Exhibit A

Technical Analysis

Viasat submits the following showing to demonstrate that the proposed gateway-type earth station, or satellite access node ("SAN"), located in Winchester County, VA, is compatible with Upper Microwave Flexible Use Service ("UMFUS") operations in accordance with Section 25.136(a)(4) and therefore should be authorized with the rights and protections afforded by Section 25.136(a).

The Viasat SAN antenna is configured to operate with the ViaSat-3 satellite at 88.9° W.L., and this configuration provides the relevant operational azimuth and elevation angles. In normal operation, the input power density is constant for all atmospheric conditions and is not increased during rain fade events and thus, the operations during clear sky conditions will be the same as worst-case operating scenarios.

The antenna parameters used in the analysis are identified in the FCC Form 312 application and supporting exhibits, and reflect measured gain patterns for the proposed earth station antenna.

Description	Value	Unit
Antenna Diameter	2.4	m
Antenna Gain	52.4	dB(i)
Antenna Input Density	-19.2	dB(W/MHz)
EIRP Density	33.2	dB(W/MHz)
Average Antenna Disc toward Horizon	83.4	dB
Density toward Horizon	-50.2	dB(W/MHz)
Polarization Discrimination	1.5	dB
Gain of m^2 area (28.35 GHz)	50.5	dB(m^2)
Boundary Limit in flux density	-107.6	dB(W/(m^2*MHz))
Average free space distance to limit	175.9	m

Table 1 – Antenna Parameters

The above calculation provides a simple baseline estimate of the average required separation distance for all azimuths around the 2.4 meter antenna to meet the -77.6 dB(mW/(m^2 * MHz)) power flux density ("pfd") limit based only on free space loss and 1.5 dB of polarization discrimination[1]. The minimum and maximum required free space distances for this antenna to meet the -77.6 dB(mW/(m^2 * MHz)) pfd limit range from 35 meters to 446 meters but are typically much lower once terrain and clutter are considered, as described further below.

A. Computation of pfd Contour

[1] Use of 1.5 dB for polarization discrimination is a conservative value consistent with Appendix 8 Section 2.2.3 of the ITU-R Radio Regulations.

While the above table provides an estimate of the average distance around the earth station where the pfd at a height of 10 meters above ground level would be equal to or greater than -77.6 dB(mW/(m^2 * MHz)) for a flat field with no obstructions nearby, in most cases, terrain and objects on the Earth's surface provide for some additional reduction of the region around the SAN antenna where the pfd value above is exceeded.

To determine whether terrain or surface obstructions around the SAN antenna would provide any further reduction of the pfd at a 10 meter reference height, an analysis was performed using the NTIA ITS Irregular Terrain Model.[2] In the computation of the contour, surface data with 1 meter resolution from Intermap was used to provide both clutter height and terrain information.

The computation of the contour around the antenna used the nominal input power density to the SAN antenna along with measured antenna gain information to determine the e.i.r.p. density along a particular azimuth. Next, path and clutter/terrain losses were taken into consideration for all the locations around a SAN site along with polarization discrimination to determine which blocks around the SAN site exceed the -77.6 dB(mW/(m^2 * MHz)) limit at the 10 meter reference height.

For this SAN antenna, additional reduction in the pfd over and above that from terrain and clutter in the area around a SAN antenna was required to avoid coverage of locations restricted by Section 25.136(a)(4)(iii) and shielding was used. The attenuation from shielding was computed using the TICRA Tools antenna analysis program which is the latest version of the industry standard GRASP analysis software. The attenuation is computed for each degree of azimuth around the earth station antenna and ranges from 7 dB to 34 dB around the antenna with an average attenuation of 22 dB.

The approach uses a Geometrical Theory of Diffraction (GTD) analysis whereby the total RF energy in the direction of the interference source (or victim) antenna was computed for various wall dimensions and compared to the total RF energy when no shield wall was present. The shield wall was modeled as a perfect conductor and diffraction was allowed to occur on the top and sides of the wall. The bottom edge was assumed to be below grade so no bottom edge diffraction was included. The wall dimensions and position were adjusted until the required shielding level was reached. The wall height used with the 2.4 m antenna is 10 feet. The nominal shielding design uses solid corrugated steel walls in a rectangular configuration around the antenna. The standard enclosure is 25 feet long 12 feet wide as depicted below. The dimensions provide sufficient room for the antenna beam to clear the wall at the operating elevation angle and also provide room for ancillary equipment to be located behind the antenna.

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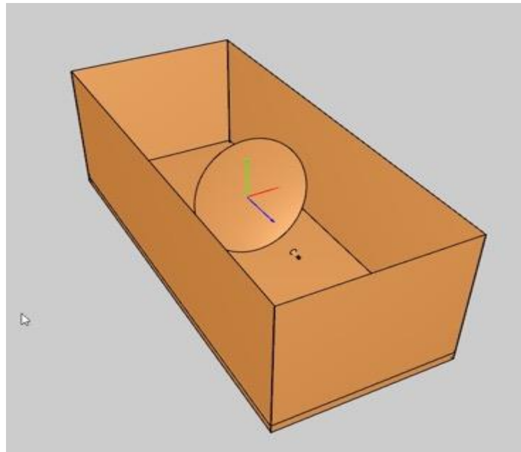
[2] *See* NTIA Report 82-100 (Apr. 1, 1982), available at: https://www.ntia.doc.gov/report/1982/guide-use-its-irregular-terrain-model-area-prediction-mode. A link to the particular implementation used can be found here: https://www.its.bldrdoc.gov/media/50674/itm.pdf. Additional information on Viasat's use of the Irregular Terrain Model is included in Attachments 1 and 2 below.



Finally, once the analysis is completed, a GIS shape file of the resulting contour is created for import into Viasat's ArcGIS tool and can be examined with respect to population and other elements of Section 25.136. An illustration of the contour is included below as Figure 1, and is also included in a .kmz file attached separately in IBFS.

B. Satisfaction of Section 25.136 Criteria

a. Section 25.136(a)(4)(i)

The earth station location is in Winchester County, VA. A search of the IBFS database indicates that there are no other earth stations licensed in the 27.5-28.35 GHz band segment in that county.

Therefore, the earth station satisfies the requirement in Section 25.136(a)(4)(i) that there be no more than two other earth stations operating or authorized to operate in the 27.5-28.35 GHz band within the county on a protected basis under Section 25.136.

b. Section 25.136(a)(4)(ii)

The total population covered by the -77.6 dB(mW/(m^2 * MHz)) contour is below the applicable threshold specified in Section 25.136(a)(4)(ii).

Overlaying the -77.6 dB(mW/(m^2 * MHz)) contour on a map depicting census blocks, Viasat has calculated an estimate of the population covered by the contour using 2010 census data and assuming that the population coverage within a partially covered census block is equal to the percentage of the geographic area of the census block covered by the contour.[3] Figure 1 below contains a diagram depicting the contour overlaid on a census block map.

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[3] This approach to estimating population coverage using the most recently available decennial census block data and the actual area method is consistent with the recommended approach in the International Bureau's guidance regarding earth station siting. *See International Bureau*

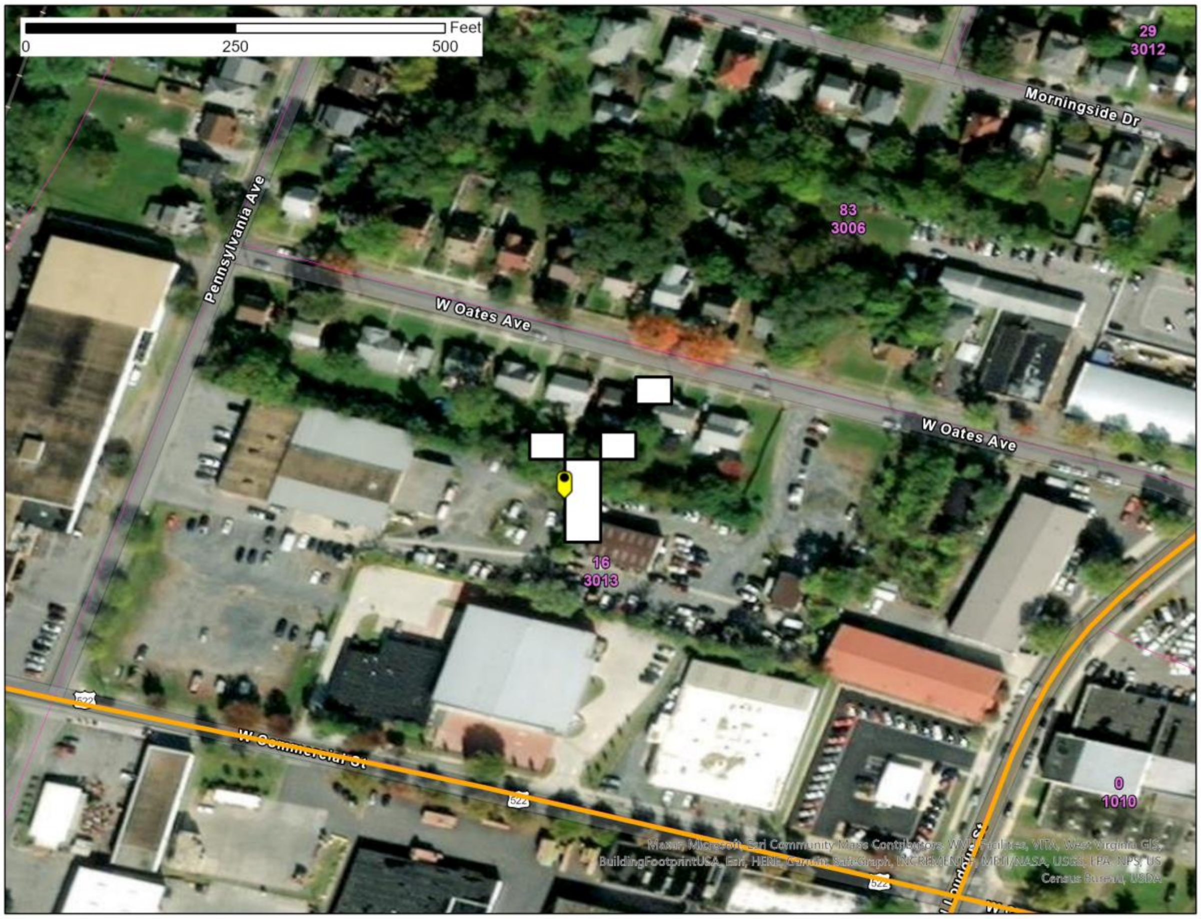

Figure 1 – Winchester, VA SAN -77.6 dB(mW/(m^2 * MHz)) pfd contour

The population of Winchester County is 26,203, and thus the applicable population limit under Section 25.136(a)(4)(ii) is 450.

The following identifies the census block, population and the population coverage estimate as determined by the actual area method.

Issues Guidance on Siting Methodologies for Earth Stations Seeking to Operate in the 24.75-25.25 GHz, 27.5-28.35 GHz, 37.5-40 GHz, 47.2-48.2 GHz, and 50.4-51.4 GHz Frequency Bands to Demonstrate Compliance with Section 25.136, 35 FCC Rcd 6347 (2020). Viasat notes that the Satellite Industry Association, of which Viasat is a member, has petitioned for reconsideration of this guidance. *See* Petition for Reconsideration of SIA, IB Docket. No. 17-172 (filed July 16, 2020). Nothing herein should be construed to prejudice that pending petition, or otherwise suggest that Viasat agrees with the Bureau's guidance.

Census Block Number	Total Population of Census Block	Population Coverage Estimate	Percent of Block Covered by Pattern
518400002013013	16	0	1.33%
Total Estimated Population Coverage:		0	

Table 2 – Population Coverage Overview

The total estimated population covered by the contour thus is below the applicable population limit.

c. Section 25.136(a)(4)(iii)

The -77.6 dB(mW/(m^2 * MHz)) contour does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port, or any road identified as an Interstate, Other Freeway and Expressway, or Other Principal Arterial road in the Federal Highway Administration Office of Planning, Environment, and Realty Executive Geographic Information System map.[4] Viasat notes that roads that intersect the contour (if any) have not been designated by the relevant state agency as Other Freeways and Expressways, or Other Principal Arterials.

d. Section 25.136(a)(4)(iv)

Viasat has completed frequency coordination with the UMFUS licensees within the area covered by the -77.6 dB(mW/(m^2 * MHz)) contour with respect to existing facilities constructed and in operation by the UMFUS licensees. The Prior Coordination Notice (PCN) was sent by Comsearch on 11/23/2020 and no objections were received within the 30 day notice period. The Comsearch coordination report is attached as Exhibit C. Viasat has requested an updated PCN Report for this site and will supplement the record upon receipt.

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[4] *See* Federal Highway Administration, Office of Planning, Environment, and Realty Executive Geographic Information System Map, *available at* https://hepgis.fhwa.dot.gov/fhwagis/#; *see also Use of Spectrum Bands Above 24 GHz for Mobile Radio Services*, Second Report and Order, 32 FCC Rcd 10988, App'x B (2017) ("[T]he roads listed in the revision to Section 25.136 . . . can readily be identified by consulting the Federal Highway Administration (FHWA) Office of Planning, Environment, and Realty Executive Geographic Information System (HEPGIS) map . . . . HEPGIS allows the user to enter any street address in the U.S. and display an interactive map with a legend that identifies road classifications as they are defined by the Department of Transportation at 23 C.F.R. Section 470.105 pursuant to 23 U.S.C. Sections 101 and 103."); 47 C.F.R. § 25.136(a)(4)(iii).

ATTACHMENT 1

USE OF IRREGULAR TERRAIN MODEL (ITM) FOR COORDINATING EARTH STATIONS WITHIN 1 KM

Viasat has engaged RKF Engineering Solutions, LLC (RKF) to determine the model to calculate contours around each Satellite Access Node (SAN) earth station which exceeds a power flux density (PFD) of -77.6 dBW/m^2/MHz.

RKF relied upon the National Telecommunications and Information Administration (NTIA)'s Irregular Terrain Model (ITM)[5] to compute the power densities from these transmitting earth stations / SANs for distances greater than 100 m. The ITM model was selected in large part because it is an accepted Federal Communications Commission (FCC) model and was assessed to produce conservative results (low path loss) for propagation paths for the site-specific geometries analyzed, thereby building confidence in the ability to achieve successful spectrum sharing. For elevation and terrain data RKF relied upon the 5-meter NEXTMap[6] Elevation data suite.

In choosing ITM, there were several considerations. First, the Defense Information System's Agency (DISA) Spectrum Sharing Test and Demonstration (SSTD) working group, made up of many Government stakeholders, uses 2D terrain path loss models for predicting clutter in the band 1.755 to 1.780 GHz, for rural and suburban areas. These predictions were shown to be accurate when compared to measurements in the band. In the paper, *"What are the underlying calculations, parameters, and assumptions for the Longley-Rice (ITM) propagation model?*[7], the nominal frequency range for the ITM model is listed as 20 MHz to 40 GHz. While the upper limit was modified to 20 GHz in some later documentation, 28 GHz frequencies, within these topologies, conform to the model.

While the ITM doesn't explicitly account for loss within the first kilometer, the model's formulas were used in association with the NEXTMap data. Specifically, to improve the fidelity of the estimates, NEXTMap terrain and clutter data were calculated from 100 m from the SAN sites. In his doctoral thesis, Kasampalis Stylianos[8] reviews many diffraction models including ITM and observed that the ITM model can be used for distances as low as 200 meters.

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[5] Model available at https://github.com/NTIA/itm

[6] https://www.intermap.com/nextmap

[7] "What are the underlying calculations, parameters, and assumptions for the Longley-Rice (ITM) propagation model?" September 24, 2013, in RF Engineering Article, (https://www.softwright.com/knowledgebase/faq/underlying-calculations-parameters-assumptions-longley-rice-itm-propagation-model/)

[8] "Modelling and Coverage Improvement of DVB-T Networks," A thesis submitted for the degree of Doctor of Philosophy by Kasampalis Stylianos, March 2018

The probability of reflections in rural and suburban areas is low at higher frequencies and reflections tend to attenuate quickly at these frequencies if they aren't close to the direct path. Furthermore, an accepted 3D model that accurately predicts loss is not available and the 5-meter NEXTMap data does not have enough resolution to predict reflections accurately. Consequently, a 3D model was not employed.

To demonstrate the conservative nature of the ITM model used, simulations were performed with a series of single knife edge terrain path, where the knife edge height was assumed to be 2 m. The table below compares the knife edge diffraction loss to the ITM predicted loss (ITM path loss minus free space loss) for paths equal to or less than 1 km. In all but one case shown, the ITM model significantly underestimates the loss compared to the knife edge prediction.

Frequency	Total Path Distance	Distance to Knife Edge	Knife Edge Loss	ITM Predicted Loss
GHz	meters	meters	dB	dB
28	1000	250	19.02	16.2
18	1000	250	17.28	10
28	800	200	19.94	14
18	800	200	18.15	8.4
28	500	100	22.57	23.6
18	500	100	20.71	15.1
28	200	60	25.33	7.3
18	200	60	23.43	3.5

In summary, the ITM propagation model is well-accepted by regulators and has been used in many instances up to the frequencies associated with the SANs under consideration and down to distances below 1 km, where results were shown to be conservative for pathloss thereby helping to build confidence in successful sharing with these earth station nodes.

ATTACHMENT 2

RESPONSES TO MAY 13, 2022 FCC QUESTIONS ON VIASAT'S USE OF THE IRREGULAR TERRAIN MODEL (ITM)

(1) Which mode (area or point to point) of the ITM model did ViaSat implement?

In preparing analysis for its SAN earth station applications, the point-to-point mode of the ITM was used.

(2) What inputs did Viasat use in the ITM model for the following: a) Surface Refractivity; b) Radio Climate; c) Dielectric Constant of Ground d) Conductivity of Ground

Viasat's analysis utilized inputs that were based on conservative and widely accepted values for Earth characteristics and radio climate. For the short distances analyzed, the dominant path loss consideration is diffraction. Additionally, the vast majority of the sites are located in the eastern United States in regions with similar climates. As such, a standard atmosphere was assumed, and only median path loss components were considered across Viasat's SAN earth stations. RKF Engineering Solutions, LLC ("RKF"), the engineering firm engaged by Viasat to calculate contours using the ITM, verified that for the short distances modeled the results were not sensitive to changes in refractivity, radio climate, or ground constants.

The following specific inputs were used:

a) Surface Refractivity: 301 (minimum globally-worst-case, it gives 4/3 Earth radius)

b) Radio Climate: 6 - Maritime Temperate, Over Land (most of the U.S. population is located on the East and West coasts)

c) Dielectric Constant of Ground: 15 (average ground)

d) Conductivity of Ground: 0.005 (average ground)

(3) If Point-to-point Mode implemented: a) Percentage of confidence; b) Percentage of reliability

The point-to-point mode was implemented with median propagation conditions, specifically:

a) Percentage of confidence: 50%

b) Percentage of reliability: 50%

(4) If Area mode implemented: a) Mode of Variability; b) Delta h; c) Percentage of Confidence for time, situation, and location

N/A

(5) Do the elevation heights from the high resolution NEXTmap data include building and clutter heights? If so, were those heights input directly into the

ITM model as terrain heights? If not, could you explain the components/inputs from the NEXTmap data and how they were used in the ITM model?

The NEXTMap Five digital elevation model is Intermap's next-generation global 3D terrain dataset.[9] It provides seamless data at five-meter resolution enabling precise spatial analysis. NEXTMap Five is a comprehensive worldwide offering that is available as a digital surface model ("DSM") and digital terrain model ("DTM"). The NEXTMap DSM contains elevations of natural terrain features including vegetation and cultural features such as buildings and roads. The NEXTMap DTM provides elevations of the bare earth where surface features such as buildings, vegetation, and other infrastructure have been removed.

Both DSM and DTM files were used in Viasat's analysis. The DTM bare earth file was used to site terminal heights relative to bare earth. Clutter in close proximity to terminals was then removed from the DSM file. For receive terminals clutter within 5 meters of the terminal location was removed and for transmit terminals clutter within 10 meters was removed. This process ensured that the ITM returned valid numerical results for all receiver locations tested. A larger clutter removal distance was considered for transmit terminals because they are more carefully sited and installed. The DSM terrain database with the removed clutter in close proximity to terminals, along with terminal locations and heights, were then used in the ITM.

(6) Is Viasat using NTIA source code for the ITM model, or its own code based on the formulas/algorithms described in https://www.its.bldrdoc.gov/media/50674/itm.pdf, If the former did the NTIA software produce any error codes, and could those be provided?

Viasat used the NTIA C++ source code base available on the NTIA's website.[10] The C++ implementation (the archived v1.2.2 version) is functionally identical to the version of the ITM currently available on Github, but does not generate the same warning or error messages as the Github version in certain cases. The C++ code downloaded from NTIA's website and implemented by Viasat for its demonstrations compiles and runs without error for the distances and frequency ranges analyzed by Viasat.

The Github code generates the following messages for the distances and frequencies considered in Viasat's analysis:

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9 *See* https://www.intermap.com/nextmap.

10 *See* https://its.ntia.gov/research-topics/radio-propagation-software/itm/itm.aspx. The C++ code was downloaded and used for Viasat's analysis prior to the Github version becoming available. RKF has implemented, for different projects, both the Github version and the older C++ code utilized in Viasat's analysis. It was inadvertently stated in the Explanatory Addendum that RKF used the Github version for Viasat's analysis. However, as both versions are functionally identical this discrepancy has no material effect on the analysis.

- WARN_PATH_DISTANCE_TOO_SMALL_2: Path distance is small - care must be taken with result
- ERROR_FREQUENCY: Frequency is out of range

Neither of these messages in any way impacts the validity of Viasat's analysis using the ITM; notwithstanding the fact that the Github version may generate an error message for frequencies above 20 GHz, the original source for the ITM makes clear that it is valid up to 40 GHz.[11] Moreover, the code in the current Github version is easily modified to bypass the error message.

Furthermore, and as noted above, at distances less than one km the dominant factor affecting path loss is diffraction. The ITM results are insensitive to changes in refractivity, radio climate, or ground constants. The diffraction model itself is geometric and as such, there is no reason why it should not be valid in the frequency range studied.

(7) What were the factors or rationale that led Viasat to use the ITM model vs other models?

The ITM was selected based on several considerations. The ITM is the Commission's physics model of choice and has regularly been applied in a variety of Commission proceedings.[12] The ITM also includes a widely used and sophisticated diffraction model, which was the dominant propagation mechanism explored for Viasat's analysis. The model uses a combination of double knife edge and irregular terrain diffraction. As discussed in the Explanatory Addendum (see Attachment 1 above), the ITM is known for accuracy in modeling and can be applied in frequency bands ranging from 20 MHz to 40 GHz.[13]

RKF has explained to Viasat that RKF has extensive experience applying the ITM to perform analyses for its other clients, including application of the ITM with terrain, building, and clutter data (*e.g.*, DISA and the Wireless Coalition).

- For the past five years, RKF has supported the Spectrum Sharing Test & Demonstration ("SSTD") program under DISA in its effort to develop more accurate clutter models. This modeling included analyzing path loss using physics-based models (including the ITM) with terrain plus clutter data as

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11 *See infra* n.13.

12 *See, e.g.*, *The Commission Begins the Process for Authorizing 6 GHZ Band Automated Frequency Coordination Systems*, FCC 21-100, ¶ 5 (Sept. 28, 2021).

13 A.G. Longley & P. Rice, *Prediction of Tropospheric Radio Transmission Loss Over Irregular Terrain. A Computer Method*, ESSA Tech. Rep. ERL 79-ITS 67, U.S. Government Printing Office, at 2 (1968), https://its.ntia.gov/umbraco/surface/download/publication?reportNumber=erl%2079-its%2067.pdf (noting that the model is intended for use in frequencies from "20 to 40,000 MHz," *i.e.*, 20 MHz to 40 GHz); *see also* Explanatory Addendum, n.3.

inputs. Currently, RKF is also supporting DISA in developing path-loss prediction approaches for the CBRS band with the ITM as a baseline.

- For several years working for the Wireless Coalition, RKF developed models for predicting interference between a national deployment of Wi-Fi and FS Microwave stations in the 6 GHz band. This included a wide variety of morphologies and site-specific situations that incorporated both terrain and clutter.
- RKF is also currently the technical developer of the Open Automated Frequency Coordination ("OpenAFC") tool for coordinating operations in the 6 GHz band. This code base has been adopted by the WInnForum, the Wi-Fi Alliance, and hundreds of companies. In addition to incorporating agreed-to standard approaches, this is a testbed where sensitivity and site-specific effects can be explored.
- In its effort to model clutter accurately, RKF has extensively studied and implemented a variety of advanced approaches and concepts. RKF has not found any better approach than using a 2D physics-based model with terrain plus clutter for estimating path loss and identifying critical line-of-sight paths for site-specific cases like Viasat's.

Viasat's use of the ITM was also driven by discussions with Commission and NTIA staff. On June 30, 2021, Viasat met with staff from the Commission's International Bureau and Wireless Telecommunications Bureau and staff from NTIA to discuss Viasat's use of the ITM for modeling attenuation of emissions in the immediate vicinity of Viasat's SAN earth stations. The attendees of the June 30 meeting discussed the contents of the Explanatory Addendum, "Use of Irregular Terrain Model (ITM) for Coordinating Earth Stations within 1 km." The focus of the discussion was on the use of the ITM at 28 GHz and explaining some studies indicating that use of the model was appropriate up to 40 GHz. The discussion also covered use of the model below one km and explained how Viasat approached modeling of knife-edge losses in the area immediately next to the earth station.

After Viasat explained its proposed use of the ITM, NTIA agreed that use of the model was appropriate at the 28 GHz frequencies being studied by Viasat for its SAN applications. Likewise, NTIA agreed that the augmentation of the model with the knife edge path loss predictions was appropriate as well. Based on the feedback from NTIA and Commission staff, Viasat proceeded to use the ITM to model its PFD contours and provided an Explanatory Addendum with each SAN application.

(8) Were any field tests/measurements performed to verify model accuracy? If so what were they?

There is a large body of third-party measurements validating the ITM. Additionally, the NTIA version of the model is well-tested and stable. As such, no additional on-site verification testing was performed to validate the ITM results produced in connection with the specific SAN earth stations at issue here.

That said, Viasat notes that it has previously validated the accuracy of the ITM in other contexts. More specifically, as part of the Commission's *Spectrum Frontiers* proceeding, Viasat contracted with Comsearch to perform on-site measurements of radio frequency levels around its Carlsbad, CA facility from a 1.8 m roof-mounted antenna operating in the Ka band.[14] This testing was performed by Comsearch using calibrated test equipment to measure emissions from a 1.8 m antenna facility similar to the SAN earth station antennas currently pending before the Commission for use with the ViaSat-3 satellite network. The tests were conducted at 28212.5 MHz and measurements were taken at both 2 m and 10 m heights above ground level ("AGL") at a number of locations around the earth station location.

The test results demonstrated that at each test location the measured signal levels were significantly less than those predicted by free space path loss values. Thus, the actual path loss was larger than free space path loss. The lowest additional loss value measured was 7.98 dB, but in many cases the signal was below the spectrum analyzer noise floor resulting in over 40 dB of additional attenuation in some cases. On average the additional attenuation was 24 dB at the 10 m AGL height and 32.6 dB at the 2 m AGL height, noting that at many of the test locations the test signal was below the instrument noise floor so actual attenuation was higher than reported. These measurements are comparable to the typical attenuation predicted using the ITM in Viasat's analysis for the SAN earth stations.

[14] *See* Letter from Viasat to FCC, GN Docket No. 14-177 *et al.* (filed Apr. 20, 2017).