communities have access to multiple sources of severe weather information. NOAA Weather Radio, television, the internet and radio broadcasts are some of these sources. In severe weather, one or more can fail unexpectedly.

Emergency Managers Weather Information Network (EMWIN) is another of the family of weather information services available from the National Weather Service. It was developed to provide delivery of weather information to the emergency management community nationwide. EMWIN is a satellite-based service available throughout the continental US. (See Appendix A for additional service limitations).

EMWIN broadcast began as an experiment in Washington D.C., and has grown into a fully supported NWS program. The service provides near-real-time delivery of severe weather watches and warnings. Not surprisingly, the early acceptance of EMWIN occurred in Oklahoma – located in the center of "tornado alley". Communities embraced the rapid delivery of weather information to provide early warning against tornados and other severe weather events.

As the popularity of EMWIN increased, communities implemented EMWIN rebroadcast services. Radio transmitters, usually on local National Guard radio channels, were connected to EMWIN satellite downlinks. Weather information could then be received at locations throughout these communities at a fraction of the cost of a complete satellite downlink. At this time, over 50 transmitter locations nationwide are listed on the NWS web site.

In recognition of this popularity, the National Weather Service set aside five nationwide radio channels to expand EMWIN rebroadcast services. The NWS policy allows a "cooperator" to provide the equipment and all system maintenance in exchange for an authorization to deliver EMWIN information on a dedicated federally licensed channel.

EMWIN rebroadcast provides a range of services to the local community.

- immediate information to many emergency management users
- Hazardous Weather Outlook information on a daily basis
- Severe weather Watches and Warnings
- Flood and Flash flood watches and warnings
- Civil Emergency Messages (Homeland Security)
- AMBER alerts (also called Child Abduction Emergencies)
- local radar images

For the emergency manager, an EMWIN rebroadcast system provides a number of valuable features.

- software available to run on almost any Windows pc
- provides near real time weather information to the desktop
- service is free - no recurring monthly fee

Once the information is delivered to a local computer, the capabilities to distribute the information are nearly unlimited.

- Save time by automating alert policies
- Send email alerts to users automatically
- Send alerts to pagers and digital cell phones automatically
- Display pop-ups on 911 dispatcher screen for specific events
- Turn on remote lights or sirens when severe weather approaches
- Provide voice alerts on public safety radio channels

EMWIN rebroadcast provides the additional benefit of local content control. The administrators of a system can modify the content over time. As new needs are identified, information can be added or re-prioritized to fulfill the user requirements quickly. Critical messages can be transmitted multiple times to improve reliability of the network. Most importantly, all these decisions can be made locally. While using a radio channel of the federal government, the local users can control the information delivered in their area. Further, an emergency manager in one city can select unique alert criteria based on city policy. She can have members added or deleted in her city's automated alert system independent of other cities receiving the same broadcast.

While no system is 100% reliable, EMWIN offers unique features independent of telephone lines and underground cables. It provides information quickly and allows extensive use of automation to improve response times. As part of a larger emergency preparedness strategy, EMWIN rebroadcast can provide significant value to the communities served. The ultimate design of any EMWIN rebroadcast service depends on the user requirements. A system can be expanded over time to grow with the needs of the community and provide the level of reliability expected by its users.

The National Weather Service continues to exhance the EMWIN service. In 2003, they are testing a high speed digital data link to replace the existing service. The new digital service will operate at twice the speed of the current system with increased reliability.

III. System Design

A. Goals

The goal of this project is to design and implement an EMWIN rebroadcast system for the UDFCD service area in 2003. The UDFCD Board of Directors has committed funds for this purpose. This system is intended to provide forecasts, watch and warning products for the Denver area. Local radar from the NWS office in Boulder will be added along with forecast and warning reports from the UDFCD network. The desire is for a single transmitter site serving the entire area. Equipment needed to receive the EMWIN signal is not included in this project, but is the responsibility of individual emergency management entities.

B. End User Needs

Emergency managers from local organizations participated in a discussion of their needs and priorities. The top priority is a need for rapid notification of important weather and homeland security events. Second is the ability to receive this information away from their desks and computers. Third is to receive critical information independent of the internet – in the event of service failures.

These stated needs are consistent with those of similar user groups throughout the country. Other common features in a rebroadcast system include:

Local radar content delivered at regular intervals
Lightning strike maps
Repetition of critical warnings
Regionally sensitive threat information –i.e., flash flood info
Redundant elements to increase system reliability
Remote management for rapid updates and failure recovery

C. Derived System Design Requirements

The next step of the design process is the listing of system requirements – literal or implied - based on the goals and end-user needs.

A. Implement an EMWIN rebroadcast system for the UDFCD service area in 2003

B. Provide forecasts, watch and warning products

i. UDFCD network forecast and warning reports
ii. outbound computer, software and configuration

C. Local radar from the NWS

i. Internet access at downlink site

D. Desire single transmitter site

i. Wide area transmitter coverage
ii. High power transmitter compliant with NTIA spec

E. Rapid Notification of severe weather/homeland security events

i. EMWIN downlink from NOAA satellite
ii. Ingest computer, software and configuration
iii. Filter content for regional applicability
iv. Prioritize local content delivery

F. Emergency managers can receive information out of the office

i. Broadband Internet access with email service
ii. Email client in rebroadcast software
iii. EM's manage their own content delivery

G. Provide information independent of landline based services

i. Radio-based delivery
ii. Key information from non-landline sources

H. System Reliability

i. System is important, but not mission-critical
ii. Power backup system (UPS) on site
iii. Redundant components
iv. Automated computer data switchover
v. Internet push backup
vi. Remote management access to computers
vii. On-going maintenance support

I. Limited space availability at downlink - per UDFCD

i. ingest and outbound on single computer platform
    1. 1400 MHz Pentium processor minimum
    2. 256 MB RAM minimum
    3. Two (2) RS-232 serial ports minimum
ii. KVM (keyboard video mouse) switch

J. Remote management capability

i. Broadband internet access at downlink site
    1. Cable / DSL router and Ethernet hub
ii. Email account for error reports / alarms
iii. remote management software
iv. fixed IP address

K. 9600 bps radio channel – per UDFCD

i. 9600 bps modulation system design

IV. EMWIN Re-broadcast System Design

An EMWIN re-broadcast system should provide the level of reliability dictated by the needs of the end users. As mentioned previously, the National Weather Service recommends access to multiple sources for warning and watch information. The appropriate EMWIN solution in the Denver area depends on the ultimate level of system availability (or "up-time") necessary.

Upon startup, a system typically provides a flood of information to the users. Emergency managers quickly come up a learning curve and become adept in using the new capabilities. As they become familiar with the system, their policies and processes will begin to incorporate EMWIN features. They will request additional information products. Reliance on the system will grow rapidly with time. It is common to construct a basic EMWIN system initially and then enhance the system reliability in subsequent budgetary cycles. Elements can be added to the system without significant cost penalties.

A complete EMWIN re-transmission block diagram is shown in Figure 1 below.

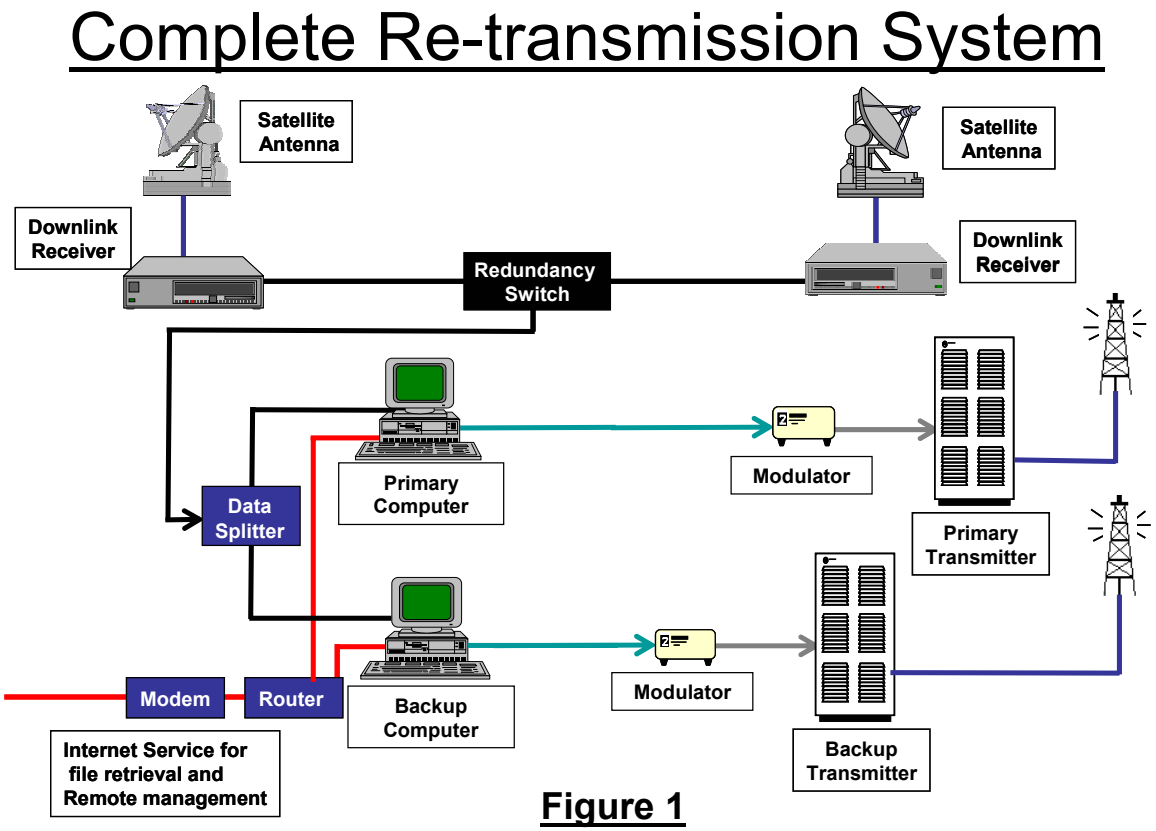

Figure 1

V. Radio Coverage Estimation

Radio signal coverage is dependent on many factors including transmit and receive antenna heights, transmitter power, local terrain, and fade margin. Generally, higher transmit and receive antennas allow greater signal range. Terrain obstructions are included in the coverage estimates through use of the the SRTM (Shuttle Radar Topography Mapping) database from the U.S. Department of the Interior. Signal margin is a design parameter used to assure a reliable signal path when terrain and conditions can affect performance. The EMWIN radio signal is considered important but not “mission-critical” such as a public safety radio channel. A moderate fade margin (20dB) is used for this analysis.

Transmitter location and height in the service area is another key element in determining system coverage. Three possible sites have been selected for the coverage estimation process, based on conversations with Kevin Stewart. The city of Westminster’s Public Safety facility has been proposed by Mike Reddy – Westminster’s Emergency Manager. This location is a likely candidate based on the city’s willingness to provide antenna space, power, and equipment facilities at no charge. Alternate locations for the study include a hypothetical downtown building top site, and a radio tower site currently used by the Arapahoe County Sheriff. While none of these sites have been formally approved for the EMWIN system, they will provide good indications of the coverage available.

The scale on all coverage maps is held constant. Colors are used to show relative signal strengths in the service area. Black indicates the radio signal falls below the system design requirements.

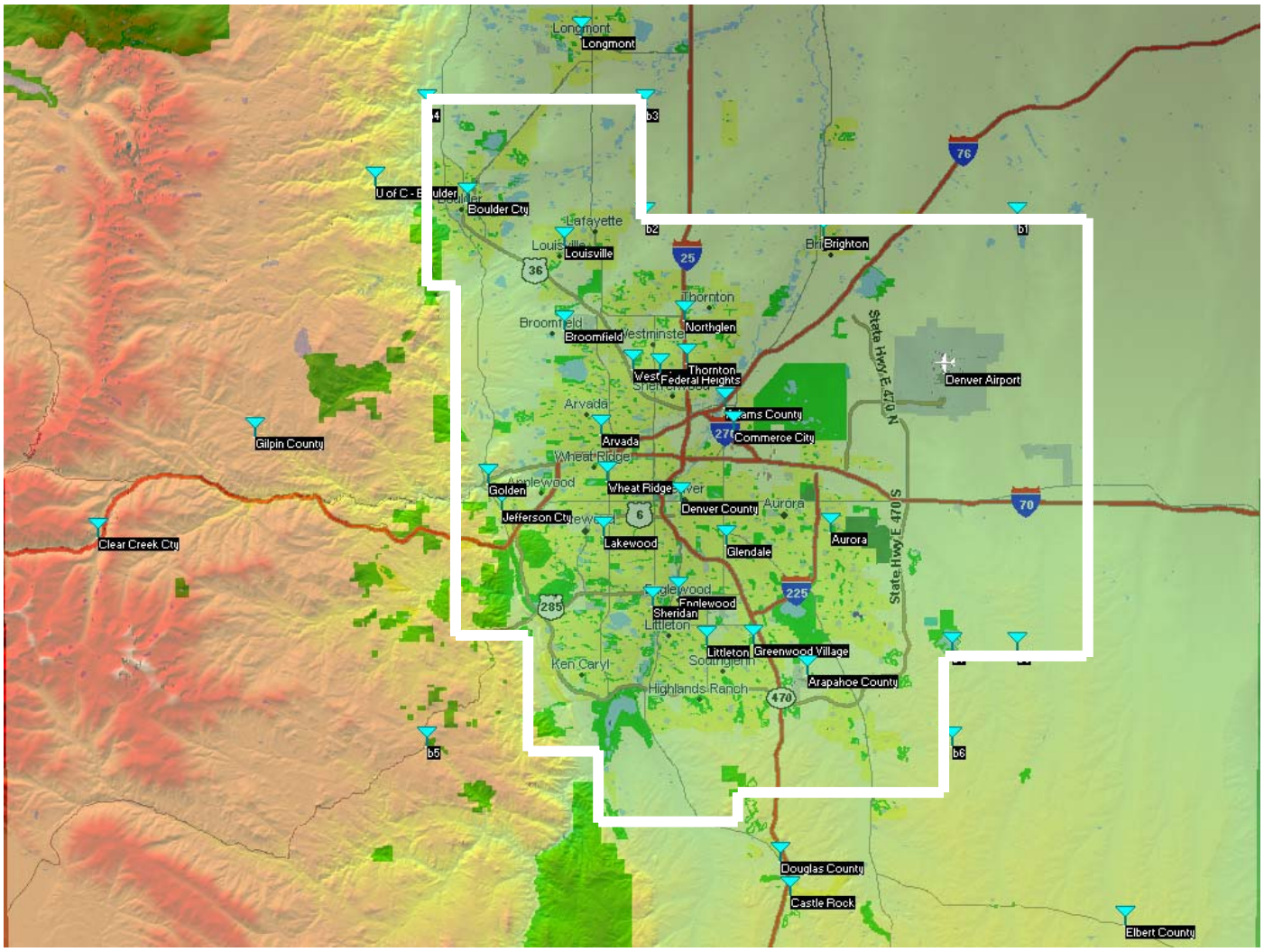

Figure 2

Figure 2 is an approximate map of the UDFCD boundaries. Location references b1 through b8 on the drawing indicate coordinates pulled from UDFCD information for boundary definition. This outline will be used on all coverage estimates to give a consistent frame of reference between the alternatives. The highlighted locations are found in the Proposed Receiver Site listing in Appendix E.

Discussion:

Westminster

The site in Westminster is on a local terrain peak. The facility is approx. 30 feet high, and provides moderate coverage for the UDFCD service area. See Figure 3.

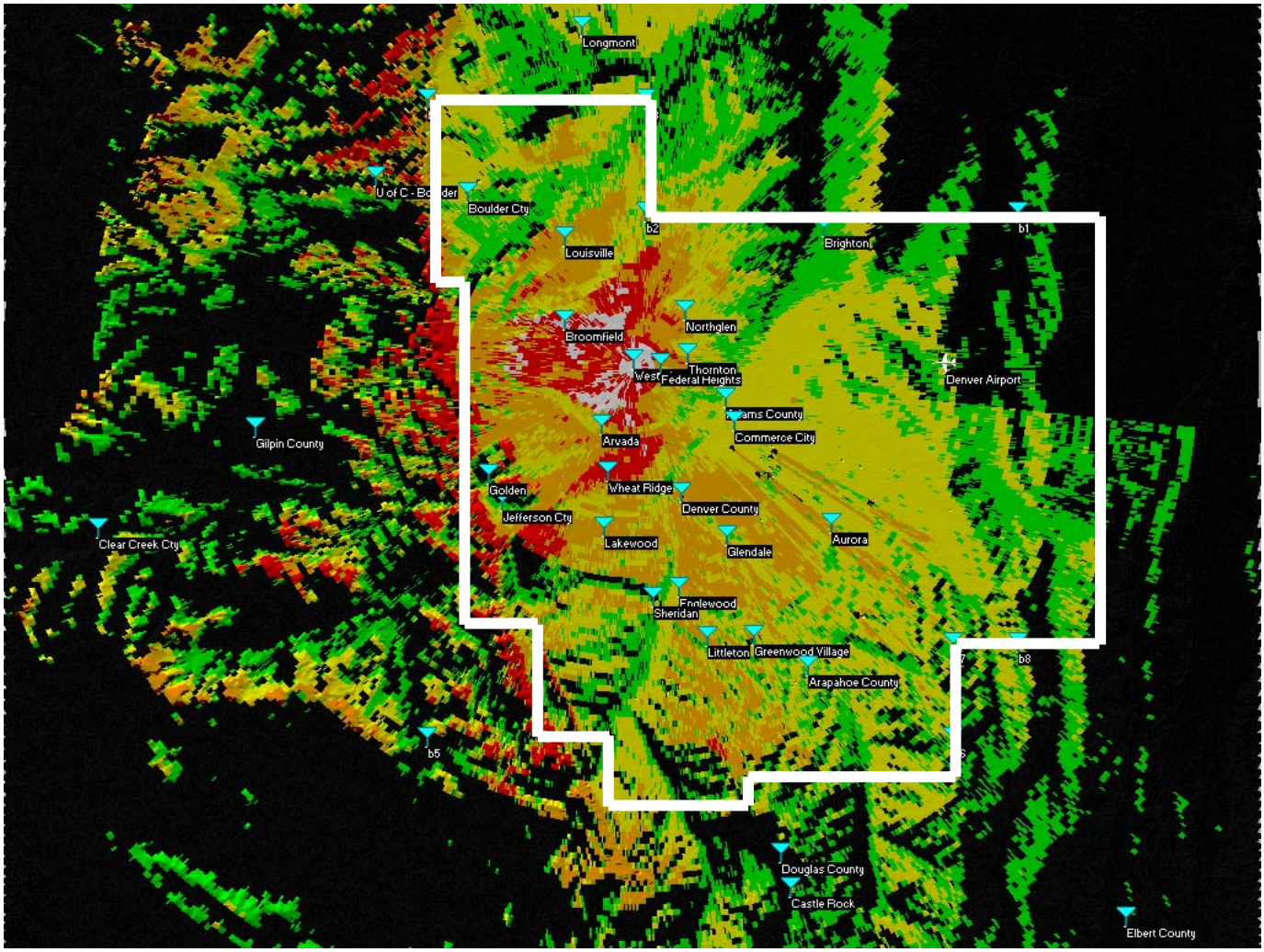

Figure 3

Signal strength estimate from the City of Westminster Public Safety Center

Overall, the signal coverage falls short in the south and northeast quadrants. Within the service area, Denver County does not meet the minimum signal requirements. Outside the service area, Castle Rock, Douglas County, Elbert County, Gilpin County, and Clear Creek County fail to meet the minimum signal requirements.

An EMWIN rebroadcast system usually requires compromise in initial implementation. The satellite downlink should be placed close to the ground and away from interference sources. Transmitters provide better coverage with increased height above ground. It may be necessary or useful to separate these functions by use of a remote radio link. Westminster would provide a prime location for the satellite downlink and computer equipment in the eventuality a downtown transmitter site is found.

Downtown Denver

At the April 22 meeting, it was suggested the emergency management community has contacts with businesses in downtown Denver. One of these contacts may be able to donate space and power for the EMWIN rebroadcast service. A specific site has not been identified to date. The Denver County office address was used as the location of a hypothetical building 200m (650 feet) in height. The downtown area is lower in elevation than Westminster, but the increased building height can provide a larger area of coverage for the EMWIN radio signal. See Figure 4.

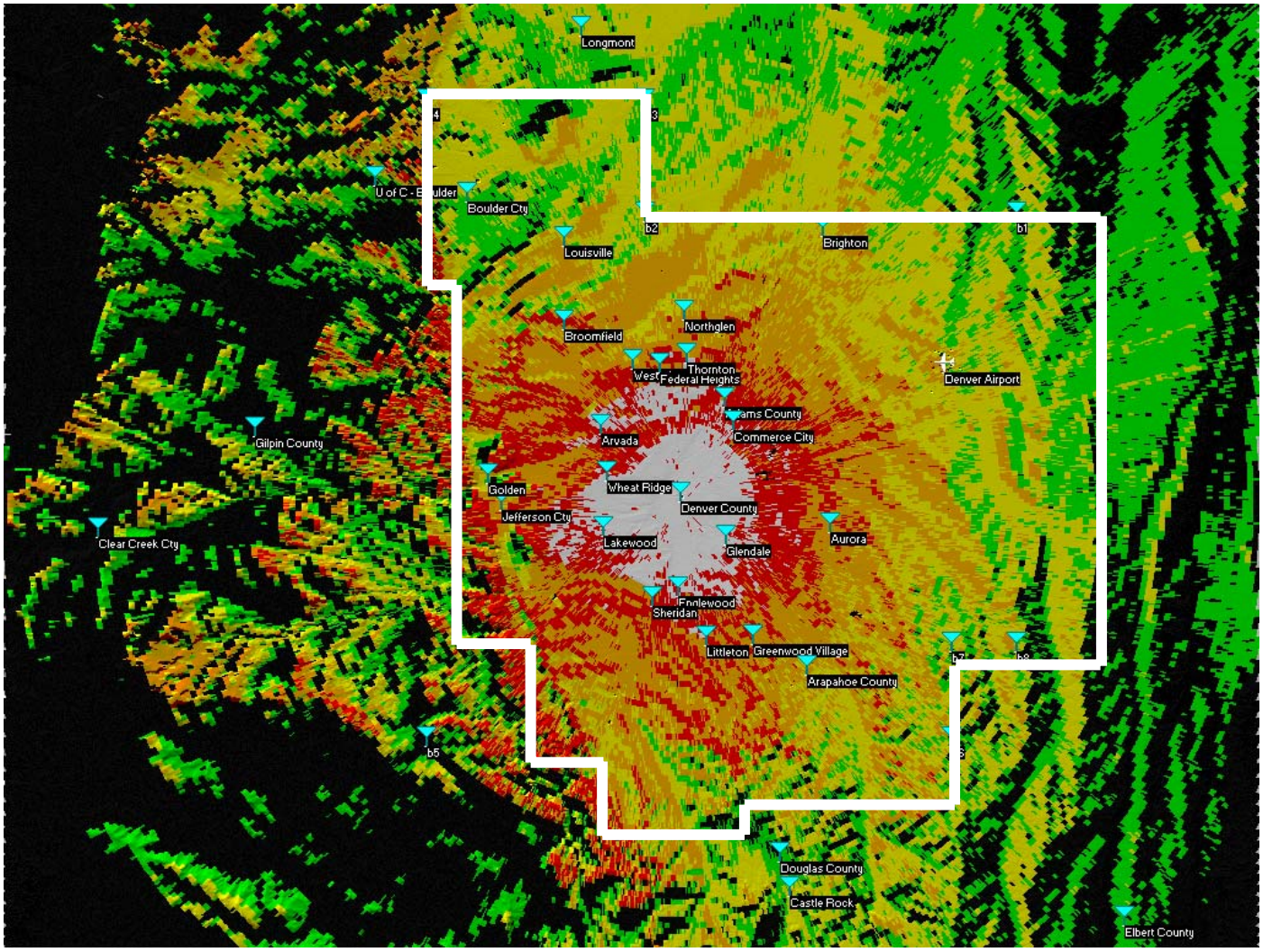

Figure 4

Signal strength estimate from a downtown Denver site.

The actual coverage will vary dependent on the height and position of any downtown site. A more specific analysis using the parameters of a site will be required if one becomes available.

A downtown site provides the best overall signal coverage, though some shortfalls occur. Within the service area, the far eastern areas have inadequate signal levels. All identified emergency management sites within the service area meet the requirements. Outside the service area, Gilpin County and Clear Creek County fail to meet the minimum signal requirements.

Arapahoe County radio tower

Arapahoe County Sheriff uses radio communications equipment at several commercial towers in the area. They have been identified as strong supporters of UDFCD initiatives, and therefore reasonable candidates to provide radio tower access for EMWIN. The tallest tower with similar radio equipment was selected based on the possibility of sharing the existing antenna and cable installation to control costs. The selected tower provides an antenna location more than 90 meters above ground. See Figure 5.

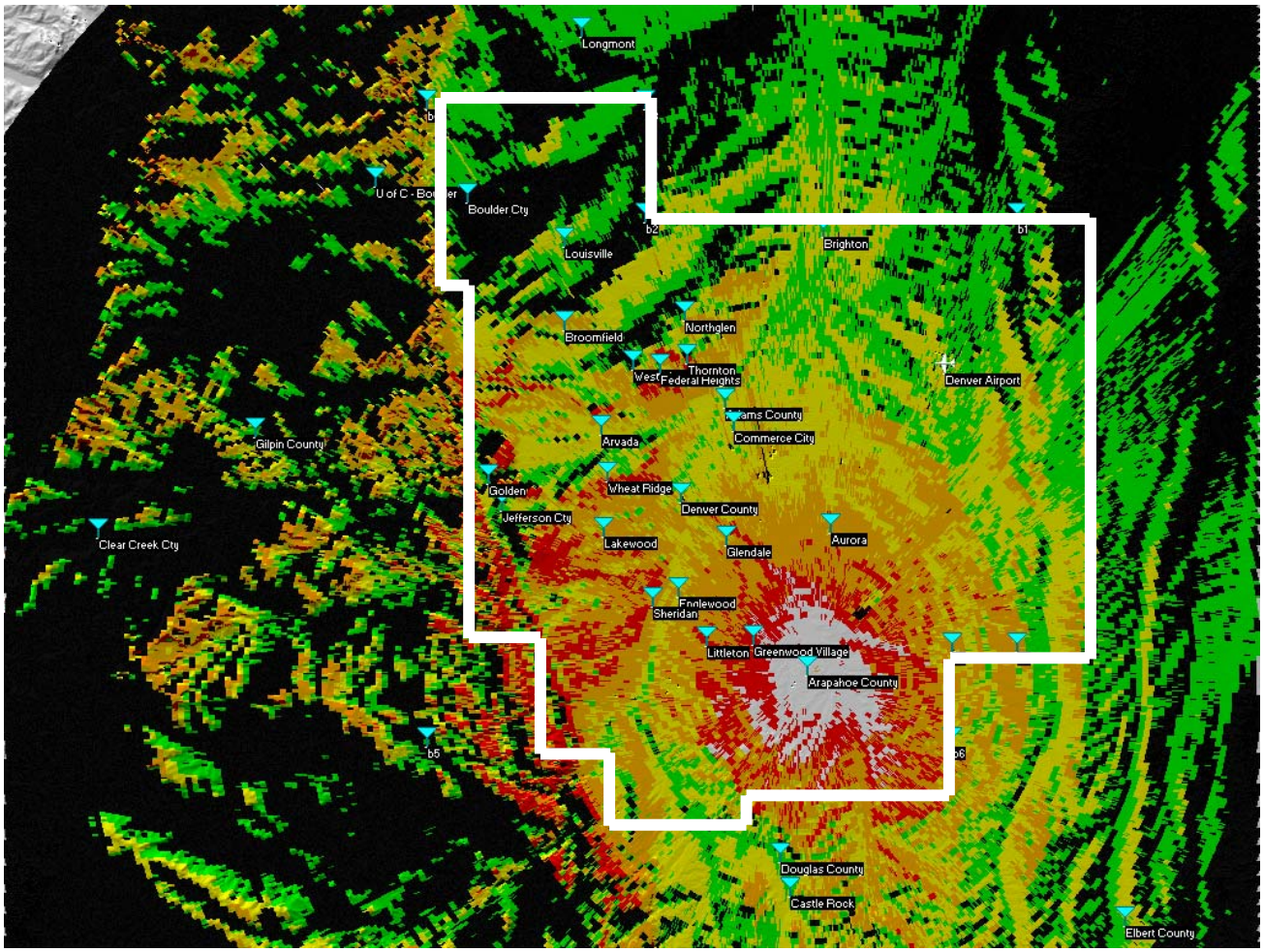

Figure 5

Signal strength estimate from an Arapahoe County radio tower.

The Arapahoe County location provides excellent signal coverage over the southern half of the UDFCD district, but falls short approaching the northern boundary. Within the service area, Boulder County and Golden do not meet the minimum signal requirements. Outside the service area, Castle Rock, Gilpin County, and Clear Creek County fail to meet the minimum signal requirements.

VI. Conclusions / Recommendations

While none of the three proposed transmitter sites provides complete coverage of the service area based on the models, a downtown Denver building-top location would deliver the most comprehensive service.

It is recommended UDFCD pursue an agreement with the city officials in Westminster for the EMWIN rebroadcast service. If Westminster will provide the necessary infrastructure resources, the location would be a reasonable start-up site – in excess of 90% of the proposed county, city and town receiver locations in Appendix E would be served based on the model presented. The location has the advantages of generator backed-up power, site security, and protected downlink space.

In parallel, efforts should be undertaken to identify a downtown Denver location for the final implementation. Westminster would provide an excellent long term downlink site and would be a logical choice for the final implementation.

It is further recommended UDFCD implement a complete EMWIN re-broadcast system over a two year period. Initially, an intermediate system including a backup computer will allow the service to meet performance expectations in the area. Supplemental equipment installations in year two deliver the components necessary to assure a highly reliable delivery system. See Appendix D.

Appendix A

EMWIN Disclaimer

NOUS90 KWBC 021530
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

DISCLAIMER

THE EMERGENCY MANAGERS WEATHER INFORMATION NETWORK /EMWIN/ DATASTREAM CONTAINS CURRENT OFFICIAL WEATHER OBSERVATIONS FORECASTS AND WARNINGS FROM GOVERNMENT SOURCES FOR USE BY THE NATIONAL AND INTERNATIONAL EMERGENCY MANAGERS COMMUNITY. BEFORE USING INFORMATION OBTAINED FROM THIS DATASTREAM SPECIAL ATTENTION SHOULD BE GIVEN TO THE DATE AND TIME OF THE DATA AND PRODUCTS. WHILE EVERY EFFORT IS MADE TO ENSURE THIS DATASTREAM IS AVAILABLE 24 HOURS A DAY SEVEN DAYS A WEEK INTERRUPTIONS MAY OCCUR.

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THE INFORMATION IN THIS DATASTREAM IS IN THE PUBLIC DOMAIN UNLESS SPECIFICALLY ANNOTATED OTHERWISE AND MAY BE USED FREELY BY THE PUBLIC.

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UNITED STATES NATIONAL WEATHER SERVICE INTERNET ACCESSIBLE SERVICES OR FOR SOURCE IDENTIFICATION OF NATIONAL WEATHER SERVICE PRODUCTS IS PROHIBITED.

OTHER DISSEMINATION SYSTEMS

OTHER NWS DISSEMINATION SYSTEMS PROVIDING MORE SECURE AND TIMELY DELIVERY OF PRODUCTS AND DATA THAT COULD BE USED DURING INTERRUPTIONS TO EMWIN ARE LISTED BELOW

NOAA WEATHER RADIO
NOAA WEATHER WIRE
FAMILY OF SERVICES
INTERNATIONAL SATELLITE COMMUNICATION SYSTEM
NOAAPORT
YOUR LOCAL NATIONAL WEATHER SERVICE FORECAST OFFICE

Appendix B

Transmitter Site Requirements

Transmitter site – outdoor equipment
Waterproof cable access to the roof – three cables max.
- 7/8" cable from transmitter cabinet to roof location for TX antenna
- ½" cable from transmitter cabinet to roof location for satellite
- ½" cable from transmitter cabinet to roof location for link receiver antenna (optional)

17 foot antenna mounted on roof structure with ground-bonding for lightning protection
- VHF transmit antenna must have clear view of the surrounding area in all directions
- 2 ½" pipe mount to roof structure

6 foot satellite "dish" antenna mounted on roof structure with ground-bonding for lightning protection
- must have clear view of the sky to the southeast and southwest
- can be mounted to a 4" pipe to the roof structure or…
- can be mounted with a 6 foot by 6 foot non-penetrating roof mount assembly and sand bags

3 foot by 3 foot directional antenna mounted to 2 ½ " pipe for link antenna (optional)
- must have clear view of the surrounding area in all directions
- can mount to same pipe as 17 foot antenna

Transmitter site – indoor equipment
120VAC power with generator-backed UPS service 2 - 15A circuits
Temperature-controlled space
2 foot by 2 foot floor space by 6 foot tall cabinet for transmitter
- 600W continuous heat load into room

2 foot by 2 foot floor space by 4 foot tall cabinet for computers – or existing rack/ table space
- 250W continuous heat load into room

Structural support to mount cabinets top and bottom

Computer connectivity to internet
FTP Access to remote servers
- Direct ftp access through firewall or…
- Approved FTP account to allow pulling FTP files through firewall

Email access to internet for system messages and alerts
- email account through local ISP or…
- Approved email account and authentication on local email server

Remote Management Access
- Open ports 5631 (TCP) and 5632 (UDP) for pcAnywhere remote management

Admin account on computer – issue only if on local intranet

Other
Reasonable access privileges to equipment for ongoing technical hardware support

Appendix C

Model parameters for Westminster

TX antenna height:	10 meters
TX antenna gain:	8 dBi
TX power:	100 Watts
Feedline loss	1 dB
RX antenna height:	3 meters
RX sensitivity:	1 microvolt
RX antenna gain:	7 dBd

Model parameters for Denver downtown

TX antenna height:	200 meters
TX antenna gain:	8 dBi
TX power:	100 Watts
Feedline loss	3.5 dB
RX antenna height:	3 meters
RX sensitivity:	1 microvolt
RX antenna gain:	7 dBd

Model parameters include:

TX antenna height:	91 meters
TX antenna gain:	8 dBi
TX power:	100 Watts
Feedline loss	4.5 dB
RX antenna height:	3 meters
RX sensitivity:	1 microvolt
RX antenna gain:	7 dBd

Appendix D
Preliminary Equipment List**

QTY	ITEM	UNIT PRICE	EXT. PRICE
1	100W VHF reconditioned transmitter	$3,200.00	$3,200.00
1	Transmit antenna 6dB gain	662.00	662.00
1	Bandpass cavity	600.00	600.00
1	single isolator 125 w	395.00	395.00
1	100 feet 7/8" feedline	754.00	754.00
2	3 foot flex jumpers	109.50	219.00
1	6 foot jumper	120.00	120.00
1	9600 bps modulator	345.00	345.00
	SUBTOTAL Transmitter		**6,295.00**
1	WX13 rx and 6' mesh dish	1,595.00	1,595.00
1	snow cover - 6 foot	159.00	159.00
1	non-penetrating roof mount	95.00	95.00
1	shipping	75.00	75.00
	SUBTOTAL Satellite Rcvr		**1,924.00**
2	Dell Computer Model 2350	1,250.00	2,500.00
1	DSL / Cable Modem	122.00	122.00
1	Ethernet Router	125.00	125.00
1	KVM Switch	99.00	99.00
2	Serial cables	14.00	28.00
3	Ethernet Cables - 6 ft	10.00	30.00
1	Ethernet cable - 25 ft.	18.00	18.00
1	RS-232 switchover unit	350.00	350.00
	SUBTOTAL Computer Equipt.		**2,846.00**
	TOTAL		**$11,065.00**

**** Notes**

1) Equipment list will be finalized after installation location is selected and interference study completed

2) Does not include shipping and handling charges except sat rcvr equipt.

3) Does not include installation labor or configuration services

Appendix E
Emergency Management Proposed Receiver Sites

THREE COUNTY REGION
Adams County
4201 E. 72nd Ave.
Commerce City, CO 80022

Broomfield
11600 Ridge Parkway
Broomfield, CO 80021

Jefferson County
800 Jefferson County Pkwy
Golden, CO 80401

City of Arvada
8101 Ralston Rd.
Arvada, CO 80001

Commerce City
5291 E. 60th Ave.
Commerce City, CO 80222

City of Federal Heights
2380 W. 90th Ave.
Federal Heights, CO 80221

City of Golden
911 Tenth St.
Golden, CO 80401

City of Lakewood
480 S. Allison Pkwy
Lakewood, CO 80226

City of Westminster
4800 W. 92nd Ave.
Westminster, CO 80031

City of Wheat Ridge
7500 W. 29th Ave.
Wheat Ridge, CO 80215
The following would be included with the above to form REGION 7

Arapahoe County
13101 ER. Bronco Pkwy.
Centennial, CO 81101

Boulder County
1805 33rd St.
Boulder, CO 80301

Clear Creek County
PO Box 2000
Georgetown, CO 80444

Denver County
1437 Bannock St.
Denver, CO 80202

Douglas County
4000 Justice Way
Castle Rock, CO 80104

Elbert County
P O Box 295
Kiowa, CO 80117

Gilpin County
P O Box 615
Blackhawk, CO 80422

City of Aurora
15151 E. Alameda Pkwy
Aurora, CO 80012

City of Brighton
22 S. 4th Ave.
Brighton, CO 80601

City of Castle Rock
300 Perry St.
Castle Rock, CO 80104

City of Englewood
3615 S. Elati
Englewood, CO 80110

City of Glendale
950 S. Birch St.
Glendale, CO 80222

City of Greenwood Village
6060 S. Quebec St.
Greenwood Village, CO 80110

City of Littleton
2415 E. Maplewood Ave.
Littleton, CO 80121

City of Louisville
749 Main St.
Louisville, CO 80027

City of Northglen
11701 Community Center Dr.
Northglen, CO 80233

City of Sheridan
4101 S. Federal Blvd.
Sheridan, CO 80110

City of Thornton
9500 Civic Center Dr.
Thornton, CO 80229

University of Colorado – Boulder
Campus Box 375
Boulder, CO 80309

Appendix F

SAMPLE EMWIN FREQUENCY ASSIGNMENT REQUEST FORM

Owner/ operator: _____
Point of Contact: _____
Organization: _____
Street Address: _____
City, State Zip: _____
TP#: _____
Fax #: _____
EMail Address: _____
Internet Address: _____

2) Transmit Antenna Location in degrees, minutes and seconds :___
Lat: Long:
Description: _____
Owner Name: _____
Street Address: _____
City, State, Zip: _____
TP#: _____
4) Height above Mean Sea Level of the terrain under antenna site in meters (Feet/3.2808): _____
5) Antenna Height above Ground in meters to the feed point (Feet/3.2808): _____
6) Transmitter Manufacturer & Model:_____
7) Frequency : _____163.3250 MHz
8) Emission Designator: _____10K0F1D
9) Transmitter Power: _____
10) Antenna Manufacturer and Type:_____

11) Antenna Gain in dBi (Decibels above an Isotropic antenna)
(Note: most antenna catalogs give the gain in DB and it really means dBd or Decibels above a Dipole. dBi
= dBd+2.11. Round to the nearest full dBi: _____dBi

11) Additional Information on site and tower, eg. Owner, other users and their frequencies:
Note: _____

Signature_____ Date_____

Name:

Position:
[freqapp.004