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March 10, 2020

Mayor Logan Harvey
Vice Mayor Rachel Hundley
Council Members Madolyn Agrimonti,
 David Cook and Amy Harrington
City Council
City of Sonoma
No. 1 The Plaza
Sonoma, California 95476

> Re: Verizon Wireless Response to Appeals
> Small Cell Wireless Facilities in the Right-of-Way
> Use Permits Site-006 (near 574-552 Fifth Street West), Site-007 (near
> 550 Second Street West) and Site-012 (near 25 McDonell Street)
> Council Agenda March 16, 2020

Dear Mayor Harvey, Vice Mayor Hundley and Council Members:

We write again on behalf of Verizon Wireless to respond to the appeals of the Planning Commission's January 23, 2020 decisions to approve three small cells in the right-of-way (the "Proposed Small Cells").[1] With minimal equipment placed on new street light poles, the Proposed Small Cells meet all findings for approval of use permits. Appellants Lin Marie DeVincent and Mark Marthaler ("Appellants") have presented no substantial evidence to warrant denial of the Proposed Small Cells, as required by the federal Telecommunications Act. Further, denial would constitute a prohibition of service in violation of the Telecommunications Act. We urge the Council to reject these appeals, and to approve all three small cells as proposed by Verizon Wireless.

The Proposed Small Cells Satisfy All Findings for Approval of a Use Permit.

Verizon Wireless has worked closely with the City to design small cells that will present minimal visual impact while providing needed service to residents and visitors. Each small cell consists of a narrow, two-foot tall cylindrical antenna atop a new street light pole, with a total facility height of 33 feet 2 inches. A single radio unit with a

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[1] Verizon Wireless appreciates the Commission's approval, and separately has appealed two conditions of approval, as described in our February 3, 2020 letter: Condition 1 requiring placement of a single radio underground, and Condition 16 requiring a use permit modification if Verizon Wireless uses new technology to increase effective radiating power more than 25 percent.

sunshield is flush-mounted at 23.5 feet on the pole, just below the light arm, and it measures 32.3 inches tall, 11.9 inches wide and 6.5 inches deep. A very small disconnect switch is concealed behind a street sign. Photosimulations of the Proposed Small Cells are attached as Exhibit A.

Given their slim profile using minimal new infrastructure, the Proposed Small Cells meet all required findings for approval of a use permit. Sonoma Municipal Code § 19.54.040(E). Notably, the location, size, design, and operating characteristics of the Proposed Small Cells are compatible with the commercial nature of the downtown area and other right-of-way infrastructure nearby. They use will not impair the architectural integrity or character of the commercial zone, as they are designed as street lights which are found throughout downtown, and the wireless equipment on each pole is of the minimum size required to provide service, posing little visual impact.

Because the Proposed Small Cells satisfy the use permit findings, the Council should grant its approval.

Appellants Provide No Substantial Evidence for Denial, as Required by Federal Law.

Pursuant to the federal Telecommunications Act, a local government's denial of a wireless facility application must be based on "substantial evidence." *See* 47 U.S.C. § 332(c)(7)(B)(iii). Federal courts have held that denial of an application must be based on requirements set forth in the local code and supported by evidence in the record. *See Metro PCS, Inc. v. City and County of San Francisco,* 400 F.3d 715, 725 (9th Cir. 2005) (denial of application must be "authorized by applicable local regulations and supported by a reasonable amount of evidence").

Appellants raised only a few, vague grounds for appeal. They alleged that each small cell "incommodes the public," referencing "aesthetic conditions of land use," but offering no further elaboration or evidence of actual impacts. Such generalized concerns or opinions about aesthetics do not constitute substantial evidence upon which a local government can deny a permit. *See City of Rancho Palos Verdes v. Abrams*, 101 Cal. App. 4th 367, 381 (2002). In contrast, Verizon Wireless's photosimulations show how the Proposed Small Cells pose little impact by mimicking typical right-of-way infrastructure, such as street light poles and small utility cabinets on utility poles.

California Public Utilities Code Section 7901 grants telephone corporations the right to place equipment, including new poles, along any right-of-way, provided it does not "incommode the public use." The Proposed Small Cells involve only minimal new infrastructure that is typical along downtown Sonoma streets. They will not incommode the public use any more than existing poles and utilities placed along sidewalks. For each small cell, Condition of Approval 3 requires an encroachment permit, to ensure that City staff "will determine that the path of travel on the sidewalk will not be impaired."

In sum, Appellants provide no evidence – let alone the substantial evidence required by federal law – that the Proposed Small Cells would incommode the public use, or pose aesthetic impacts that contradict use permit findings. The appeals must be rejected.

Concern over Radio Frequency Emissions Cannot Be a Factor for Denial.

Appellants previously opposed the Proposed Small Cells because of concern over radio frequency emissions, which they referenced in their comments at the January 23, 2020 Commission hearing.[2] However, the City may not consider concerns over the environmental effects of radio frequency emissions if a wireless facility complies with Federal Communications Commission ("FCC") exposure guidelines. 47 U.S.C. § 332(c)(7)(B)(iv). As confirmed by reports prepared by Hammett & Edison, Inc., Consulting Engineers, attached as Exhibit B, the maximum exposure at ground level from each small cell will be only 1.2 percent – or 83 times below – the FCC's public exposure limit. The maximum exposure at the second floor of any nearby building will be only 2.8 percent – or 35 times below – the FCC's public exposure limit. Condition of Approval 8 requires that, prior to activation, Verizon Wireless submit a report with measurements of radio frequency exposure to confirm compliance with FCC guidelines.

Denial Would Constitute an Unlawful Prohibition of Service.

The Telecommunications Act provides that local government regulation of wireless facilities "shall not prohibit or have the effect of prohibiting" the provision of personal wireless service. 47 U.S.C. § 332(c)(7)(B)(i)(II). Under Ninth Circuit case law, a local government violates this clause if the wireless provider can show two things: (1) that it has a "significant gap" in service; and (2) that the proposed facility is the "least intrusive means," in relation to the land use values embodied in local regulations, to address the gap. *See T-Mobile USA, Inc. v. City of Anacortes*, 572 F.3d 987 (9th Cir. 2009).

In a recent Declaratory Ruling, the FCC determined that the Ninth Circuit's two-part test is too narrow. *See In the Matter of Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment, Declaratory Ruling and Third Report and Order*, FCC 18-133, WT Docket No. 17-79 and WC Docket No. 17-84 (September 27, 2018) (the "Infrastructure Order"). The FCC confirmed that a wireless carrier need not show an insurmountable barrier, or even a significant gap, to prove a prohibition of service. Infrastructure Order, ¶¶ 35, 38. Instead, "a state or local legal requirement constitutes an effective prohibition if it 'materially limits or inhibits the ability of any competitor or potential competitor to compete in a fair and balanced legal and regulatory environment.'" *Id.*, ¶ 35. Thus, state or local regulations are preempted if they materially inhibit "densifying a wireless network, introducing new services, or otherwise improving service capabilities." *Id.*, ¶ 37.
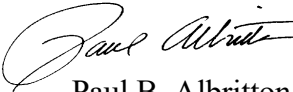
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[2] Sonoma Planning Commission video, January 23, 2020.

In this case, denial would not survive judicial review under this standard, as it would materially inhibit Verizon Wireless's ability to improve service on its network. Coverage maps submitted to the City show a lack of coverage downtown in the PCS and AWS frequency bands. This information was reviewed by the City's independent consultant, CTC Technology & Energy ("CTC"). CTC also conducted its own field tests, and concluded that the Proposed Small Cells will provide greater network capacity in the vicinity in the PCS and AWS bands, which the report notes constitute 75% of Verizon Wireless's available bandwidth in Sonoma. Specifically, the CTC report states: "The proposed small cells, placed at targeted locations, would provide additional capacity and increased signal strength to serve users in areas that do not currently have access to Verizon PCS and AWS signal coverage." *See Review of Verizon Wireless Small Wireless Application* for Sites 6, 7 and 12, October 2018, p.6.

The Proposed Small Cells will improve service to residents, workers and visitors in the downtown Sonoma area, resulting in more reliable connections, improved call quality, and overall increased capacity for the network. From the user's perspective, this means more reliable service, with consistent access to Verizon Wireless's Voice over LTE ("VoLTE") 4G technology. Denial would prevent Verizon Wireless from providing these improvements to its service, and therefore effectively prohibit service in violation of the Telecommunications Act. *See* 47 U.S.C. § 332(c)(7)(B)(i)(II); Infrastructure Order, ¶¶ 35, 37.[3]

Conclusion

Verizon Wireless has worked diligently to identify the ideal location and design for three new small cells to serve downtown Sonoma. As designed by Verizon Wireless, the Proposed Small Cells meet all findings for a use permit. Appellants have raised no substantial evidence to warrant denial. Ensuring reliable Verizon Wireless service in the area is critical to residents, workers and visitors as well as emergency service personnel. We strongly encourage you to reject the appeals, and to approve all three small cells as proposed by Verizon Wireless.

Very truly yours,

Paul B. Albritton

cc: John Abaci, Esq.
    David Storer

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[3] In rejecting the Ninth Circuit's significant gap/least intrusive means test, the Infrastructure Order made the question of alternative sites irrelevant to effective prohibition analysis. But even if alternatives were still relevant, the result would be the same.

<u>Schedule of Exhibits</u>

Exhibit A: Photosimulations
Exhibit B: Radio Frequency Exposure Reports by Hammett & Edison, Inc.

Exhibit A

THE CBR GROUP

<div style="border:1px solid black">**Exhibit B**</div>

Statement of Hammett & Edison, Inc., Consulting Engineers

The firm of Hammett & Edison, Inc., Consulting Engineers, has been retained on behalf of Verizon Wireless, a personal wireless telecommunications carrier, to evaluate its small cell (No. 425161 "Sonoma 006") proposed to be sited in Sonoma, California, for compliance with appropriate guidelines limiting human exposure to radio frequency ("RF") electromagnetic fields.

Executive Summary

Verizon proposes to install a cylindrical antenna on a light pole to be sited in the public right-of-way near 574-552 Fifth Street West in Sonoma. The proposed operation will comply with the FCC guidelines limiting public exposure to RF energy.

Prevailing Exposure Standards

The U.S. Congress requires that the Federal Communications Commission ("FCC") evaluate its actions for possible significant impact on the environment. A summary of the FCC's exposure limits is shown in Figure 1. These limits apply for continuous exposures and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health. The most restrictive limit for exposures of unlimited duration at several wireless service bands are as follows:

Wireless Service Band	Transmit Frequency	"Uncontrolled" Public Limit	Occupational Limit (5 times Public)
Microwave (point-to-point)	1–80 GHz	1.0 mW/cm^2	5.0 mW/cm^2
Millimeter-wave	24–47	1.0	5.0
Part 15 (WiFi & other unlicensed)	2–6	1.0	5.0
CBRS (Citizens Broadband Radio)	3,550 MHz	1.0	5.0
BRS (Broadband Radio)	2,490	1.0	5.0
WCS (Wireless Communication)	2,305	1.0	5.0
AWS (Advanced Wireless)	2,110	1.0	5.0
PCS (Personal Communication)	1,930	1.0	5.0
Cellular	869	0.58	2.9
SMR (Specialized Mobile Radio)	854	0.57	2.85
700 MHz	716	0.48	2.4
600 MHz	617	0.41	2.05
[most restrictive frequency range]	30–300	0.20	1.0

General Facility Requirements

Small cells typically consist of two distinct parts: the electronic transceivers (also called "radios" or "channels") that are connected to the traditional wired telephone lines, and the passive antennas that send the wireless signals created by the radios out to be received by individual subscriber units. The radios are typically mounted on the support pole or placed in a cabinet at ground level, and they are connected to the antennas by coaxial cables. Because of the short wavelength of the frequencies

assigned by the FCC for wireless services, the antennas require line-of-sight paths for their signals to propagate well and so are installed at some height above ground. The antennas are designed to concentrate their energy toward the horizon, with very little energy wasted toward the sky or the ground. This means that it is generally not possible for exposure conditions to approach the maximum permissible exposure limits without being physically very near the antennas.

Computer Modeling Method

The FCC provides direction for determining compliance in its Office of Engineering and Technology Bulletin No. 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation," dated August 1997. Figure 2 describes the calculation methodologies, reflecting the facts that a directional antenna's radiation pattern is not fully formed at locations very close by (the "near-field" effect) and that at greater distances the power level from an energy source decreases with the square of the distance from it (the "inverse square law"). This methodology is an industry standard for evaluating RF exposure conditions and has been demonstrated through numerous field tests to be a conservative prediction of exposure levels.

Site and Facility Description

Based upon information provided by Verizon, including drawings by The CBR Group, dated December 19, 2019, it is proposed to install one CommScope Model VVSSP-360S-F, 2-foot tall, omnidirectional[*] cylindrical antenna on top of a new light pole to be sited in the public right-of-way in front of the single-story commercial building at 531 Fifth Street West in Sonoma. The antenna would employ 7° downtilt and would be mounted at an effective height of about 32 feet above ground. The maximum effective radiated power proposed in any direction is 460 watts, representing simultaneous operation at 230 watts each for AWS and PCS service. There are reported no other wireless telecommunications base stations at the site or nearby.

Study Results

For a person anywhere at ground, the maximum RF exposure level due to the proposed Verizon operation is calculated to be 0.012 mW/cm^2, which is 1.2% of the applicable public exposure limit. The maximum calculated level at the second-story elevation of any nearby building[†] is 2.8% of the public exposure limit. It should be noted that these results include several "worst-case" assumptions and therefore are expected to overstate actual power density levels from the proposed operation.

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[*] Assumed to be omnidirectional, although manufacturer's patterns show reduced power in certain directions.
[†] Located at least 30 feet away, based on the drawings.

Recommended Compliance Measures

Due to its mounting location and height, the antenna would not be accessible to unauthorized persons, and so no measures are necessary to comply with the FCC public exposure guidelines. To prevent occupational exposures in excess of the FCC guidelines, it is recommended that appropriate RF safety training be provided to all workers who have access within 13 feet outward from the antenna. No access within 2½ feet directly in front of the antenna, such as might occur during certain maintenance activities high on the pole, should be allowed while the antenna is in operation, unless other measures can be demonstrated to ensure that occupational protection requirements are met. It is recommended that explanatory signs[‡] be posted at the antenna and/or on the pole below the antenna, readily visible from any angle of approach.

Conclusion

Based on the information and analysis above, it is the undersigned's professional opinion that operation of the small cell proposed by Verizon Wireless near 574-552 Fifth Street West in Sonoma, California, will comply with the prevailing standards for limiting public exposure to radio frequency energy and, therefore, will not for this reason cause a significant impact on the environment. The highest calculated level in publicly accessible areas is much less than the prevailing standards allow for exposures of unlimited duration. This finding is consistent with measurements of actual exposure conditions taken at other operating small cells. Training authorized personnel and posting explanatory signs are recommended to establish compliance with occupational exposure limits.

Authorship

The undersigned author of this statement is a qualified Professional Engineer, holding California Registration No. E-21306, which expires on September 30, 2021. This work has been carried out under his direction, and all statements are true and correct of his own knowledge except, where noted, when data has been supplied by others, which data he believes to be correct.

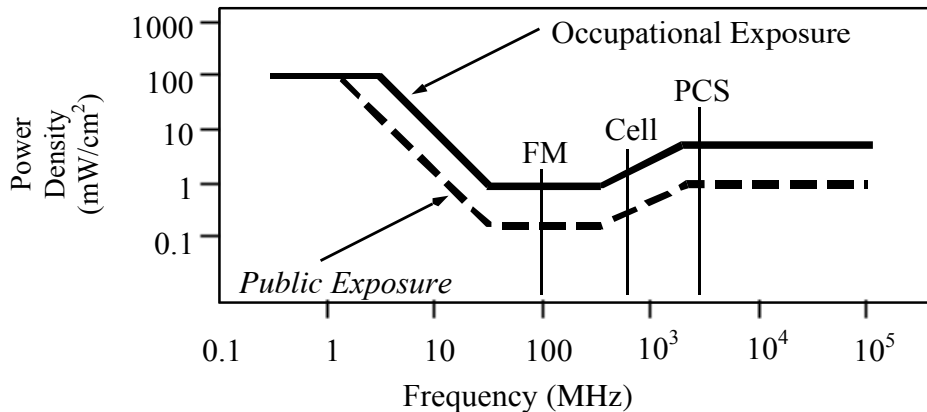Neil J. Olij, P.E.
707/996-5200

January 9, 2020

[‡] Signs should comply with OET-65 color, symbol, and content recommendations. Contact information should be provided (*e.g.*, a telephone number) to arrange for access to restricted areas. The selection of language(s) is not an engineering matter, and guidelines from the landlord, local zoning or health authority, or appropriate professionals may be required.

FCC Radio Frequency Protection Guide

The U.S. Congress required (1996 Telecom Act) the Federal Communications Commission ("FCC") to adopt a nationwide human exposure standard to ensure that its licensees do not, cumulatively, have a significant impact on the environment. The FCC adopted the limits from Report No. 86, "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," published in 1986 by the Congressionally chartered National Council on Radiation Protection and Measurements ("NCRP"). Separate limits apply for occupational and public exposure conditions, with the latter limits generally five times more restrictive. The more recent standard, developed by the Institute of Electrical and Electronics Engineers and approved as American National Standard ANSI/IEEE C95.1-2006, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," includes similar limits. These limits apply for continuous exposures from all sources and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health.

As shown in the table and chart below, separate limits apply for occupational and public exposure conditions, with the latter limits (in *italics* and/or dashed) up to five times more restrictive:

Frequency	Electromagnetic Fields (f is frequency of emission in MHz)					
Applicable Range (MHz)	Electric Field Strength (V/m)		Magnetic Field Strength (A/m)		Equivalent Far-Field Power Density (mW/cm^2)	
0.3 – 1.34	614	*614*	1.63	*1.63*	100	*100*
1.34 – 3.0	614	*823.8/f*	1.63	*2.19/f*	100	*180/f^2*
3.0 – 30	1842/f	*823.8/f*	4.89/f	*2.19/f*	900/f^2	*180/f^2*
30 – 300	61.4	*27.5*	0.163	*0.0729*	1.0	*0.2*
300 – 1,500	3.54$\sqrt{f}$	*1.59$\sqrt{f}$*	$\sqrt{f}$/106	*$\sqrt{f}$/238*	f/300	*f/1500*
1,500 – 100,000	137	*61.4*	0.364	*0.163*	5.0	*1.0*

Higher levels are allowed for short periods of time, such that total exposure levels averaged over six or thirty minutes, for occupational or public settings, respectively, do not exceed the limits, and higher levels also are allowed for exposures to small areas, such that the spatially averaged levels do not exceed the limits. However, neither of these allowances is incorporated in the conservative calculation formulas in the FCC Office of Engineering and Technology Bulletin No. 65 (August 1997) for projecting field levels. Hammett & Edison has incorporated those formulas in a computer program capable of calculating, at thousands of locations on an arbitrary grid, the total expected power density from any number of individual radio frequency sources. The program allows for the inclusion of uneven terrain in the vicinity, as well as any number of nearby buildings of varying heights, to obtain more accurate projections.

RFR.CALC™ Calculation Methodology

Assessment by Calculation of Compliance with FCC Exposure Guidelines

The U.S. Congress required (1996 Telecom Act) the Federal Communications Commission ("FCC") to adopt a nationwide human exposure standard to ensure that its licensees do not, cumulatively, have a significant impact on the environment. The maximum permissible exposure limits adopted by the FCC (see Figure 1) apply for continuous exposures from all sources and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health. Higher levels are allowed for short periods of time, such that total exposure levels averaged over six or thirty minutes, for occupational or public settings, respectively, do not exceed the limits.

Near Field.

Prediction methods have been developed for the near field zone of panel (directional) and whip (omnidirectional) antennas, typical at wireless telecommunications base stations, as well as dish (aperture) antennas, typically used for microwave links. The antenna patterns are not fully formed in the near field at these antennas, and the FCC Office of Engineering and Technology Bulletin No. 65 (August 1997) gives suitable formulas for calculating power density within such zones.

For a panel or whip antenna, power density $\quad S = \dfrac{180}{\theta_{BW}} \times \dfrac{0.1 \times P_{net}}{\pi \times D \times h}$, in mW/cm2,

and for an aperture antenna, maximum power density $\quad S_{max} = \dfrac{0.1 \times 16 \times \eta \times P_{net}}{\pi \times h^2}$, in mW/cm2,

$$
\begin{aligned}
\text{where} \quad \theta_{BW} &= \text{half-power beamwidth of antenna, in degrees,} \\
P_{net} &= \text{net power input to antenna, in watts,} \\
D &= \text{distance from antenna, in meters,} \\
h &= \text{aperture height of antenna, in meters, and} \\
\eta &= \text{aperture efficiency (unitless, typically 0.5-0.8).}
\end{aligned}
$$

The factor of 0.1 in the numerators converts to the desired units of power density.

Far Field.

OET-65 gives this formula for calculating power density in the far field of an individual RF source:

power density $\quad S = \dfrac{2.56 \times 1.64 \times 100 \times RFF^2 \times ERP}{4 \times \pi \times D^2}$, in mW/cm2,

$$
\begin{aligned}
\text{where} \quad ERP &= \text{total ERP (all polarizations), in kilowatts,} \\
RFF &= \text{three-dimensional relative field factor toward point of calculation, and} \\
D &= \text{distance from antenna effective height to point of calculation, in meters.}
\end{aligned}
$$

The factor of 2.56 accounts for the increase in power density due to ground reflection, assuming a reflection coefficient of 1.6 (1.6 x 1.6 = 2.56). The factor of 1.64 is the gain of a half-wave dipole relative to an isotropic radiator. The factor of 100 in the numerator converts to the desired units of power density. This formula is used in a computer program capable of calculating, at thousands of locations on an arbitrary grid, the total expected power density from any number of individual radio frequency sources. The program also allows for the inclusion of uneven terrain in the vicinity, as well as any number of nearby buildings of varying heights, to obtain more accurate projections.

Statement of Hammett & Edison, Inc., Consulting Engineers

The firm of Hammett & Edison, Inc., Consulting Engineers, has been retained on behalf of Verizon Wireless, a personal wireless telecommunications carrier, to evaluate its small cell (No. 425162 "Sonoma 007") proposed to be sited in Sonoma, California, for compliance with appropriate guidelines limiting human exposure to radio frequency ("RF") electromagnetic fields.

Executive Summary

Verizon proposes to install a cylindrical antenna on a light pole to be sited in the public right-of-way near 550 Second Street in Sonoma. The proposed operation will comply with the FCC guidelines limiting public exposure to RF energy.

Prevailing Exposure Standards

The U.S. Congress requires that the Federal Communications Commission ("FCC") evaluate its actions for possible significant impact on the environment. A summary of the FCC's exposure limits is shown in Figure 1. These limits apply for continuous exposures and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health. The most restrictive limit for exposures of unlimited duration at several wireless service bands are as follows:

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Small cells typically consist of two distinct parts: the electronic transceivers (also called "radios" or "channels") that are connected to the traditional wired telephone lines, and the passive antennas that send the wireless signals created by the radios out to be received by individual subscriber units. The radios are typically mounted on the support pole or placed in a cabinet at ground level, and they are

connected to the antennas by coaxial cables. Because of the short wavelength of the frequencies assigned by the FCC for wireless services, the antennas require line-of-sight paths for their signals to propagate well and so are installed at some height above ground. The antennas are designed to concentrate their energy toward the horizon, with very little energy wasted toward the sky or the ground. This means that it is generally not possible for exposure conditions to approach the maximum permissible exposure limits without being physically very near the antennas.

Computer Modeling Method

The FCC provides direction for determining compliance in its Office of Engineering and Technology Bulletin No. 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation," dated August 1997. Figure 2 describes the calculation methodologies, reflecting the facts that a directional antenna's radiation pattern is not fully formed at locations very close by (the "near-field" effect) and that at greater distances the power level from an energy source decreases with the square of the distance from it (the "inverse square law"). This methodology is an industry standard for evaluating RF exposure conditions and has been demonstrated through numerous field tests to be a conservative prediction of exposure levels.

Site and Facility Description

Based upon information provided by Verizon, including drawings by The CBR Group, dated December 19, 2019, it is proposed to install one CommScope Model VVSSP-360S-F, 2-foot tall, omnidirectional[*] cylindrical antenna on top of a new light pole to be sited in the public right-of-way on the east side of Second Street West about 150 feet south of its intersection with West Napa Street in Sonoma. The antenna would employ 7° downtilt and would be mounted at an effective height of about 32 feet above ground. The maximum effective radiated power proposed in any direction is 460 watts, representing simultaneous operation at 230 watts each for AWS and for PCS service. There are reported no other wireless telecommunications base stations at the site or nearby.

Study Results

For a person anywhere at ground, the maximum RF exposure level due to the proposed Verizon operation is calculated to be 0.012 mW/cm^2, which is 1.2% of the applicable public exposure limit. The maximum calculated level at the second-story elevation of any nearby building[†] is 2.8% of the public exposure limit. It should be noted that these results include several "worst-case" assumptions and therefore are expected to overstate actual power density levels from the proposed operation.

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[*]   Assumed to be omnidirectional, although manufacturer's patterns show reduced power in certain directions.
[†]   Located at least 50 feet away, based on photographs from Google Maps.

Recommended Compliance Measures

Due to its mounting location and height, the antenna would not be accessible to unauthorized persons, and so no measures are necessary to comply with the FCC public exposure guidelines. To prevent occupational exposures in excess of the FCC guidelines, it is recommended that appropriate RF safety training be provided to all workers who have access within 13 feet outward from the antenna. No access within 2½ feet directly in front of the antenna, such as might occur during certain maintenance activities high on the pole, should be allowed while the antenna is in operation, unless other measures can be demonstrated to ensure that occupational protection requirements are met. It is recommended that explanatory signs‡ be posted at the antenna and/or on the pole below the antenna, readily visible from any angle of approach.

Conclusion

Based on the information and analysis above, it is the undersigned's professional opinion that operation of the small cell proposed by Verizon Wireless near 550 Second Street in Sonoma, California, will comply with the prevailing standards for limiting public exposure to radio frequency energy and, therefore, will not for this reason cause a significant impact on the environment. The highest calculated level in publicly accessible areas is much less than the prevailing standards allow for exposures of unlimited duration. This finding is consistent with measurements of actual exposure conditions taken at other operating small cells. Training authorized personnel and posting explanatory signs are recommended to establish compliance with occupational exposure limits.

Authorship

The undersigned author of this statement is a qualified Professional Engineer, holding California Registration No. E-21306, which expires on September 30, 2021. This work has been carried out under his direction, and all statements are true and correct of his own knowledge except, where noted, when data has been supplied by others, which data he believes to be correct.

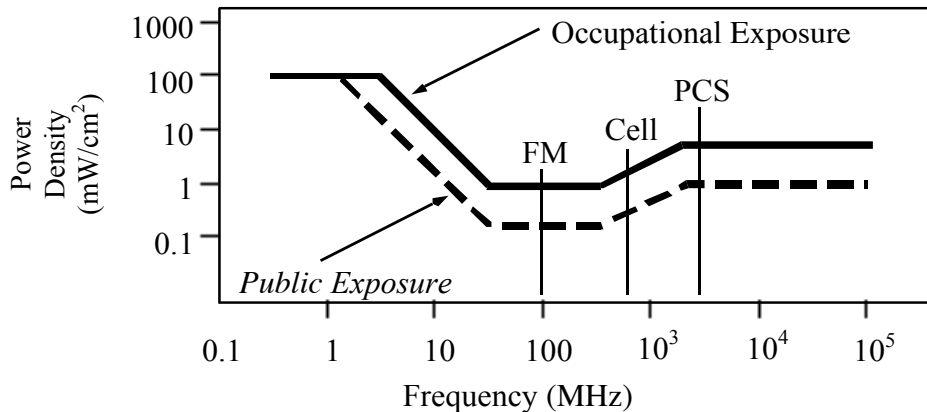Neil J. Olij, P.E.
707/996-5200

January 9, 2020

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‡ Signs should comply with OET-65 color, symbol, and content recommendations. Contact information should be provided (*e.g.*, a telephone number) to arrange for access to restricted areas. The selection of language(s) is not an engineering matter, and guidelines from the landlord, local zoning or health authority, or appropriate professionals may be required.

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30 – 300	61.4	*27.5*	0.163	*0.0729*	1.0	*0.2*
300 – 1,500	3.54√f	*1.59√f*	√f/106	*√f/238*	f/300	*f/1500*
1,500 – 100,000	137	*61.4*	0.364	*0.163*	5.0	*1.0*

Higher levels are allowed for short periods of time, such that total exposure levels averaged over six or thirty minutes, for occupational or public settings, respectively, do not exceed the limits, and higher levels also are allowed for exposures to small areas, such that the spatially averaged levels do not exceed the limits. However, neither of these allowances is incorporated in the conservative calculation formulas in the FCC Office of Engineering and Technology Bulletin No. 65 (August 1997) for projecting field levels. Hammett & Edison has incorporated those formulas in a computer program capable of calculating, at thousands of locations on an arbitrary grid, the total expected power density from any number of individual radio frequency sources. The program allows for the inclusion of uneven terrain in the vicinity, as well as any number of nearby buildings of varying heights, to obtain more accurate projections.

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The U.S. Congress required (1996 Telecom Act) the Federal Communications Commission ("FCC") to adopt a nationwide human exposure standard to ensure that its licensees do not, cumulatively, have a significant impact on the environment. The maximum permissible exposure limits adopted by the FCC (see Figure 1) apply for continuous exposures from all sources and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health. Higher levels are allowed for short periods of time, such that total exposure levels averaged over six or thirty minutes, for occupational or public settings, respectively, do not exceed the limits.

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Prediction methods have been developed for the near field zone of panel (directional) and whip (omnidirectional) antennas, typical at wireless telecommunications base stations, as well as dish (aperture) antennas, typically used for microwave links. The antenna patterns are not fully formed in the near field at these antennas, and the FCC Office of Engineering and Technology Bulletin No. 65 (August 1997) gives suitable formulas for calculating power density within such zones.

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and for an aperture antenna, maximum power density $\quad S_{max} = \dfrac{0.1 \times 16 \times \eta \times P_{net}}{\pi \times h^2}$, in mW/cm^2,

where $\quad \theta_{BW}$ = half-power beamwidth of antenna, in degrees,
$\qquad P_{net}$ = net power input to antenna, in watts,
$\qquad D$ = distance from antenna, in meters,
$\qquad h$ = aperture height of antenna, in meters, and
$\qquad \eta$ = aperture efficiency (unitless, typically 0.5-0.8).

The factor of 0.1 in the numerators converts to the desired units of power density.

Far Field.

OET-65 gives this formula for calculating power density in the far field of an individual RF source:

power density $\quad S = \dfrac{2.56 \times 1.64 \times 100 \times RFF^2 \times ERP}{4 \times \pi \times D^2}$, in mW/cm^2,

where $\quad ERP$ = total ERP (all polarizations), in kilowatts,
$\qquad RFF$ = three-dimensional relative field factor toward point of calculation, and
$\qquad D$ = distance from antenna effective height to point of calculation, in meters.

The factor of 2.56 accounts for the increase in power density due to ground reflection, assuming a reflection coefficient of 1.6 (1.6 x 1.6 = 2.56). The factor of 1.64 is the gain of a half-wave dipole relative to an isotropic radiator. The factor of 100 in the numerator converts to the desired units of power density. This formula is used in a computer program capable of calculating, at thousands of locations on an arbitrary grid, the total expected power density from any number of individual radio frequency sources. The program also allows for the inclusion of uneven terrain in the vicinity, as well as any number of nearby buildings of varying heights, to obtain more accurate projections.

Statement of Hammett & Edison, Inc., Consulting Engineers

The firm of Hammett & Edison, Inc., Consulting Engineers, has been retained on behalf of Verizon Wireless, a personal wireless telecommunications carrier, to evaluate its small cell (No. 425102 "Sonoma 012") proposed to be sited in Sonoma, California, for compliance with appropriate guidelines limiting human exposure to radio frequency ("RF") electromagnetic fields.

Executive Summary

Verizon proposes to install a cylindrical antenna on a light pole to be sited in the public right-of-way near 25 McDonell Street in Sonoma. The proposed operation will comply with the FCC guidelines limiting public exposure to RF energy.

Prevailing Exposure Standards

The U.S. Congress requires that the Federal Communications Commission ("FCC") evaluate its actions for possible significant impact on the environment. A summary of the FCC's exposure limits is shown in Figure 1. These limits apply for continuous exposures and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health. The most restrictive limit for exposures of unlimited duration at several wireless service bands are as follows:

Wireless Service Band	Transmit Frequency	"Uncontrolled" Public Limit	Occupational Limit (5 times Public)
Microwave (point-to-point)	1–80 GHz	1.0 mW/cm^2	5.0 mW/cm^2
Millimeter-wave	24–47	1.0	5.0
Part 15 (WiFi & other unlicensed)	2–6	1.0	5.0
CBRS (Citizens Broadband Radio)	3,550 MHz	1.0	5.0
BRS (Broadband Radio)	2,490	1.0	5.0
WCS (Wireless Communication)	2,305	1.0	5.0
AWS (Advanced Wireless)	2,110	1.0	5.0
PCS (Personal Communication)	1,930	1.0	5.0
Cellular	869	0.58	2.9
SMR (Specialized Mobile Radio)	854	0.57	2.85
700 MHz	716	0.48	2.4
600 MHz	617	0.41	2.05
[most restrictive frequency range]	30–300	0.20	1.0

General Facility Requirements

Small cells typically consist of two distinct parts: the electronic transceivers (also called "radios" or "channels") that are connected to the traditional wired telephone lines, and the passive antennas that send the wireless signals created by the radios out to be received by individual subscriber units. The radios are typically mounted on the support pole or placed in a cabinet at ground level, and they are connected to the antennas by coaxial cables. Because of the short wavelength of the frequencies

assigned by the FCC for wireless services, the antennas require line-of-sight paths for their signals to propagate well and so are installed at some height above ground. The antennas are designed to concentrate their energy toward the horizon, with very little energy wasted toward the sky or the ground. This means that it is generally not possible for exposure conditions to approach the maximum permissible exposure limits without being physically very near the antennas.

Computer Modeling Method

The FCC provides direction for determining compliance in its Office of Engineering and Technology Bulletin No. 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radio Frequency Radiation," dated August 1997. Figure 2 describes the calculation methodologies, reflecting the facts that a directional antenna's radiation pattern is not fully formed at locations very close by (the "near-field" effect) and that at greater distances the power level from an energy source decreases with the square of the distance from it (the "inverse square law"). This methodology is an industry standard for evaluating RF exposure conditions and has been demonstrated through numerous field tests to be a conservative prediction of exposure levels.

Site and Facility Description

Based upon information provided by Verizon, including drawings by The CBR Group, dated December 19, 2019, it is proposed to install one CommScope Model VVSSP-360S-F, 2-foot tall, omnidirectional[*] cylindrical antenna on top of a new light pole to be sited in the public right-of-way on the south side of McDonell Street, about 90 feet east of its intersection with First Street West, in front of the two-story office building at 25 McDonell Street in Sonoma. The antenna would employ 7° downtilt and would be mounted at an effective height of about 32 feet above ground. The maximum effective radiated power proposed in any direction is 460 watts, representing simultaneous operation at 230 watts each for AWS and PCS service. There are reported no other wireless telecommunications base stations at the site or nearby.

Study Results

For a person anywhere at ground, the maximum RF exposure level due to the proposed Verizon operation is calculated to be 0.012 mW/cm^2, which is 1.2% of the applicable public exposure limit. The maximum calculated level at the second-story elevation of any nearby building[†] is 2.8% of the public exposure limit. It should be noted that these results include several "worst-case" assumptions and therefore are expected to overstate actual power density levels from the proposed operation.

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[*] Assumed to be omnidirectional, although manufacturer's patterns show reduced power in certain directions.
[†] Located at least 30 feet away, based on the drawings.

Recommended Compliance Measures

Due to its mounting location and height, the antenna would not be accessible to unauthorized persons, and so no measures are necessary to comply with the FCC public exposure guidelines. To prevent occupational exposures in excess of the FCC guidelines, it is recommended that appropriate RF safety training be provided to all workers who have access within 13 feet outward from the antenna. No access within 2½ feet directly in front of the antenna, such as might occur during certain maintenance activities high on the pole, should be allowed while the antenna is in operation, unless other measures can be demonstrated to ensure that occupational protection requirements are met. It is recommended that explanatory signs[‡] be posted at the antenna and/or on the pole below the antenna, readily visible from any angle of approach.

Conclusion

Based on the information and analysis above, it is the undersigned's professional opinion that operation of the small cell proposed by Verizon Wireless near 25 McDonell Street in Sonoma, California, will comply with the prevailing standards for limiting public exposure to radio frequency energy and, therefore, will not for this reason cause a significant impact on the environment. The highest calculated level in publicly accessible areas is much less than the prevailing standards allow for exposures of unlimited duration. This finding is consistent with measurements of actual exposure conditions taken at other operating small cells. Training authorized personnel and posting explanatory signs are recommended to establish compliance with occupational exposure limits.

Authorship

The undersigned author of this statement is a qualified Professional Engineer, holding California Registration No. E-21306, which expires on September 30, 2021. This work has been carried out under his direction, and all statements are true and correct of his own knowledge except, where noted, when data has been supplied by others, which data he believes to be correct.

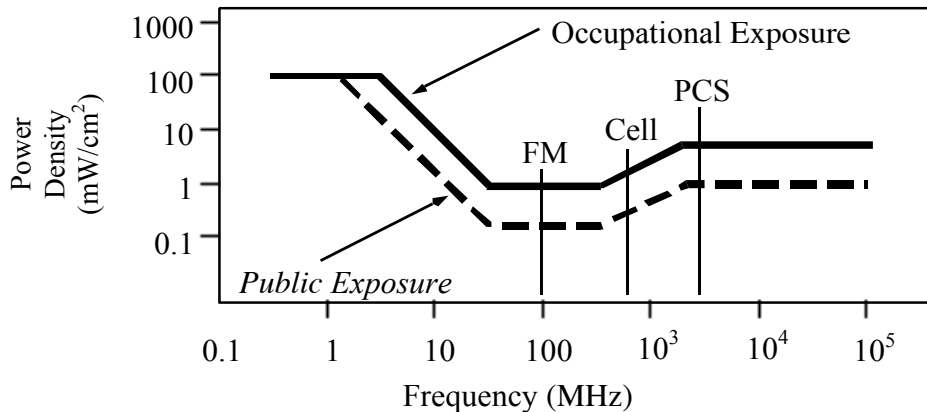Neil J. Olij, P.E.
707/996-5200

January 9, 2020

[‡] Signs should comply with OET-65 color, symbol, and content recommendations. Contact information should be provided (*e.g.*, a telephone number) to arrange for access to restricted areas. The selection of language(s) is not an engineering matter, and guidelines from the landlord, local zoning or health authority, or appropriate professionals may be required.

FCC Radio Frequency Protection Guide

The U.S. Congress required (1996 Telecom Act) the Federal Communications Commission ("FCC") to adopt a nationwide human exposure standard to ensure that its licensees do not, cumulatively, have a significant impact on the environment. The FCC adopted the limits from Report No. 86, "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," published in 1986 by the Congressionally chartered National Council on Radiation Protection and Measurements ("NCRP"). Separate limits apply for occupational and public exposure conditions, with the latter limits generally five times more restrictive. The more recent standard, developed by the Institute of Electrical and Electronics Engineers and approved as American National Standard ANSI/IEEE C95.1-2006, "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," includes similar limits. These limits apply for continuous exposures from all sources and are intended to provide a prudent margin of safety for all persons, regardless of age, gender, size, or health.

As shown in the table and chart below, separate limits apply for occupational and public exposure conditions, with the latter limits (in *italics* and/or dashed) up to five times more restrictive:

Frequency	Electromagnetic Fields (f is frequency of emission in MHz)					
Applicable Range (MHz)	Electric Field Strength (V/m)		Magnetic Field Strength (A/m)		Equivalent Far-Field Power Density (mW/cm^2)	
0.3 – 1.34	614	*614*	1.63	*1.63*	100	*100*
1.34 – 3.0	614	*823.8/f*	1.63	*2.19/f*	100	*180/f^2*
3.0 – 30	1842/f	*823.8/f*	4.89/f	*2.19/f*	900/f^2	*180/f^2*
30 – 300	61.4	*27.5*	0.163	*0.0729*	1.0	*0.2*
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RFR.CALC™ Calculation Methodology

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