ATTACHMENT B

UMFUS Compatibility Showing (Cheyenne, WY; Call Sign E170164)

1. Section 25.136(a)(4) assessment – 27.5-28.35 GHz

1.1. Section 25.136(a)(4)(i) – Number of earth stations

As of November 2020, the only other earth station licensed or proposed in the 27.5-28.35 GHz band in the relevant license area is a collocated earth station licensed to Hughes (call sign E150077) that is grandfathered in 27.85-28.35 GHz.

1.2. Section 25.136(a)(4)(ii) and (iii) – Power Flux Density ("PFD") contour population and highway/event/railway/port coverage

1.2.1. Assumptions

The Section 25.136 PFD was determined using the publicly available software program Visualyse and based upon the Table 1 technical parameters for the Jupiter 3 earth station.

Parameter	Value
Latitude/longitude	41° 7' 54.5" N/ 104° 44' 10.8" W
Frequency (GHz)	28
Channel bandwidth (MHz)	470
Transmit power (dBW)	5.09
Antenna midline height above ground (m)	7
Antenna size (m)	10
On-axis antenna Gain (dBi)	67.91
Clear sky EIRP (dBW)	73
Antenna radiation pattern	Manufacturer calculated off-axis gain pattern (see Figure 1)
Clutter	Recommendation ITU-R P.452-16, Park lands
Terrain	NASA SRTM data 30 m resolution[1]

Table 1. Jupiter 3 gateway earth station technical parameters at 28 GHz

[1] http://dwtkns.com/srtm30m/

Figure 1 shows the sum of the manufacturer's calculated co-polarized and cross-polarized off-axis gain patterns. Measured antenna patterns are not available for the off-axis angles of importance because of the size of the antenna[2]; hence, calculated antenna patterns provided by the manufacturer are used.

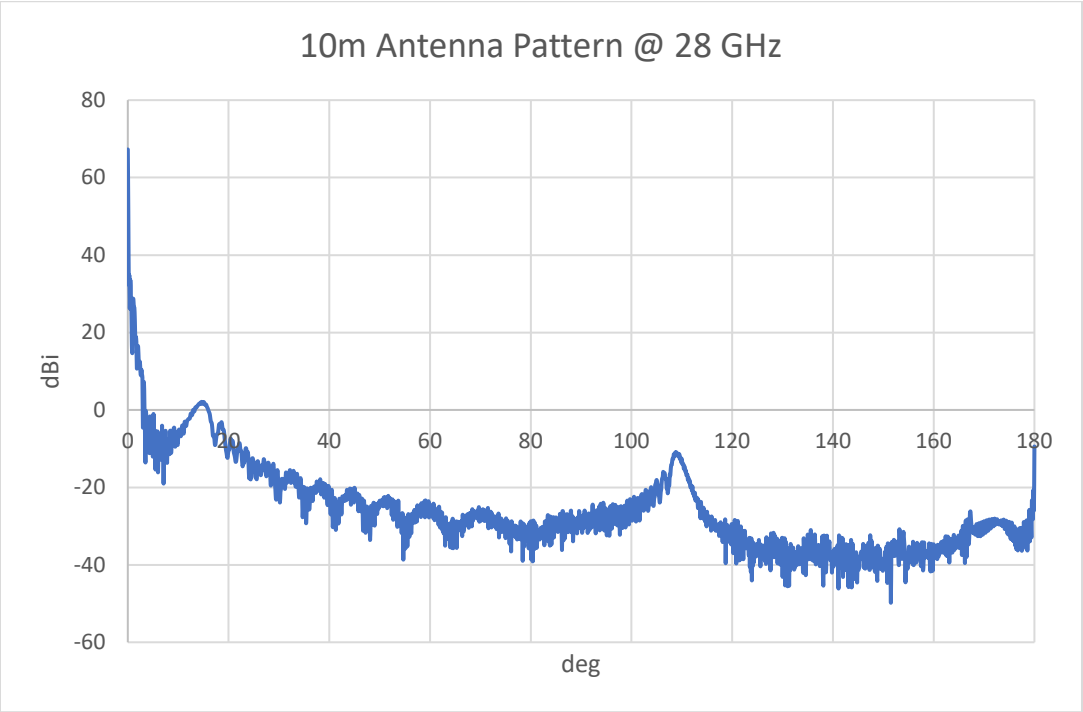

Figure 1. SED calculated off-axis gain pattern at 28 GHz

The earth station uses adaptive modulation and coding as well as uplink power control to maintain the desired availability. The percentage of time that the earth station will exceed the clear sky levels is small. Using Recommendation ITU-R P.618, Hughes has determined that the power levels are within 1 dB of the clear sky input power for 98.15% of the time and within 2 dB of the clear sky input power for 99.32% of the time.

Further, the earth station is licensed for clear sky EIRP levels pursuant to Section 25.204(e) of the Commission's rules.

The earth station is collocated with a grandfathered earth station (call sign E150077) operating in 27.85-28.35 GHz. Results are provided in Section 2.2.2 for the 27.5-27.85 GHz band, where the Jupiter 3 single entry PFD is assessed, and in Section 2.2.3 for the 27.85-28.35 GHZ band, where the aggregate PFD contour for the grandfathered earth station and Jupiter 3 operating together is compared to the grandfathered PFD contour.

1.2.2. Results for 27.5-27.85 GHz

[2] *See* 47 C.F.R. § 25.132(d).

Visualyse Version 7 software was run using the Recommendation ITU-R P.452-16 propagation model option to generate the Section 25.136 contour for the 28 GHz band where the earth station generates a PFD, at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz. The resulting PFD contour is shown in Figure 2 (and further specified in a KMZ file submitted with this application).

Figure 2. Section 25.136 pfd contour around the Cheyenne earth station in the 27.5-27.85 GHz band

The 27.5-27.85 GHz PFD contour does not cover any major roads (*i.e.,* Interstate, Other Freeways and Expressways, or Other Principal Arterial, according to the Federal Highway Administration HEPGIS map or Other Freeways and Expressways, or Other Principal Arterials identified by the Wyoming Department of Transportation). The PFD contour also does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port according to a visual inspection in Google Earth.

The population covered by the 27.5-27.85 GHz PFD contour was determined using the actual area method, where the population within the contour was calculated based on the proportion of the census geographic area covered by the PFD contour. Figure 3 shows the PFD contour overlaid on a census block map of the service area, with census block ID numbers depicted.

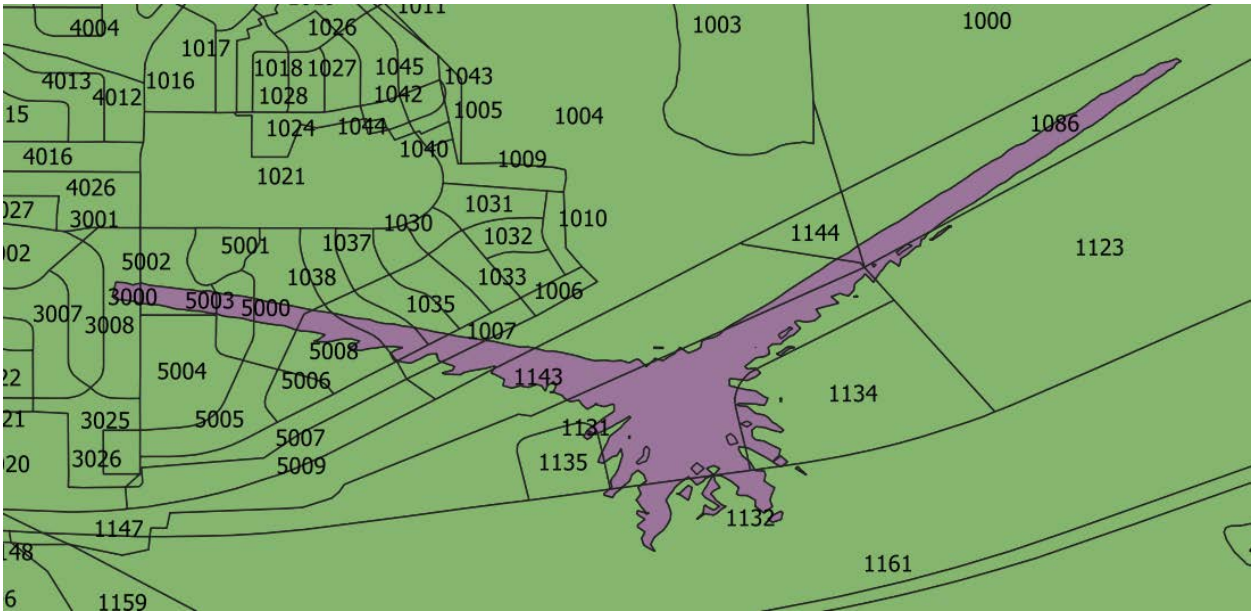

Figure 3. 27.5-27.85 GHz pfd contour overlaid on labeled census blocks

Table 2 provides the percentage of area of each census block covered by the contour, the associated population covered, and sums the population covered. The population covered is 145, thus the population coverage limit of 450 persons is met.

Census Tract	Census Block	Block Population	Total Block Area	Area Covered	Weighted Population
501	1004	2	688089.6	11802.9	0.0
501	1007	53	23062.3	7701.0	17.7
501	1036	52	22120.8	1816.2	4.3
501	1039	55	21719.7	11530.5	29.2
501	3000	144	50450.9	3366.7	9.6
501	5000	130	51181.0	7926.8	20.1
501	5002	95	39154.3	11338.0	27.5
501	5003	51	22758.0	6210.5	13.9
501	5008	78	42919.4	12033.0	21.9
2000	1086	0	897716.7	57900.6	0.0
2000	1131	0	320265.6	156832.2	0.0
2000	1132	0	1655248.6	25764.4	0.0
2000	1134	0	194239.5	13455.9	0.0
2000	1135	0	40850.1	840.9	0.0
2000	1143	0	283319.2	41065.8	0.0
2000	1144	0	31462.4	1582.1	0.0
				Total	**145**

Table 2. Population coverage of 27.5-27.85 GHz pfd contour

1.2.3. Results for 27.85-28.35 GHz

Visualyse Version 7 software was run using the Recommendation ITU-R P.452-16 propagation model option to generate the Section 25.136 PFD contours for the 27.85-28.35 GHz band where 1) the collocated grandfathered earth station generates a pfd, at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz ("the grandfathered PFD contour") and 2) where the collocated grandfathered earth station operating simultaneously with the Jupiter 3 earth station generates the same PFD ("the aggregate PFD contour").

The Table 3 technical parameters were used for the grandfathered earth station:

Parameter	**Value**
Latitude/longitude	41° 7' 54.4"N/ 104° 44' 13.9"W
Frequency (GHz)	28
Channel bandwidth (MHz)	250
Transmit power (dBW)	2.9
Antenna midline height above ground (m)	5.4
Antenna size (m)	9.2
On-axis antenna Gain (dBi)	66.1
Clear sky EIRP (dBW)	69
Antenna radiation pattern	Section 25.209(a)(1)
Clutter	Recommendation ITU-R P.452-16, Park lands
Terrain	NASA SRTM data 30 m resolution[3]

Table 3. Grandfathered gateway earth station technical parameters at 28 GHz

The resulting PFD contours are shown in Figure 4 (and further specified in a KMZ file submitted with this application). The blue PFD contour is the grandfathered PFD contour, and the red PFD contour is the aggregate PFD contour.

[3] http://dwtkns.com/srtm30m/

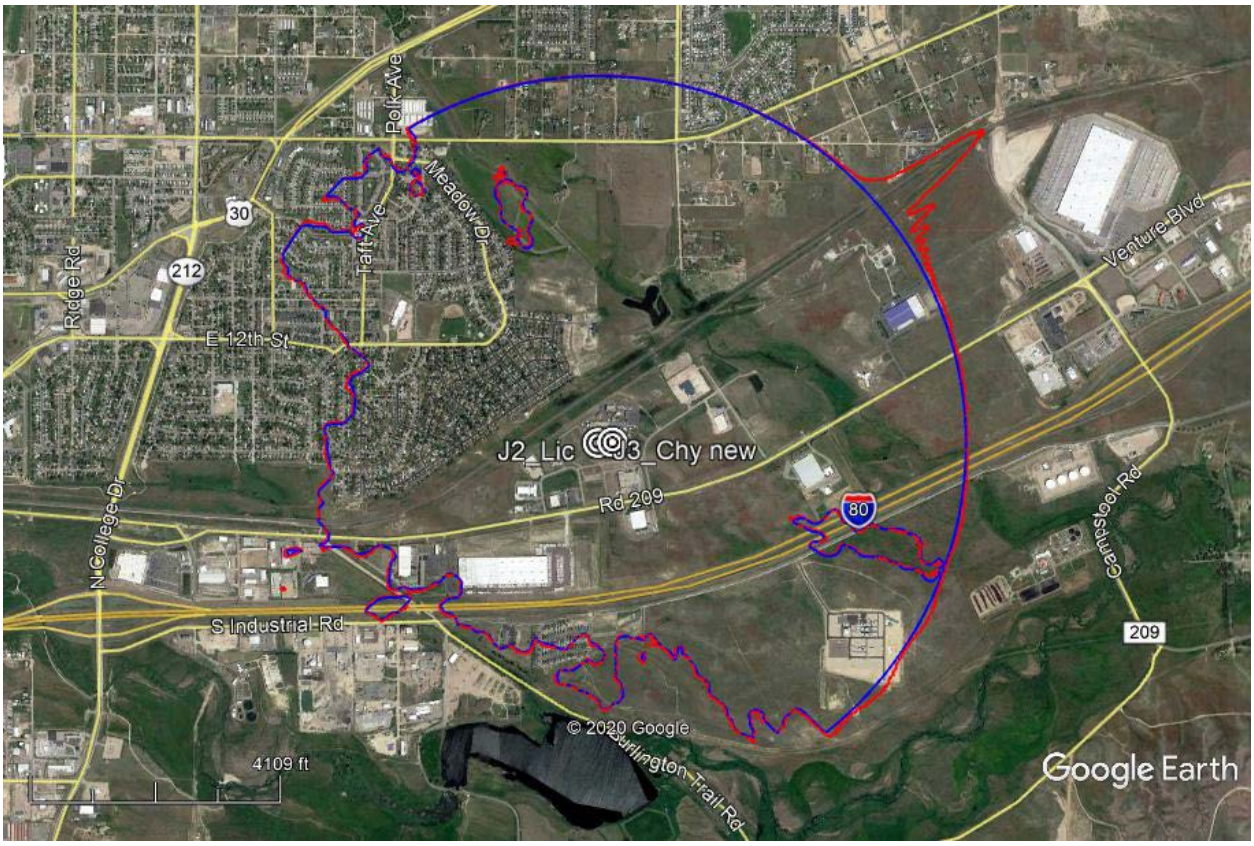

Figure 4. Section 25.136 grandfathered and aggregate PFD contours around the Cheyenne earth station in the 27.85-28.35 GHz band

With respect to coverage of any major roads (*i.e.,* Interstate, Other Freeways and Expressways, or Other Principal Arterial, according to the Federal Highway Administration HEPGIS map or Other Freeways and Expressways, or Other Principal Arterials identified by the Wyoming Department of Transportation), the 27.85-28.35 GHz PFD contour covers virtually the same portion of Interstate 80 as that covered by the grandfathered PFD contour. The PFD contour does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port according to a visual inspection in Google Earth.

The population covered by the 27.85-28.35 GHz aggregate PFD contour, but not within the grandfathered contour, was determined using the actual area method, where the population within the contour was calculated based on the proportion of the census geographic area covered by the PFD contour. Figure 5 shows the PFD contours overlaid on a census block map of the service area, with census block ID numbers depicted. The area colored green – inside the aggregate PFD contour but outside the grandfathered PFD contour – was assessed against the population limits.

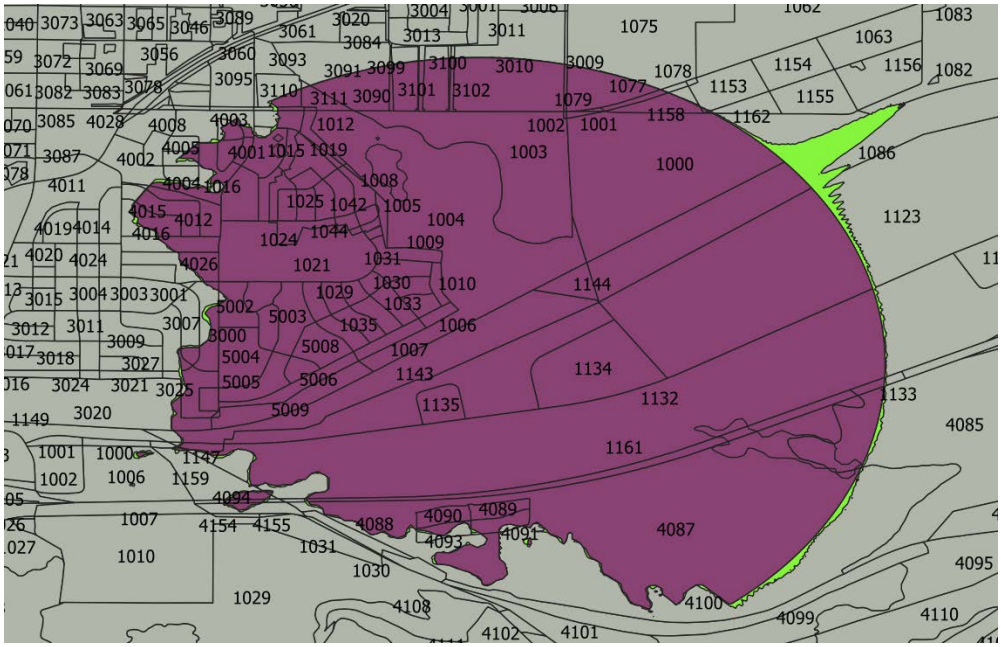

Figure 5. 27.85-28.35 GHz pfd contour overlaid on labeled census blocks

Table 4 provides the percentage of area of each census block covered by the green area, the associated population covered, and sums the population covered. The population covered is 69, and thus the population coverage limit of 450 persons is met. Only census blocks with non-zero population covered are shown.

COUNTYFP10	TRACTCE10	BLOCKCE	POP10	Block Area	Block Area covered by Agg but not J2	Weighted population
21	501	1000	40	648731.11	28263.16	1.74
21	501	1013	18	23445.32	621.37	0.48
21	501	1015	116	42736.94	956.97	2.60
21	501	1016	257	47131.23	15.02	0.08
21	501	3000	144	50450.92	3279.41	9.36
21	501	3007	164	52274.18	825.42	2.59
21	501	3008	116	36949.41	914.67	2.87
21	501	3025	66	40322.59	1026.44	1.68
21	501	4000	450	153582.22	6157.20	18.04
21	501	4001	119	15366.35	125.87	0.97
21	501	4003	167	12369.37	467.67	6.31
21	501	4004	37	13691.55	22.97	0.06
21	501	4005	68	14400.12	1342.00	6.34
21	501	4006	48	13233.81	157.95	0.57
21	501	4012	138	31454.00	75.43	0.33
21	501	4013	124	45109.64	278.78	0.77
21	501	4015	72	44134.73	1987.86	3.24
21	501	4016	169	41837.11	389.66	1.57

21	501	4026	271	53918.44	1001.15	5.03
21	501	5002	95	39154.31	429.46	1.04
21	1502	3010	110	260272.94	1099.45	0.46
21	1502	3091	10	159515.33	744.22	0.05
21	1502	3099	26	44150.68	354.63	0.21
21	1502	3100	14	12164.49	70.22	0.08
21	1502	3101	2	43788.06	158.67	0.01
21	2000	1075	145	827712.44	931.27	0.16
21	2000	1077	2	12323.98	89.72	0.01
21	2000	1080	19	1085812.41	2136.59	0.04
21	2000	1153	8	65934.39	203.27	0.02
21	2000	1158	8	35800.09	479.95	0.11
21	2000	1162	9	24099.14	135.96	0.05
21	2000	4087	18	1751127.93	38535.85	0.40
21	2000	4093	28	21679.06	1215.70	1.57
					Total	**69**

Table 4. Population coverage of 27.85-28.35 GHz PFD contour (aggregate – grandfathered)

1.3. Section 25.136(a)(4)(iv) – Coordination

As demonstrated in the attached Coordination Report (Attachment A), coordination of the modified earth station operations was completed through Comsearch pursuant to Sections 25.136(a)(4)(iv) and 101.103(d) of the Commission's rules.

2. Section 25.136(d)(4) assessment – 47.2-48.2 GHz

2.1. Section 25.136(d)(4)(i) – Number of earth stations

As of November 2020, there are no other earth stations licensed or proposed in the 47.2-48.2 GHz band in the relevant license area.

2.2. Section 25.136(d)(4)(ii) and (iii) – PFD contour population and highway/event/railway/port coverage

2.2.1. Assumptions

The Section 25.136 PFD was determined using the publicly available software program Visualyse and based upon the Table 5 technical parameters for the Jupiter 3 earth station.

Parameter	Value

Latitude/longitude	41° 7'54.5"N/ 104°44'10.8"W
Frequency (GHz)	47
Channel bandwidth (MHz)	470
Transmit power (dBW)	0.39
Antenna midline height above ground (m)	7
On-axis antenna Gain (dBi)	71.61
Clear sky EIRP (dBW)	72
Antenna radiation pattern	Manufacturer calculated off-axis gain pattern
Clutter	Recommendation ITU-R P.452-16, Park lands
Terrain	NASA SRTM data 30 m resolution[4]

Table 5. Jupiter 3 gateway earth station technical parameters at 47 GHz

Figure 6 provides a plot of the manufacturer's calculated combined co-polarized and cross-polarized off-axis gain patterns. Measured antenna patterns are not available for the off-axis angles of importance because of the size of the antenna; hence, calculated antenna patterns provided by the manufacturer are used.

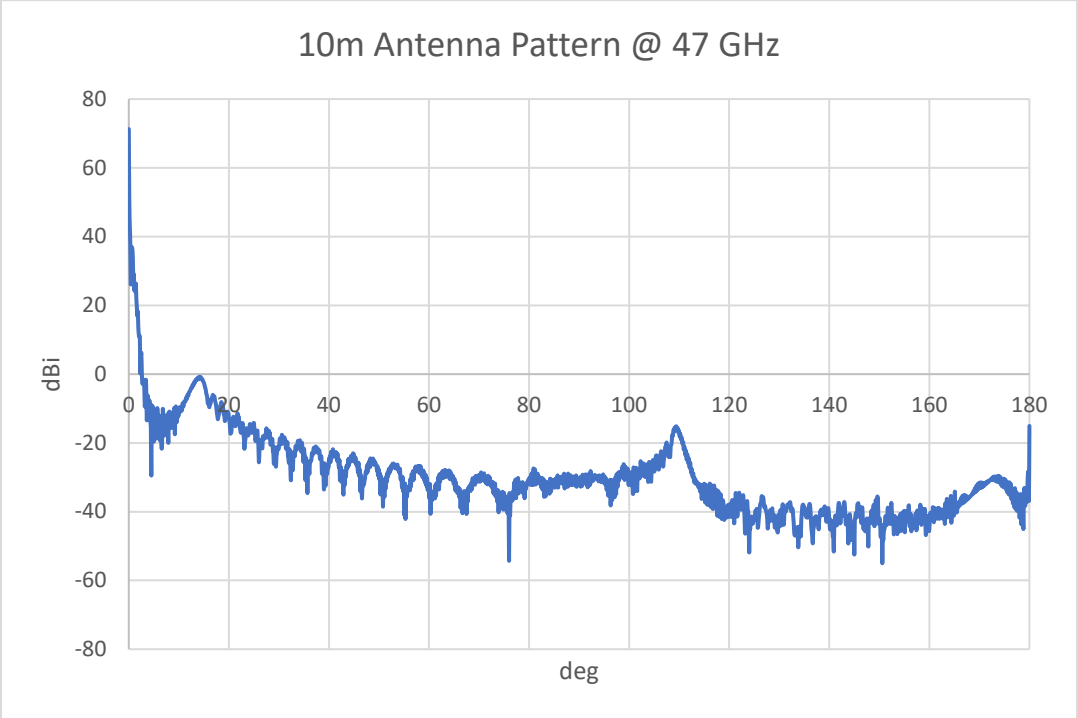

Figure 6. SED calculated off-axis gain pattern at 47 GHz

[4] http://dwtkns.com/srtm30m/

The earth station uses adaptive modulation and coding as well as uplink power control to maintain the desired availability. The percentage of time that the earth station will exceed the clear sky levels is small. Using Recommendation ITU-R P.618, Hughes has determined that the power levels are within 1 dB of the clear sky input power for 93.91% of the time and within 2 dB of the clear sky input power for 97.63% of the time.

Further, the earth station is licensed for clear sky EIRP levels pursuant to Section 25.204(e) of the Commission's rules.

2.2.2. Results

Visualyse Version 7 software was run using the Recommendation ITU-R P.452-16 propagation model option to generate the Section 25.136 contour for the 47 GHz band where the earth station generates a pfd, at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz. The resulting PFD contour is shown in Figure 7 (and further specified in a KMZ file submitted with this application).

Figure 7. Section 25.136 pfd contour around the Cheyenne earth station in the 47 GHz band

The 47 GHz PFD contour does not cover any major roads (*i.e.*, Interstate, Other Freeways and Expressways, or Other Principal Arterial according to the Federal Highway Administration HEPGIS map, or highways designated as Other Freeways and Expressways, or Other Principal Arterials by Wyoming State Department of Transportation). The PFD contour also does not contain any major event venue, urban mass transit route, passenger railroad, or cruise ship port according to a visual inspection in Google Earth.

The population covered by the 47 GHz PFD contour was determined using the actual area method, where the population within the contour was calculated based on the proportion of the census geographic area covered by the PFD contour. Figure 8 shows the 47 GHz PFD contour overlaid on a census block map of the service area, with census block ID numbers depicted.

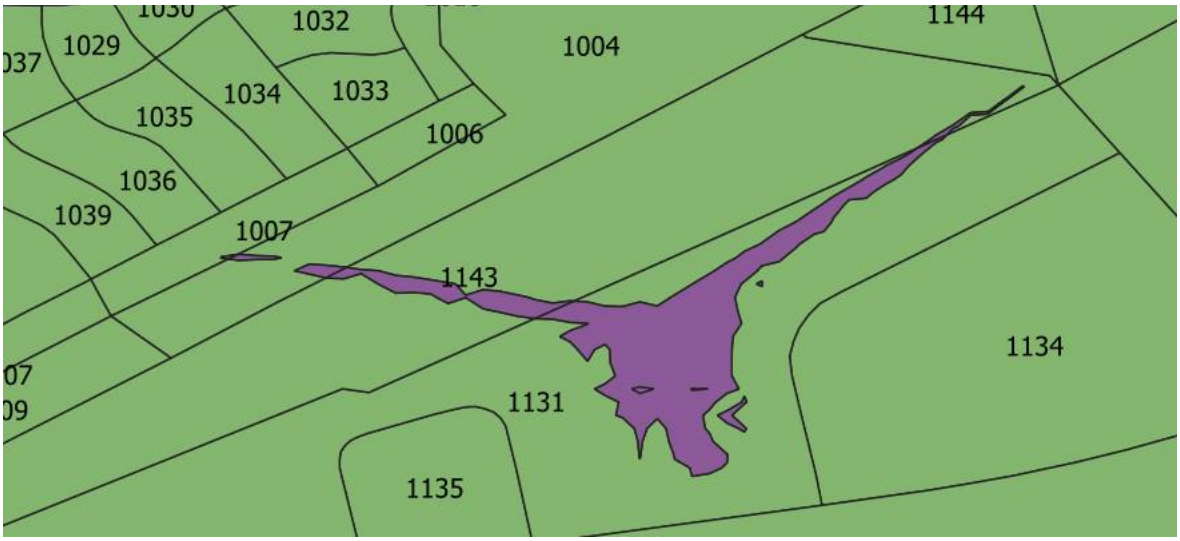

Figure 8. 47 GHz pfd contour overlaid on labeled census blocks

Table 6 provides the percentage of area of each census block covered by the contour, the associated population covered, and sums the population covered. The population coverage limit of 2250 persons is met.

Census Tract	Census Block	Block Population	Total Block Area	Area Covered	Weighted Population
2000	1131	0	320266	43492	0.0
501	1007	53	23062	54	0.1
501	1004	2	688090	1011	0.0
2000	1143	0	283319	6232	0.0
				Total	1

Table 6. Population coverage of 47 GHz pfd contour

2.3. Section 25.136(d)(4)(iv) – Coordination

As demonstrated in the attached Coordination Report (Attachment B), coordination of the modified parameters for the earth station was completed through Comsearch pursuant to Sections 25.136(d)(4)(iv) and 101.103(d) of the Commission's rules.

3. Section 25.136(e)(3) assessment – 50.4-51.4 GHz

Operations in the 50.4-51.4 GHz band are grandfathered pursuant to 47 C.F.R. § 25.136(e)(3). The proposed modifications create no significant increase in interference risk to terrestrial operations with respect to PFD contour coverage of populations and major roads and venues, as shown below.

3.1. PFD contour population and highway/event/railway/port coverage

3.1.1. Assumptions

The Section 25.136 PFD was determined using the publicly available software program Visualyse and based upon the 7 technical parameters for the Jupiter 3 earth station.

Parameter	Old site	New site
Latitude/longitude	41° 7'54.50"N / 104°44'15.20"W	41° 7'54.5"N/ 104°44'10.8"W
Frequency (GHz)	50.9	50.9
Channel bandwidth (MHz)	470	470
Transmit power (dBW)	0	0
Antenna midline height above ground (m)	7	7
On-axis antenna Gain (dBi)	72	72
Clear sky EIRP (dBW)	72	72
Antenna radiation pattern	Manufacturer calculated off-axis gain pattern	Manufacturer calculated off-axis gain pattern
Clutter	Recommendation ITU-R P.452-16, Park lands	Recommendation ITU-R P.452-16, Park lands
Terrain	NASA SRTM data 30 m resolution[5]	NASA SRTM data 30 m resolution[6]

Table 7. Jupiter 3 gateway earth station technical parameters at 50 GHz

Figure 9 provides a plot of the manufacturer's calculated combined co-polarized and cross-polarized off-axis gain patterns. Measured antenna patterns are not available for the off-axis angles of importance because of the size of the antenna; hence, calculated antenna patterns provided by the manufacturer are used.

[5] http://dwtkns.com/srtm30m/
[6] http://dwtkns.com/srtm30m/

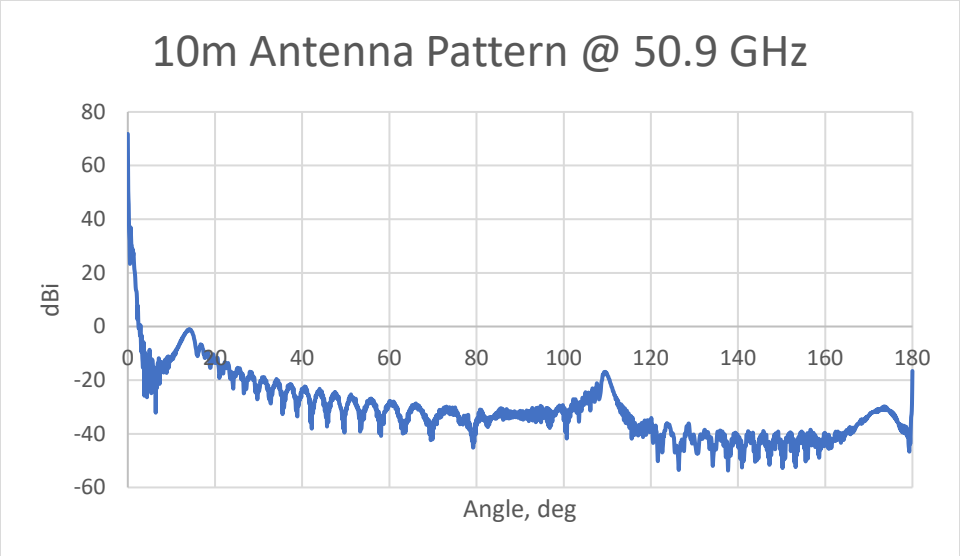

Figure 9. SED calculated off-axis gain pattern at 50.9 GHz

3.1.2. Results

Visualyse Version 7 software was run using the Recommendation ITU-R P.452-16 propagation model option to generate the Section 25.136 contour for the 50.9 GHz band where the earth station generates a pfd, at 10 meters above ground level, of greater than or equal to −77.6 dBm/m^2/MHz. The resulting PFD contours for the old and new sites are shown in yellow and orange, respectively, in Figure 10.

Figure 10. Section 25.136 pfd contours around the Cheyenne earth station in the 50 GHz band at the old site location (yellow) and the new (orange)

Neither PFD contour covers: (i) any major roads (*i.e.*, Interstate, Other Freeways and Expressways, or Other Principal Arterial according to the Federal Highway Administration HEPGIS map, or highways designated as Other Freeways and Expressways, or Other Principal Arterials by the Washington State Department of Transportation); or (ii) any major event venue, urban mass transit route, passenger railroad, or cruise ship port, according to a visual inspection in Google Earth.

ATTACHMENT A – COMSEARCH COORDINATION REPORT FOR 28 GHZ

ATTACHMENT B – COMSEARCH COORDINATION REPORT FOR 47 GHZ