

ANALYSIS OF THE HART REPORT
DECEMBER 2001
(BLACK – HART REPORT, BLUE – IMPORTANT, RED – COMMENTS)

Page 1, paragraph 1 - Jefferson County engaged HARTECH, Inc. to perform a theoretical engineering study to compare the propagation of FM, NTSC TV and DTV broadcast stations located at Eldorado Mountain, Lookout Mountain, Mount Morrison and Lower Squaw Mountain over the Denver Metropolitan area. In performing the study we calculated the theoretical coverage from each site making many assumptions. These are spelled out in our analysis. We stress our conclusions are based on theoretical parameters and testing is necessary. As one of our mentors used to say “The proof of the pudding is in the eating”.

HART said that Jefferson County engaged HART to perform a study over the Denver Metropolitan area, yet you will see most information in this report discusses Boulder. Boulder is not in the mandated coverage area by the FCC. Boulder is an optional area. Boulder represents less than 5% of the Denver Metro population. Only stations **licensed to Boulder** are required to have a city grade service over Boulder such as Channel 14 TV and KBCO. Note that Mount Morrison (the Channel 14 TV site) has such a significant shadow over Boulder that two users on that site have installed Boosters or Translators to serve Boulder. Likewise some Lookout broadcasters use Translators to serve Boulder. Boulder is going to require Booster technology to be used from all sites except Eldorado. Eldorado has its own shadowing issues. Note that Mr. Hart states that his conclusions are theoretical and testing is necessary. Yet at the back, only mentions testing Squaw. **WHY WOULD ALL THE OTHER SITES BE LESS THEORETICAL AND MORE CERTAIN?** There are certainly going to be variances from the theoretical at ALL sites. Testing is the only way to be certain of the exact real coverage from ANY of the sites.

Page 2 paragraph 4- It may be observed that the metropolitan area of Denver is pretty well covered by all four sites. Mount Morrison has slightly better coverage than Lookout Mountain because the site is slightly higher in elevation. Squaw and Eldorado have the greatest area coverage because of their relative heights when compared with either Mount Morrison or Lookout Mountain. There are holes in the coverages from each site. Some, we believe, are more important than others. The Eldorado site has excellent coverage of Boulder, Lookout Mountain and Mt. Morrison have slightly less Boulder coverage, and Lower Squaw Mountain’s Boulder coverage is quite poor due to the mountain shadowing. The Lower Squaw Mountain site has good coverage particularly for the TV and DTV stations excepting near the foothills and probably extends close to the east state line although our analysis stopped at 120 miles east of the site. It is noted there is a dip in the terrain.

Please note while the report states Eldorado has excellent coverage in Boulder and that Lookout and Mt. Morrison have slightly less and that Squaw is quite poor. In reality it doesn't matter whether you get 40% or 70% of Boulder, it is projected that Lookout, Mount Morrison and Squaw Mountain will ALL put a Booster in that area, which is evidenced by the existing Translator/Booster technology being used in Boulder now. See the attached sheet on Booster/Translators. **On Lookout, Channel 6 TV, Channel 31 TV, 95.7 FM and 103.5 FM all presently have Booster equipment in Boulder in order to obtain Boulder coverage. Both Channel 20 TV and 100.3 FM from Mt. Morrison also presently have Boosters or Translators in Boulder.** So there are two basic areas to look at in the above paragraph; one is Boulder is not in the area that is mandated by the FCC and two, that there is technology that can allow the broadcasters, regardless of the site whether it be Squaw, Lookout, Mt. Morrison or Eldorado to achieve coverage in any shadowed area. In addition, the last line states Squaw Mountain has good coverage particularly for the TV and DTV, except near the Foothills. Please note, while Squaw Mountain's shadowing is in Boulder and the Foothills, every site due to Colorado's topography, has shadowing (including Eldorado). Please see the study on Boosters and shadows attached. You will note Squaw Mountain only needs 2-3 Boosters to get blanket coverage while Eldorado needs 3- 5, Lookout 3-4, Mt. Morrison 4-5. In addition, the end of that last sentence in that paragraph, I believe what Hart is trying to state which is not quite clear, is that Squaw Mountain's coverage not only gets the Greater Denver Metropolitan area but extends to **NEAR** the East state line. It's just that his analysis stopped short of where Squaw's coverage would continue to extend.

Page 3 - The ranking of the sites by coverage areas are:

Squaw Mountain
Eldorado Mountain
Mt. Morrison
Lookout Mountain

Page 3 - The two paragraphs on page three, the first one deals with Channel 12 and that they need a Boulder TV Booster/Translator. Please see the letter from the Chief Engineer for Channel 12. This Chief Engineer for Channel 12 is in charge of designing the DTV site and ordering the equipment. He has performed all the studies and is very pleased with the coverage that Channel 12 presently achieves with their Analog and what he predicts he will get with DTV from Squaw Mountain. Note, that Channel 32 just turned on with HDTV on Lookout Mountain and it is reported they don't get Boulder. When there's enough high definition programming viewers, it would be very likely there will be an on-channel Booster added to fill Channel 32's (FOX32) signal into Boulder (for the same reason FOX31 uses a Translator to cover Boulder now!). The next paragraph talks about Translators and yes, Translators at this time are almost impossible to get. While they work, Translator frequencies are not available but the on channel Booster always has a channel available.

Page four; the first paragraph says that Squaw Mountain would not get satisfactory reception in Boulder. Yes that is true but the statement is also clearly true of Lookout, and Mount Morrison given the large number of boosters and translators serving Boulder...And that is never mentioned in this report.

Page 4, paragraph 2 – this paragraph deals with Boosters. Mr. Hart is concerned that Boosters must be perfectly synchronized. The Merrill Weiss Report, which was hand delivered to Mr. Hart's office on December 7th, should alleviate the concerns about on-channel Boosters for DTV. While I believe Mr. Hart is taking the half empty glass approach on Boosters, HDTV is a new technology so therefore there will continue to be new and updated equipment to enhance HDTV. Also, I believe what needs to be addressed is that there are several engineers nationally testing several different systems. What is not mentioned in this report is that both of Squaw's areas of shadowing are isolated from the main coverage and isolation is when a Booster works the very best. There are many DTV booster methods being tried and so far all are successful. There will be many ways to solve any real coverage problems.

Page 6, paragraph 3 – Eldorado Mountain, Mt. Morrison and Lookout Mountain have direct LOS to most of the metropolitan areas. Some communities close to the mountains are shadowed from the Squaw Mountain sites and the signals are diffracted by the intervening mountains.

The areas of note on page 6 is that Mr. Hart only points out Squaw's area of shadow or diffraction and unfortunately left out all the shadowed areas on **Eldorado** which are; Golden, Lakewood West, Green Mountain South and East, Morrison and Ken Caryl. The shadowing areas for **Lookout** which are; Boulder South and West, Broomfield West, Morrison, Green Mountain Southeast, Ken Caryl Southwest (Golden from Lookout is one of their worse coverage areas due to diffraction that is why cable penetration is so high in the Golden area). The shadowing areas for **Mt. Morrison** which are; Boulder, Broomfield West, Golden, Lakewood NW, Ken Caryl West. The bottom line is it doesn't matter what site you're from since all sites have shadowing. Only the exact location of the shadow varies. Everywhere there is a shadow, there will be some defraction and some multipath filling in the signal in that particular shadow. It is the same for each shadow from each and every site not just from Squaw.

Page 7, paragraph 2

<u>Receiving Site</u>	<u>Transmitting Site</u>	<u>Diffraction Loss</u>
Green Mountain Village	Eldorado Mountain	0 dB
	Lookout Mountain	0 dB
	Mt. Morrison	0 dB
	Lower Squaw Mountain	26 dB

Littleton	Eldorado Mountain	0 dB
	Lookout Mountain	0 dB
	Mt. Morrison	0 dB
	Lower Squaw Mountain	0 dB
Boulder	Eldorado Mountain	0 dB
	Lookout Mountain	8.4 dB
	Mt. Morrison	8 dB
	Lower Squaw Mountain	30 dB

Note there was a comparison done for Green Mountain Village, however the interesting thing is Eldorado Mountain is shadowed in Green Mountain Southeast, Lookout is shadowed in Green Mountain Southeast and Squaw Mountain is shadowed in Green Mountain East. Keep in mind these are only three very specific and narrow examples, if you picked three other places in town, Squaw might have been the best and any one of the other sites might have been the worst and vice versa. There is a location to fit any conclusion you want to make, but three points do not make a credible picture of the coverage of Metro Denver.

Conclusions

1. In our analysis for FM, NTSC TV and DTV, all four sites appear to have good coverage of the Denver Metropolitan area with the exception of a few holes. We are concerned about DTV transmission from Lower Squaw Mountain to the western metro area suburbs and to Boulder. We do not think a DTV station at the Lower Site will adequately cover Boulder.

Mr. Hart is right. **All four sites do have good coverage in the Denver Metropolitan area.** We also agree that Squaw Mountain will not get into Boulder unaided, but note that Mr. Hart only mentions that Squaw Mountain doesn't get into Boulder, when in reality if you look at the documentation that is attached, Lookout Mountain and Mt. Morrison do not get into Boulder well either. So while we agree with Mr. Hart's summary that
for FM, NTSC TV and DTV, all four sites appear to have
good coverage of the Denver Metropolitan area with the exception
of a few holes.

We point out that he stopped short and did not put in the extra effort to show that ALL SITES have "a few holes". Mr. Hart also mentions his concern for Squaw Mountain covering the Western Metropolitan suburbs. Yes, while it is also true that our second shadowed area is the strip along the foothills, Hart neglected to show the shadows that all the other sites have, The shadowing for **Eldorado** is; Golden, Lakewood West, Green Mountain South and East, Morrison and Ken Caryl. Shadowing for **Lookout** is; Boulder South and West, Broomfield West, Morrison, Green Mountain Southeast, Ken Caryl Southwest (Golden from Lookout is one of their worse coverage areas due to diffraction that is why cable penetration is so high in the Golden area). Shadowing for **Mt. Morrison** is; Boulder, Broomfield West, Golden, Lakewood NW, Ken Caryl West.

2. Channel 12 at the Upper Squaw Mountain site with its antenna center of radiation about 640 feet above the Lower Squaw Mountain has reports of some reception problems in the Foothills. A TV Translator is used to cover Boulder. Since it is assumed the propagation will be poorer at Lower Squaw Mountain, it is problematic whether DTV stations will have optimum coverage for the western edge of the Denver metro area.

This is addressed fully in question number 1 above.

3. The licensing of FM or TV Translators is frozen by the FCC so no new Translator applications are allowed. Even if they were allowed, there are no frequencies available in the Denver area at this time. Frequencies will be available after the NTSC stations are taken off the air. NTSC stations will not be turned off until there is an 85% DTV penetration.

While Translators work, we agree that the frequencies are frozen. Therefore DTV on-channel Boosters will be utilized where fill in is needed.

4. DTV Boosters are being developed which may be used to cover DTV station holes. There are practically no NTSC TV Boosters in service at this time because of feedback problems. The susceptibility to multipath and effectiveness of DTV Boosters is not yet known. Only experimental Boosters exist today. There are no FCC regulations at this time to cover the licensing DTV Booster.

On-channel DTV Boosters are not just a problem for the Denver area, this is a nationwide issue. That is why there are several people in the field who have experimental licenses through the FCC for testing on-channel DTV Boosters. The ATTC Test that was performed in 1999 in a mountainous area for an on-channel Booster was very successful. The Merrill Weiss Report should alleviate any concerns Mr. Hart has about synchronization of on-channel DTV Boosters. But whether the shadowing is on Squaw or Lookout or one of the other sites, you can be assured that the broadcasters will have the technology available to cover any areas THEY feel are important enough to fill in.

5. We believe if Jefferson County were to approve towers at the Eldorado Mountain, Lookout Mountain or the Mt. Morrison site, any of them could handle all the Denver FM, TV and DTV broadcast stations and with the property antennas meet the NIER and NRQZ standards. Assuming three 200-foot towers have been approved by Clear Creek County zoning at Lower Squaw Mountain we believe all the FM and DTV stations could be accommodated there enough multiplexing the stations on a few antennas.

Yes, we concur. Squaw Mountain can accommodate all the FM TV and DTV stations in the Denver area.

6. Using profiles it may be seen there are direct lines of sight between the Eldorado Mountain, Lookout Mountain and Mt. Morrison sites to most Denver metropolitan community locations. LOS's between Lower Squaw Mountain and Foothills communities, including Boulder, have terrain blockage causing signal diffraction losses. The diffracted signals may be below the threshold of DTV receivers and multipath reflections could impair HDTV picture reception.

This is more of an isolated opinion than a supported conclusion since the viewers do not all live at those few sample locations. In order to do an valid study it is necessary at least to superimpose a grid across the community evenly spaced with a minimum of one study point for each ten thousand people...or at least 210 sample points all over the populated areas. Then it would be possible to score the advantage or disadvantage of any site.

Therefore we concluded, based on our study, the best sites for FM, NTSC TV and DTV transmission facilities are Eldorado Mountain, Lookout Mountain and/or Mt. Morrison providing they utilize adequate antennas to meet the NRQZ and NIER standards. The Lower Squaw Mountain has the potential to serve the area but we recommend field test be conducted to make sure reflected and diffracted signals are acceptable for HDTV receivers used in the metropolitan western foothill areas.

Again I am puzzled why no other site should be tested since all sites have shadows over populated areas...only the addresses of the shadowed viewers will be different. Do some viewers not count? And ALL shadows will have diffracted signals and multipath signal problems. ALL theoretical studies vary from the real world somewhat and actual test WILL define how things really work. But no one with an application pending before Jeffco would dare show that some other site is useable or accept the results of such a test if SQUAW were to run it. To be acceptable beyond question such a test would have to be run by someone not owning any of the sites and should be run for ALL sites. Let the chips fall where they may. In my professional opinion such a test will show the following: **All sites will have populated pockets of substandard reception** with total populations effected varying from 1.5 to 5% of the total. Essentially it will show that **all sites provide competitive coverage of the Denver Metropolitan area.** The broadcasters will have the technology available to fill in any of these pockets that they feel are significant.

Even though one does a theoretical study and analysis, the real world may be quite different because it is impossible to take all variables into account.

True. No theoretical analysis can replace a definitive test comparing the same facility on each of the sites. Such a test will reveal what the Hart report correctly summarized:

Page2 Paragraph4- "the metropolitan area of Denver is pretty well covered by all four sites."

Respectfully submitted,
Timothy C. Cutforth P.E.
22 February 2002