



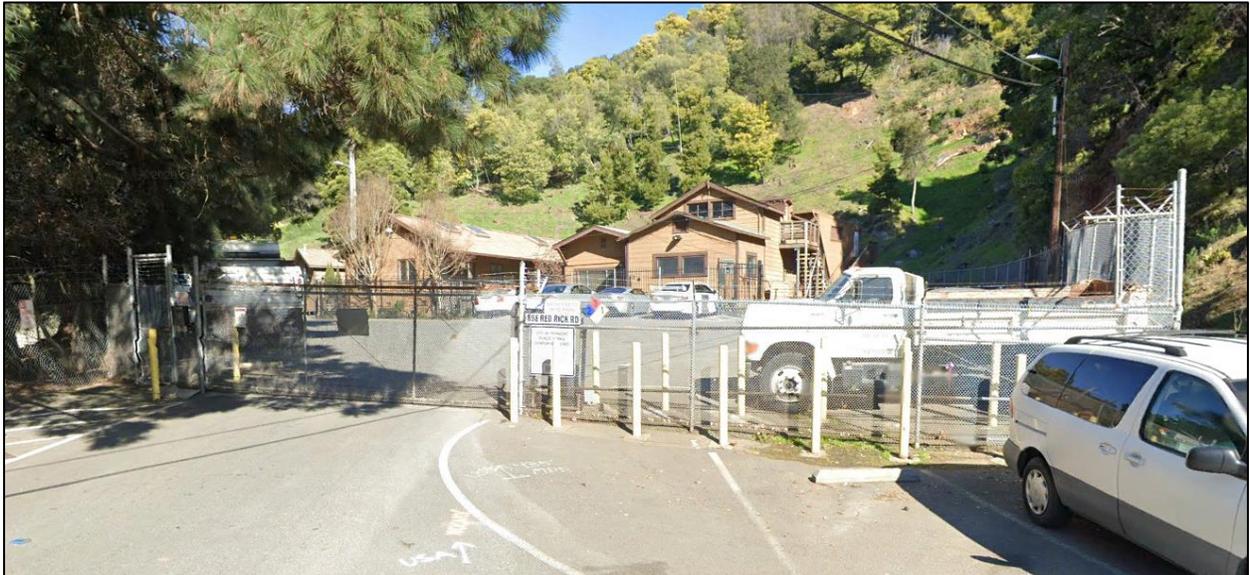
**Global RF Solutions**<sup>SM</sup>

*PREDICT, DETECT, PROTECT*

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## **Evaluation of Human Exposure to Radio Frequency Emissions**



**Analysis of Gulf South Towers  
Piedmont Corporate Yard  
Proposed Installation  
Piedmont, CA**

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# 1. INTRODUCTION

An analysis and evaluation of this proposed monopole site has been performed on January 27<sup>th</sup>, 2021 in accordance with FCC Rules for human exposure to radio frequency emissions.

In 1997, the Telecommunications Act of 1996 was implemented. One of the purposes of this law was to set Federal standards for FCC Licensed transmitters to comply with the National Environmental Policy Act (NEPA) of 1969. This was accomplished by combining National Council on Radiation Protection (NCRP) limits and Institute of Electrical and Electronics Engineers (IEEE) limits adopted by the American National Standards Institute (ANSI), into the current two tier limits also known as the Maximum Permissible Exposure (MPE) limits. These standards (limits) are found in Title 47 CFR 1.1307 and 47 CFR 1.1310 (referenced in Appendix A) and are enforced by the FCC. This two tier standard has been developed to establish the limits of human exposure to radio frequency (RF) emissions so that no adverse biological effects from these RF emissions will occur in either Occupational personnel or the General Public. The Occupational/Controlled Standard (higher limit) has been set to a limit that is 10 times below (1/10<sup>th</sup>) the threshold that the human body experiences any adverse biological effects from these RF Emissions. The FCC General Population/Uncontrolled limit is the lower limit (also referred to as FCC Public Limit) that is five times lower than the FCC Occupational limit, which adds a significant safety factor for the General Public for any possible adverse effects from RF emissions. For persons to be allowed to enter areas that exceed the FCC Public limit (restricted areas) and the FCC Occupational limits (5 times stronger than the Public limit) a level of awareness (awareness is accomplished typically through training) is required for those persons to enable them to control their exposure level. Locations that have RF emission levels above the FCC Public limit should have a written RF Safety program in place at the site that contains information to provide the means for personnel to achieve awareness.

Methods for preparing this analysis are based on guidelines contained in the FCC OET 65 document "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields". This document is available for download and review at [www.FCC.gov](http://www.FCC.gov) .

The FCC has proposed changes to RF Compliance regulations in FCC 19-126 and is scheduled to become law at some time in 2021. These changes include requirements for RF Safety plans for sites that may exceed the FCC Public limits. Based on these changes, this site was analyzed from a public (Unrestricted/Uncontrolled) perspective as well as a worker (Restricted/Controlled) perspective in two separate areas or zones.

There are two areas (zones) that were evaluated for this analysis. The first zone (Unrestricted/Zone 1) is the unrestricted areas that are readily accessible to anyone at ground level adjacent to the site (considered the general public). The second zone (Restricted/Zone 2) is the elevated area near the antenna structure(s). These elevated areas are only accessible to personnel that utilize vertical lift equipment (i.e. bucket trucks) or climb the tower to perform maintenance activities on the monopole. This second zone could qualify as a restricted (controlled) area for RF Safety purposes only if sufficient information is provided to all personnel accessing these areas that will enable them to control their exposure (awareness/training).

# 2. SCOPE

The FCC Public limits apply to Unrestricted/Uncontrolled areas at ground level (Unrestricted/Zone 1) and surrounding buildings. The Restricted/Controlled areas near the antenna arrays are the areas that workers may access elevated areas (Restricted/Zone 2) near the antenna arrays. These workers will require sufficient information to allow them to control their RF exposure (awareness/training).

An analysis and evaluation of this proposed wireless communications facility has been performed with theoretical predictions in accordance with FCC Rules for human exposure to radio frequency emissions.

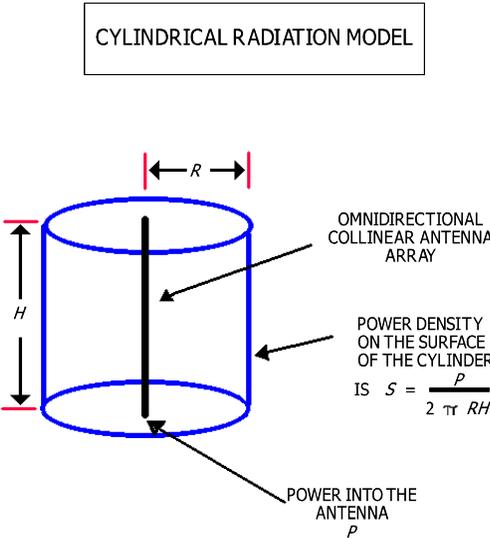
## Theoretical Analysis:

The software tool utilized for theoretical analysis is RoofView®, a product of Richard Tell Associates, Inc. RoofView® is recognized as a commercially available software program for determining human radiofrequency exposure limits as noted in FCC OET 65.

All proposed transmitting antennas that have a possibility of having a *significant contribution*<sup>1</sup> to the radiofrequency environment at this location have been included in this analysis. It will be assumed that all of the transmitting antennas will be operating at 100% capacity and 100% duty cycle to simulate a most intensive scenario for safety reasons. This analysis tool is very conservative in nature and in almost all instances will predict exposure levels greater than the actual measured values.

The primary calculation engine utilized by RoofView® is the cylindrical model. This model was used to compute the average power density on the surface of an imaginary cylinder, with a height equal to the antenna’s aperture, and a radius equal to the distance of interest.

**Figure 2b Cylindrical model utilized within RoofView®**



<sup>1</sup>Significant Contribution to the environment is any RF emitter that contributes >1% of the FCC Public limit to the area of interest being analyzed.

# 3. SUMMARY AND CONCLUSION

## Summary:

This analysis was accomplished for the proposed monopole site in all readily accessible locations. The determination of compliance was made using theoretical analysis results at ground level and nearby rooftops (Zone 1). The restricted areas (Zone 2) above ground level were also analyzed utilizing RoofView®.

The two FCC standards are FCC Occupational/Controlled limit (for workers made “fully aware” of their exposure i.e. trained) and the FCC Public/Uncontrolled limit (untrained workers are also in this category) which has an additional safety factor of five times less RF power density than the FCC Occupational limit (see Appendix A for FCC limit details). The FCC Public limit is the applicable standard to apply to the entire Zone 1 area (including rooftops).

Persons that are exposed to RF energy in the FCC Public category can receive RF energy exposure up to or less than 100% of the FCC Public limit indefinitely without exceeding the FCC Public limit.

## Conclusion:

### Zone 1 (unrestricted areas)

This entire area is considered “unrestricted” access by the general public at ground level surrounding the antenna monopole.

The most intensive scenario predicted exposure level based on theoretical analysis performed by RoofView® will be 15.3% of the FCC Public limit (see figure 5b green area). This site will be compliant with FCC Public limit rules for human exposure at all readily accessible locations at ground level near this existing site. The rooftop areas in the vicinity of the proposed monopole have also been analyzed. The Firetruck Storage rooftop is predicted to be 1.2% of the FCC Public Limit and the Corporate Yard Offices rooftop should not exceed 0.0307% of the FCC Public Limit.

### Zone 2 (restricted areas)

This area is considered “restricted” access and only persons fulfilling a maintenance function that have access to vertical lift equipment (i.e. bucket trucks) or will have access to climb the monopole. Persons working above ground level may encounter RF exposure limits much greater than 100% of the FCC Occupational limit (see figure 5d).

The theoretical calculated MPE limit maximum is 2,044.9% of the FCC Occupational limit at a height of 57 feet AGL. This is a Level 4 RF Exposure category (see Appendix C). Workers accessing the monopole 45 feet above the ground must follow RF Safety Plan guidelines while performing any work above the 45 foot level.

Please see Appendix C for “Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz IEEE C95.7-2014”. The Exposure Categories are listed as well as RF Safety Program controls.

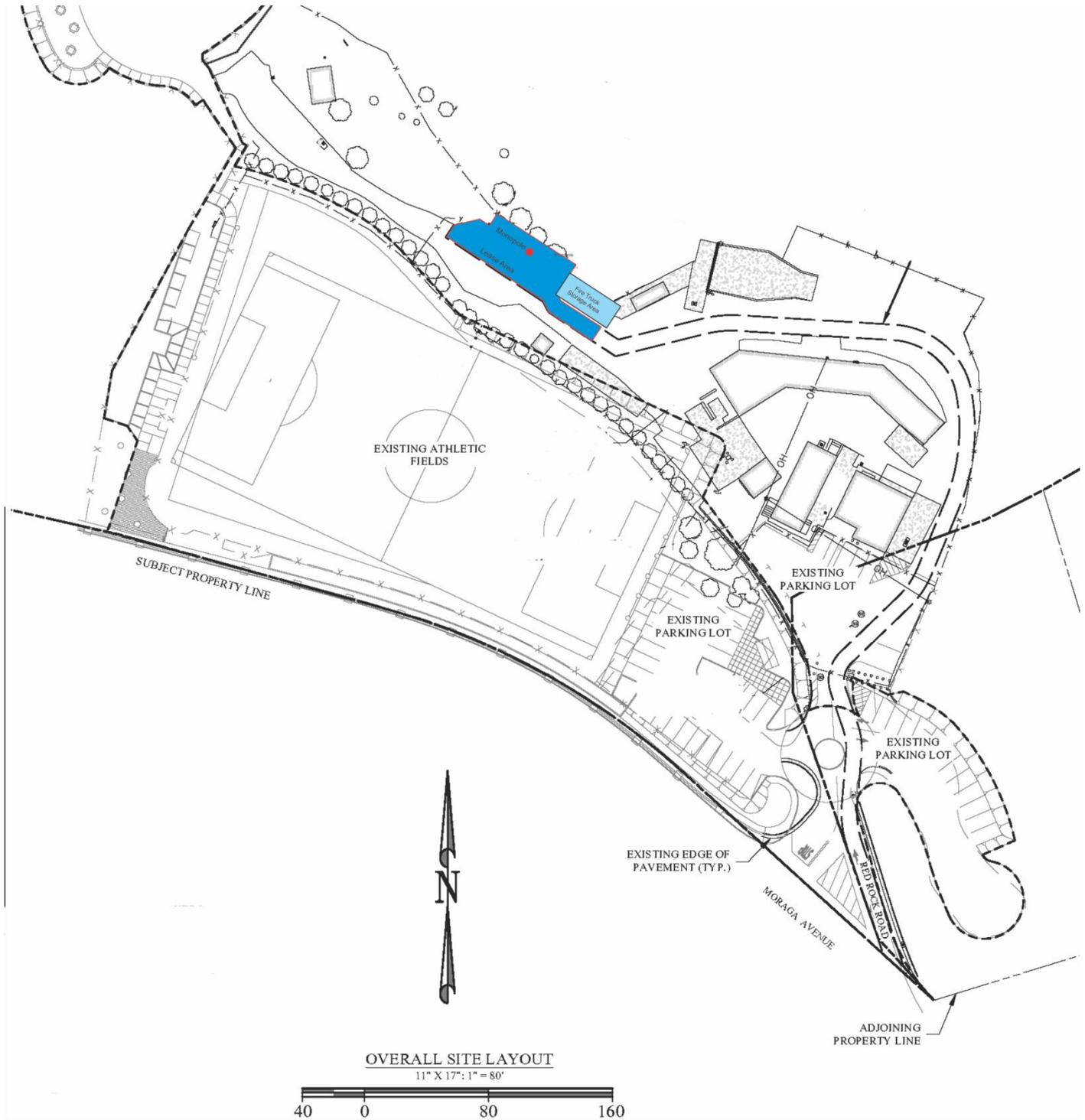
Appropriate RF Alerting signage must be displayed at the base of the antenna structure (tower) with appropriate contact information to enable workers to coordinate working in areas that may require power reductions or shut down to prevent their exposure beyond the FCC MPE limits. A Category 4 RF Exposure site requires a red "Warning" sign at the base of the tower.

**Warning:** Category 4 is the highest RF Exposure category! Safety Measures must be established and verified before sending workers aloft to maintain a Category 4 site.

# 4. SITE DESCRIPTION

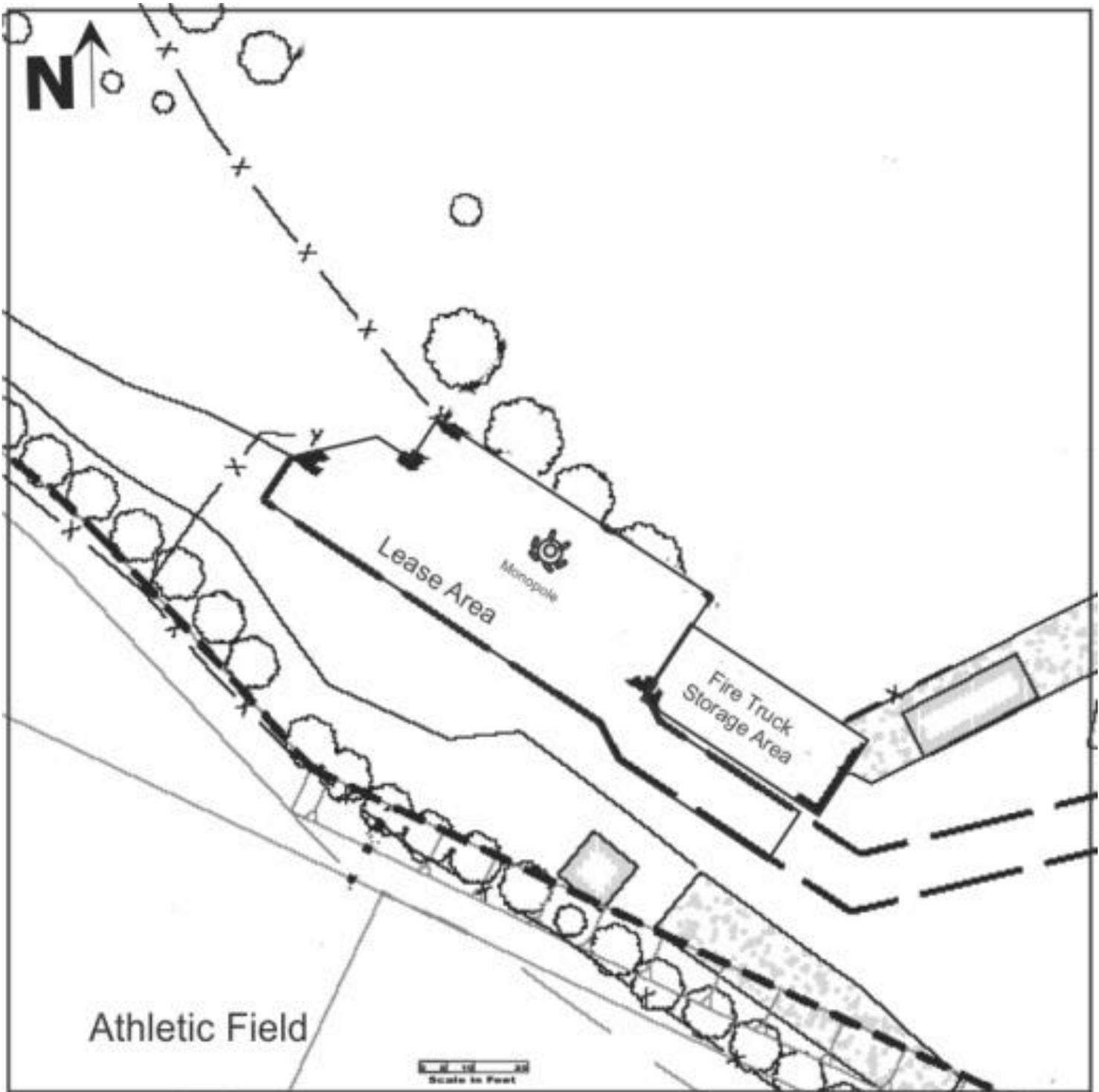
<b>Site ID: CA-2016003</b>		<b>Site Name: Piedmont Corporate Yard</b>			
<b>Date of Evaluation</b>	<b>January 27<sup>th</sup>, 2021</b>	<b>Site Evaluator (name): Marv Wessel</b>			
<b>Site Type</b>	<b>Building</b>	<b>Tower/Monopole</b>	<b>XX</b>	<b>Water Tower</b>	
<b>Address: 898 Red Rock Road, Piedmont, CA 94611</b>					
<b>GPS NAD83</b>	<b>N 37.83188</b>	<b>W 122.2295</b>			

**Figure 4a** Layout of the proposed antenna structure/monopole.



## 4. SITE DESCRIPTION (continued)

**Figure 4b** Detailed layout of the proposed location for the antenna structure/monopole.



# 5. THEORETICAL ANALYSIS RESULTS

The table listed below contains the data utilized for the theoretical calculations in RoofView®. The data utilized for the analysis was supplied by T-Mobile for their proposed antenna installation. The data for the other providers is based on typical data for similar installations utilizing the frequencies and RF power settings normally associated with a typical installation of the listed providers. The azimuths (pointing directions) for all antennas were determined by mimicking the planned azimuths provided by T-Mobile for all other antennas. T-Mobile has already determined the best azimuths for desired coverage of existing and potential customers.

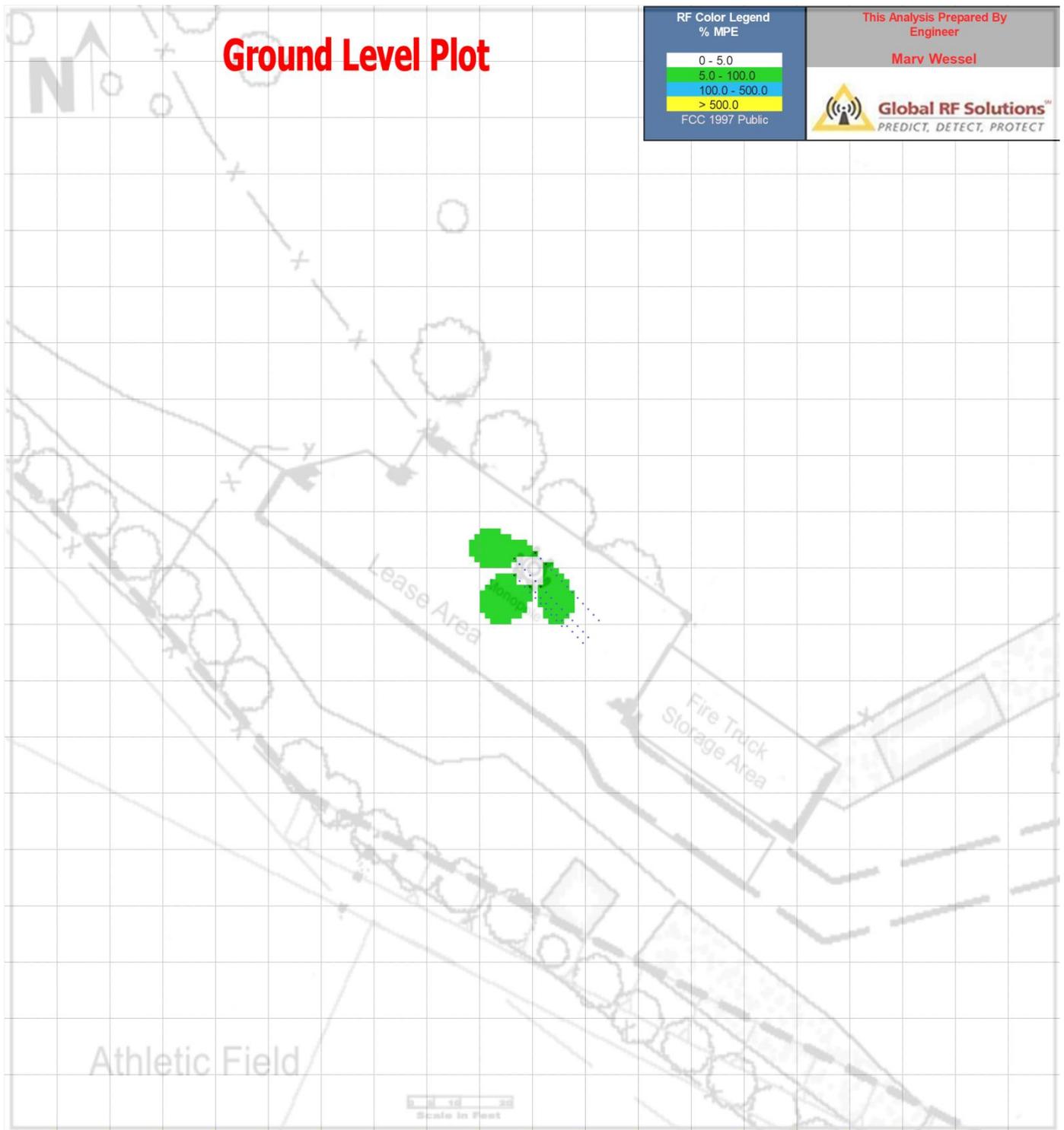
**Figure 5a** RoofView® data table used for theoretical analysis.

ID	Name	(MHz) Freq	Input Power	Calc Power	Mfg	Model	(ft) X	(ft) Y	(ft) Z	Type	(ft) ApHt	dBd Gain	BWdth Pt Dir
A	T-Mobile	2500.00000		320.0	Ericsson	Air 6449	97.0	102.0	88.2		2.5		120;290
B	T-Mobile	630.00000		60.0	RFS	APXVAARR24 43 U NA	101.0	103.0	86.0		8.0		65;290
b	T-Mobile	740.00000		60.0	RFS	APXVAARR24 43 U NA	101.0	103.0	86.0		8.0		62;290
bb	T-Mobile	1940.00000		160.0	RFS	APXVAARR24 43 U NA	101.0	103.0	87.0		6.0		66;290
bbb	T-Mobile	2120.00000		160.0	RFS	APXVAARR24 43 U NA	101.0	103.0	87.0		6.0		59;290
C	T-Mobile	2500.00000		320.0	Ericsson	Air 6449	103.0	101.0	88.2		2.5		120;150
d	T-Mobile	740.00000		60.0	RFS	APXVAARR24 43 U NA	102.0	97.0	86.0		8.0		62;120
D	T-Mobile	630.00000		60.0	RFS	APXVAARR24 43 U NA	102.0	97.0	86.0		8.0		65;120
dd	T-Mobile	1940.00000		160.0	RFS	APXVAARR24 43 U NA	102.0	97.0	87.0		6.0		66;120
ddd	T-Mobile	2120.00000		160.0	RFS	APXVAARR24 43 U NA	102.0	97.0	87.0		6.0		59;120
E	T-Mobile	2500.00000		320.0	Ericsson	Air 6449	100.0	97.0	88.2		2.5		120;230
F	T-Mobile	630.00000		60.0	RFS	APXVAARR24 43 U NA	97.0	99.0	86.0		8.0		65;230
f	T-Mobile	740.00000		60.0	RFS	APXVAARR24 43 U NA	97.0	99.0	86.0		8.0		62;230
ff	T-Mobile	1940.00000		160.0	RFS	APXVAARR24 43 U NA	97.0	99.0	87.0		6.0		66;230
fff	T-Mobile	2120.00000		160.0	RFS	APXVAARR24 43 U NA	97.0	99.0	87.0		6.0		59;230
G	AT&T	700.00000		160.0	Commscope	NHH-65B-R2B	97.0	102.0	77.0		6.0		65;290
g	AT&T	850.00000		320.0	Commscope	NHH-65B-R2B	97.0	102.0	77.0		6.0		60;290
ggg	AT&T	2100.00000		160.0	Commscope	NHH-65B-R2B	97.0	102.0	77.5		5.0		64;290
gg	AT&T	1900.00000		160.0	Commscope	NHH-65B-R2B	97.0	102.0	77.5		5.0		69;290
H	AT&T	700.00000		160.0	Commscope	NHH-65B-R2B	101.0	103.0	77.0		6.0		65;290
h	AT&T	2300.00000		120.0	Commscope	NHH-65B-R2B	101.0	103.0	77.5		5.0		57;290
I	AT&T	700.00000		160.0	Commscope	NHH-65B-R2B	103.0	101.0	77.0		6.0		65;150
i	AT&T	850.00000		320.0	Commscope	NHH-65B-R2B	103.0	101.0	77.0		6.0		60;150
ii	AT&T	1900.00000		160.0	Commscope	NHH-65B-R2B	103.0	101.0	77.5		5.0		69;150
iii	AT&T	2100.00000		160.0	Commscope	NHH-65B-R2B	103.0	101.0	77.5		5.0		64;150
J	AT&T	700.00000		160.0	Commscope	NHH-65B-R2B	102.0	97.0	77.0		6.0		65;150
j	AT&T	2300.00000		120.0	Commscope	NHH-65B-R2B	102.0	97.0	77.5		5.0		57;150
K	AT&T	700.00000		160.0	Commscope	NHH-65B-R2B	100.0	97.0	77.0		6.0		65;230
k	AT&T	850.00000		320.0	Commscope	NHH-65B-R2B	100.0	97.0	77.0		6.0		60;230
kk	AT&T	1900.00000		160.0	Commscope	NHH-65B-R2B	100.0	97.0	77.5		5.0		69;230
kkk	AT&T	2100.00000		160.0	Commscope	NHH-65B-R2B	100.0	97.0	77.5		5.0		64;230
L	AT&T	700.00000		160.0	Commscope	NHH-65B-R2B	97.0	99.0	77.0		6.0		65;230
l	AT&T	2300.00000		120.0	Commscope	NHH-65B-R2B	97.0	99.0	77.5		5.0		57;230
M	Verizon	750.00000		120.0	Commscope	NHH-65B-R2B	97.0	102.0	67.0		6.0		65;290
m	Verizon	885.00000		120.0	Commscope	NHH-65B-R2B	97.0	102.0	67.0		6.0		60;290
mm	Verizon	1900.00000		160.0	Commscope	NHH-65B-R2B	97.0	102.0	67.5		5.0		69;290
N	Verizon	750.00000		120.0	Commscope	NHH-65B-R2B	101.0	103.0	67.0		6.0		65;290
n	Verizon	2100.00000		160.0	Commscope	NHH-65B-R2B	101.0	103.0	67.5		5.0		64;290
p	Verizon	2100.00000		160.0	Commscope	NHH-65B-R2B	102.0	97.0	67.5		5.0		64;150
P	Verizon	750.00000		120.0	Commscope	NHH-65B-R2B	102.0	97.0	67.0		6.0		65;150
oo	Verizon	1900.00000		160.0	Commscope	NHH-65B-R2B	103.0	101.0	67.5		5.0		69;150
o	Verizon	885.00000		120.0	Commscope	NHH-65B-R2B	103.0	101.0	67.0		6.0		60;150
O	Verizon	750.00000		120.0	Commscope	NHH-65B-R2B	103.0	101.0	67.0		6.0		65;150
Q	Verizon	750.00000		120.0	Commscope	NHH-65B-R2B	100.0	97.0	67.0		6.0		65;230
q	Verizon	885.00000		120.0	Commscope	NHH-65B-R2B	100.0	97.0	67.0		6.0		60;230
qq	Verizon	1900.00000		160.0	Commscope	NHH-65B-R2B	100.0	97.0	67.5		5.0		69;230
R	Verizon	750.00000		120.0	Commscope	NHH-65B-R2B	97.0	99.0	67.0		6.0		65;230
r	Verizon	2100.00000		160.0	Commscope	NHH-65B-R2B	97.0	99.0	67.5		5.0		64;230
S	TBT	750.00000		120.0	Commscope	NHH-65B-R2B	97.0	102.0	57.0		6.0		65;290
s	TBT	885.00000		120.0	Commscope	NHH-65B-R2B	97.0	102.0	57.0		6.0		60;290
ss	TBT	1900.00000		160.0	Commscope	NHH-65B-R2B	97.0	102.0	57.5		5.0		69;290
T	TBT	750.00000		120.0	Commscope	NHH-65B-R2B	101.0	103.0	57.0		6.0		65;290
t	TBT	2100.00000		160.0	Commscope	NHH-65B-R2B	101.0	103.0	57.5		5.0		64;290
U	TBT	2100.00000		160.0	Commscope	NHH-65B-R2B	102.0	97.0	57.0		5.0		64;150
u	TBT	750.00000		120.0	Commscope	NHH-65B-R2B	102.0	97.0	57.0		6.0		65;150
uu	TBT	1900.00000		160.0	Commscope	NHH-65B-R2B	103.0	101.0	57.5		5.0		69;150
V	TBT	885.00000		120.0	Commscope	NHH-65B-R2B	103.0	101.0	57.0		6.0		60;150
v	TBT	750.00000		120.0	Commscope	NHH-65B-R2B	103.0	101.0	57.5		6.0		65;150
W	TBT	750.00000		120.0	Commscope	NHH-65B-R2B	100.0	97.0	57.0		6.0		65;230
ww	TBT	885.00000		120.0	Commscope	NHH-65B-R2B	100.0	97.0	57.0		6.0		60;230
www	TBT	1900.00000		160.0	Commscope	NHH-65B-R2B	100.0	97.0	57.5		5.0		69;230
X	TBT	750.00000		120.0	Commscope	NHH-65B-R2B	97.0	99.0	57.0		6.0		65;230
x	TBT	2100.00000		160.0	Commscope	NHH-65B-R2B	97.0	99.0	57.5		5.0		64;230

## 5. THEORETICAL ANALYSIS RESULTS (continued)

This is the predicted software plot for the "Zone 1" (unrestricted ground level access) using the FCC PUBLIC standard for all existing antennas operating at full capacity (most intensive scenario). The grid is in 10-foot increments. The results show that the FCC Public MPE limits may not be exceeded at any ground level location (15.3% FCC Public limit maximum).

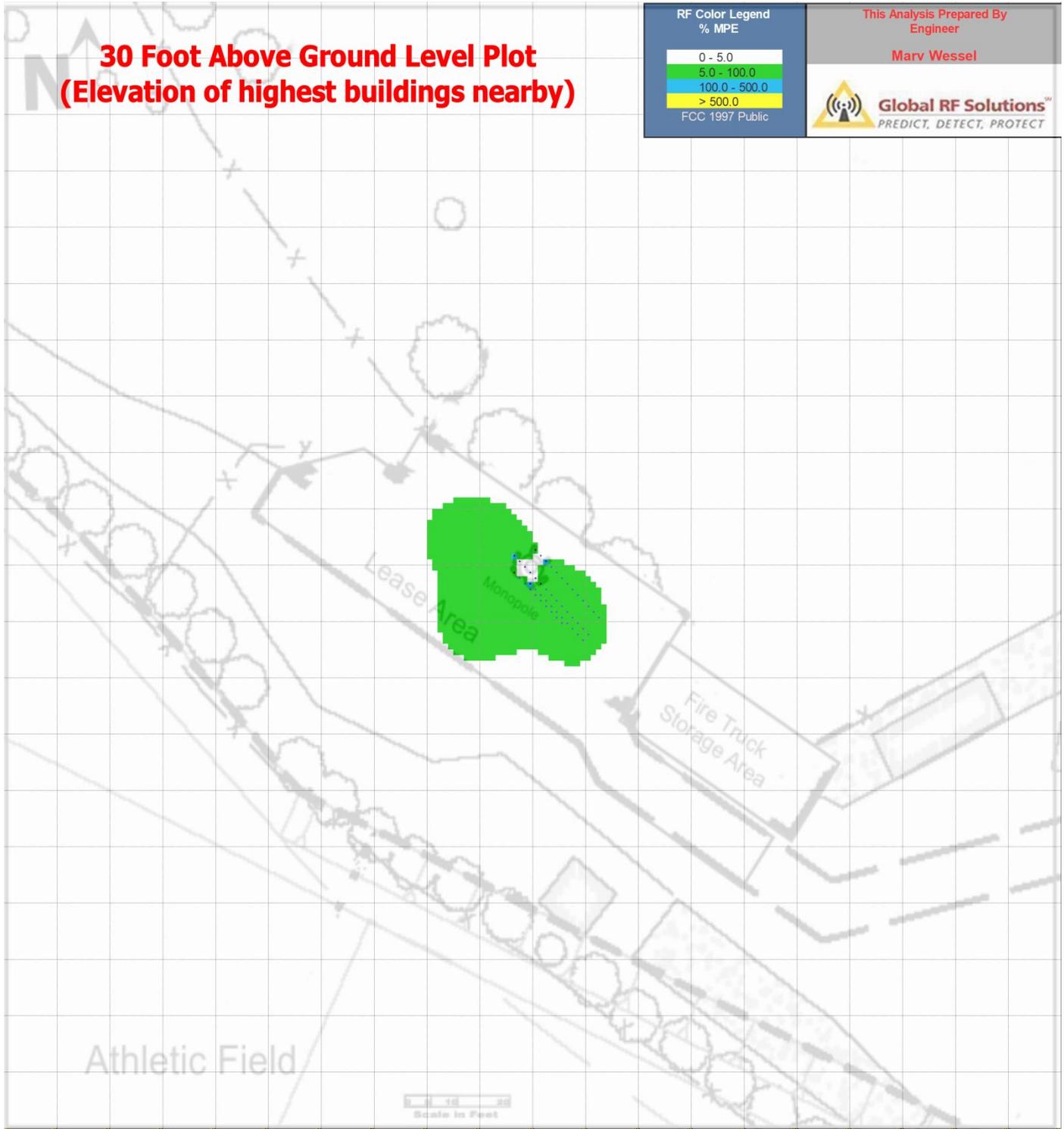
**Figure 5b** RoofView® plot Zone 1 (unrestricted ground level).



## 5. THEORETICAL ANALYSIS RESULTS (continued)

This is the predicted software plot for the "Zone 1" (unrestricted rooftop level access) using the FCC PUBLIC standard for all existing antennas operating at full capacity (most intensive scenario). The grid is in 10-foot increments. The results show that the FCC Public MPE limits may not be exceeded at any rooftop level location (1.2% FCC Public limit on the fire truck storage rooftop and 0.0307% FCC Public limit on the Corporation Yard Office rooftop).

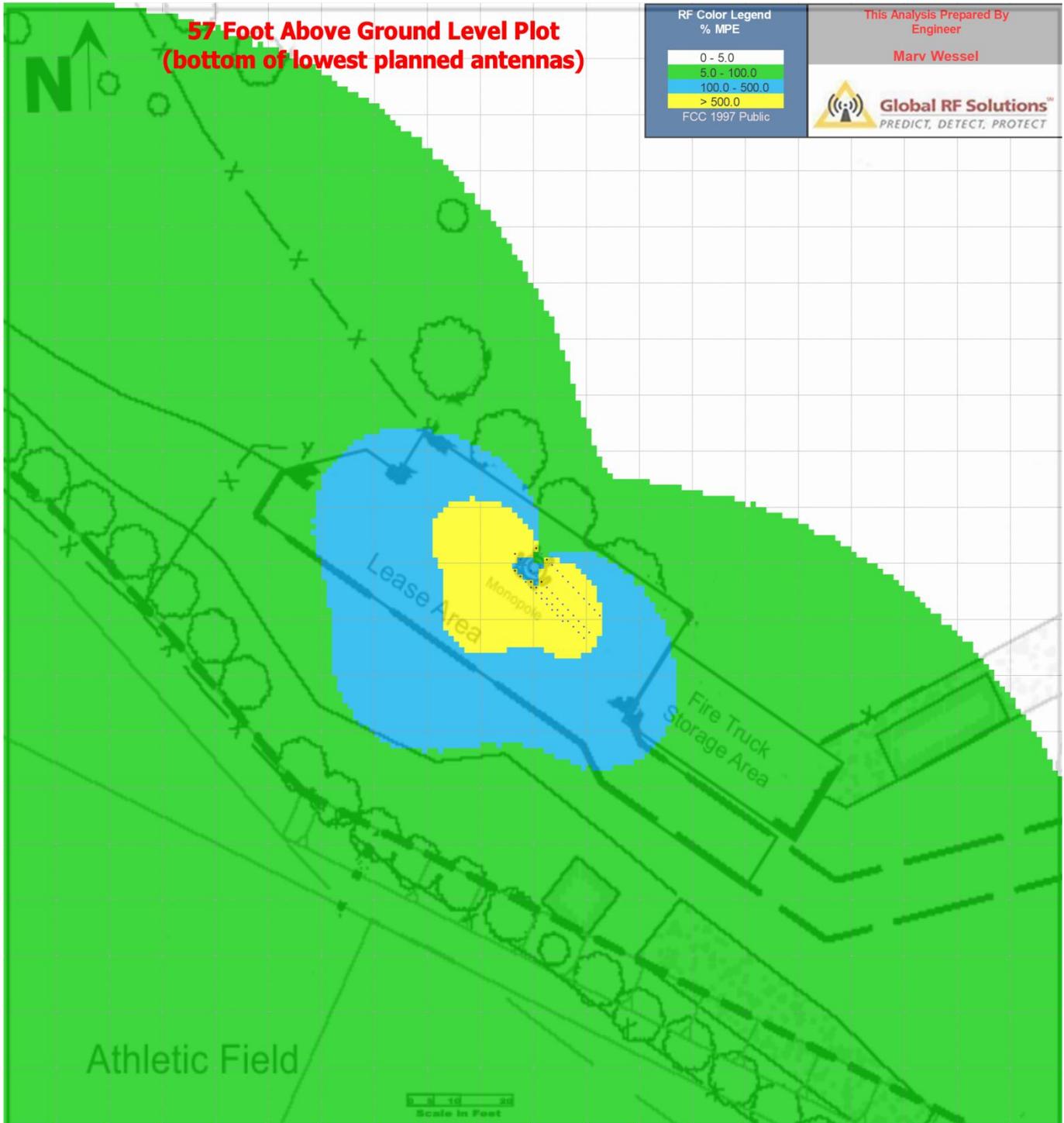
**Figure 5c** RoofView® plot Zone 1 (30 foot above ground level for rooftops).



## 5. THEORETICAL ANALYSIS RESULTS (continued)

This is the predicted software plot for the "Zone 2" (restricted areas 57' above ground level or bottom of the lowest planned antennas) using the FCC PUBLIC standard for all proposed antennas operating at full capacity (most intensive scenario). The results show that the FCC Public MPE limits (Blue Color) may be exceeded up to 37 feet away from the antennas and the FCC Occupational limit may be exceeded up to 17 feet away from the antennas (Yellow Color). Maximum predicted in front of the antennas is 10,224.5% of the FCC Public Limit or 2,044.9% of the FCC Occupational limit.

**Figure 5d** RoofView® plot 57' AGL.



# APPENDIX A- LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

(REFERENCE= TABLE 1. Title 47 CFR)

## (A) 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 <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842/f	4.89/f	(900/f <sup>2</sup> )*	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6

## (B) 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 <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f <sup>2</sup> )*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz\*Plane-wave equivalent power density

NOTE 1: **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.

NOTE 2: **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 be fully aware of the potential for exposure or can not exercise control over their exposure.

# APPENDIX B – RECCOMENDATIONS FOR RF SAFETY PLANS

The FCC recognizes "Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz IEEE C95.7-2014" as a document outlining components of an RF Safety Program for persons working in RF exposure environments. This document classifies 4 RF Safety Program (RFSP) Exposure categories described in the table below.

Table B1 RFSP Categories

Categories of RF Exposure (FCC)		
RFSP Category	Exposure Level	Control Actions
1	Emitter does not exceed action level (<FCC Public Limit)	None
2	Levels can exceed action limit unless controls are applied (>FCC Public Limit)	RFSP should include signs, training, barriers and other safety elements
3	Levels could exceed exposure limit unless controls are applied (>FCC Occupational Limit)	As 2 above, with additional elements
4	Levels will exceed exposure limit in accessible areas (>10x FCC Occupational Limit)	Prevent personnel access

The Following are possible RFSP Controls that may be used to develop an RF Safety Program (RFSP):

- Engineering
  - Shielding, site configuration, barriers
- Administrative
  - Signs, floor markings, work practices, lockout/ tag-out, time averaging, personal monitors
- PPE
  - Gloves, protective clothing
- Training
  - General awareness, limits, controls, medical devices, over-exposures, electro-explosives, ancillary hazards

If more detail is required it is advisable that you obtain IEEE C95.7-2014 for further guidance.

# APPENDIX C – DISCUSSION

There were several questions raised by staff based on the last report prepared for this site. Most of them have been answered in this revised report format. Question #6 actually had several questions regarding the RoofView display. We were using RoofView Version 4.15 in 2018. We are now using RoofView version 5.12 with several enhancements.

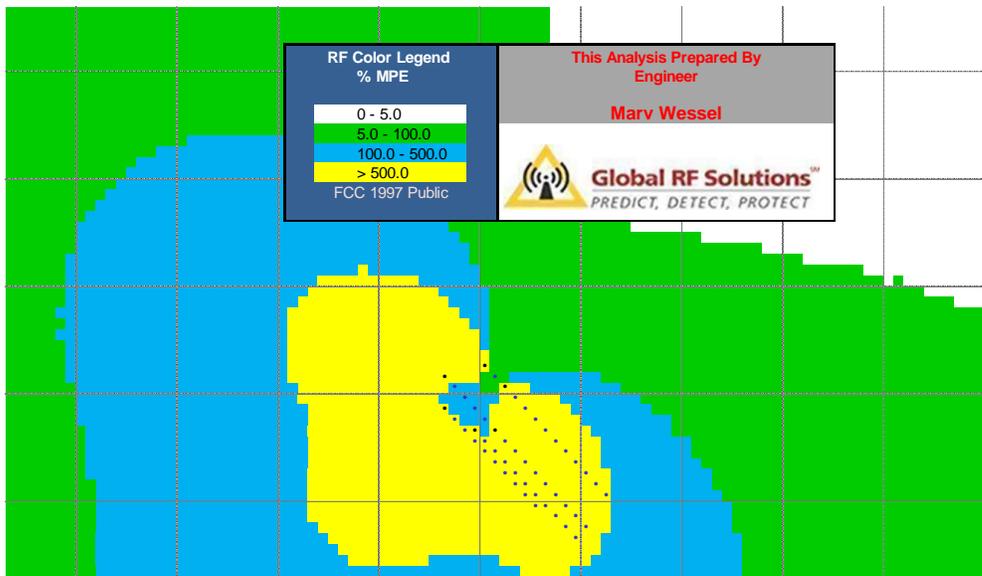
These are the several questions asked in question 6 below:

6. Pages 10 and 11, please explain in the analysis that all areas shown in green, except the points that are blue are less than the MPE. Usually, RF reports submitted to the City have a more clear delineation where the RF emissions are at or near the maximum limits and do not show areas mixed together like these diagrams do. We would prefer to see the blue dots connected together as a field to suggest the limits of the maximum limits area. What do the black dots represent? Does the base station equipment emit RF? If so, please expand the study to include the base station equipment.

Responses:

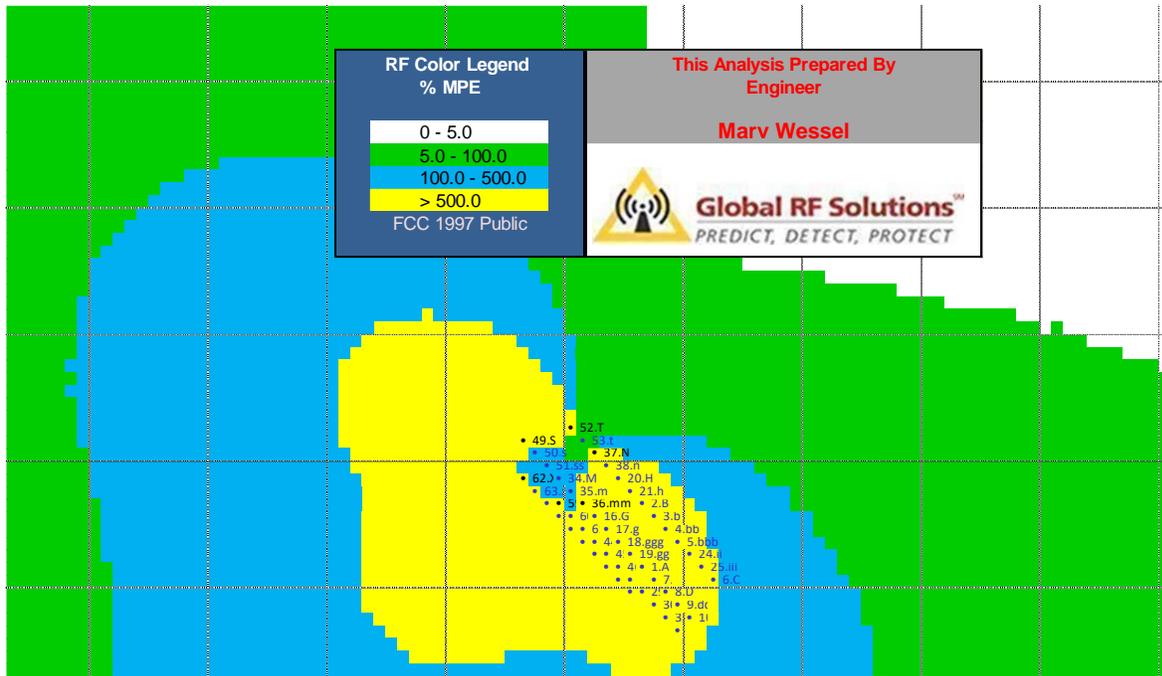
- Areas previously in green are now “White” for <5% of the FCC limit. An additional color (4 total) has been added to RoofView. The plots in Section 5 have a legend included (see figure C1 below).

**Figure C1**



The square pixels are colors that match the legend. The very small dots represent antennas. Black dots are the antenna locations looking from a top down view. If multiple antennas occupy the same x-y coordinates like they do for this analysis and are placed on top of one another (i.e. multiple carriers underneath or multiband antennas that have several antennas in the same radome) the antennas that occupy the same x-y coordinates are displayed in the analysis in blue. I have turned the identifying labels off to make a cleaner presentation. Unfortunately you cannot completely disable the identifying dots from the presentation. Round dots do not represent exposure values displayed in the legend. This is what it would look like if the labels were left on (figure C2).

Figure C2



This should help understand that the dots are not displaying exposure values.

It was also asked "Does the base station equipment emit RF?" The answer is yes but only through balanced transmission line connected to the antennas on the monopole. RF does not radiate directly from the base station equipment cabinet. All of the equipment is shielded very well. If the coax were disconnected from the antennas the RF would reflect back into the transmitter. There is nothing to study for exposure near base station equipment unless an antenna had been connected to the equipment at ground level (which should never occur).