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SKADDEN, ARPS, SLATE, MEAGHER & FLOM LLP

1440 NEW YORK AVENUE, N.W.

WASHINGTON, D.C. 20005-2111

TEL. (202) 371-7000

FAX: (202) 393-5760

http://www.skadden.com

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February 17, 2000

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Magalie Roman Salas, Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Re: ***Ex Parte* Meeting of Northpoint Technology, Ltd.**
ET Docket No. 98-206, RM-9147, RM-9245

Dear Ms. Salas:

In accordance with Section 1.1206 of the Commission's rules (47 CFR § 1.1206), this letter is written to notify you that on Wednesday, February 16, 2000, Sophia Collier and Linda Rickman of Northpoint Technology, Ltd. ("Northpoint") and I met with the individuals listed below. The issues discussed are summarized, in part, in Attachment 1 hereto. In addition, the parties discussed the rulemaking proceeding and Northpoint's pending license applications. The documents referenced in the discussions or provided at the meeting are also attached.

An original and six copies of this letter and attachments are submitted for inclusion in the public record for the above-captioned proceedings. Please direct any questions concerning this submission to the undersigned.

Sincerely,

Antoinette C. Bush/cat

Antoinette Cook Bush
Counsel for Northpoint Technology, Ltd.

cc: Kathleen Ham
Thomas Stanley
Craig Bomberger
Michael Sozan
Michael Pollak
Herbert Zeiler
Jennifer Burton

Attachment 1

Presentation Overview

- Response to erroneous DirecTV claims on Northpoint testing
  - Harmful interference
  - Northpoint performance during rain events
  - Unavailability
- Methodology for calculating C/I contours
- Washington DC deployment conceptual design
- STA

Response To DirecTV Claims of Harmful Interference

- DirecTV's entire report rests primarily on a single location (Ericsson Memorial) where DirecTV claims to have recorded a signal strength meter depression of 8 ticks for Echostar 61.5
- The FCC Compliance and Information Bureau Report directly refutes DirecTV's claim of harmful interferences at this exact location
  - FCC CIB found a 1.18 tick change and "no harmful interference"
- How did DirecTV produce this 8 tick difference?
  - DirecTV simulated "Northpoint off" by shielding the DBS dish, thus blocking adjacent BSS interference of up to 20 dB C/I (p. 35, 39)
  - DirecTV used a modified DBS dish antenna ("removed from mount") (p. 45)
    - Result: higher than actual initial reading combined with lower actual final reading = greater that actual difference
  - DirecTV, itself, admits the Ericsson data is higher than the signal meter readings predicted by it own propagation model (p. 49)

Response to DirecTV
Northpoint Performance in Rain

- DirecTV claims the Ericsson data is the basis of its New York rain test, yet in New York DirecTV used a "power level for Northpoint" that was **twice** as high as even the erroneous Ericsson Memorial readings (p. 25 – 26)
- In its single reported test, DirecTV injected artificial noise into its receiver and drove it down by at least 12 - 14 ticks - Even in this unrealistic case the resulting "rain outage" was minimal: only 1 minute and 40 seconds (p. 25 - 26)
- Had DirecTV used actual values from Northpoint's Washington test, DirecTV would not have been able to show any outage whatsoever, just as no outage occurred in the real world during Northpoint operation during Hurricane Floyd
- DirecTV attempts to explain the lack of outage during Hurricane Floyd with a statement that Hurricane Floyd was a "moderate" rain event - despite the fact that Hurricane Floyd's rain rates exceeded the critical 0.1% rain rate which is sufficient to cause outages to a system with 99.9% availability

Response to DirecTV
Northpoint Impact on DirecTV Unavailability

DirecTV Unavailability Claims in Summary:

- "The highest level of interference recorded by DirecTV was found at site 5...[where] DirecTV recorded a change in signal meter reading of 3 counts...equat[ing] to a 15% or higher degradation in unavailability." (p. 41)
- "The calculated availability for this Washington, D.C. link is 99.9399%. When measured interference is included, this link availability is reduced to 99.9307%, which results in a 15.4% unavailability for the DirecTV service." (p. 38)

Response to DirecTV Unavailability Discussion

- Northpoint believes that DirecTV's test procedures overstated Northpoint "interference" and that DirecTV has improperly extrapolated from the "worst case" to the "general case," but even accepting DirecTV's data and logic at face value, the DirecTV claim of harm from Northpoint is not compelling.
- The math for DirecTV's "highest level of interference":

DirecTV availability	99.9399%
After Northpoint	99.9307%
DirecTV claim of impact	00.0092%
DirecTV projected minutes per year of outage	48
Minutes per month	4
% of day when TV is on in the home (50 hrs/week)	30%
DirecTV consumer impact in minutes per month	1.2

Northpoint Network Design Methodology

- Northpoint has developed a detailed methodology for predicting interaction between DBS and Northpoint services – this will be used as a design tool to layout Northpoint terrestrial networks
- The methodology predicts the number of homes in various parts of its service area and the impact of its service on DBS. It is used iteratively to develop network designs that meet desired carrier to interference ratios ("C/I ratios")
  - Uses an algorithm to calculate power levels for both services at given points including:
    - "RMD" propagation model (reflection plus multiple diffraction loss) to determine the signal strength at a receive location
    - DBS antenna characteristics
  - Integrates these points into contours and determines the area and population within a given C/I ratio contour.

Application of Methodology
Washington, D.C Conceptual Design

- Northpoint households served: 1,303,245
- Square miles: 1,700
- Sites: 23
- Average tower height: 330 feet

C/I Contour		
Households within contour	20 dB	15 dB
% total households	303	25
Households without natural shielding (14%)	0.02%	0.002%
DBS market share factor (10%)	42	4
	4	0

Based on a national survey of 400 DBS owners filed with the FCC in July 1999

General Northpoint Deployment

- General discussion
  - Each Northpoint cell will be individually engineered to provide coverage to its intended service area and to prevent harmful interference to DBS
  - As a terrestrial service Northpoint has a wide range of techniques available to customize individual cells
  - In order to maximize coverage areas and minimize interference to DBS Northpoint will use all of these techniques to meet its goals

- Antenna height
- Antenna pattern
- Mechanical beam tilting
- Beam forming

- Reduced power in populated areas
- Higher power in unpopulated areas
- Pointing away from population
- New technologies

Northpoint – NGSO Co-Sharing With DBS

- Taken together, the impact from the total increase in noise from the full deployment of NGSO (at current EPFD limits) and Northpoint will not exceed the larger of:
  - 10% increase in DBS unavailability or
  - 5 minutes per month
- Northpoint's contribution to increased unavailability is significantly less than the NGSO's because Northpoint's average C/I ratio - even before accounting for natural shielding - exceeds 41.6, a level at which the increase in DBS unavailability is less than .05%

Attachment 2

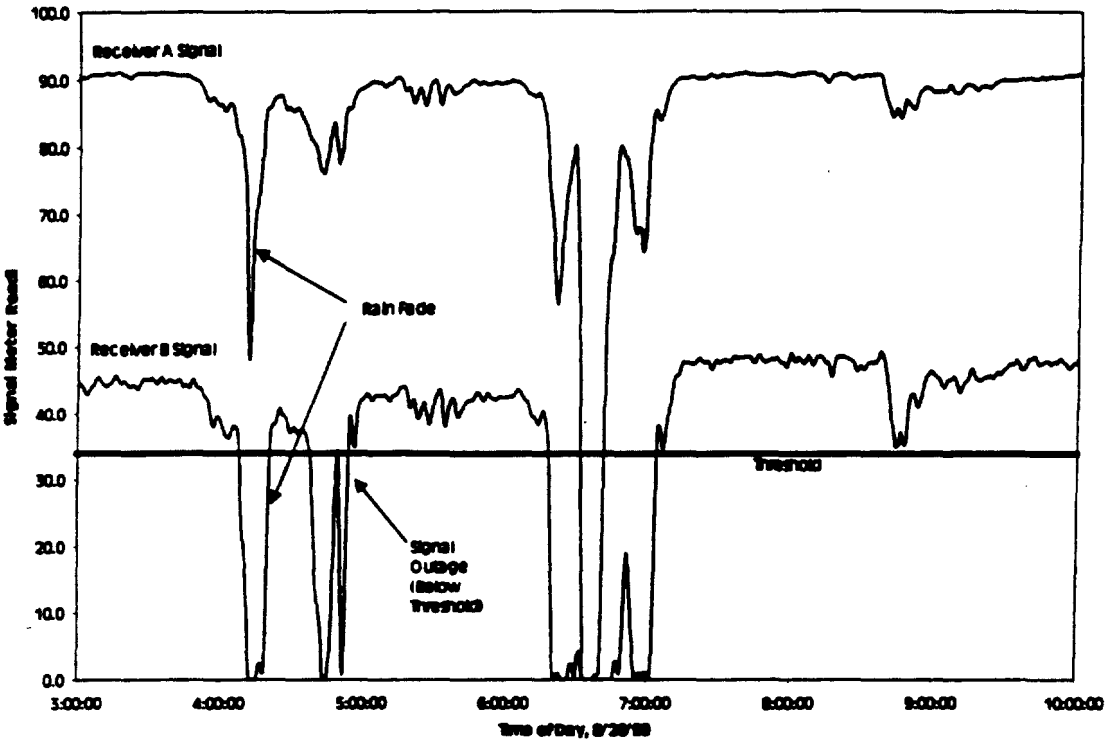

Figure 3.4.1.1-1: New York Rain Event, August 26, 1999

Later the same day, the rain rate reaches a sufficiently high level to cause even Receiver A to lose lock. This occurs near 6:30 on the time line. Note, however, that Receiver B with its significantly reduced clear-sky margin loses lock much earlier than Receiver A, and recovers much later.

In summary, Receiver B has suffered both more frequent and longer rain outages than Receiver A because of the added interference.

3.4.1.2 New York Rain Event of October 4, 1999

After a clear case of interference was observed at the Ericsson Memorial/Polo Field site in the Northpoint Washington, D.C. demonstration, DIRECTV went to its New York site with the goal of testing a similar interference level in rain conditions. The C/I level of the New York test equipment was set at 16.6 dB under clear-sky conditions (slightly higher than the C/I of 16 dB measured at the Ericsson Memorial / Polo Field site in Washington, D.C.). Results from one rain event after this interference level readjustment are discussed below and shown in Figure 3.4.1.2-1.

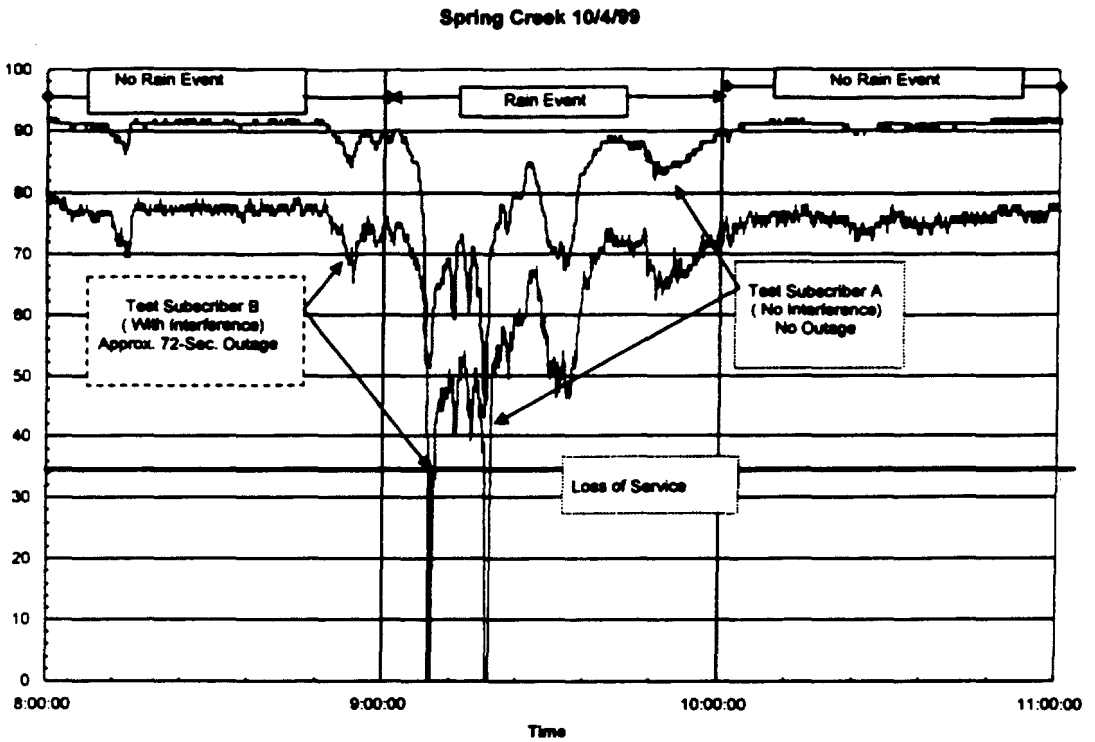

Figure 3.4.1.2-1: New York Rain Event, October 4, 1999

Figure 3.4.1.2-1 shows the recorded performance of a rain event (with and without interference) during a three-hour rain event on October 4, 1999. From observations of the clear-sky signal meter readings and from the calibration figures for this receiver, it appears however that the C/I ratio was near 13.7 dB on this day. As before, test Subscriber A receiver (IRD1) was identical to test Subscriber B receiver (IRD2). Test subscriber A receiver (IRD1) had no interference. Test subscriber B receiver (IRD2) had added noise equivalent to a C/I of about 13.7 dB

Here, Receiver A again has a nominal clear-sky signal meter value of approximately 92, corresponding to a C/(N+I) of about 16 db. Again note that the added interference has degraded the clear-sky C/(N+I) of Receiver B, whose signal meter level is now around 78.

An outage (loss of signal) again occurs when the signal meter drops below approximately 34, corresponding to a C/N below about 6 dB. As clearly demonstrated Receiver B (with added interference) suffered rain fades in this event while Receiver A suffered no rain fades.

3.4.1.3 Summary of New York Rain Observations

Attachment 3

ROUTING AND TRANSMITTAL SLIP Date 10/06/99

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REMARKS

Attached is CIB's final report regarding the test conducted on Diversified's system.

DO NOT use this form as a RECORD of approvals,concurrences,disposals clearances, and similar actions

FROM: *(Name, org. symbol, Agency/Post)*	Room
George R. Dillon	Phone

5041-102

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FEDERAL COMMUNICATIONS COMMISSION

COMPLIANCE AND INFORMATION BUREAU

BACKGROUND

On September 28, 1999, the Compliance and Information Bureau received a request from the Office of Engineering and Technology to investigate an allegation that Diversified Communications Engineering (licensee of experimental station WA2XMY), Northpoint Communications, and Broadwave Communications, hereafter Diversified, was causing harmful interference to the operation of EchoStar and DirectTV.

Harmful interference is defined in the Commission's Rules as interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunication service operating in accordance with the (international) Radio Regulations. 47 C.F.R. § 2.1.

OET noted that Diversified was testing its system in the Washington D.C. area and that DirecTV and EchoStar have alleged that the test is causing harmful interference to their operations. Further, according to OET, DirecTV and EchoStar have submitted test results showing that harmful interference exists. According to OET, Diversified has set up a test at the same site used by DirecTV and EchoStar and they have concluded that no harmful interference exists.

OET stated that a condition attached to the Diversified grant provides that the FCC shall determine if harmful interference exists in the case of a dispute and requested assistance from CIB to resolve the issue.

TEST procedure

On September 29, 1999, George Dillon, James Higgins and James Walker met with Dr. Darrell Word, Saleem Tawil, Sofia Collier, Katherine Reynolds and others representing Diversified.

The test was conducted at a traffic circle at the entrance to West Potomac Park (river side) southwest of intersection of Ohio Drive SW and Independence Ave SW, Washington, DC. The testing took place from approximately 10:00 a.m. to 12:00 noon. The test consisted of turning the Diversified transmitter on and off while observing television monitors tuned to EchoStar's and DirecTV's programming. The location was selected by Diversified and Diversified stated that it was the same location at which EchoStar and Direct TV reported the interference.

Mr. James T. Higgins accompanied Ms. Reynolds to the transmitter site, which was located on the rooftop of the USA Today building in Rosslyn, VA. Also at the transmitter was operator Floyd Nelson.

Mr. Dillon and Mr. Walker observed Diversified's monitors at Potomac Park. Diversified's transmitter was switched on and off while observations were made at the Potomac Park receive site of; a receiver "s-meter"; and of the TV picture.

Power levels at the transmitter during this testing were observed to be in the range (-0.5 dBm to -1.61 dBm), as indicated by a Hewlett Packard Power meter connected to the drop side of a directional coupler at the output of the transmitter. The transmitter operator in most cases adjusted levels to keep them nominally around -1.1 to -1.3 dBm range. Mr. Tawil stated that a reading of –1.5 dBm at the drop side of the directional coupler corresponds to an effective radiated power of +12.5 dBm. Testing was conducted on 12.47 GHz, then repeated on 12.4135 GHz. According to Mr. Tawil, the modulating signal was digital video with a 24 MHz bandwidth.

The results of the "s-meter" observations are shown in the following tables. Table 1 shows the predominant "s-meter" readings. Table 2 shows the number of samples, the average value of the samples and the standard deviation of the samples. We recognize that the sample size is small.

Table 1.

Diversified transmitter	EchoStar 61.5° (transponder 18)	EchoStar 61.5° (transponder 14)	EchoStar 119° (transponder 18)	Direct TV 101° (transponder 18)
	"s-meter" readings	"s-meter" readings	"s-meter" readings	"s-meter" readings
off	91 to 92	89 to 90	86 to 87	84 to 87
on	87 to 88	87 to 89	86 to 87	83 to 87.

Table 2

EchoStar 119 Transponder 18 channel 171		Echostar 61.5 Transponder 14 Channel 218		DirecTV Transponder 18 Channel 371	
Average "s-meter" reading when Diversified transmitter was on. Ten samples.	86.30	Average "s-meter" reading when Diversified transmitter was on. Twenty-nine samples.	88.34	Average "s-meter" reading when Diversified transmitter was on. Fifteen samples.	84.47
Average "s-meter" reading when Diversified transmitter was off. Fourteen samples.	86.21	Average "s-meter" reading when Diversified transmitter was off. Twenty-nine samples.	89.52	Average "s-meter" readings when Diversified transmitter was off. Twenty-five samples.	84.88
Standard deviation of "s-meter" readings when Diversified transmitter was on	0.48	Standard deviation of "s-meter" readings when Diversified transmitter was on.	0.86	Standard deviation of "s-meter" readings when Diversified transmitter was on.	1.92
Standard deviation of "s-meter" readings when Diversified transmitter was off	0.43	Standard deviation of "s-meter" readings when Diversified transmitter was off.	0.83	Standard deviation of "s-meter" readings when Diversified transmitter was off.	1.67

Test Results.

Diversified contends that the receiver "s-meter" is a relative indication of the signal or carrier to noise ratio and ranges from "0" to "100", "100" being the most desirable. We do not know what the variation in "s-meter" readings is between different receivers. We do know, however, that for the values of "s-meter" reading that we observed that we had a very good TV picture, TASO Grade 5.

Observations of TV programming showed no detectable degradation of the picture on EchoStar 119° channel 171 or Direct TV channel 317 when Diversified turned its transmitter on. As programming was not accessible on any EchoStar 61.5° channel operating on transponder 18, the tests were repeated on transponder 14 (channel 218) and again no degradation of the picture was noted.

We did not observe any harmful interference as defined in § 2.1 during this testing.

Attachment 4

Methodology for Predicting

Terrestrial Interaction with DBS

In the 12.2 - 12.7 GHz Band

January 18, 2000

Bob Combs, Broadwave USA
Darryl DeLawder, DeLawder Communications

1.0 Summary

This paper describes a methodology for predicting the impact of terrestrially based directional Northpoint-type, fixed, point-to-multipoint transmissions on co-channel reception of direct broadcast satellite ("DBS") services in a real world setting. This methodology predicts the potentially effected percentage of population by using an algorithm to calculate power levels for both services at given points, and then determining the area and population within a given Carrier to Interference ratio ("C/I ratio") contour. Market penetration and natural shielding can also be significant factors in determining the potential impact, and the methodology considers these factors as well. It is envisioned that this methodology will be used as Northpoint is deployed in order to minimize the impact of Northpoint operations on co-channel DBS reception.

Northpoint Technology

Northpoint is a terrestrial fixed point-to-multipoint system with a broadcast transmission typically oriented in a southerly manner. Northpoint operates at substantially lower power levels than most point-to-point fixed-service (FS) applications, and employs a number of localized engineering techniques to facilitate sharing frequency spectrum with satellite systems. One such technique is the transmit antenna directionality, which provides substantial isolation of 30 dB below vertical. By employing such localized interference mitigation techniques, the Northpoint system minimizes its RF energy at ground level near the transmitter, solving the "near-far" problem, and thereby facilitating sharing with the DBS customers within the Northpoint service area.

A methodology to define given C/I ratio contours is needed to identify both the potential mitigation zones located near a Northpoint FS transmitter site, and the potentially effected population within a given mitigation zone. Once these areas are defined, localized design solutions can be modeled to reduce the forecast impact to DBS users in areas where the methodology predicts C/I ratios that are lower than target values.

One such methodology is described in this paper. The geometry is identified in Section 2. The C/I ratio at any point is given in Section 3. In Section 4, a method for incorporating the population density and natural shielding factors is described. In Section 5, a commercial software program is used to evaluate a typical metropolitan layout, and to make an estimate of household counts within given C/I contours of the metropolitan FS system.

2.0 Sharing Geometry

The interference caused by terrestrial emissions into a DBS system is static, in contrast to the interference from non-geostationary satellites. As the interference power does not vary over time, once the geometry is specified, the interference environment can be completely identified. It is useful to define a coordinate system with origin at the ground level below the transmitter, and the *Y*-axis in the typical direction of transmission (south), as shown in Figure 1.

In Figure 1, the Northpoint transmission is due south, in the *Y* direction. (The methodology can easily be adapted for transmit antenna boresight angles other than due south.) A point *R* within the service area is at a given azimuth angle (α) relative to the boresight of the Northpoint transmit antenna. It is assumed that the earth station look angle, β (relative to true north), to the satellite is known.

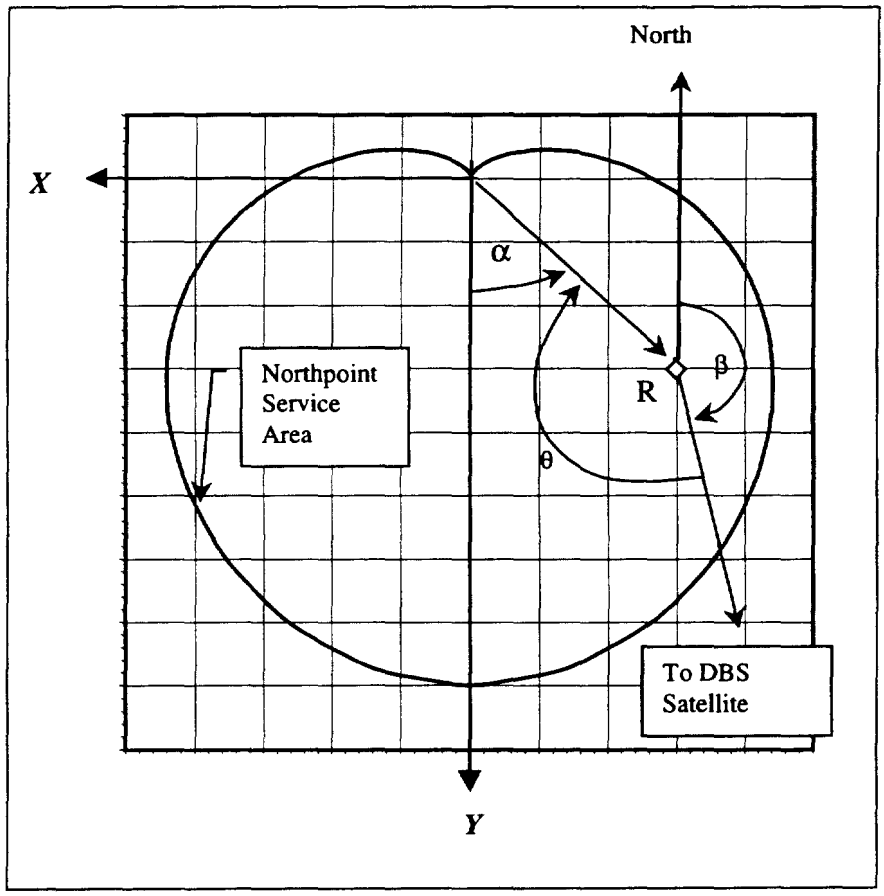

Figure 1. Coordinate System

Northpoint transmitters are typically installed on hills, towers or buildings. The geometry is presented in Figure 2. The transmitter is installed at a height above average terrain h_t. (The receiver can also have a height relative to average terrain (h_r), although the average height variation among DBS receivers will be equal to the average terrain, and therefore can generally be neglected.) The direction of maximum EIRP may also have a tilt angle *t*, relative to the

horizon plane (in order to minimize the power level near the transmitter). The relationship among the geometric variables follows Figure 2, and is presented in Table 1.

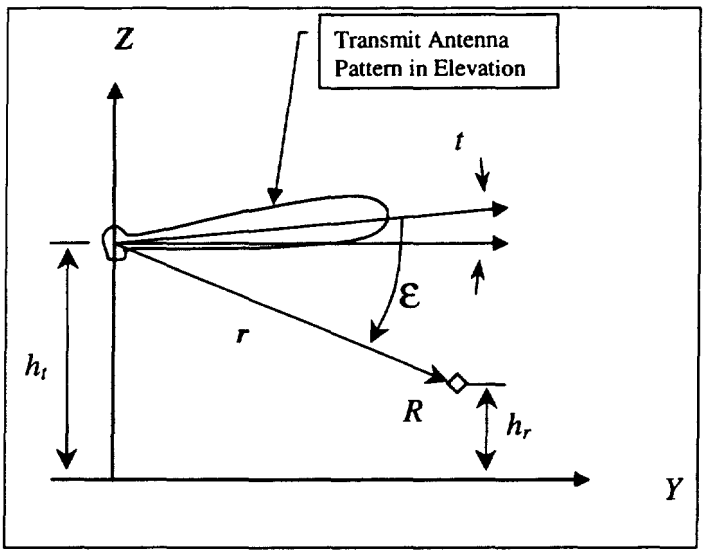

Figure 2. Elevation Geometry

Table 1. Geometry and Relationship among Geometric Variables

Symbol	Item	Calculation	Units
R	Point of interest (DBS receive antenna)	(x, y, h_r)	km
$r(x, y, h_t, h_r)$	Range to point R from transmitter	$= \lvert(x, y, h_r\text{-}h_t)\rvert$	km
h_t	Transmitter height above average terrain	*Given*	km
h_r	Receiver height above average terrain	*Given*	km
h	Transmitter height above receiver	$= h_t - h_r$	km
t	Transmitter tilt angle above the horizontal	*Given*	deg
$\alpha(x, y)$	Off boresight angle in azimuth from transmitter to victim	$= arctan(x / y)$	deg
$\varepsilon(h, x, y, t, \alpha)$	Off boresight angle in elevation from transmitter to victim	$= arctan((h / (x^2 + y^2)^{0.5}) + t * cos(\alpha)$	deg
β	Receiver azimuth look angle to satellite	*Given*	deg
$\theta(\alpha, \beta)$	Off boresight angle to terrestrial transmitter	$= \lvert\alpha + \beta\rvert$	deg

In Table 1, the calculation of ε takes into account a possible tilt angle t of the fixed transmitter. Along the transmit antenna boresight, the antenna tilt angle is t. Opposite the boresight, the tilt angle is $-t$. In any given azimuth angle α, the antenna tilt angle is $t * cos(\alpha)$.

3.0 Carrier to Interference Ratio Calculation

C/I ratios of unfaded signals can be used to identify zones of potential interference (from the Northpoint FS system to DBS systems) where additional interference mitigation techniques may be required. The identification of appropriate interference criteria to be met by the C/I ratios is beyond the scope of this paper. The appropriate C/I ratio interference criteria would be based upon the level of interference deemed "harmful", and would vary with the DBS carrier power and the estimated local rain margin.

The interference power at the input of the DBS LNB is equal to the radiated power (in EIRP) in the direction of the victim receiver, minus any radio transmission losses, plus the gain of the DBS antenna in the direction of the Northpoint transmitter.

$$I = EIRP_{eff} - FSL(x) - (atmospheric\ losses) + G(\theta) + A \qquad dB \qquad \textit{Equation (1).}$$

In equation 1, the first term, the $EIRP_{eff}$ is the effective terrestrial EIRP in the direction of the victim receiver, as calculated per Table 2. The only losses considered are due to free space and polarization isolation; atmospheric losses are negligible. The Northpoint transmit antenna is a broadbeam horn (as opposed to a parabolic reflector), and the antenna patterns between azimuth and elevation substantially differ. The typical antenna patterns are presented in the annex.

The DBS gain in the direction of the transmitter, $G(\theta)$, varies as a function of the relative azimuth towards the Northpoint transmitter. In North America, the most commonly used and most sensitive DBS antenna is the 45 cm offset feed parabolic reflector antenna. The gain towards the horizon of this typical receive antenna is well defined by the DBS antenna manufacturers. Because the antenna gain realized by this DBS antenna is significantly attenuated at angles below the nose of the antenna, the gain towards the horizon is typically more than 36 dB below maximum, and varies between -2 and -16 dBi. The average gain at the horizon is approximately -10 dBi. This gain is largely unchanged for satellite elevation angles between 20 and 50 degrees for the 45 cm offset feed parabolic reflector.[1] Thus, it is important to correctly determine the earth station antenna gain towards the fixed Northpoint transmitter, which is accomplished by using only the relative azimuth of the antenna bore sight and the fixed transmitter location. Only a methodology that uses the appropriate antenna gain will accurately describe the interference environment.

The interference power is calculated according to Table 2. The received undesired signal level I, from the Northpoint transmit facility (in the direction of R) is a function of the free space loss and the Northpoint transmit and DBS receive antenna patterns in elevation and azimuth (see annex). As mentioned above, atmospheric losses are negligible within a few kilometers of the transmitter, and can be ignored. (Attenuation, due to either buildings or foliage in the propagation path, can be significant, and will be taken into account at a later point.)

[1] Terrestrial Interference in the DBS Downlink Band, DIRECTV, 1994, and confirmed by recent and thorough studies, presented in ITU-R study groups, of the 45 cm offset feed most commonly used in North America.

Table 2. Interference Power Calculation

Symbol	Item	Calculation	Units
f	Frequency	*Given*	MHz
$TxAzDis(\alpha)$	Transmitter Azimuth Discrimination	*Function of the antenna pattern in azimuth and the angle α to point R, according to the pattern given in the appendix.*	dB
$TxElDis(\varepsilon)$	Transmitter Elevation Discrimination	*Function of the antenna pattern in elevation, and the angle ε to point R, according to the pattern given in the appendix.*	dB
$EIRP_{max}$	Maximum transmitted EIRP	*Given*	dBW
$EIRP_{eff}$	Transmitted EIRP in the direction of point R	$= EIRP_{max} - TxAzDis - TxElDis$	dBW
$FSL(x, f)$	Free space loss	$= 32.45 + 20 \log(x) + 20 \log(f)$	dB
A	Polarization Isolation Factor	*= -3 for linear to circular polarization*	dB
$G(\theta)$	Gain of the victim receiver in the direction of the terrestrial transmitter	*Per victim antenna pattern, see annex*	dBi
I	Interference Power	$= FSL + EIRP_{eff} + G(\theta) + A$	dB
C/I	Carrier to interference ratio	$= C - I$	dB

The C/I ratio into DBS can be calculated using the following equation:

$$C/I = C - EIRP_{eff} - FSL(x) + G(\theta) + A \qquad dB \qquad \textit{Equation (2).}$$

In Equation 2, the first term C is the DBS carrier power at the input of the LNB, (see Table 3 for a sample calculation).

Table 3. DBS Carrier Power Calculation.

Symbol	Item	Calculation	Units
f	Frequency	*Given*	MHz
$EIRP_s$	Satellite EIRP in the direction of the receiver	*Given*	dBW
PL	Pointing loss of the receive antenna towards the satellite	*Given*	dB
Gas	Gaseous absorption attenuation of satellite carrier power	*According to ITU-R*	dB
$FSL(r, f)$	Free space loss	$= 32.45 + 20 \log(r) + 20 \log(f)$	dB
G	Receive Antenna Gain	*Given*	dBi
C	Satellite Clear Sky Carrier Level	$= EIRP_s - FSL(sat) - PL - Gas + G$	dBW

Tables 4 and 5 provide sample calculations for Washington D.C. (see Section 5).

Table 4. DBS Carrier Power Sample Calculation

Line	Symbol	Item	Input	Output	Units
1.	*EIRPs*	EIRP(sat)	51.7		dBW
2.	*f*	Frequency	12500		MHz
3.		Elevation Towards Satellite	38.6		°
4.		Range to Satellite	37889		km
5.	*FSL(sat)*	FSL (Satellite)		-206	dB
6.	*Gas*	Gaseous Absorption	-0.2		dB
7.	*PL*	Pointing Loss	-0.5		dB
8.	*G*	Antenna Gain	34		dBi
9.	*C*	Carrier Power Level (Clear Sky)		-121.0	dBW

Table 5. Sample Interference Calculation

Line	Symbol	Item	Input	Output	Units
1.		Site Latitude	38.9		°
2.		Site Longitude	77W		°
3.		Satellite Longitude	101 W		°
4.	$EIRP_{max}$	Transmitter maximum EIRP	-17.5		dBW
5.	*A*	Polarization isolation	-3.0		dB
6.	*H*	Tower height $(= h_t - h_r)$	0.075		km
7.	*x*	East delta component of point *R*	1.0		km
8.	*y*	South delta component of point *R*	2.0		km
9.		Range from tower base to point *R*		2.236	km
10.	*r*	Total path from transmitter to point *R*		2.241	km
11.	*FSL*	Pathloss from transmitter to victim		-121.3	dB
12.	α	Transmitter azimuth off bore sight angle		-26.6	°
13.	*TxAzDis*	Transmitter azimuth gain down from peak		-0.9	dB
14.	*t*	Beam Tilt	3.0		°
15.	ε	Transmitter OBS angle in elevation		-6.5	°
16.	*TxElDis*	Transmitter elevation gain down from peak		-1.3	dB
17.	$EIRP_{eff}$	Effective EIRP in direction of victim		-19.8	dBW
18.	β	Azimuth towards satellite	-144.0		°
19.	θ	OBS angle from victim to transmitter		117.4	
20.	$G(\theta)$	Victim gain towards transmitter		-4.5	dBi
21.	*I*	Total interference power		-148.6	dBW
22.	*C/I*	Carrier to interference ratio		27.0	dB

Determination of C/I Ratio Contours

A specific C/I ratio contour can be determined by setting Equation (2) equal to the desired C/I value and solving for the set of points that compose the contour. By integrating over the C/I ratio contour, the area inside any given contour is determined. The practical matter of generating C/I ratio contours and integrating the affected area may be accomplished in a spreadsheet by developing a grid of sufficient fidelity. In the following example, a 0.1 km delta grid of 18 x 18 kilometers (32,400 points) is used to determine the area inside a given contour.[2] Figure 3 provides the C/I ratio contours throughout the service area using the assumptions identified for Washington D.C. in the above sample calculations. Commercially available software, such as EDX MSite™, can also be used to generate C/I ratio contours, as discussed in Section 5.

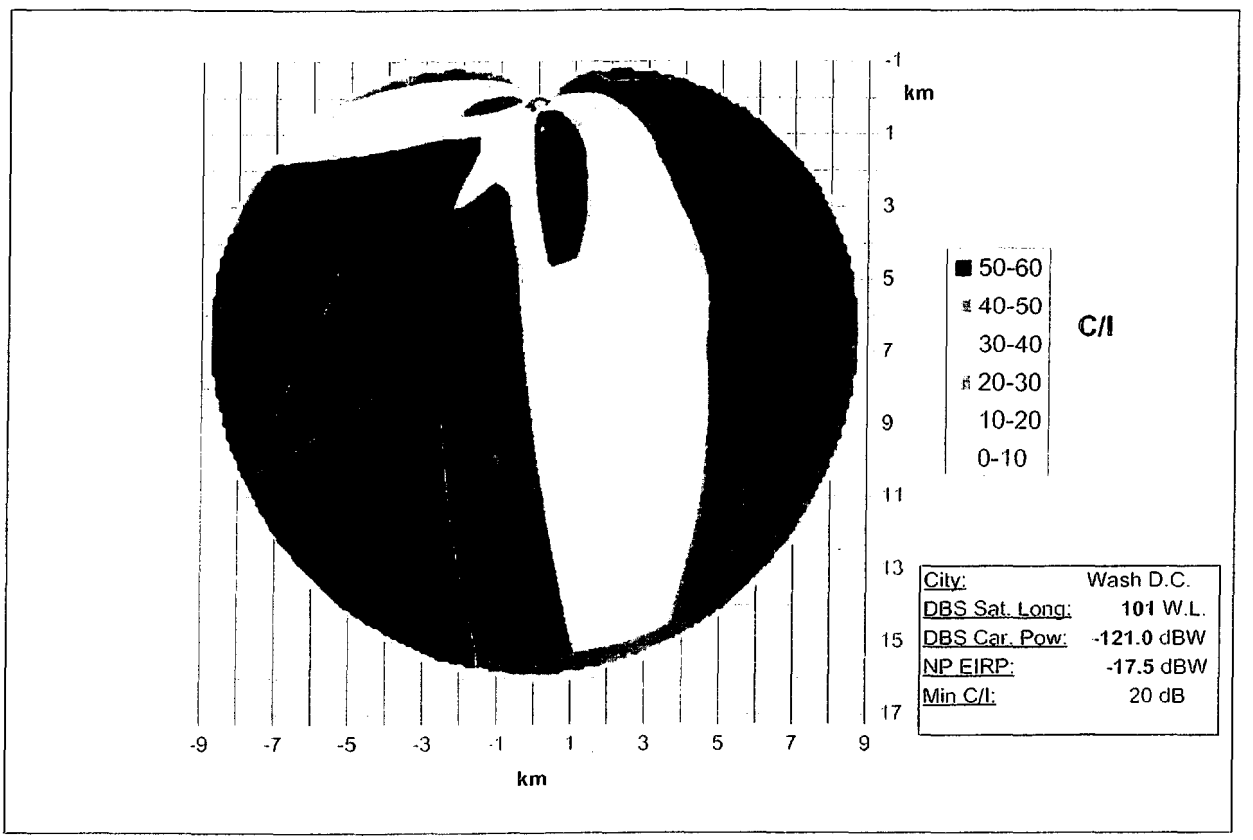

Figure 3. C/I Contours for Washington D.C.

The area inside a given C/I contour can be compared to the total service area for a particular FS transmit facility. In the case of Northpoint, the service area is defined by the area where the isotropic receive signal level is greater than about -156 dBW when only free space loss is taken into account. For an EIRP of -17.5 dBW, and using the azimuth antenna pattern in the appendix, the service area is 234 km^2.

[2] It was found that grid spacing of less than 0.1 km did not improve the accuracy of calculation.

A Microsoft Excel™ spreadsheet with Visual Basic was used to determine the C/I ratio at each point within the Northpoint service area in a 0.1 km delta grid of 18 square kilometers, for a total of 32,400 points. Use of the "count( )" and "countif( )" functions in the spreadsheet enables the user to determine the area of a specific C/I contour. The distribution of C/I values within the service area is shown in Figure 4. Note especially the small percentage of the service area where the C/I ratio is less than 30 dB, and that the average C/I ratio is greater than 40 dB.

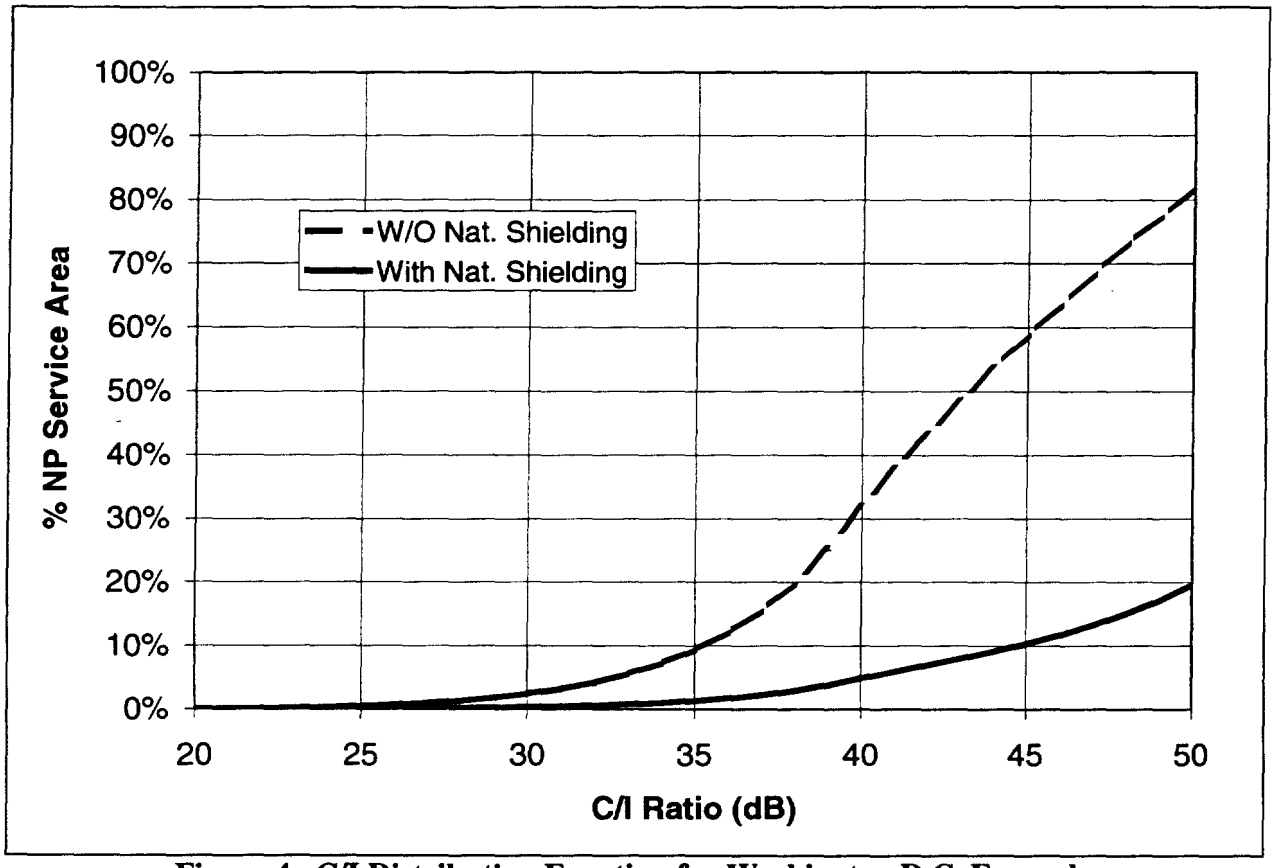

Figure 4. C/I Distribution Function for Washington D.C. Example

4.0 Determination of Potential Population in a Given C/I Ratio Contour

In the previous section, it was shown that the average C/I ratio in the Northpoint service area is over 40 dB. Furthermore, the area that might be deemed a mitigation zone will be very small -- on the order of 1% of the Northpoint service area. However, this does not mean that any DBS customer will be within the contour, or even if he is within the contour, that the Northpoint transmit facility will affect him. A number of factors significantly effect the interference environment. These factors include: market penetration, attenuation due to natural shielding, the location of transmitters in low population density areas, and localized engineering techniques that can be used to mitigate any potential interference. Taken together, these mitigation factors can reduce or eliminate any potential for interference. This section describes how these factors contribute to the sharing environment, and an example is presented of a possible implementation in a large metropolitan area.

Natural Shielding–Attenuation due to foliage and buildings along the propagation path will significantly reduce levels of interference. The amount of natural shielding present for DBS customers was recently identified in a national survey conducted by the survey firm of Bennett, Petis and Blumenthal in July of 1999. In this survey, it was found that 86% of DBS dish owners are naturally shielded due to a building, tree or other obstacle; therefore, only 14% of DBS customers will lack a natural shield.[3] The amount of protection that shielding can provide will vary greatly. It is a function of the type of material, as well as the amount of signal diffraction around the obstacle. An average of 15 dB of attenuation is assumed for the various obstacles identified in the survey, and this is sufficient in the mitigation of potential interference from a Northpoint transmit facility. The effect of natural shielding is also shown in Figure 4.

Market Penetration Rate–DBS market penetration currently averages 10% throughout the U.S.

Population Density–Northpoint tower locations can be selected to take advantage of variations in population density (PD). Typical transmitter locations are on high towers, high buildings and hills or mountains. Some, or many of these transmitter locations will be located in unpopulated areas, or areas lightly served by the DBS industry, such as industrial and commercial centers, regional public land, cemeteries, etc. In practice, the transmitters can be placed such that mitigation zones will exist in unpopulated or lightly populated areas. As a practical matter, each metropolitan area can be locally engineered to minimize transmitter installation in the densest urbanized areas. The population density can be determined using commercially available census data. In the example in the following section, it is shown that the household population density factor (HD) is on the order of 5%. That is, a metropolitan area can be designed for Northpoint service such that the household (or population) density near the transmitter is $1/20^{th}$ that of the overall household (or population) density.

The effect of the various factors can be related through the following equation:

$$HH = A * NS * HD * MPR \quad \textit{Equation (3).}$$

[3] Margin of error +/- 4% with 95% confidence level.

Equation 3 relates all the critical factors in determining a population within a given area. An estimate of the expected number of households within a given contour is provided in the following table.

Table 6. Estimate of the percent of households possibly affected by Northpoint

Item	Description	Order of Magnitude
A	Percent area of a given contour	On the order of 1%
NS	Percent of households not protected by natural shielding	On the order of 15%
HD	Relative household density in the mitigation zone	On the order of 5%
MPR	Market Penetration Rate	On the order of 20%
HH	Households estimated to require local shielding at the transmitter. (0.000015 = 0.01 * 0.15 * 0.05 * 0.2)	On the order of 0.0015%

As shown in the above table, it is estimated that less than 0.002% of DBS subscribers would actually be subject to potential interference from the Northpoint transmit facility, possibly requiring addition mitigation techniques such as local shielding.

Localized Engineering Techniques–A variety of interference mitigation techniques can be employed such as shielding at the transmitter, shielding at the receiver, lowering the transmit power, or transmitting slightly off azimuth 180 degrees (at azimuths typically from 135 to 225) to place mitigation zones in unpopulated areas.

As demonstrated in the following example, the combination of these techniques can eliminate any potential for interference in a metropolitan installation. In the Washington D.C. area, 24 Northpoint transmitters can serve a population of 1.3 million people.[4] Of this population, less than 10 households are estimated to be within a mitigation zone.

[4] 1990 Census Data

5.0 Greater Washington, D.C. Area Example

Figure 5, attached, is a map showing the predicted coverage for a Northpoint system design of the Greater Washington, D.C. area. In designing the system, two levels of service were considered:

- A receive power level of greater than -92 dBmW at the input to the LNB is used to represent a service reliability of 99.7 percent, which is considered the minimum acceptable reliability of a Northpoint system design;

- A higher level of service reliability (99.9 percent) is predicted to exist for receive power levels above -85 dBmW at the input to the LNB.

The predicted service and interference studies of this example use EDX Engineering, Inc.'s "Free space + RMD" Signal Propagation Model (which is one of many propagation models supported by the EDX software program MSITE™) in order to determine signal propagation from each Northpoint transmitter. The acronym "RMD" stands for "reflection plus multiple diffraction loss"; and this prediction model determines free space loss plus terrain obstruction signal attenuation in determining the signal strength at a receive location. Other potential attenuation structures such as foliage and man-made structures are not included in this model.

MSITE™ supports various other propagation models[5]; however, EDX's 'Free space + RMD' model is deemed the most appropriate choice. In the literature supporting MSITE™, EDX states that the 'Free space + RMD' model "is the most appropriate to use for microwave path design, or area-wide system studies operating at microwave frequencies (such as MMDS) where the receive sites are not random or mobile locations, but engineered receive sites with directional antennas." In fact, the FCC has recently authorized the use of this model in its implementation of two-way rules for the ITFS and MDS, and a complete description of the 'Free space + RMD' model is included in Appendix D to that Report and Order.[6]

Twenty-three sites with twenty-four transmitters are employed in the design, resulting in the predicted coverage (-92 dBmW or greater) of 1,303,245 households. Most transmitter sites are located at existing tower sites, with the Northpoint antenna located at or near the overall height specified for each structure.[7] (For the taller tower structures which are more than 300 feet AGL, a height approximately 50 feet below the overall height, is typically used as the antenna radiation center height.)

Figure 5, attached, is a map of the Washington system showing the location of the 24 transmitter sites in relation to the household distribution (as centroids[8]) of the Greater Washington service area.

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[5] Including the more familiar Longely-Rice (version 1.2.2) and the NTIA Terrain Integrated Rough Earth Model (TIREM).

[6] MM Docket No. 97-217, released September 25, 1998.

[7] All sites have been surveyed, the majority are existing towers in the FCC/FAA database, according to Dataworld (Dataworld.com).

[8] The MSITE™ program uses household "centroid" information taken from a 1990 U.S. Census database. A household centroid is a point location that defines a certain number of households located in the immediate area surrounding that point.

As explained in Sections 4 and 5, the potential interference to DBS transmissions will result to a small area located near the base of each tower. By applying a very conservative C/I ratio of 20 dB, and assuming that the Northpoint antenna is oriented generally southward, the DBS concern area will generally exist within 1.5 kilometers of a Northpoint transmitter site which transmits at a nominal EIRP level of -17.5 dBW. Because the Northpoint horn antenna will be typically oriented to the south, the interference area will generally be further restricted to areas south of each transmitter site.

Close examination of Figure 5 demonstrates that very few households are shown to be located in the potentially affected areas to the south of each transmitter site. Furthermore, the number of affected households can be reduced for a particular Northpoint transmit facility by making slight adjustments to the antenna orientation, EIRP or mechanical beam tilt used at the site. In order to minimize interference (and to otherwise maximize service) for any particular Northpoint site such adjustments have been made to the various sites of the Washington system. For various sites, these adjustments include the re-alignment of the transmit antenna by as much as 50° from due south; the increase or decrease of EIRP levels by as much as 3 dB; and the addition of up to 3° of upward mechanical beam tilt. The results of these adjustments are the final system design. Table 7 lists the location and transmit facilities for the 24 individual transmitters in this design.

Table 7. Transmitter locations in the Washington D.C. metro area example

Site	Location	Latitude	Longitude	EIRP (dBW)	Antenna Azimuth Orientation	Beam Tilt	Antenna Height (ft AGL)
WA00_330	USA Today (Arlington)	38,53,36	77,04,07	-19.7	113	0	328
WA03_729	Bethesda, MD	38,58,35	77,06,53	-19.7	170	0	649
WA05_250	Henderson Corner, MD	39,12,45	77,14,19	-18.1	140	0	250
WA07_455	Potomac, MD	39,02,07	77,10,11	-21.7	130	0	405
WA18_200	Brookville, MD	39,11,23	77,06,14	-17.7	150	0	199
WA20_404	Scaggsville, MD	39,08,29	76,54,33	-16.7	160	0	354
WA22_300	Olney, MD	39,08,00	77,02,47	-20.9	210	0	300
WA23_300	Hunting Hill, MD	39,05,00	77,13,25	-17.7	200	0	300
WA28_300	Sterling, VA	39,01,46	77,24,41	-17.7	130	0	300
WA31_300	Colvin Run, VA	38,59,32	77,20,53	-18.2	160	0	300
WA33_317	Fairfax, VA	38,51,17	77,22,28	-19.9	180	0	317
WA36_689	Merrifield, VA	38,52,28	77,13,24	-19.7	150	0	639
WA38_753	Silver Spring, MD	38,59,59	77,03,27	-19.7	130	0	703
WA11_210	Greenbelt, MD	38,59,56	76,51,15	-22.7	220	0	210
WA12_500	Davidsonville, MD	38,52,33	76,41,23	-16.7	210	0	350
WA15_152	Oxon Hill, MD	38,48,19	76,58,48	-21.7	130	0	152
WA42_278	NE Washington, DC	38,55,08	76,59,47	-20.9	130	1	278
WA43_155	Reagan N'tnl: Antenna 1	38,50,48	77,01,54	-17.2	230	0	155
WA43_155	Reagan N'tnl: Antenna 2	38,50,48	77,01,54	-16.7	130	0	155
WA48_490	Alexandria, VA	38,45,13	77,07,37	-20.2	130	0	430
WA49_300	Woodbridge, VA	38,44,20	77,17,20	-18.7	180	0	300
WA52_495	Patuxent, MD	39,01,48	76,44,24	-17.7	180	0	445
WA54_200	Bladensburg, MD	38,55,35	76,50,51	-18.7	180	0	200
WA59_400	Accokeek, MD	38,41,16	76,59,47	-20.9	150	2	390

Using the facilities listed in Table 7, the 15 and 20 dB C/I contours have been determined for each Northpoint transmitter site, as these contours are predicted to exist to each satellite service located at 61.5°, 101°, 110° and 119°, as plotted in Figure 5. The map includes the 15 dB (in blue) and 20 dB (in green) C/I ratio contours for each site as well as the household centroids.

Table 8, attached, includes household interference data for the 61.5°, 101°, 110°, 119° and composite DBS locations, as is predicted to exist from the example Northpoint system for Washington. Specifically, the number of households located within the 15 and 20 dB C/I contours for each Northpoint transmitter site, as determined by MSITE™, are reported in these figures. The MSITE™ program considers all households of a centroid as receiving DBS interference at a given contour level if the centroid is located within the contour. Likewise, if the centroid is located outside the contour, none of the households within a centroid are predicted to receive interference at that contour level.

Table 8
WASHINGTON D.C. HOUSEHOLD (HH) INFORMATION (Using 1990 Census Data)

SITE	Northpoint Houseolds Served Northpoint Reliability 99.7%	99.9%	SAT 61.5 Households Within 20 dB C/I	15 dB C/I	SAT 101 Households Within 20 dB C/I	15 dB C/I	SAT 110 Households Within 20 dB C/I	15 dB C/I	SAT 119 Households Within 20 dB C/I	15 dB C/I	SAT COMBINED* HH within 20 dB C/I	HH within 15 dB C/I
WA00_330	307,865	74,962	0	0	0	0	0	0	0	0	0	0
WA03_729	274,989	39,515	0	0	0	0	0	0	0	0	0	0
WA05_250	80,225	26,560	0	0	0	0	0	0	0	0	0	0
WA07_455	77,913	11,277	0	0	10	0	0	0	0	0	10	0
WA18_200	54,744	8,887	0	0	0	0	9	0	9	9	9	9
WA20_404	104,057	28,561	16	16	14	0	14	0	14	0	30	16
WA22_300	79,744	14,947	0	0	0	0	0	0	0	0	0	0
WA23_300	47,038	6,430	0	0	0	0	0	0	0	0	0	0
WA28_300	50,748	19,833	0	0	35	0	35	0	35	0	35	0
WA31_300	80,750	26,560	0	0	0	0	0	0	0	0	0	0
WA33_317	36,322	3,340	0	0	0	0	53	0	53	0	53	0
WA36_689	155,436	29,440	0	0	0	0	0	0	0	0	0	0
WA38_753	306,579	54,751	0	0	0	0	0	0	0	0	0	0
WA43_155	218,497	119,005	0	0	0	0	8	0	0	0	8	0
WA49_300	37,765	10,168	0	0	0	0	0	0	0	0	0	0
WA11_210	58,963	13,716	0	0	0	0	0	0	0	0	0	0
WA12_500	24,022	3,457	0	0	7	0	0	0	0	0	7	0
WA15_152	31,242	10,668	4	0	107	0	107	0	107	0	111	0
WA42_278	166,714	52,730	35	0	0	0	0	0	0	0	35	0
WA48_490	37,660	19,975	0	0	0	0	0	0	0	0	0	0
WA52_495	41,988	12,588	0	0	0	0	0	0	0	0	0	0
WA54_200	85,180	20,163	0	0	0	0	0	0	0	0	0	0
WA59_400	16,268	1,321	5	0	0	0	0	0	0	0	5	0
Total	1,308,577	563,221	60	16	173	0	226	0	218	9	303	25
Total as % of population											0.023%	0.002%

*There is some overlap of the various contours, so that the total households for individual satellites does not equal the sum of the individual contours.

6.0 Summary

In this paper, a methodology is described for predicting the impact of broad beam transmissions into the broadcasting satellite service. The methodology predicts the potentially affected percentage of population, by determining the area within a given C/I contour and the population within this area. Market penetration and natural shielding can also be significant factors in determining the potential impact, and the methodology considers these factors.

An example deployment is provided to show that transmitters can be place in nearly unpopulated areas, even within major metropolitan markets. In the example shown the number of DBS households within a 20 dB C/I contour was only 303 households, out of 1,303,245 households served. Assuming a market penetration of 20%, and a natural shielding factor of 86%, the number of DBS households within the 20 dB contour falls to 8.4 households, or less than one per Northpoint transmitter. This would be less than 0.001% of the population. Of 25 households in the 15 dB contour, after accounting for natural shielding and DBS penetration rate, there would be less than one household in a 15 dB contour in the entire D.C. metro area.

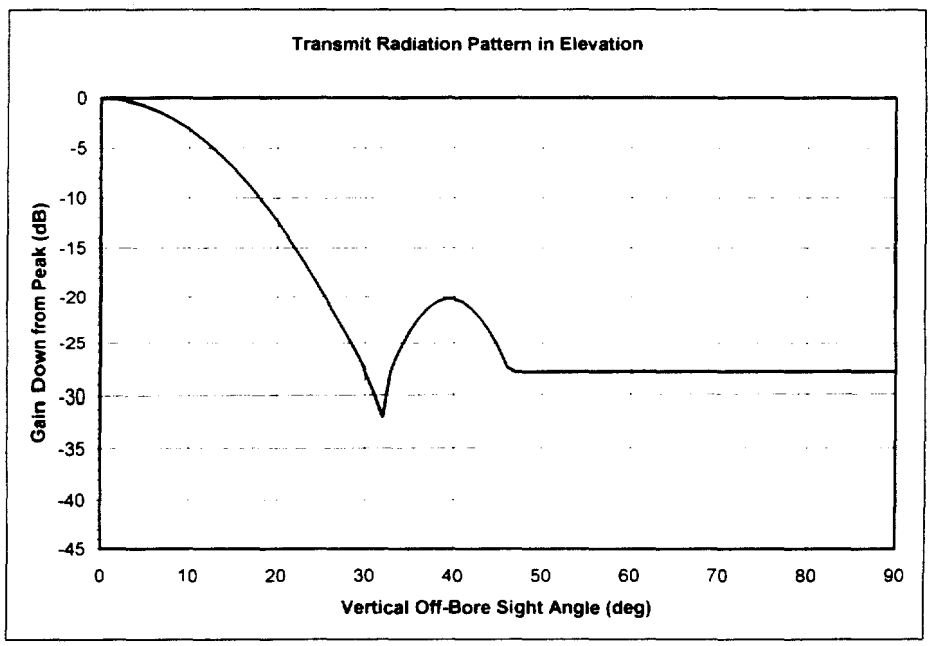
Appendix

Antenna Patterns

Northpoint Transmit Antenna Pattern in Azimuth

Azimuth angle (α)	Gain (dBi)
0	10
10	9.8
20	9.4
30	8.8
40	8.0
50	7.1
60	6.0
70	4.6
80	2.7
90	0.4
100	-2.4
110	-5.7
120	-9.4
130	-13.3
140	-17.5
150	-22.0
160	-27.1
170	-30.9
180	-34.4

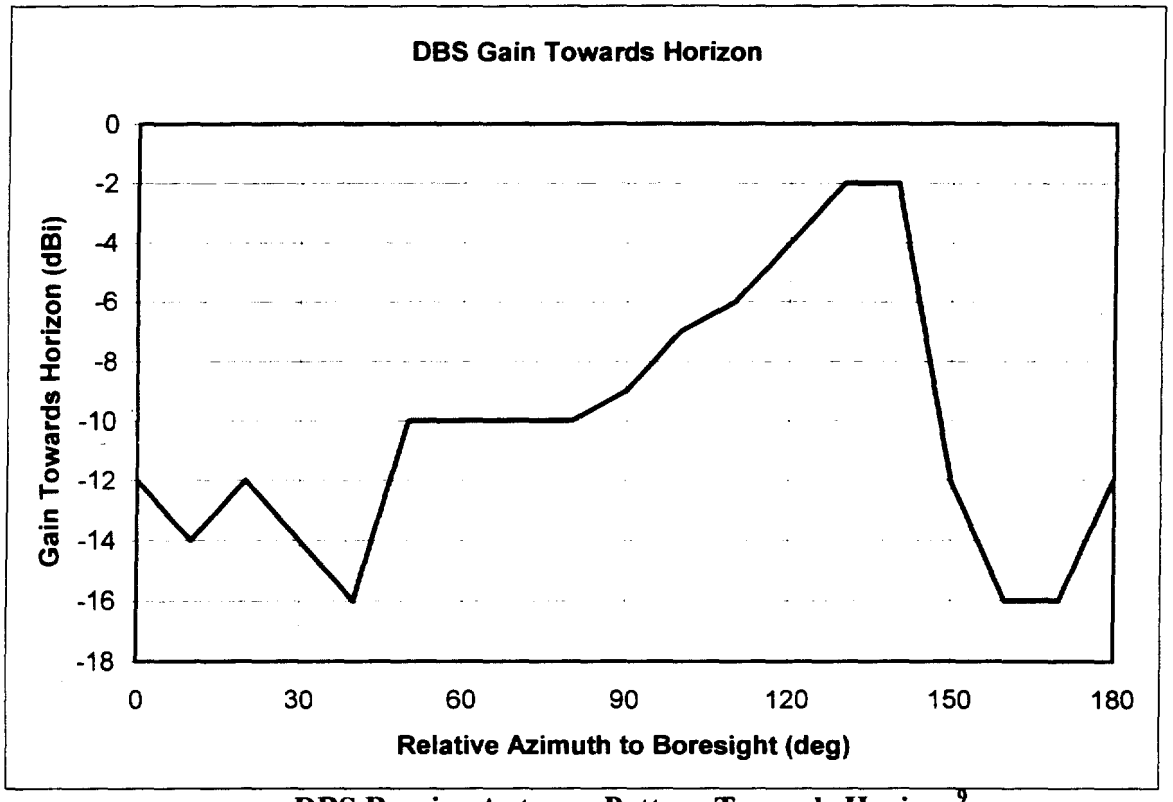
Northpoint Transmit Antenna Pattern in Elevation



Transmitter Radiation Pattern in Elevation

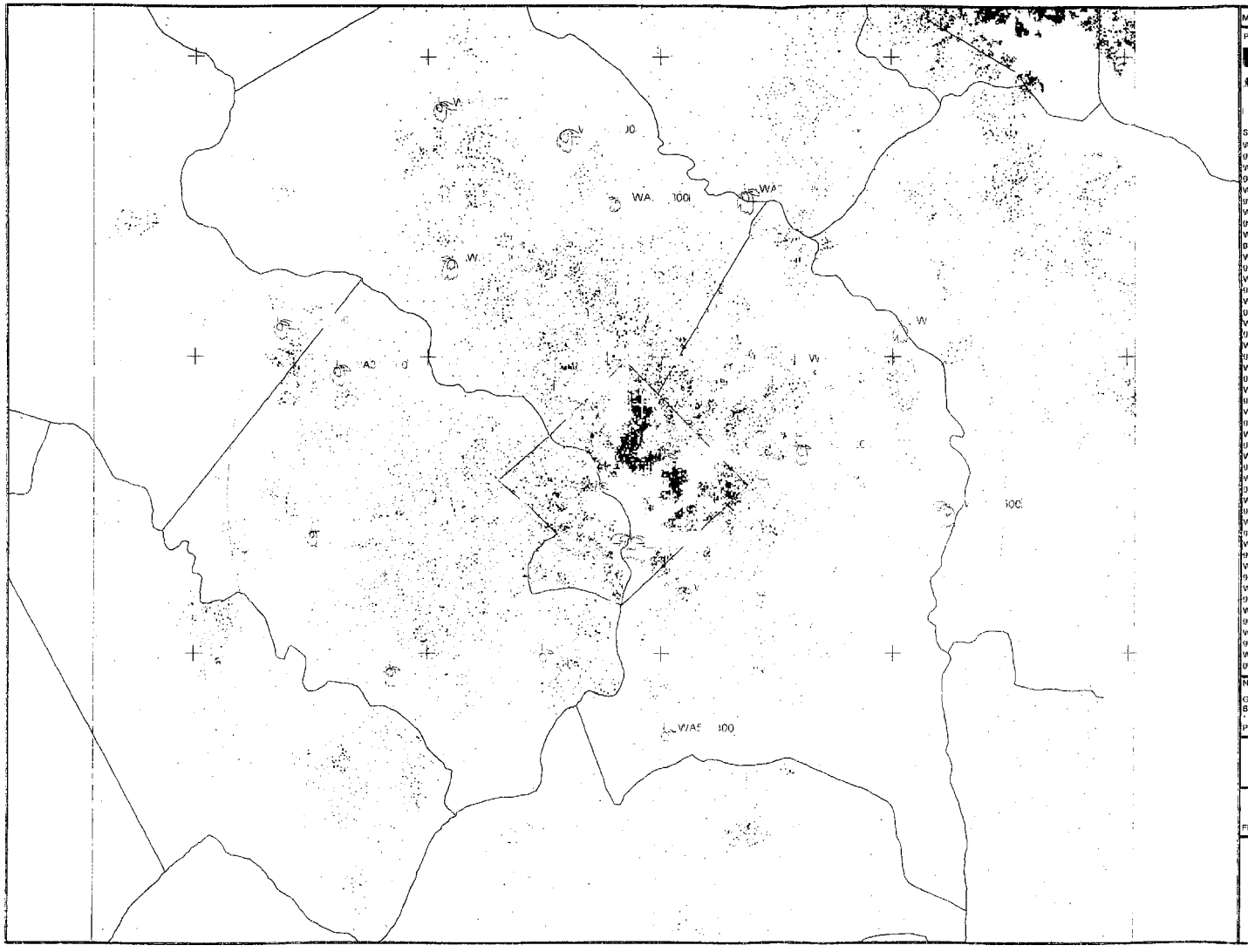
The relative transmit antenna discrimination (from Gmax = 10 dBi) in elevation is given as the following function:

$G(\varepsilon) = -0.031(\varepsilon)^2$	for	0	$\leq \varepsilon < 32$
$G(\varepsilon) = -293.2 + 13.825(\varepsilon) - 0.175(\varepsilon)^2$	for	32	$\leq \varepsilon < 46.2$
$G(\varepsilon) = -28$	for	46.2	$\leq \varepsilon < 180$



DBS Receive Antenna Pattern Towards Horizon[9]

[9] See Technical Annex to Reply Comments of DirecTV, April 14, 1999, page 10.



MSITE™: wash_alln.map

Population density

>	200.0	
	100.0 to	200.0
	50.0 to	100.0
	25.0 to	50.0
	10.0 to	25.0
	1.0 to	10.0
<	1.0	

Site	Ant. Elev. AMSL (ft)	ERPd (dBW)	Ant. Type Orient.	Coordinates
WA00_330	390.0	-19.65	DA-H	N38°53'38.00"
group: 1	12500.0000 MHz	113.0		W77°04'07.00"
WA03_729	999.0	-19.65	DA-H	N38°58'35.00"
group: 1	12500.0000 MHz	170.0		W77°06'53.00"
WA05_250	870.0	-18.05	DA-H	N39°12'45.00"
group: 1	12500.0000 MHz	140.0		W77°14'19.00"
WA07_455	755.0	-21.65	DA-H	N39°02'07.00"
group: 1	12500.0000 MHz	130.0		W77°10'11.00"
WA11_210	430.0	-22.65	DA-H	N38°59'56.00"
group: 1	12500.0000 MHz	220.0		W76°51'15.00"
WA12_500	470.0	-16.65	DA-H	N38°52'33.00"
group: 1	12500.0000 MHz	210.0		W76°41'23.00"
WA15_152	409.0	-21.65	DA-H	N38°48'19.00"
group: 1	12500.0000 MHz	130.0		W76°58'48.00"
WA18_200	698.0	-17.65	DA-H	N39°11'23.00"
group: 1	12500.0000 MHz	150.0		W77°06'14.00"
WA20_404	784.0	-16.64	DA-H	N39°08'29.00"
group: 1	12500.0000 MHz	160.0		W76°54'33.00"
WA22_300	800.0	-20.85	DA-H	N39°08'00.00"
group: 1	12500.0000 MHz	210.0		W77°02'47.00"
WA23_300	750.0	-17.65	DA-H	N39°05'00.00"
group: 1	12500.0000 MHz	200.0		W77°13'25.00"
WA28_300	600.0	-17.65	DA-H	N39°01'46.00"
group: 1	12500.0000 MHz	130.0		W77°24'41.00"
WA31_300	699.0	-18.15	DA-H	N38°59'32.00"
group: 1	12500.0000 MHz	160.0		W77°20'53.00"
WA33_317	770.0	-19.85	DA-H	N38°51'17.00"
group: 1	12500.0000 MHz	180.0		W77°22'28.00"
WA36_689	999.0	-19.65	DA-H	N38°52'28.00"
group: 1	12500.0000 MHz	150.0		W77°13'24.00"
WA38_753	999.0	-19.65	DA-H	N38°59'59.00"
group: 1	12500.0000 MHz	130.0		W77°03'27.00"
WA42_278	423.0	-20.85	DA-H	N38°55'08.00"
group: 1	12500.0000 MHz	130.0		W76°59'47.00"
WA43_155	185.0	-17.15	DA-H	N38°50'48.00"
group: 1	12500.0000 MHz	230.0		W77°01'54.00"
WA43	185.0	-16.65	DA-H	N38°50'48.00"
group: 1	12500.0000 MHz	130.0		W77°01'54.00"
WA48_490	477.0	-20.15	DA-H	N38°45'13.00"
group: 1	12500.0000 MHz	140.0		W77°07'37.00"
WA49_300	599.0	-18.65	DA-H	N38°44'20.00"
group: 1	12500.0000 MHz	180.0		W77°17'20.00"
WA52_495	633.0	-17.65	DA-H	N39°01'48.00"
group: 1	12500.0000 MHz	180.0		W76°44'24.00"
WA54_200	400.0	-18.65	DA-H	N38°55'35.00"
group: 1	12500.0000 MHz	180.0		W76°50'51.00"
WA59_400	460.0	-20.85	DA-H	N38°41'16.00"
group: 1	12500.0000 MHz	150.0		W76°59'47.00"

Notes

GREEN CONTOUR: 15 dB C/I Mitigation Zone Boundary
BLUE CONTOUR: 20 dB C/I Mitigation Zone Boundary

Population density in 1990 households

MILES

-5 0 5

WASHINGTON, DC: NORTHPOINT

MITIGATION ZONES: COMBINATION SATs

FIGURE 5 01-21-2000