Radio Frequency Exposure

NIER Report

07/25/2022

Site: SE03440A

MERCER ISLAND, WA

Prepared for: T-Mobile

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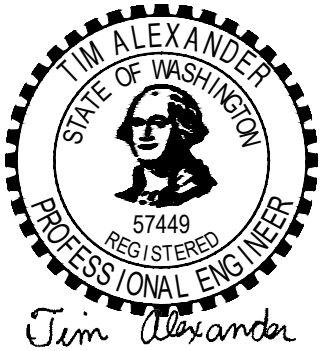
1 Certification

This report, prepared by Pramira, Inc. for **T-Mobile**, is intended to document compliance and evaluate power density levels as outlined in the report. The computations, analysis, and resulting report and conclusions were based on applicable FCC guidelines and regulations for maximum permissible exposure to humans consistent with FCC OET Bulletin 65, Edition 97-01.

Additionally, Pramira, Inc. certifies that the assumptions are valid and that the data used within Pramira' control are accurate, including information collected as part of Pramira' field surveys. Pramira, Inc. does not however certify the accuracy or correctness of any data provided to Pramira, Inc. for this analysis and report by T-Mobile or other third parties working on behalf of T-Mobile.

I certify that the attached RF exposure analysis and report is correct to the best of my knowledge, and all calculations, assumptions and conclusions are based on generally acceptable engineering practices:



SIGNED, 26 JUL 2022
EXPIRES, 3 FEB 2024

Tim Alexander, PE

Digitally signed by Tim Alexander, PE
DN: cn=Tim Alexander, PE, o, ou, email=proteuspower@outlook.com, c=US
Date: 2022.07.26 14:48:16 -07'00'

Tim Alexander, P.E.

Report Prepared by: Mohamed Ahmed, 07/25/2022
Report Reviewed by: Mike Arnold 07/25/2022

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2 Executive Summary

This report provides the results of an RF power density analysis performed for **T-Mobile** at site **SE03440A** in accordance with the Federal Communications Commission (FCC) rules and regulations for RF emissions described in OET Bulletin 65, Edition 97-01.

This report addresses RF safety for two classified groups defined by OET Bulletin 65: Occupational/ Controlled and General Population/ Uncontrolled. Based on the analysis, this site will be **Compliant** with FCC rules and regulations and T-Mobile's Signage and Barrier Policy if the mitigation details provided in Table 1 are implemented.

Final Compliant Configuration						
	GUIDELINES	**NOTICE**	**CAUTION**	**WARNING**	**NOC INFO**	**BARRIER/MARKER**
Access Point(s)	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐
Alpha	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐
Beta	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐
Gamma	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐

Notes/ Additional Compliance Requirements(s):

Table 1: Mitigation Requirements for Compliance

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2.1 Conclusion and Recommendations:

- The results of the analysis indicate that power density levels in the generally accessible areas on the Ground level will not exceed the FCC's MPE limit for General Population environments.
- The max theoretical % MPE is **0.24% (FCC General Public)** directly in front of the antenna beams at the Ground Level.
- This site will be operating in general compliance with FCC OET Bulletin 65 and T-Mobile's signage policy as the mitigation requirements outlined in the Executive Summary are implemented. See Signage/Barrier Diagram section for further details on the recommended signage placement locations.

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3 Introduction

The purpose of this analysis and report is to evaluate the cumulative power density levels of all non-excluded antennas located on the site and identify any areas of concern that require mitigation. This report also assesses the site's compliance with FCC OET Bulletin 65; "Guidelines for Human Exposure to Radio-frequency Electromagnetic Fields".

3.1 Site Description:

- **Site Name:** SE03440A
- **Street Address:** 4646 Island Crest Way.
  MERCER ISLAND, WA 98040
- **Latitude:** 47.562372° N
- **Longitude:** -122.2223753° W
- **Structure Type**: Monopole
- **Structure Height**: 91' AGL
- **BTS Equipment Location**: The BTS Equipment is located on the Ground.
- **Co-Locators/ Other Antennas**: N/A.
- **Access**: N/A

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3.2 Site Configuration Being Modeled:

- This Monopole application where T-Mobile antennas are mounted on the Pole.
- This will be a Three-Sector site with Two Active antennas in each sector.
- The rad center value of all sector antennas (88.6' & 91') based on the CDs. These values must be verified on the site audit for the post study.
- Each sector supports LTE at 600, 700, 1900, 2100, 2500 MHz bands, GSM at 1900 MHz band, N600, and N2500 bands. All LTE supports MIMO.
- All technologies were evaluated assuming the max number of channels and were running at max power 100% of the time.

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4 Predictive Analysis Details:

For purposes of this analysis, RoofMaster® was configured to provide an output based on the appropriate MPE limit(s) published in the FCC's guidelines. The antenna information was loaded into RoofMaster®, an MPE predictive analysis tool by Waterford Consultants, LLC.

4.1 Analysis Locations:

Number of Elevations Analyzed: 1

- Ground Level

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4.2 Antenna Inventory:

The following table shows all transmitting antennas and contains the technical data used to simulate the power density that may be encountered with all antennas simultaneously operating at full rated power with the exception of any excluded antennas cited in this document. If Co-Locator antennas exist and the use of "Unknown" as an antenna model that means the specific antenna details could not be secured, generic antennas, frequencies, and Tx powers were used for modeling. The assumptions used are based on past experience with communications carriers.
Z-height represents the distance from the nearest walking surface to the **Centerline** of the antenna.

ID	Name	(MHz) Freq	Trans Power	Trans Count	Other Loss	Total Input Power (Watts)	Total ERP (Watts)	Mfg	Model	Ground Z (ft)	Type	(ft) Aper	dBd Gain	BWdth	Orientation
T-Mobile Alpha_Ant1	L2500	2500	3.75	32	0.5	107.0	2979	NOKIA	AEHC	91.0	Panel	2.0	14.5	65.0	90
T-Mobile Alpha_Ant1	N2500	2500	3.75	32	0.5	107.0	11750	NOKIA	AEHC	91.0	Panel	2.0	20.4	13.0	90
T-Mobile Alpha_Ant2	L600	600	40.0	2	0.4	73.0	966	Commscope	FFVV-65B-R3	88.6	Panel	6.0	11.2	65.0	90
T-Mobile Alpha_Ant2	N600	600	40.0	2	0.4	73.0	966	Commscope	FFVV-65B-R3	88.6	Panel	6.0	11.2	65.0	90
T-Mobile Alpha_Ant2	L700	700	40.0	2	0.4	73.0	1200	Commscope	FFVV-65B-R3	88.6	Panel	6.0	12.2	59.0	90
T-Mobile Alpha_Ant2	L1900	1900	80.0	2	0.5	142.6	5508	Commscope	FFVV-65B-R3	88.6	Panel	6.0	15.9	67.0	90
T-Mobile Alpha_Ant2	G1900	1900	80.0	2	0.5	142.6	5508	Commscope	FFVV-65B-R3	88.6	Panel	6.0	15.9	67.0	90
T-Mobile Alpha_Ant2	L2100	2100	80.0	2	0.5	142.6	5636	Commscope	FFVV-65B-R3	88.6	Panel	6.0	16.0	63.0	90
T-Mobile Beta_Ant1	L600	600	40.0	2	0.4	73.0	966	Commscope	FFVV-65B-R3	88.6	Panel	6.0	11.2	65.0	200
T-Mobile Beta_Ant1	N600	600	40.0	2	0.4	73.0	966	Commscope	FFVV-65B-R3	88.6	Panel	6.0	11.2	65.0	200
T-Mobile Beta_Ant1	L700	700	40.0	2	0.4	73.0	1200	Commscope	FFVV-65B-R3	88.6	Panel	6.0	12.2	59.0	200
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T-Mobile Beta_Ant2	L2500	2500	3.75	32	0.5	107.0	2979	NOKIA	AEHC	91.0	Panel	2.0	14.5	65.0	200
T-Mobile Beta_Ant2	N2500	2500	3.75	32	0.5	107.0	11750	NOKIA	AEHC	91.0	Panel	2.0	20.4	13.0	200
T-Mobile Gamma_Ant1	L600	600	40.0	2	0.4	73.0	966	Commscope	FFVV-65B-R3	88.6	Panel	6.0	11.2	65.0	330
T-Mobile Gamma_Ant1	N600	600	40.0	2	0.4	73.0	966	Commscope	FFVV-65B-R3	88.6	Panel	6.0	11.2	65.0	330
T-Mobile Gamma_Ant1	L700	700	40.0	2	0.4	73.0	1200	Commscope	FFVV-65B-R3	88.6	Panel	6.0	12.2	59.0	330
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T-Mobile Gamma_Ant2	N2500	2500	3.75	32	0.5	107.0	11750	NOKIA	AEHC	91.0	Panel	2.0	20.4	13.0	330

The antenna Z-heights listed above are referenced to the Ground Level.

Table 2- Antenna Inventory

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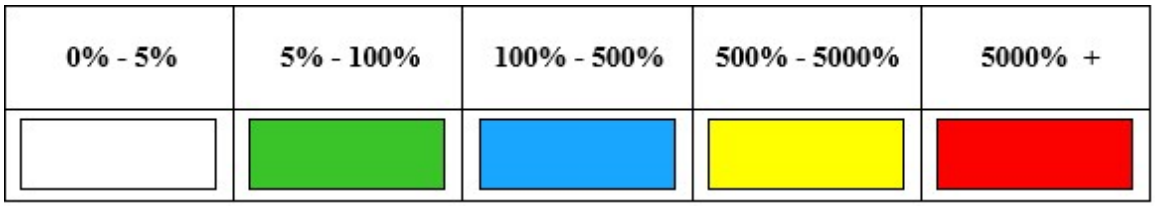
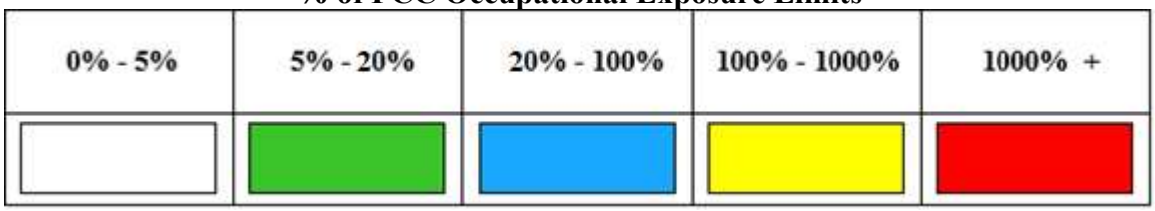
4.3 RF Emissions Diagram(s)

The RF Emissions Diagram(s) display the **Theoretical** spatially averaged Maximum Permissible Exposure (MPE) percentages that are expected for each study's elevation for T-Mobile antennas and all other carrier antennas at the site.
General Population MPE limit is included to demonstrate where T-Mobile is a significant contributor to accessible areas where multiple carrier's transmitters are present.
These diagrams use modeling as prescribed in OET Bulletin 65 and assumptions detailed in Appendix A.
The keys at the bottom of each diagram indicates if percentages displayed are referenced to **Occupational Limit and FCC General Public** Maximum Permissible Exposure (MPE) limits.

% of FCC General Public Exposure Limits

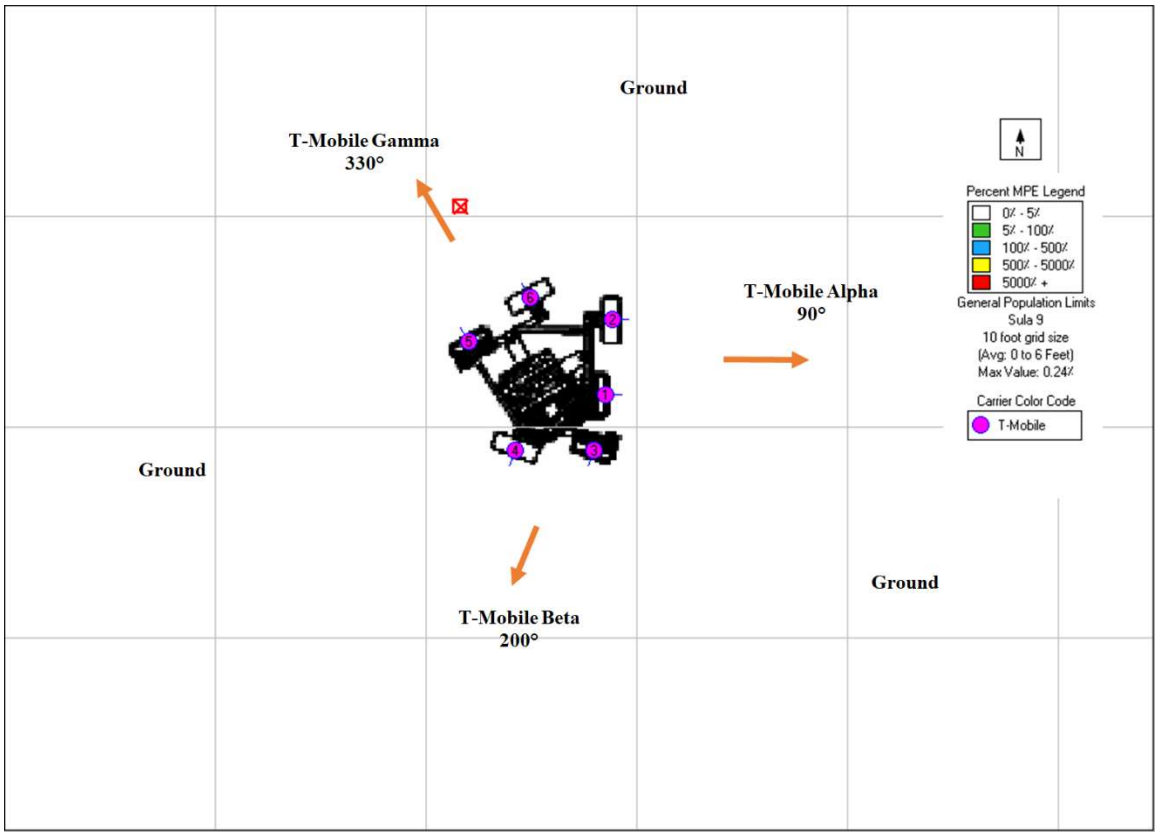


% of FCC Occupational Exposure Limits



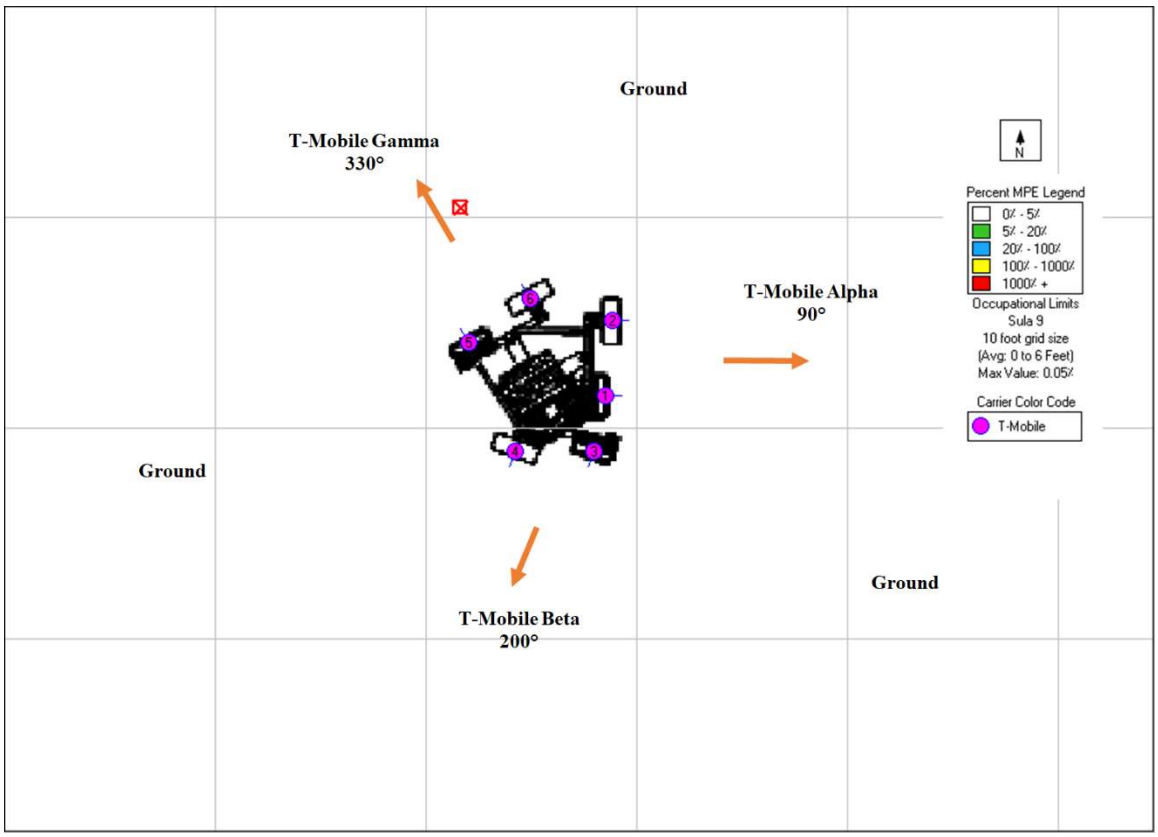
4.3.1 RF Emissions Diagram(s)- All Transmitters

Reference Plane: Ground Level



The maximum theoretical % MPE of the General Population limits =0.24%

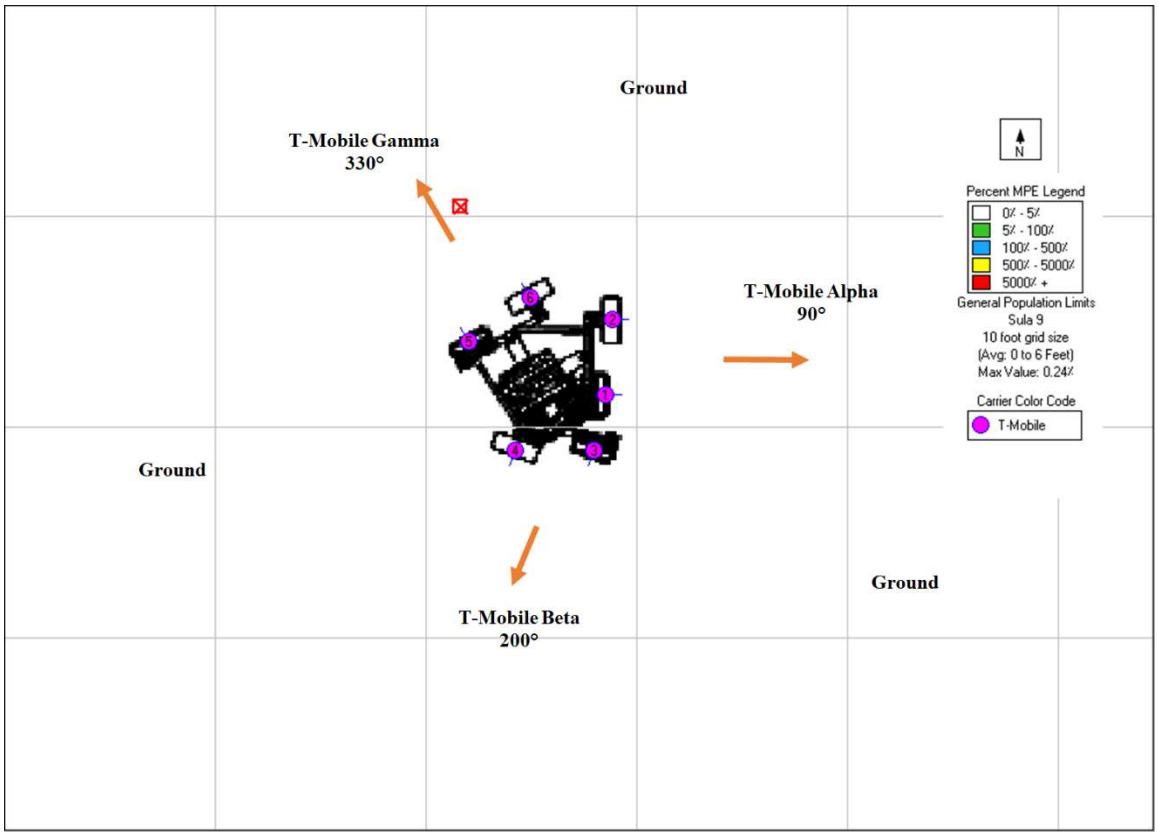
Reference Plane: Ground Level



The maximum theoretical % MPE of the Occupational Limit =0.05%

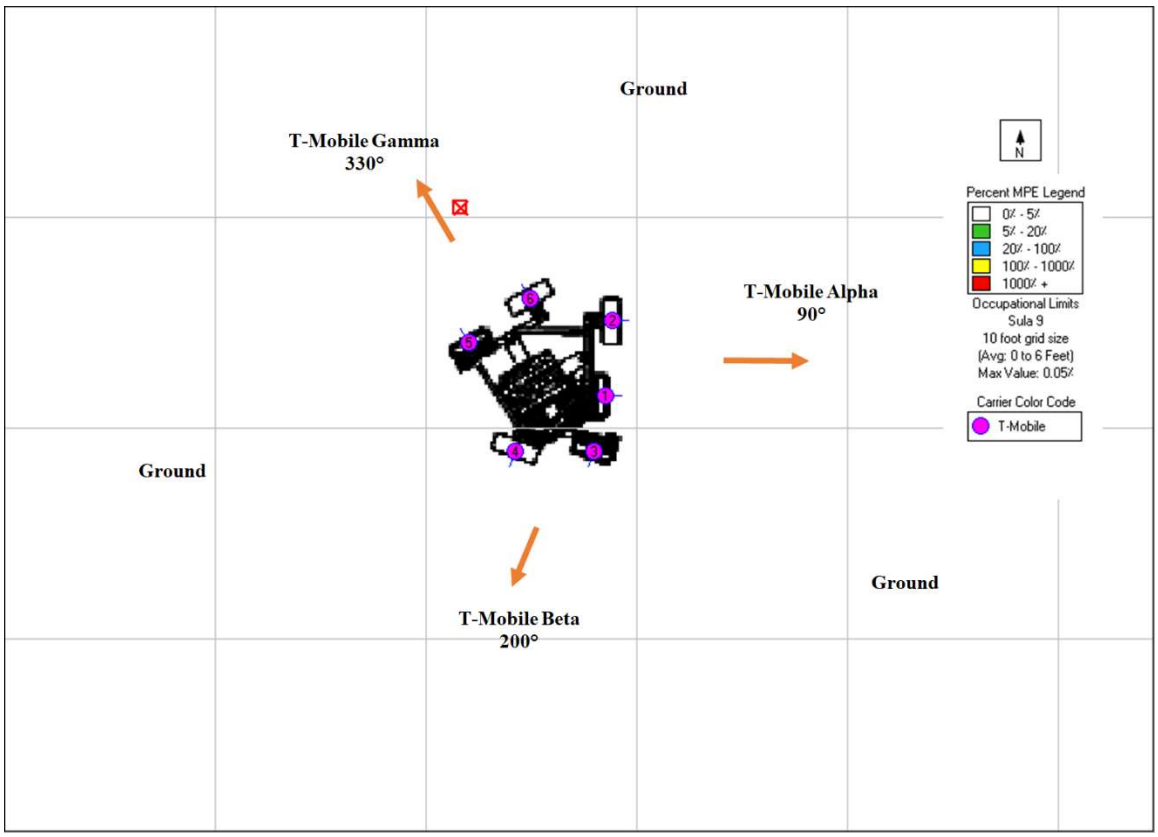
4.3.2 RF Emissions Diagram(s)- T-Mobile Transmitters Only:

Reference Plane: Ground Level



The maximum theoretical % MPE of the General Population limits =0.24%

Reference Plane: Ground Level



The maximum theoretical % MPE of the Occupational Limit =0.05%

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5 Signage/ Barrier Detail

Final Compliant Configuration							
	GUIDELINES	**NOTICE**	**CAUTION**	**WARNING**	**NOC INFO**	**BARRIER/MARKER**	
Access Point(s)	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐	
Alpha	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐	
Beta	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐	
Gamma	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐ [ ]	☐	

Table 3: Mitigation Requirements for Compliance

Notes/ Additional Mitigation Details from Audit:

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5.1 Signage/ Barrier Diagram

N/A

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6 Conclusions and Recommendations:

- The results of the analysis indicate that power density levels in the generally accessible areas on the Ground level will not exceed the FCC's MPE limit for General Population environments.
- The max theoretical % MPE is **0.24% (FCC General Public)** directly in front of the antenna beams at the Ground Level.
- This site will be operating in general compliance with FCC OET Bulletin 65 and T-Mobile's signage policy as the mitigation requirements outlined in the Executive Summary are implemented. See Signage/Barrier Diagram section for further details on the recommended signage placement locations.

Note: Modifications to the site; and/or increases in channel counts or power levels exceeding those listed in this report will require additional evaluation to determine compliance.

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7 Appendix A: FCC Compliance and RF Safety Policies

In August of 1997, the FCC published OET Bulletin 65 Edition 97-01 to regulate methods for evaluating compliance with FCC guidelines for human exposure to radiofrequency (RF) electromagnetic fields. The FCC guidelines for human exposure to RF electromagnetic fields incorporate two categories of limits; namely "Controlled" (a.k.a. Occupational) and "Uncontrolled" (a.k.a. General Public). The guidelines offer suggested methods for evaluating fixed RF transmitters to ensure that the controlled and uncontrolled limits deemed safe by the FC for human exposure are not exceeded.

OET Bulletin 65 recommended guidelines are intended to allow an applicant to "make a reasonably quick determination as to whether a proposed facility is in compliance with the limits." In addition, the guidelines offer alternate supplementary considerations and procedures such as field measurements and more detailed analysis that should be used for multiple emitter situations.

These guidelines define RF as emissions in the frequency range of 300 kHz to 100 GHz. The FCC define Maximum Permissible Exposure (MPE) limits within this frequency range based on limits recommended by the National Council on Radiation Protection and Measurement, the Institute of Electrical and Electronics Engineers (IEEE), and by the American National Standards Institute (ANSI).

As shown in Table 1 of Appendix A, the averaging time for Occupational/Controlled exposures is 6 minutes, while the averaging time for general population/uncontrolled exposures is 30 minutes.

As an illustration of the application of time-averaging to Occupational/Controlled exposure consider the following.
The relevant interval for time-averaging for Occupational/Controlled exposures is six minutes. This means, for example, that during any given six-minute period a worker could be exposed to two times the applicable power density limit for three minutes as long as he or she were not exposed at all for the preceding or following three minutes. Similarly, a worker could be exposed at three times the limit for two minutes as long as no exposure occurs during the preceding or subsequent four minutes, and so forth.

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The specific MPE limits defined by the FCC are as follows:

Limits for Occupational/Controlled Exposure				
Frequency Range [MHz]	**Electric Field Strength (E) [V/m]**	**Magnetic Field Strength (H) [A/m]**	**Power Density (S) [mW/Cm^2]**	**Averaging Time |E|^2, |H|^2 or S [minutes]**
0.3 - 3.0	614	1.63	100*	6
3.0 - 30	1842/f	4.89/f	900/f^2*	6
30 - 300	61.4	0.163	1	6
300 - 1,500	-	-	f/300	6
1,500 - 100,000	-	-	5	6

Limits for General Population/Uncontrolled Exposure				
Frequency Range [MHz]	**Electric Field Strength (E) [V/m]**	**Magnetic Field Strength (H) [A/m]**	**Power Density (S) [mW/Cm^2]**	**Averaging Time |E|^2, |H|^2 or S [minutes]**
0.3 - 3.0	614	1.63	100*	30
3.0 - 30	842/f	2.19/f	180/f^2*	30
30 - 300	27.5	0.073	0.2	30
300 - 1,500	-	-	f/1500	30
1,500 - 100,000	-	-	1	30

f = frequency *Plane-wave equivalent power density

Table 1: The specific MPE limits defined by the FCC

The FCC states that "Occupational/ Controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for Occupational/ Controlled exposure also apply in situations when an individual is transient through a location where Occupational/ Controlled limits apply provided he or she is made aware of the potential for exposure."

For General Population/ Uncontrolled limits, the FCC states that "General Population/ Uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not fully be aware of the potential for exposure or cannot exercise control over their exposure."

For purposes of this analysis, all limits are evaluated against the Power Density limits.

Typical guidelines for determining whether Occupational/ Controlled limits can be applied include ensuring the environment (such as a rooftop) as limited/controlled access via locked doors or physical barrier that are preferably controlled by a landlord that is aware of the situation and can inform anyone going through the locked door of the existence of the RF emissions. Such notification/awareness is typically accomplished by means of signage on the door, or other access to the area of concern, as well as signage on or near the antennas. Examples of such signs include the following:

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Standards for when to use each of the above signs are as follows:

No sign required: <100% of Public Limit MPE
Blue Sign, Notice: 100% to <500% of Public Limit MPE
Yellow Sign, Caution: 500% to <5000% of Public Limit MPE
Red Sign, Warning: ≥5000% of Public Limit MPE

All MPE references are to the FCC Public limits.

No sign required: <20% of Occupational MPE
Blue Sign, Notice: 20% to <100% of MPE
Yellow Sign, Caution: 100% to <1000% of MPE
Red Sign, Warning: ≥1000% of MPE

All MPE references are to the FCC Occupational limits

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8 Appendix B: Overview of RoofMaster® Functions and Assumptions

RoofMaster® is a RF Compliance software package designed to enable the analysis, assessment and mitigation of communications sites with respect to human exposure to radiofrequency electromagnetic fields.

RoofMaster® was developed in 2008 by Waterford Consultants to support compliance assessments performed at single and multi-operator wireless locations throughout North America and has been in service since 2008. Real-world experience in evaluating thousands of base station installations are reflected in the RoofMaster® design approach. This document provides a guide for creating simulations of RF hazard conditions through the characterization of antenna systems and site features and through FCC-specified computational analysis.

On any structure, one may encounter antennas installed by wireless service providers, public safety and other FCC-licensed and unlicensed operators. Siting constraints have resulted in diverse and complex environments accessible to people performing a variety of activities around these antennas. RoofMaster® supports the characterization of these locations to convey important information regarding RF sources and accessible areas necessary to evaluate the potential for human exposure to hazardous levels of RF energy.

RoofMaster® supports the depiction of communications sites through the display of construction drawing or aerial photography image files as well as providing line drawing tools. These representations are scalable to enable the modeling of any location.

RoofMaster® utilizes a three-dimensional spatial framework consisting of a 1000 x 1000 grid with unlimited vertical dimensions necessary for the positioning of antennas and modeling of RF conditions at each grid point throughout the space. Predictive analysis is performed on a study plane at a specified elevation. The subsequent sections of this guide provide the steps necessary to create a site representation and conduct these studies.

RoofMaster® employs several power density prediction models based on the computational approaches set forth in the Federal Communications Commission's Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, OET Bulletin 65. This guideline utilizes several antenna and operational parameters in calculating the power density contributions from each emitter at specified points throughout the study space. RoofMaster® enables antennas to be fully defined in site specific aspects as well as through the use of a library of manufacturer data. The parameters include:

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§ Antenna model
§ Radiation patterns
§ Aperture length
§ Gain
§ Beamwidth
§ Antenna radiation center
§ Azimuth
§ Mechanical downtilt
§ Location
§ Frequency
§ Power into antenna

In OET-65, the Cylindrical Model is presented as an approach to determine the spatially averaged power density in the near field directly in front of an antenna. In order to implement this model in all directions, RoofMaster® utilizes the antenna manufacturer horizontal pattern data. Additionally, RoofMaster® incorporates factors that reduce the power density by the inverse square of horizontal and vertical distance beyond the near field region.

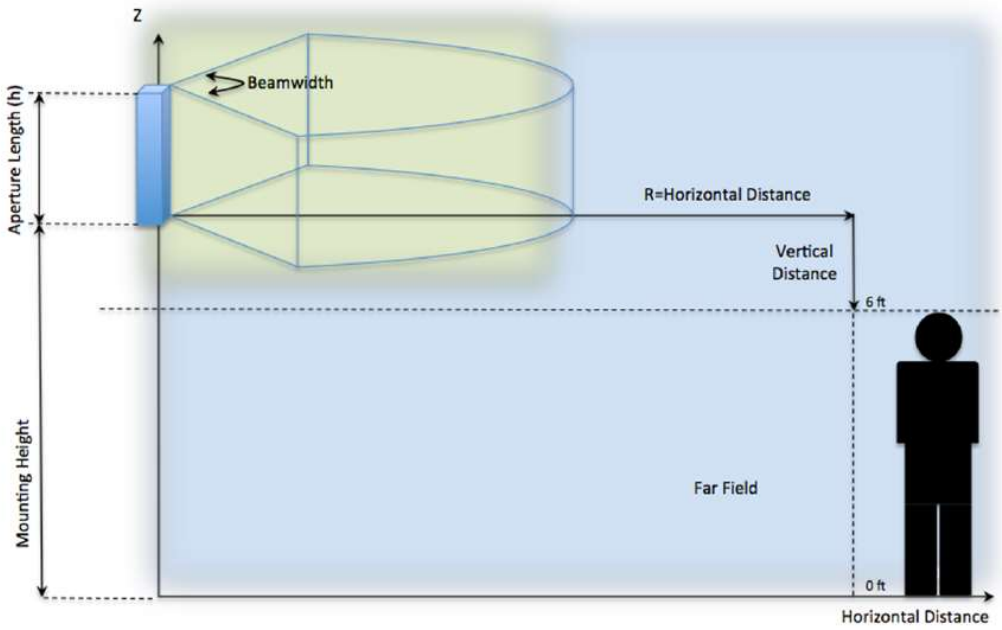
Power density is calculated as follows:

$$S = \left(\left(\frac{360}{Beamwidth} \right) \frac{P_{in} G_H H_r V_r}{2\pi Rh} \right) \frac{\mu W}{cm^2}$$

- S is the spatially averaged power density value
- R is the horizontal distance meters to the study point
- h is the aperture length in meters
- P_{in} is power into the antenna input port in Watts

RoofMaster® Implementation:

- G_H is gain offset to study point as specified in manufacturer horizontal pattern
- P_{in} is adjusted by the portion of the antenna aperture in the 0-6 ft vertical study zone
- H_r accounts for $1/R^2$ Far Field roll off which starts at 2*h
- V_r accounts for 1/ (vertical distance) ^{2} roll off from antenna bottom to the top of the 0-6ft study zone (or antenna top to bottom of 0-6ft study zone)


Z
Beamwidth
Aperture Length (h)
R=Horizontal Distance
Vertical Distance
6 ft
Mounting Height
Far Field
0 ft
Horizontal Distance

Not to Scale

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9 References

FCC (1997). "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields"; Federal Communications Commission; Office of Engineering and Technology, OET Bulletin 65, Edition 97-01, August.

Waterford Consultants, LLC. (2008). RoofMaster® User Guide, Waterford Consultants, LLC.

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10 Limited Warranty

Pramira, Inc. warrants that this analysis was performed in good faith using the methodologies and assumptions covered in this report and that data used for the analysis and report were obtained by Pramira, Inc. employees or representatives via site surveys or research of T-Mobile's available information. In the event that specific third-party details were not available, best efforts were made to use assumptions that are based on industry experience of various carriers' standards without violating any confidential information obtained under non-disclosure terms.

Pramira, Inc. also warrants that this analysis was performed in accordance with industry acceptable standards and methods.

There are no other warranties, express or implied, including but not limited to, the implied warranties of merchantability and fitness for a particular purpose, relating to this agreement or to the services rendered by Pramira hereunder. In no event shall Pramira be held liable to T-Mobile, or to any third party, for any indirect, special, incidental, or consequential damages, including but not limited to loss of profits, loss of data, loss of good will, and increased expenses. In no event shall Pramira be liable to T-Mobile for damages, whether based in contract, tort, negligence, strict liability, or otherwise, exceeding the amount payable hereunder for the services giving rise to such liability.