

*excerpts from*  
Further Report on  
Analog SCA Compatibility with iBiquity Digital's  
FM-IBOC System

Tests Performed at the Advanced Television Technology Center, Alexandria, Virginia  
March, 2002

**Project Participants and Observers**

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## Executive Summary

During 2001 the National Radio System Committee (NRSC) conducted tests to evaluate the compatibility of iBiquity Digital's FM IBOC system with analog subcarrier (SCA) operations. National Public Radio (NPR), and the International Association of Audio Information Services (IAAIS) represent members who operate SCA analog facilities. The IAAIS represents over 100 radio reading services for the blind and print-disabled. NPR provides programming and representation to over 640 public radio stations, many of which operate SCAs. Reading services in thirteen of the top sixteen radio markets utilize subcarriers of NPR member stations.

During NRSC deliberations, NPR and the IAAIS noted the inconclusiveness of test results concerning analog SCA compatibility with IBOC transmissions. The parties suggested the need for additional data points to achieve greater resolution and a better understanding of the likely interference consequences to analog SCAs of a mass deployment of IBOC transmissions in the FM band. Additional information was sought to analyze the effects of IBOC transmission on subcarriers operating on different frequencies (e.g. 92-kHz vs. 67-kHz) and design variables affecting the relative susceptibility or immunity of different SCA receivers.

iBiquity Digital volunteered to fund further tests to help resolve these concerns and sought to conduct the tests as expeditiously as possible for their consideration by the FCC during the current comment period on terrestrial digital radio. IAAIS provided ten SCA receivers believed to be representative of those currently in use. iBiquity, IAAIS, NPR and Advanced Television Technology Center (ATTC) staff, as well as outside consultants to all parties, collaborated in shaping test criteria and observing the tests that were performed by the ATTC during February and March 2002. Additionally, multipath issues were raised as a significant factor affecting SCA performance and additional work was done to analyze the audible effects of multipath on SCA performance. The ATTC's documented test plan and summarized test results were included in iBiquity Digital's filing before the FCC on this matter dated 13 May 2002.

At the conclusion of testing, NPR contracted with V-Soft Engineering of Cedar Falls, Iowa to model the results in the top sixteen radio markets using Longley/Rice propagation predictions and incorporating predictions from the test data about SCA analog receiver performance. In addition to revealing areas and populations where terrain effects would limit reception, areas and populations were calculated and plotted where coverage would be limited by existing analog adjacent channel interference, as well as the areas and populations calculated to lose coverage due to new IBOC interference (assuming all 1<sup>st</sup> and 2<sup>nd</sup> adjacent channel stations were transmitting IBOC signals). The performance characteristics of the SCA receivers were fairly closely grouped, and an average of their performance was used in generating the predictive impact maps. The coverage studies were projected to extend to the 54-dBu contour, based on an assessment that few SCA receivers are in use beyond this contour without the aid of outdoor antennas or cable FM input. This assumption was tested for four markets where actual SCA receiver distribution was available by Zip Code. Several of these maps are attached.

A tabular summary of the raw population counts within the projected SCA reception areas, the areas and populations delimited by existing analog interference, and the new areas and populations projected to be interfered with by the addition of FM-IBOC is included as Attachment B. Pie-charts representing these effects on the populations of each of the markets studied are included as Attachment C.

On average, the added IBOC-interference effect, based on population, was projected at 2.6%. This figure varied considerably, from as low as 0.3% in markets with relatively flat terrain and high transmitter power and antenna height to 8.5% in the Los Angeles market on station KPCC. In general, lower power stations suffer greater interference, both from adjacent analog stations, as well as from new potential IBOC interference.

There appeared to be no discernible distinction in the susceptibility of 92-kHz SCA receivers versus 67-kHz receivers. Additionally, second adjacent channel interference contributed the bulk of interference attributable to IBOC operations. Apparently, first adjacent channel IBOC interference was effectively “masked” by the analog interferer, whereas IBOC energy added to second adjacent station’s signal contributed a measurable increase in undesired signal competing with the capture of the desired SCA signal.

## Stations Studied

NPR sought to map the SCA coverage for radio reading services in the top sixteen radio markets, as reported by Arbitron. These sixteen markets presumably represent a fairly large number of SCA users and balance the need for a manageable number of individual studies against a large enough pool to assure a representative cross-section.<sup>1</sup> The number was chosen to assure the inclusion of several markets characterized by irregular terrain, relatively low transmitter power, varying band congestion, and varying population densities. The study includes:

New York —WNYC-FM<sup>2</sup>  
Los Angeles—KCSN-FM, Northridge  
**Los Angeles—KPCC-FM, Pasadena (significant impact)**  
Chicago—WBEZ-FM  
San Francisco—KALW-FM<sup>3</sup>  
Dallas—KERA-FM  
Philadelphia—WHYY-FM  
Houston—KUHF-FM  
**Washington, DC—WETA-FM (moderate impact)**  
Boston—WERS-FM, Boston  
Boston—WATD-FM, Marshfield<sup>4</sup>  
Detroit—WDET-FM  
Atlanta—WABE-FM  
Miami—WLRN-FM  
Seattle—KUOW-FM  
**Phoenix—KJZZ-FM (minimal impact)**  
Minneapolis—KNOW-FM  
San Diego—KPBS-FM

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<sup>1</sup>As a confidence check on predicted versus real-world performance, three additional markets were mapped, Pittsburgh, Pennsylvania (WDUQ-FM), Roanoke, Virginia (WVTF-FM), and Cedar Falls, Iowa (KHKE-FM) due to market familiarity of project participants.

<sup>2</sup>WNYC-FM, in the aftermath of the loss of transmission facilities at the World Trade Center, is currently operating from 4 Times Square. The Empire State Building, for which a construction permit is being sought, was mapped as the operative longer-term site at 6-kw.

<sup>3</sup>KALW-FM was mapped, although it reportedly no longer is the provider for the Rose Resnick Lighthouse for the Blind, which has now moved to an SAP channel. Since San Francisco is notoriously tough on radio reception the exercise was deemed of value for the depiction of complex terrain.

<sup>4</sup>WERS-FM, as well as WATD-FM were mapped as WATD covers the area to the south of Boston and originates the Talking Information Center broadcasts carried by WERS and other stations around Massachusetts. This study was especially instructive due to the high degree of predicted analog interference.

# KPCC - Subcarrier Interference - Analog vs IBOC Hybrid

**KPCC, CH 207, 89.3 MHz**

Contours= 60 & 54 dBu

BLED19880708KB

Latitude: 34-13-35 N

Longitude: 118-03-58 W

Power: 0.60 kW

AMSL Height: 1783.0 m

KAAT = 891 m

Elevation: 1672.18 m

Horiz. Pattern: Omni

Vert. Pattern: No

Prop Model: Longley/Rice

Climate: Cont temperate

Conductivity: 0.0080

Dielec Const: 8.0

Refractivity: 315.0

Receiver Ht AG: 5.0 m

Receiver Gain: 0 dB

Time Variability: 50.0%

Sit. Variability: 50.0%

ITM Mode: Broadcast

54-dBu Coverage Area:

pop. = 12,670,407

area = 11,431.3 sq. km

Terrain Blockage loss

pop. = 162,903

area = 533.8 sq. km

25 dB WQP SNR

Analog Int. loss

pop. = 2,441,731

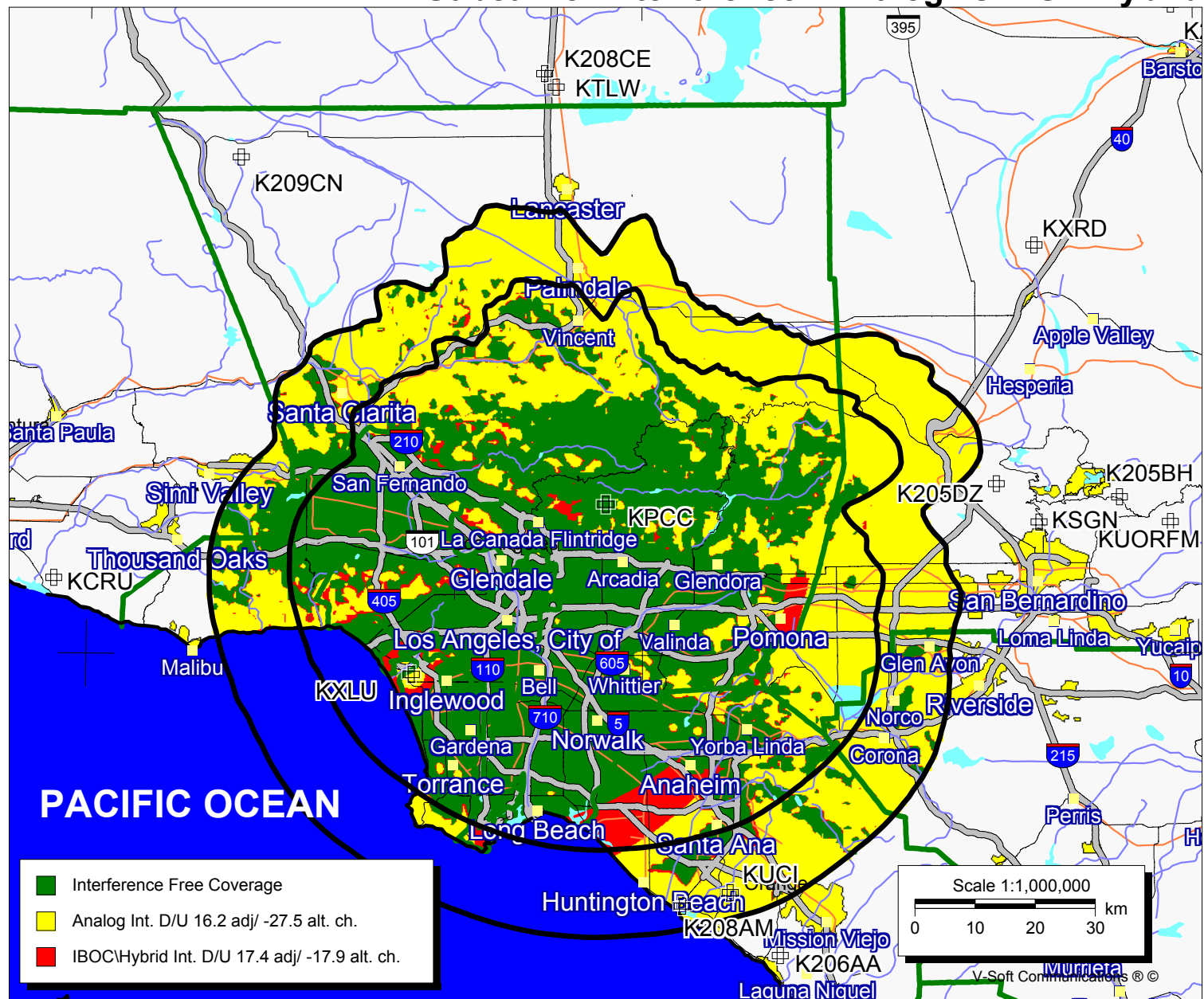
area = 5,846 sq. km

Hybrid IBOC Int. loss

pop. = 858,758

area = 647.5 sq. km

Int Free Pop. %= 8.48 %



- Interference Free Coverage
- Analog Int. D/U 16.2 adj/ -27.5 alt. ch.
- IBOC/Hybrid Int. D/U 17.4 adj/ -17.9 alt. ch.

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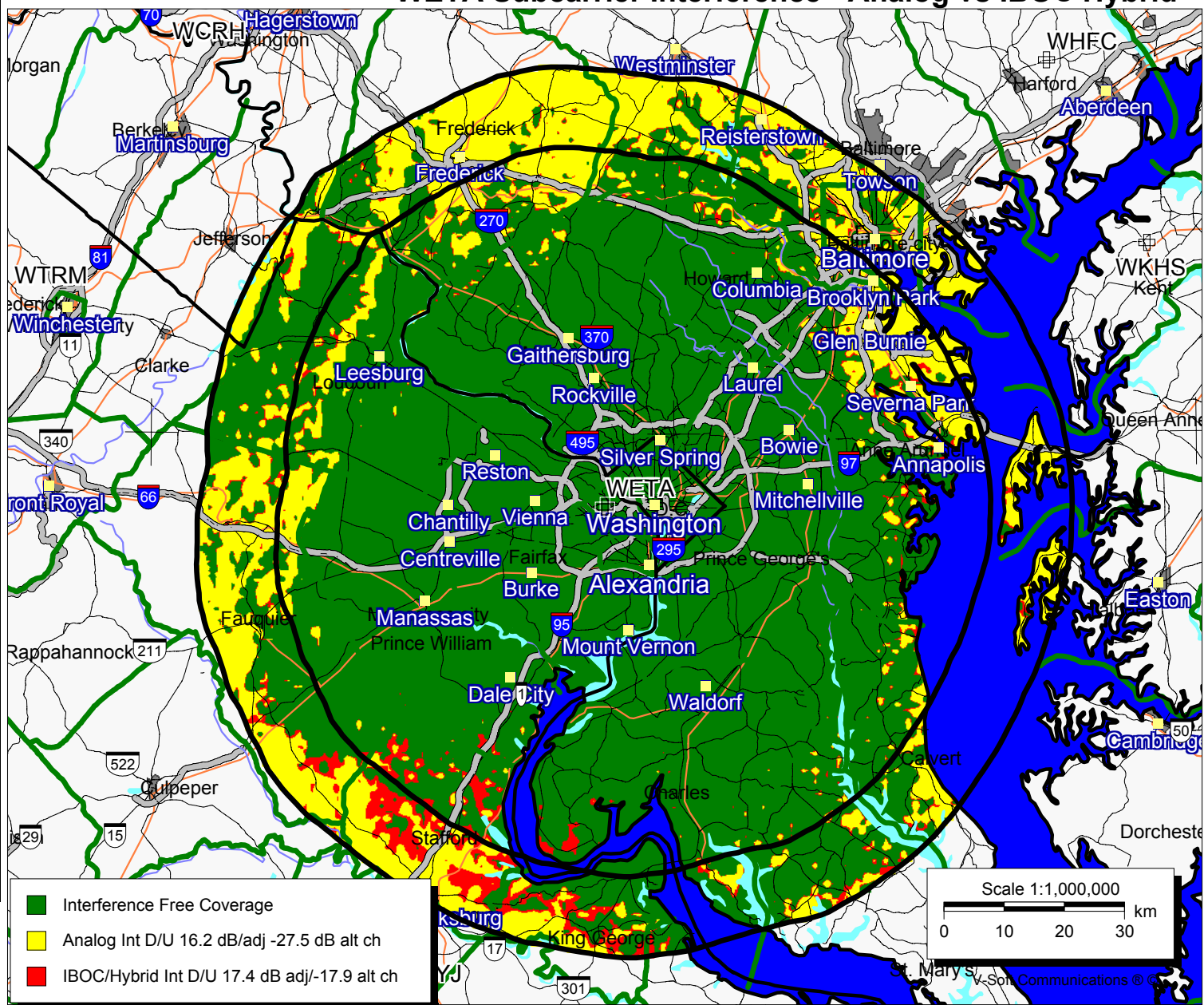
# WETA Subcarrier Interference - Analog vs IBOC Hybrid

## WETA, CH 215, 90.9 MHz

Contours = 54 and 60 dBu  
 BMLED19900315KB  
 Latitude: 38-53-30 N  
 Longitude: 077-07-55 W  
 Power: 75.00 kW  
 AMSL Height: 252.0 m  
 HAAT = 186 m  
 Elevation: 121.41 m  
 Horiz. Pattern: Omni  
 Vert. Pattern: No  
 Prop Model: Longley/Rice  
 Climate: Cont temperate  
 Conductivity: 0.0040  
 Dielec Const: 4.0  
 Refractivity: 311.0  
 Receiver Ht AG: 5.0 m  
 Receiver Gain: 0 dB  
 Time Variability: 50.0%  
 Sit. Variability: 50.0%  
 ITM Mode: Broadcast

54-dBu Coverage Area:  
 pop. = 6,481,338  
 area = 16,684.6 sq. km  
 Terrain Blockage loss  
 pop. = 57,732  
 area = 41.8 sq. km

25 dB WQP SNR  
 Analog Int. loss  
 pop. = 1,182,367  
 area = 4,214.7 sq. km  
 Hybrid IBOC Int. loss  
 pop. = 122,621  
 area = 630.4 sq. km  
 Int Free Pop. % = 2.31%



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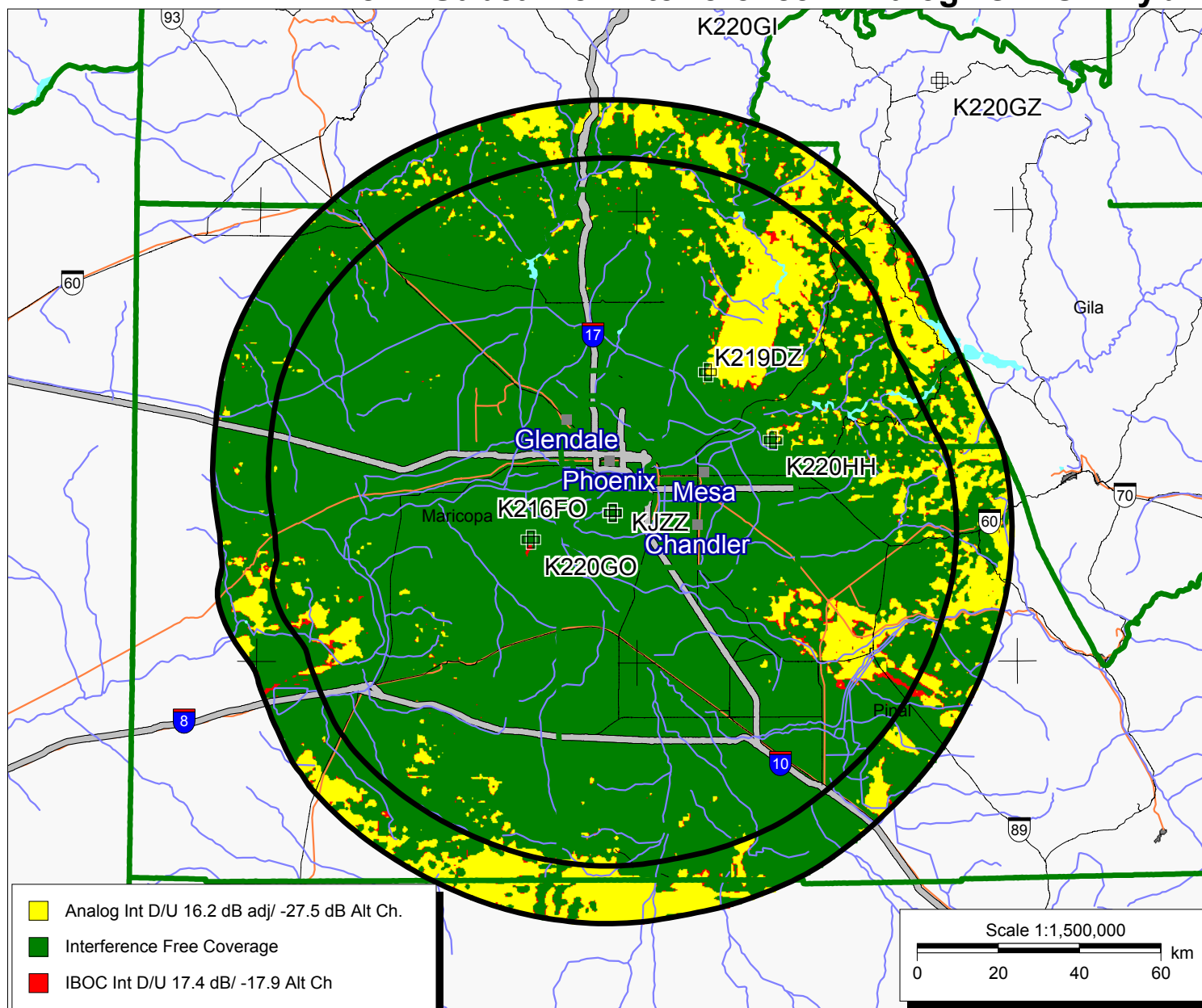
# KJZZ Subcarrier-Interference - Analog vs IBOC Hybrid

## KJZZ, CH 218, 91.5 MHz

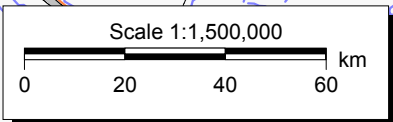
Contours= 60 & 54 dBu  
 BLED19890728KA  
 Latitude: 33-19-58 N  
 Longitude: 112-03-53 W  
 Power: 100.00 kW  
 AMSL Height: 856.0 m  
 HAAT= 490 M  
 Elevation: 728.61 m  
 Horiz. Pattern: Omni  
 Vert. Pattern: No  
 Prop Model: Longley/Rice  
 Climate: Cont temperate  
 Conductivity: 0.008  
 Dielec Const: 8.0  
 Refractivity: 300.0  
 Receiver Ht AG: 5.0 m  
 Receiver Gain: 0 dB  
 Time Variability: 50.0%  
 Sit. Variability: 50.0%  
 ITM Mode: Broadcast

### 54-dBu Coverage Area:

pop. = 3,233,062  
 area = 31,305.9 sq. km  
 Terrain Blockage loss  
 pop. = 1,721  
 area = 1,308.2 sq. km  
 Analog Int. loss  
 25 dB WQP SNR  
 pop. = 24,551  
 area = 6,742.9 sq. km  
 Hybrid IBOC Int. loss  
 pop. = 8,597  
 area = 258 sq. km  
 Int Free Pop. %= 0.26%



- Analog Int D/U 16.2 dB adj/ -27.5 dB Alt Ch.
- Interference Free Coverage
- IBOC Int D/U 17.4 dB/ -17.9 Alt Ch



**Appendix B  
SCA Data Tabulation**

Arbitron Market Rank	Market Name	Station	Area Within Predicted 54-dBu Contour (sq. km)	Area Within Predicted 54-dBu Contour with Signal Blocked by Terrain (sq. km)	Area Within Predicted 54-dBu Contour with Signal Blocked by Terrain (%)	Area Within Predicted 54-dBu Contour with Signal Impaired by Analog Interference (sq. km)	Area Within Predicted 54-dBu Contour with Signal Impaired by Analog Interference (%)	Area Within Usable Analog Signal Coverage Area with Signal Impaired by Hybrid IBOC Interference (sq. km)	Area Within Usable Analog Signal Coverage Area with Signal Impaired by Hybrid IBOC Interference (%)	Population Within Predicted 54-dBu Contour	Population Within Predicted 54-dBu Contour with Signal Blocked by Terrain	Population Within Predicted 54-dBu Contour with Signal Blocked by Terrain (%)	Population Within Predicted 54-dBu Contour with Signal Impaired by Analog Interference	Population Within Predicted 54-dBu Contour with Signal Impaired by Analog Interference (%)	Population Within Usable Analog Signal Coverage Area with Signal Impaired by Hybrid IBOC Interference	Population Within Usable Analog Signal Coverage Area with Signal Impaired by Hybrid IBOC Interference (%)
1	New York (ESB CP)	WNYC	13,612.4	17.5	0.1%	4,570.4	33.6%	510.1	5.6%	16,841,430	63,980	0.4%	1,984,697	11.8%	255,676	1.7%
2	Los Angeles	KCSN	4,543.7	27.2	0.6%	2,486.5	54.7%	124.0	6.0%	4,948,575	21,733	0.4%	2,423,291	49.0%	204,256	8.1%
<b>2</b>	<b>Los Angeles</b>	<b>KPCC</b>	<b>11,431.3</b>	<b>533.8</b>	<b>4.7%</b>	<b>5,846.0</b>	<b>51.1%</b>	<b>647.5</b>	<b>11.6%</b>	<b>12,670,407</b>	<b>162,903</b>	<b>1.3%</b>	<b>2,441,731</b>	<b>19.3%</b>	<b>858,758</b>	<b>8.4%</b>
3	Chicago	WBEZ	13,480.6	0.0	0.0%	2,980.9	22.1%	420.0	4.0%	8,334,373	1,913	0.0%	872,746	10.5%	127,647	1.7%
4	San Francisco	KALW	6,727.5	1.9	0.0%	2,907.2	43.2%	260.7	6.8%	3,791,451	8,987	0.2%	1,489,312	39.3%	142,077	6.2%
5	Dallas/Ft. Worth	KERA	26,716.0	2.1	0.0%	4,217.1	15.8%	1,010.2	4.5%	5,223,979	4,084	0.1%	1,247,915	23.9%	51,895	1.3%
6	Philadelphia	WHYY	13,137.3	31.4	0.2%	3,228.1	24.6%	383.0	3.9%	6,224,057	61,129	1.0%	810,704	13.0%	128,410	2.4%
7	Houston/Galveston	KUHF	33,244.4	0.0	0.0%	1,238.4	3.7%	439.0	1.4%	4,771,581	478	0.0%	28,926	0.6%	25,128	0.5%
<b>8</b>	<b>Washington</b>	<b>WETA</b>	<b>16,684.6</b>	<b>41.8</b>	<b>0.3%</b>	<b>4,214.7</b>	<b>25.3%</b>	<b>630.4</b>	<b>5.1%</b>	<b>6,481,338</b>	<b>57,732</b>	<b>0.9%</b>	<b>1,182,367</b>	<b>18.2%</b>	<b>122,621</b>	<b>2.3%</b>
9	Boston	WERS	6,614.8	0.9	0.0%	2,690.5	40.7%	347.3	8.8%	3,739,332	6,224	0.2%	777,946	20.8%	80,692	2.7%
9	Boston	WATD	3,861.4	0.0	0.0%	2,577.6	66.8%	347.3	27.1%	680,412	1,130	0.2%	505,637	74.3%	13,633	7.8%
10	Detroit	WDET	14,070.2	2.7	0.0%	4,140.5	29.4%	709.1	7.1%	4,535,327	890	0.0%	236,500	5.2%	71,524	1.7%
11	Atlanta	WABE	17,507.7	52.5	0.3%	1,894.4	10.8%	346.2	2.2%	4,130,474	22,771	0.6%	154,886	3.7%	22,340	0.6%
12	Miami	WLRN	18,776.8	0.0	0.0%	3.3	0.0%	75.5	0.4%	4,590,285	0	0.0%	155	0.0%	19,751	0.4%
13	Seattle/Tacoma	KUOW	19,906.0	174.0	0.9%	4,440.0	22.3%	321.0	2.1%	3,524,585	24,439	0.7%	137,853	3.9%	27,796	0.8%
<b>14</b>	<b>Phoenix</b>	<b>KJZZ</b>	<b>31,305.9</b>	<b>1,308.2</b>	<b>4.2%</b>	<b>6,742.9</b>	<b>21.5%</b>	<b>258.0</b>	<b>1.1%</b>	<b>3,233,062</b>	<b>1,721</b>	<b>0.1%</b>	<b>24,551</b>	<b>0.8%</b>	<b>8,597</b>	<b>0.3%</b>
15	Minneapolis/St. Paul	KNOW	27,327.2	65.1	0.2%	4,408.9	16.1%	829.5	3.6%	3,199,550	9,865	0.3%	81,919	2.6%	18,546	0.6%
16	San Diego (CP)	KPBS	14,282.9	42.0	0.3%	3,748.5	26.2%	707.7	6.7%	2,798,794	17,634	0.6%	54,857	2.0%	16,661	0.6%
23	Pittsburgh	WDUQ	10,534.3	29.8	0.3%	3,259.0	30.9%	287.7	4.0%	2,394,578	76,069	3.2%	317,584	13.3%	42,189	2.0%
105	Roanoke	WVTF	35,970.4	600.9	1.7%	8,485.2	23.6%	401.5	1.5%	1,296,791	103,878	8.0%	233,396	18.0%	15,300	1.4%
233	Cedar Falls	KHKE	6,813.0	0.0	0.0%	983.7	14.4%	397.5	6.8%	209,270	10	0.0%	18,340	8.8%	13,232	6.9%
<b>totals and averages:</b>			<b>346,548.4</b>	<b>2,931.8</b>	<b>0.8%</b>	<b>75,063.8</b>	<b>21.7%</b>	<b>9,453.2</b>	<b>3.5%</b>	<b>103,619,651</b>	<b>647,570</b>	<b>0.6%</b>	<b>15,025,313</b>	<b>14.5%</b>	<b>2,266,729</b>	<b>2.6%</b>