Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Review of the Commission's Rules Governing the 896-901/935-940 MHz Band	))	WT Docket No. 17-200

To: The Commission

REPLY COMMENTS
OF
ENTERPRISE WIRELESS ALLIANCE
AND
PDVWIRELESS, INC.

Respectfully submitted,

ENTERPRISE WIRELESS ALLIANCE

By:______________________________
Mark E. Crosby
President/CEO
2121 Cooperative Way, Ste. 225
Herndon, VA 20171
(703) 528-5115
mark.crosby@enterprisewireless.org

PDVWIRELESS, INC.

By:______________________________
John C. Pescatore
President and Chief Executive Officer
3 Garret Mountain Plaza, Ste. 401
Woodland Park, NJ 07424
(973) 771-0300
jpescatore@pdvwireless.com

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EXECUTIVE SUMMARY

> The iron reality is this: Broadband networks are expensive to build. And they don't have to be built. Capital doesn't have to be spent. Risks don't have to be taken. So the more difficult government makes the business case for deployment, the less likely it is that broadband providers, big and small, will invest the billions of dollars needed to connect consumers.

Remarks Of FCC Chairman Ajit Pai At The Institute For Policy Innovation's Hatton W. Sumners Distinguished Lecture Series, Irving, Texas, 9/7/17.

The record in this proceeding confirms that the diversity of the businesses that comprise the Private Enterprise ("PE") community, including those classified as Critical Infrastructure Industry ("CII"), is mirrored in the complexities of their communications demands. Some need only narrowband, primarily voice systems to support their business requirements. However, others face an increasingly challenging environment. The Comments are clear on two foundational points: (1) a significant number of PE users, including CII entities recognize that broadband already is or soon will be an essential tool in their communications arsenal; and (2) PE/CII broadband requirements often are not satisfied on current commercial networks. Those whose communications systems must be capable of processing significant amounts of data for purposes such as control, telemetry, IoT, network and security management, and cybersecurity monitoring, in addition to voice dispatching, need a private carrier broadband option.

The 900 MHz Band rule changes proposed by EWA/PDV are premised on this concept of optionality for this user community. PE/CII entities will be free to continue operating narrowband systems exclusively, to combine narrowband operations with access to broadband functionality, or to migrate entirely to a broadband service built to address their unique requirements. The choice will be theirs.

This freedom is achievable because advances in technology and in spectrum management policies make possible today what would have been unthinkable less than a decade ago. This allows limited spectrum resources to be used even more intensively without compromising incumbent operations. For example, it is no longer necessary to rely on guard bands of fallow spectrum to prevent interference between dissimilar technologies, when it can be demonstrated that appropriately stringent emission standards will achieve the same result. As detailed herein, a broadband system is expected to cause less interference to adjacent narrowband systems, both in-band and in adjacent allocations, than could be generated under the current rules by other narrowband systems. Thus, the 900 MHz Band can be shared by narrowband and broadband facilities by adopting rules that will allow co-existence on adjacent allocations. Broadband cannot displace narrowband usage, but neither should narrowband thwart the introduction of broadband opportunities.

Moreover, there is sufficient experience with in-band system realignment to assure any reasonable incumbent that systems can be modified to different, comparable channels with minimal disruption and without unscheduled service interruptions. The process has been tested in the repurposing of numerous bands and can be tailored to address any specific issues that might arise in the 900 MHz Band.

Much progress has been made already in this proceeding in defining a path forward toward a shared broadband/narrowband allocation. It is clear than many PE/CII entities have devoted serious, thoughtful consideration to how such a band plan might be implemented. EWA/PDV will continue to work with parties that would be affected by a 900 MHz Band realignment and are encouraged that these discussions may produce a blueprint for further FCC action.

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The Enterprise Wireless Alliance ("EWA") and pdvWireless, Inc. ("PDV") (collectively "EWA/PDV") are pleased to file these Reply Comments in the above-entitled proceeding.[1] The Commission's inquiry into whether the public interest would be served by making changes in the rules governing the 896-901/935-940 MHz band ("900 MHz Band") has generated substantial comments from a variety of parties. As noted in the Motion for Extension of Time filed in this proceeding,[2] parties that would be most directly affected by a realignment, including, but not limited to, EWA/PDV, Southern Company Services, Inc. ("Southern") and Sensus USA, Inc. ("Sensus") continue to have construction discussions in the hope of identifying a path forward that will enable the FCC to ensure that this spectrum "is put to its best and highest use for the American public." [3]

[1] Review of the Commission's Rules Governing the 896-901/935-940 MHz Band, WT Docket No. 17-200, *Notice of Inquiry*, 32 FCC Rcd 6421(2017) ("NOI").

[2] Motion of Enterprise Wireless Alliance; pdvWireless, Inc.; Southern Company Services, Inc.; Utilities Technology Council; and Sensus USA Inc. for Extension of Time (filed Oct. 24, 2017) ("Motion") (denied by Order, DA 17-1056 (Oct. 27, 2017).

[3] NOI at ¶ 18.

While certain specific issues will need to be addressed in a Notice of Proposed Rulemaking, the record is clear on two foundational points: (1) a significant number of Private Enterprise ("PE") users, including entities classified as Critical Infrastructure Industry ("CII"), recognize that broadband already is or soon will be an essential tool in their communications arsenal; and (2) PE/CII broadband requirements often are not satisfied on current commercial networks. Adoption of the Private Enterprise Broadband ("PEBB") option proposed by EWA/PDV[4] would allow PE/CII entities to participate in the deployment of broadband systems designed, constructed, and operated to their exacting standards, in some instances including rural coverage and cybersecurity requirements, in a band whose favorable propagation characteristics will make deployment cost effective. Enabling broadband in the 900 MHz Band, would "increase access to spectrum, improve spectrum efficiency, and expand flexibility,"[5] while allowing for the co-existence of narrowband systems. The parties submit this approach should be recommended by the FCC in the next stage of this proceeding.

The commitment to preserving narrowband functionality in the 900 MHz Band is a cornerstone of the EWA/PDV proposal. The licensees operating in this band represent a cross-section of our most essential American businesses. They manufacture our goods, transport our citizens and property, produce and distribute the energy sources that power the nation, and maintain and protect the facilities used to deliver electric, gas, and water services to the American public. The crucial importance of that last responsibility has been starkly illustrated by the speed and scope of utility restoration on the U.S. mainland during the recent hurricane season.

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[4] Petition for Rulemaking of the Enterprise Wireless Alliance and Pacific DataVision, Inc., RM-11738 (filed Nov. 17, 2014) ("EWA/PDV Petition").
[5] NOI at ¶ 1.

At present, for entities that choose it, broadband can be a supplement to, and not a replacement for, the Private Land Mobile Radio ("PLMR") systems on which PE/CII entities rely, whether in the 900 MHz Band or in other Part 90 spectrum. The PEBB proposal advanced by EWA/PDV does not dictate how PE/CII entities will address their communications needs. Rather, it provides optionality, an opportunity for them to determine their own communications future by electing to continue operating narrowband technology exclusively, by adding a broadband capability to their narrowband PLMR facilities, or by migrating to broadband functionality.

For those that choose broadband as an enhancement to, or possibly in some cases as a substitute for PLMR, it will provide enhanced reliability by facilitating additional technologies, applications, and access to data for using drones, managing industrial processes, and enhancing safety. Broadband is inherently flexible, as evidenced by the recent Alphabet balloon-distributed wireless LTE network enhancement set-up through its Project Loon that has provided critical connectivity to tens of thousands of wireless users in Puerto Rico, many of whom had lost all communication. That initiative uses 900 MHz Band 8 spectrum, including spectrum contributed temporarily by PDV, to address a catastrophic situation where traditional solutions could not be delivered on a timely basis.

While not all PE/CII requirements have this same criticality, a PEBB system could help PLMR entities, both 900 MHz Band incumbents and others, to function even more effectively in addressing the types of communications needs described in the Comments in this proceeding. For example:

> Western Farmers Electric Cooperative ("WFEC") is a generation and transmission cooperative that provides essential electric service to 21-member cooperatives, Altus Air Force Base, farming interests, oil and gas producers, and other commercial and industrial applications throughout Oklahoma and parts of New Mexico…WFEC currently faces challenges when trying to accomplish some or all

> of [its] objectives while employing low speed networks designed for power telemetry information.[6]
>
> Railroads use ATCS for critical direct control of wayside track switches and signals by the train traffic control centers. ATCS ensures proper train routing and speed, allowing railroads to operate more safely, efficiently, and economically.[7]
>
> PECO uses this spectrum for advanced meter reading, outage management and distribution automation. ComEd currently uses spectrum within the 896-901 and 935-940 MHz bands for its mission critical PLMR communications system for emergency communications and dispatch, outage recovery and general field communications.[8]
>
> UPS is currently licensed to operate multi-channel trunked radio systems on 900 MHz business, industrial and land transportation (B/ILT) channels at nine of our most-critical hub facilities…With a total capital investment exceeding $19 million, these 900 MHz trunked radio systems provide mission-critical push-to-talk voice communications. UPS relies on these systems to support reliable, time-critical communications related to employee health and safety; hazardous materials response; aircraft fueling; aircraft deicing; aircraft weight and balance, severe weather notification…; plant maintenance; Customs compliance; Transportation Security Administration compliance; internal security; site escorts for local police, fire and ambulance services; and numerous other important business functions.[9]
>
> The core purpose of the utility is electric service, but has grown to provide traffic signals operation and maintenance, a complimentary downtown WiFi network, a dark fiber system and street lighting….[10]

There is no question that these types of PLMR communications, and others described in the Comments, are essential to these businesses and to the customers they serve. EWA/PDV have proposed rules that will allow their narrowband PLMR systems to continue addressing their current operational requirements, while providing a private carrier option to address PE/CII broadband needs, which the record in this proceeding demonstrates compellingly exist today and are increasing exponentially.

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[6] Comments of WFEC at 1, 2.
[7] Comments of Association of American Railroads ("AAR") at 3.
[8] Comments of Exelon Corporation ("Exelon") at 3.
[9] Comments of United Parcel Service ("UPS") at 2-3.
[10] Comments of Traverse City Light & Power ("TCL&P") at 1.

I. THE COMMENTS CONFIRM THE NEED FOR A PE/CII BROADBAND SOLUTION.

The record speaks for itself:

> …utilities need access to licensed broadband spectrum to meet their increasing capacity requirements. Utilities must increase capacity to support smart grid deployment and new cybersecurity requirements…While some utilities may use commercial wireless broadband services to meet their needs, they continue to need their own private internal broadband networks and licensed broadband spectrum to ensure reliability and meet their increasing demands for capacity and coverage.[11]

> As an initial matter, Southern fully recognizes the ways in which broadband can provide effective and valuable support to utility operations, and Southern generally supports efforts to expand the availability of broadband spectrum for utility and [CII] communications needs. Dedicated broadband service provides utilities and CII the high data capacity and low latency necessary for the deployment of technologies and applications that support the increasing reliability, security and efficiency needs of the nation's energy infrastructure.[12]

> The PEBB concept provides not only a potential spectrum option, but also addresses other issues presented by attempting to shoehorn critical systems onto carrier networks that were developed for, and still focused on, consumer markets.[13]

> [E]lectric companies have a critical need for more broadband spectrum to support their current and growing 900 MHz facilities…[14]

> Third party broadband service providers cannot provide the required network services for the exclusive use by the utilities and other CII users, nor can they provide the consistent network availability and reliability that is critical in all cases and imperative in emergency situations…Utilities will have little interest in CMRS services that do not provide the necessary levels of control, availability, and reliability required for restoration communications systems.[15]

> The entrance of a 900 MHz PEBB licensee will provide a much-needed enterprise-grade provider in the marketplace for commercial LTE services, where current providers are understandably more focused on the typical consumer's needs. UPS is a heavy user of commercial LTE services throughout many parts of our business, but for mission-critical communications at many of our larger facilities, no existing

[11] Comments of the Utilities Technology Council ("UTC") at 8-9.
[12] Southern Comments at 9.
[13] Comments of the American Petroleum Institute ("API") at 4.
[14] Comments of the Edison Electric Institute ("EEI") at 5 (but opposing the proposed 900 MHz Band realignment because it "would result in harmful interference to incumbent operations in 900 MHz and adjacent bands….")
[15] Comments of NextEra Energy, Inc. ("NextEra") at 9 (but opposing the realignment of the 900 MHz Band to create a private carrier broadband option).

LTE service provider to date has been willing or able to guarantee contractually the service levels we require.[16]

…broadband LTE technology will be an ingredient in most future operations. It is a universally accepted standard in the commercial broadband marketplace, but American business enterprise and critical infrastructure entities can take advantage of its functionality and economies of scale almost exclusively as commercial network subscribers, at least if they require licensed spectrum. That option is fine for certain applications, but, as many companies have explained to the FCC, priority access and security, among other requirements, are not met on today's commercial systems.[17]

WFEC has established the need for broadband network connectivity in support of its power operations and supports the proposed reconfiguration of the [900 MHz] band in question to provide broadband operations to critical infrastructure operators, especially utilities…[w]e do not enjoy the same access to telecommunications infrastructure and much of our service territory is underserved or unserved by common carriers and non-regulated telecommunications companies.[18]

Our company already uses commercial broadband networks to address some needs, but networks designed primarily for consumer use do not always offer the coverage, security, reliability, redundancy, priority access, or control functions needed for certain operations. For example, we run voice communications on commercial networks but are not able to rely on them for applications such as remote tank reading. A business-focused broadband option below 1 GHz will allow us to address those needs on spectrum that offers meaningful cost savings.[19]

…energy companies must also modernize the telecommunications networks that support so many of their functions. Access to affordable broadband spectrum that can be used for systems designed to the demanding specifications of a utility will be essential to this modernization process.[20]

Unsurprisingly, given all of these benefits [of LTE technology], Ericsson is seeing interest from critical infrastructure entities in moving to LTE as a communications solution. Many utilities have existing equipment in the band that is reaching the end of its life system, and they will need to purchase new equipment. Transitioning this spectrum at this time will enable such entities that want to switch to LTE to directly jump to LTE, rather than having to re-purchase existing equipment and then later pay again to transition to LTE. This will be a valuable cost savings opportunity and a prudent use of funds for many utilities and critical infrastructure entities.[21]

[16] UPS Comments at 4.
[17] Comments of TeleWorld Solutions ("TeleWorld").
[18] WFEC Comments at 1, 2.
[19] Comments of Victory Propane, LLC.
[20] Comments of Intercept Technologies *et al* ("Intercept").
[21] Comments of Ericsson at 5.

> …electric utilities do not have priority on commercial networks, so when disasters occur, electric utility personnel are competing with all other members of the public for use of such networks. Thus, commercial networks cannot be relied upon to enable the crucial and time-sensitive work of restoring the electric grid.[22]

> …Duke Energy is strongly in favor of the Commission granting additional sub-one GHz spectrum to electric utilities to build private broadband LTE networks to use for their ever-expanding broadband needs resulting from grid modernization. While Duke Energy would prefer that the Commission grant utilities that spectrum in a band other than the 900 MHz band, if the Commission is only willing to consider allocation of the 900 MHz band for that purpose, Duke Energy sets forth a proposal below to minimize such disruption.[23]

The consistency of these PE/CII comments in describing their need for broadband spectrum is driven by the growing number of use cases that rely on access to that technology. Smart grids, smart cities, IoT, oil/gas monitoring and cyber-secure communications networks are just some examples of applications that are optimally addressed on broadband networks.[24] The issue, then, is not whether there is a need for custom-built PE/CII broadband systems, but whether realigning the 900 MHz band to create a private carrier option for the deployment of such systems is in the public interest.[25] As described in the Comments and explained more fully below, EWA/PDV believe the record clearly demonstrates that the public interest would be served by adoption of the PEBB proposal.

II. THE RECORD SUPPORTS THE FINDING THAT A 900 MHz BROADBAND ALLOCATION CAN CO-EXIST WITH IN-BAND AND ADJACENT BAND NARROWBAND SYSTEMS.

The most consistent objection to the PEBB proposal is the concern that an adjacent broadband allocation will cause interference to narrowband PLMR systems operating in the 2/2

[22] Comments of Westar Energy, Inc. ("Westar") at 3.
[23] Comments of Duke Energy Corporation ("Duke Energy") at 1.
[24] *See, e.g.*, Duke Energy and WFEC Comments for detailed descriptions of those utilities' conclusions that their operations require broadband service from other than consumer-oriented commercial networks.
[25] AAR took the position that broadband might be an appropriate solution for its members' freight train operations at some future date¸ suggesting that it sees no current need for broadband applications. AAR Comments at 5. AAR did recommend making wideband channels available in the 900 MHz Band, which EWA/PDV have proposed in their Comments on the NOI.

megahertz segment of the 900 MHz Band and/or to systems operating in the adjacent Narrowband PCS ("NPCS") allocation at 901/902/940-941 MHz.[26] The need to assure themselves that their operations will be adequately protected is understandable, particularly for those 900 MHz Band incumbents whose PLMR systems are used in support of essential services, including CII operations. EWA/PDV willingly stipulate to the importance of those systems. EWA, which represents a number of 900 MHz Band incumbents, and PDV, which expects to partner with them in build-to-suit broadband operations, would not propose, nor would the FCC ever approve, rule changes that would permit the dire result described colorfully by EEI: "…the magnitude of harmful, wideband interference that the proposed 3/3 MHz broadband operations would create would completely eliminate the ability of many existing electric company PLMR 900 MHz systems to continue operation."[27]

What is missing in the record, however, is any technical analysis supporting the assertions that a system in the 3/3 megahertz PEBB allocation, operating pursuant to the technical rules proposed by EWA/PDV, in fact, would cause harmful interference to adjacent narrowband systems.[28] These conclusory claims seemingly rest on several inter-related assumptions that are not borne out by the facts.

A. Potential Broadband Interference

Some incumbents opposed to the PEBB proposal state that the FCC previously has relied on external guard bands of vacant spectrum to prevent interference from broadband to

[26] *See, e.g.*, NextEra Comments; *see also* Sensus Comments.
[27] EEI Comments at 14.
[28] The lone technical analysis submitted to support that claim is the Real Wireless Analysis appended to Attachment 1 to the Sensus Comments in this proceeding. That Attachment 1 is a copy of the June 29, 2015 Comments filed by Sensus in RM-11738, a predecessor to this proceeding. EWA/PDV refuted each point in that analysis in Exhibit A to their July 14, 2015 Reply Comments in RM-11738, which they previously requested be incorporated by reference in this proceeding, but are attached hereto as Attachment 1 for the FCC's convenience.

narrowband services. They argue that the absence of an external guard band, *ipso facto*, renders this proposal defective.[29] Setting aside the fact that the FCC has not required guard bands between all broadband and narrowband allocations,[30] and the existence of an internal guard band in every LTE channel, this conclusion ignores the purpose of guard bands.

Spectral separation is needed when the technical rules, in particular the out-of-band-emission ("OOBE") standard, are not sufficiently stringent to ensure that transmitted energy from a service is below a level that would cause harmful interference to an adjacent allocation. That is why EWA/PDV have proposed an OOBE mask in their Rule Section 90.1419 that, combined with the inherent characteristics of an LTE channel, will provide appropriate protection to adjacent PLMR and NPCS systems.[31] In fact, the proposed rules protect narrowband systems to the same or even better levels than the current regulations for narrowband operations. Contrary to the assumptions of certain incumbents, broadband is as good a neighbor, and in most cases a better neighbor, than other narrowband systems in the regulatory environment proposed by EWA/PDV. In a world where spectrum resources are scarce, in particular spectrum below 1 GHz, managing potential interference through rigorous technical standards clearly is superior to relying on vacant guard band spectrum.

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[29] *See, e.g.*, EEI Comments at 14.

[30] The FCC authorized broadband usage in the 813.5-824/858.5-869 MHz Enhanced SMR ("ESMR") band in the Southeastern United States without establishing a guard band between broadband and immediately adjacent narrowband operations, including Public Safety operations. It noted that the ESMR licensees would be permitted to utilize CDMA, LTE, and other advanced wireless technologies. The Commission determined that there was "no basis to conclude that EA-based 800 MHz SMR operations using bandwidths wider than 25 kHz must be subject to more stringent technical requirements than our rules in Part 90 currently impose…due in part to the fact that other things being equal, the use of wider channels generally spreads the available power across a much wider bandwidth than narrowband technologies…" Improving Spectrum Efficiency for EA-based 800 MHz SMR Licensees, WT Docket No. 12-64, *Report and Order*, 27 FCC Rcd 6489 at ¶ 27 (2012).

[31] *See Ex Parte* Comments of EWA/PDV; Proposed 900 MHz PEBB Allocation Rules, RM-11738 (filed May 3, 2015); *see also* EWA/PDV Reply Comments, RM-11738, (filed July 14, 2015), (collectively, "Proposed PEBB Rules"). That mask was updated, but not modified, to conform to current FCC measurement bandwidth for defining broadband masks in Attachment 12 to the EWA/PDV Comments in this proceeding.

The adequacy of the technical rules proposed by EWA/PDV has been validated by two experienced, highly respected consultants: Pericle Communications Company ("Pericle") and DVA Consulting, LLC ("DVA Consulting"). Both were charged with testing the proposed standards from the perspective of a narrowband incumbent based on their extensive knowledge of PLMR systems and Advanced Metering Infrastructure ("AMI") systems typically found on adjacent NPCS spectrum, including those used for mission-critical operations.

Pericle responded as follows:

> We conclude that a 3 MHz broadband LTE carrier operating from 937 to 940 MHz can co-exist with narrowband Part 90 and Part 24 incumbents. In the rare case of harmful interference, we propose remedies similar to those found in § 90.672 (which also has existing remedies) and § 22.913, including a Power Flux Density (PFD) limit of 3,000 $\mu W/m^2$ to harmonize in part with § 22.913(b).[32]

Pericle also noted that, "…guard bands waste spectrum."[33]

DVA Consulting reached the same conclusion:

> DVA has also concluded that sources for potential interference between the proposed broadband allocation and narrowband systems in adjacent bands do exist. However, they appear no worse, and are in many cases reduced, from what is possible today with narrowband licenses that comply with the current rules. Still, specific actions and precautions can be taken by the broadband licensee and incorporated into the proposed rules to protect against the risk of interference and mitigate any occurrences that may arise.[34]

The technical rules proposed by EWA/PDV include just such protections.

Ericsson echoed those findings:

> The 900 MHZ band is suitable to sustain a viable service with 3X3 megahertz paired blocks allocated for broadband, and our analysis indicates that, under the rules proposed in 2015 by the Enterprise Wireless Alliance and Pacific DataVision (the "EWA/PDV rules"), such an allocation would not cause harmful interference to an adjacent 2X2 megahertz allocation for traditional narrowband operations.[35]

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[32] Pericle Comments at 3.
[33] *Id.* at 2.
[34] EWA/PDV Comments, Attachment 2 at 3.
[35] Ericsson Comments at 1.

Consistent with its earlier report, the attached analysis from Pericle evaluates the potential downlink and uplink interference to PLMR operations from an immediately adjacent LTE carrier versus interference to PLMR networks from other narrowband systems.[36] Pericle confirms that even a small number of simultaneously operating PLMR base stations create the same potential for OOBE interference as LTE, numbers so small that the threshold would be exceeded routinely based on typical PLMR narrowband build-out and usage patterns. As stated by Pericle:

> When we compare the prospective LTE network to a fully built-out narrowband system (or systems) we see that the narrowband system creates more downlink out-of-band emissions interference than the LTE system by a wide margin. But even a lightly-loaded network (well less than a full build out) creates as much interference as the LTE network. Thus, we can conclude that the LTE network is likely to create *less* interference than the next best alternative, not more.[37]

The single technical showing proffered to support a theoretical interference claim was the Real Wireless study submitted by Sensus, a report that was filed by Sensus in RM-11738 and refuted by EWA/PDV in that proceeding.[38] As demonstrated by EWA/PDV, the Real Wireless study is based on worst case analyses under the most extreme, and therefore most unlikely, conditions. The FCC, properly, does not base its rules or allocation decisions on worst case scenarios, as doing so often would prevent the introduction of newer technologies and would erect protection barriers that would result in underutilization of spectrum.[39] Instead, it assesses the likelihood of such situations arising in a spectral environment in which no incumbent is or could

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[36] *See* Attachment 2.
[37] *Id.* at 4
[38] *See* n. 28.
[39] In granting a waiver to Higher Ground, LLC to share the use of the 6 GHz band over the objection of microwave incumbents, the FCC stated, "We thus find that Higher Ground's proposed system and operation, under certain conditions, would further the Commission's interest in ensuring the highest public benefit is derived from this finite spectrum resource." Higher Ground, LLC, *Order and Authorization*, IBFS File No. SES-LIC-20150616-00357, 32 FCC Rcd 728 (2017).

be guaranteed entirely interference-free usage and makes a public interest determination. As the Commission has stated:

> Furthermore, it is a fundamental reality that every radio communication system must work in the presence of some amount of RF noise and interference. Consequently, communication system designers typically incorporate some built-in operational margin that maintains reasonable performance in the face of variables such as anticipated interference/noise levels, component degradation over time, temperature-related circuit fluctuations, the impact on signal levels from the weather, and the like. In other words, the system design must include some reasonable margin for acceptable performance in a changing environment.[40]

The Commission has recognized this concept in numerous proceedings, most recently in the Mid-Band Spectrum Notice of Inquiry in which it is seeking input on potential opportunities for more flexible broadband services in the 3.7-24 GHz bands.[41] That Inquiry asks how the FCC could facilitate deployment of mobile services and minimize the potential for harmful interference. Clearly, in attempting to make more efficient, intensive use of that spectrum, the Commission will not require a showing that there is no possibility of harmful interference in any instance, but will put in place reasonable protections to ensure that such situations will be rare. The rules proposed by EWA/PDV are designed in accordance with that principle. They also incorporate a defined procedure in proposed Rule Section 90.1421 for addressing situations in which parties believe they are experiencing harmful interference from the PEBB operation.[42]

B. <u>The Noise Floor</u>

Some incumbents object to a band realignment on the basis that relocating narrowband systems to the 2/2 megahertz allocation, as stated by EEI, "…ignores the low noise floor environment currently and historically existing in the 900 MHz band, which licensees rely on for

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[40] Establishment of an Interference Temperature Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fixed, Mobile and Satellite Frequency Bands, ET Docket No. 03-237, *Notice of Inquiry and Notice of Proposed Rulemaking*, 18 FCC Rcd 25309 at ¶ 27 (2003).

[41] *See* Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz, GN Docket No. 17-183, *Notice of Inquiry*, 32 FCC Rcd 6373 (2017).

[42] *See* Proposed PEBB Rules.

mission-critical communications."[43] Of course, there is no statutory or regulatory "right" to rely on a "low noise floor," however that term is defined, but only on the spectral environment that the current rules permit, rules that are designed to facilitate full utilization of all narrowband channels. As spectrum utilization increases, the noise floor inevitably rises, but within the parameters the Commission has deemed acceptable as reflected in its technical rules.

The complexity, perhaps impossibility, of quantifying a permissible noise floor as a baseline on which all facilities in a particular service may rely in perpetuity is amply illustrated in the Office of Engineering and Technology's Technological Advisory Council's investigation into this issue.[44] The FCC also spoke to this issue in detail when considering the appropriate interference protection standard for Public Safety systems in the 800 MHz rebanding proceeding:

> [W]e conclude, based on the record in this proceeding, that a readily identifiable objective standard should be established to determine what constitutes unacceptable interference, and which systems are entitled to protection from such interference. We also believe that both unacceptable interference and the scope of protection afforded to eligible systems should be subject to objective measurement criteria.…We…find that certain interference definition and measurement procedures contained in the record allow us to establish a reasonable standard for determining when public safety and other non-cellular systems can expect to operate free from unacceptable interference. …We further believe that adoption of the unacceptable interference definition and associated measurement procedures is in furtherance of our goal to employ sound spectrum management principles in resolving the 800 MHz interference problem.…[W]e believe that the measures we adopt here will meet our goal of ensuring that 800 MHz communications critical to the safety of life and property will not be impaired by unacceptable interference.[45]

The same reasoning applies in the 900 MHz Band.

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[43] EEI Comments at 14. Sensus claimed in a filing submitted in RM-11738 that NPCS incumbents were legally entitled to the noise floor as it had existed ten years earlier, an extraordinary claim by any standard. Sensus Comments, RM-11738, filed June 29, 2015 at iv.

[44] *See* Office of Engineering and Technology Announces Technological Advisory Council (TAC) Noise Floor Technical Inquiry, ET Docket No. 16-191, *Public Notice*, 31 FCC Rcd 6939 (2016).

[45] In the Matter of Improving Public Safety Communications in the 800 MHz Band, WT Docket No. 02-55, *Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order,* 19 FCC Rcd 14969 at ¶ 101 (2004) ("800 MHz Rebanding Order").

The rules proposed by EWA/PDV mirror the approach adopted by the Commission in establishing a harm claim threshold for 800 MHz public safety systems that claim cellular interference. Public safety licensees are entitled to corrective action by cellular operators if their systems meet a signal level the FCC has deemed reasonable for a system operating in that band. A system that is under-designed in reliance on less intensive band utilization cannot demand protection for operations at the "far fringes of its noise-limited coverage area."[46] Thus, if a Public Safety licensee in Wyoming chooses to install fewer sites and rely on very low signal levels because there is less spectral congestion in its remote operating area, it is free to do so, but is not then permitted to claim remediation rights against cellular operators should it experience interference from them. The same should be true at 900 MHz.

EWA/PDV do not believe that an adjacent PEBB system will cause harmful interference for the reasons described in their Comments, including the DVA Report, the Comments filed by Pericle and Ericsson, and the Pericle Report included as Attachment 2 to this filing. They do not believe a broadband neighbor will raise the noise floor above what the Commission anticipated when it allocated this spectrum and adopted technical rules for narrowband systems operating in the 900 MHz Band. Nonetheless, they have proposed a process to address such an event should it occur.

That process, mirroring the rules governing 800 MHz, is defined in proposed Rule Section 90.1421, Interference Protection Rights, with the revised signal strength standards of -98 dBm for mobiles and -95 dBm for portables when making an interference claim.[47] As at 800 MHz, the PEBB licensee cannot be held responsible, in the FCC's words, for contributing even the slightest

[46] *Id*. at ¶ 94.
[47] *See* Proposed PEBB Rules; *see also* EWA/PDV Reply Comments, RM-11738, (filed July 14, 2015).

amount of noise to an incumbent's receiver; that is, it cannot be required to have zero impact on the noise floor. The -98/-95 dBm harm claim threshold proposed by EWA/PDV is protective of systems designed with an appropriate level of robustness to operate effectively under the current 900 MHz Band rules. As long as the PEBB has no greater impact on the noise floor than would the narrowband systems authorized to operate in this band today, incumbent licensees have not been adversely affected.

C. Consolidating Narrowband in a 2/2 Megahertz Allocation

Some opponents of the PEBB proposal also have the belief that relocating all narrowband systems into the 2/2 megahertz allocation will result in intra- and inter-system interference.[48] Yet the realignment proposed by EWA/PDV would not assign more narrowband channels in a market within that 2/2 megahertz allocation than are authorized today. Since the current FCC rules presume that all 900 MHz Band channels could be operating in any area, this argument seemingly suggests that today's regulatory structure carries precisely the same potential for interference within and among narrowband systems.[49]

This concern is particularly surprising, since all narrowband channels have been assigned in the major markets in the country for decades. Before Sprint (then Nextel) purchased geographic rights at auction and integrated 900 MHz Band spectrum into its iDEN network, it and other Specialized Mobile Radio ("SMR") licensees operated site- and frequency-specific narrowband systems on the SMR channels that are interleaved with Business/Industrial/Land Transportation ("B/ILT") channels on which PLMR licensees were and still are operating. The channels were

[48] *See, e.g.,* NextEra Comments at 7; Comments of Critical Infrastructure Coalition ("CIC") at 11.
[49] It should be noted that two major utilities, each operating in one of the country's most spectrum-congested markets, have exchanged spectrum with PDV so that their new multi-channel, multi-site systems are operating exclusively on channels in the proposed 2/2 megahertz allocation below 898/937 MHz. PDV has made similar spectrum swaps with other CII entities that preferred to deploy on channels in the 2/2 megahertz allocation.

fully deployed across the entire 900 MHz Band without triggering the types of interference that allegedly would result from substantial use within the 2/2 megahertz allocation. To the extent that isolated problems arose, as referenced by Lower Colorado River Authority ("LCRA"),[50] they were resolved by licensees working cooperatively as is the case in many spectrum bands, and should continue to be resolved that way in the 900 MHz Band.

There is no technical support for the claim that realigning systems into a portion of the band already intended to be used by contiguous 12.5 kHz bandwidth channels would potentially require a doubling of sites, or any need for additional sites, to maintain coverage comparable to what is achievable today.[51] While it is theoretically possible that tighter channel spacing could result in some reduced system performance, such as a less intelligible audio signal in outlying areas, Pericle points out that there are various ways of compensating for any such loss. According to dBSpectra, a leading vendor of transmitter combiners, modern ceramic cavity filter combiners have at least 1 dB less loss than older combiners like the popular DB8062G for the same frequency spacing.[52]

- Combiner losses, if they occur, can be made up with higher transmit power (in some cases), greater antenna gain (in some cases) or lower loss coaxial cable (e.g., LDF-7, 1-5/8" diameter versus LDF-5, 7/8" diameter).

- As a last resort, the incumbent's channels can be split between two combiners (and antennas) to achieve greater frequency spacing.[53]

A similar issue arose in the Canadian Border Regions ("CBRs") during the 800 MHz rebanding process. As will be the case in this proposed realignment, no incumbent received fewer replacement channels than it had pre-rebanding. However, post-rebanding sub-allocations within

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[50] LCRA Comments at 6.
[51] *See, e.g.*, CIC Comments at 11.
[52] Pericle Comments at 23, Figure 9, n. 12.
[53] *Id*. at 23.

the band were modified, the number of channels available to B/ILT entities was reduced in certain regions, and the B/ILT channels were in a contiguous portion of the allocation, rather than interleaved throughout the band. In response to concerns that this band restructuring would result in more closely spaced channel assignments within a system, the Commission stated the following:

> We recognize that assigning replacement channels to non-ESMR [B/ILT and high-site SMR entities] licensees in the manner described above will reduce the potential separation between the upper and lower bounds of available frequencies in the non-ESMR pool, which may require some non-ESMR licensees to make use of more efficient combiners in order to compensate for decreased frequency separation. We note that where more efficient combiners are required for this reason, Sprint must pay the reasonable cost of such combiners….[54]

The realignment rules proposed by EWA/PDV likewise would make the cost of any combiner equipment required to provide comparable coverage the obligation of the PEBB licensee. It is notable that 800 MHz incumbents did not claim that coverage losses due to decreased frequency separation would require the addition of sites and, in fact, no additional permanent sites were determined to be necessary to provide comparable facilities in the rebanding process, either in the CBRs or elsewhere.

D. Fixed vs. Mobile UE Operations

In its Comments, Sensus asserted that the EWA/PDV interference analysis model in RM-11738 filed in response to the Sensus-sponsored Real Wireless LTD exhibit, applies only to a mobile use case.[55] Sensus claimed it does not cover machine-to-machine communications with fixed endpoints that have different characteristics and will cause higher levels of interference than mobile usage.

[54] In the Matter of Improving Public Safety Communications in the 800 MHz Band, WT Docket No. 02-55, *Second Report and Order*, 23 FCC Rcd 7605 at ¶ 19 (2008).
[55] Sensus Comments at 10; *see also* n. 28.

That is incorrect. The EWA/PDV model applies to both LTE fixed endpoints and mobile UEs deployed in the proposed PEBB. Some of the assumptions, attributes, and derived conclusions of this model are highlighted below:

- The model assumes that in the LTE technology's FDMA structure for UE uplinks, only 1 UE transmits in its assigned frequency segment (one or more resource blocks) at any given time in a sector. Pericle has further confirmed that UEs in a second sector could have a negligible effect on potential interference and that the contribution to interference from sectors beyond is insignificant.[56]

- The model assumes a power back-off of 9 dB or more for 95.9% of the UEs. Thus, a single UE is not likely to cause interference when reasonable assumptions are made for losses, incumbent NB network design, and propagation models.[57]

The EWA/PDV model suggests that a fixed LTE endpoint, transmitting at the highest likely power with a full buffer (constantly transmitting) from the worst-case, highest power location with respect to the location of the narrowband base station, is unlikely to cause harmful interference to that base station. That likelihood is further reduced drastically due to the low probability of all required attributes coming together: The endpoint is fixed at the worst-case location, is transmitting with the highest possible power, and is constantly transmitting with a full buffer. This condition has a very low probability, as machine-to-machine communications typically are characterized by intermittent transfers of low bit rate information.

As outlined above, the nature of the FDMA/TDMA and power back-off methods inherent in LTE technology are applicable to both fixed and mobile UE/endpoints. If one were to assume a use case wherein all sector demand was from fixed endpoints, with no mobile usage, the same operating premise would hold true, as only a single endpoint would be transmitting at a time on any available frequency resource within any sector. Moreover, the distribution of broadband

[56] Pericle Comments at 20-21.
[57] Commerce Spectrum Management Advisory Committee, Final Report, Working Group 1 – 1695-1710 MHz Meteorological -Satellite, Appendix 3 (Jan. 22, 2013).

endpoints across a given sector would result in millisecond transmissions from many different locations over any given period of time, thus ensuring a low probability of any AMI endpoint being interfered with by a broadband endpoint that is in close proximity.

III. A 900 MHz BAND REALIGNMENT CAN BE IMPLEMENTED SAFELY AND WITHOUT INTERRUPTION TO NARROWBAND SERVICE.

Spectrum is a scarce public resource. While the laws of physics are immutable, extraordinary technology advances over the years have caused the FCC to determine that bands should be reallocated, or repurposed, or realigned to take advantage of those improvements and thereby better serve the public interest. These changes always involve some controversy; there likely never has been an instance when all incumbents whose operations might be affected by the proposed changes have embraced them. This is neither surprising, nor unreasonable. Modernizing a band to permit deployment of more advanced technologies often requires "touching" incumbent systems and some disruption of their operations. In some cases, the whole band is cleared to make way for an entirely different service, with incumbents moved to a different part of the spectrum.[58] In others, incumbent frequencies are exchanged to allow different technologies to co-exist as neighbors.[59] More recently, when the allocations are large enough and the technologies smart and agile enough, the FCC allows different types of systems to share spectrum on an opportunistic basis.[60] Importantly, for purposes of this proceeding, the Commission has extensive experience with repurposing spectrum. It has established, tested processes for implementing these changes with minimal disruption to incumbent operations and with a guarantee of comparable facilities at no cost to them.

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[58] *See Second Report and Order*, GN Docket No. 90-314, 8 FCC Rcd 7700 (1993), *recon. Memorandum Opinion and Order*, FCC 94-144 (rel. June 13, 1994).

[59] *See* 800 MHz Rebanding Order.

[60] Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Report and Order and Second Further Notice of Proposed Rulemaking*, 30 FCC Rcd 3959 (2015).

EWA/PDV appreciate both the complexities and mission-critical nature of certain 900 MHz incumbent systems. Any frequency exchange must be carefully planned and meticulously implemented to prevent the disruption of those services. Fortunately, as noted in the EWA/PDV Comments, recent 800 MHz rebanding activity offers useful guidance in these matters and proof that even the largest, most complicated systems that support the emergency response communications of police, fire and EMS users can be moved to replacement in-band frequencies with no unplanned loss of service.[61]

Without in any way diminishing the importance of the 900 MHz systems that would be realigned under the PEBB proposal, EWA/PDV must question the basis for NextEra's claim that "The 900 MHz environment is even more complicated [than 800 MHz]."[62] The statement suggests a lack of familiarity with the scope of the 800 MHz rebanding effort. It involved more than four times the number of all 900 MHz systems, only some of which will be modified under this proposal. It included Public Safety systems, some of which had statewide operations, extensive interoperability arrangements, hundreds of trunked sites, statewide mutual aid repeaters, and more than 50,000 radios. It also involved rebanding a number of utility and other CII systems, the same types of systems with the same critical operational requirements about which NextEra is concerned. The facts are clear: the 900 MHz Band is not as complicated as 800 MHz, does not involve even a quarter as many systems, does not involve any Public Safety systems with their complex chains of mutual aid interdependencies,[63] involves only 60 PE/CII

[61] EWA/PDV Comments at 18-20. Some 800 MHz systems that were rebanded successfully even involved nuclear facilities.

[62] NextEra Comments at 7.

[63] EWA/PDV appreciate that LCRA shares its system on a non-profit basis with Public Safety entities. LCRA Comments at 4. This is commendable and undoubtedly of enormous benefit to those users. However, that situation is the exception. Public Safety entities are not eligible to hold 900 MHz licenses and their use of this spectrum is *de minimis*. Where they are users on 900 MHz systems, as in this instance, their realignment experience will be managed

systems nationwide with as many as 25 licensed transmitters, and will benefit from the extensive experience in non-disruptive rebanding that has developed through the 800 MHz retuning projects. [64]

Additionally, as many 900 MHz Band PLMR systems are reaching end of life, this replacement cycle provides an opportune time to migrate to new channels and thereby avoid any realignment disruption. Several major entities have worked directly with PDV during these transitions, including utilities and oil and gas companies, to successfully and preemptively relocate their new or upgraded systems to the lower 2/2 megahertz allocation proposed to be reserved for narrowband operations by exchanging channels with or selling channels to PDV.[65] For example, NextEra recently announced the full replacement of "their legacy analog LMR network with a new system…by 2018."[66] By reaching agreement now on replacement channels in the 2/2 megahertz allocation, they would be able to cut over from their legacy network to a new system already programmed on their new narrowband channels, an approach already adopted by other 900 MHz Band utility incumbents.

Another criticism often lodged against 800 MHz rebanding is the length of time it has taken. It is important to view that timeline in perspective. 800 MHz rebanding proceeded in two distinct steps. First, incumbents in the 806-809/851-854 MHz ("1-120") segment had to be moved up to channels in the 809-815/854-860 MHz ("interleaved") portion to create room for National

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to avoid unscheduled downtime, just as it has been for the many mission-critical Public Safety networks operating at 800 MHz.

[64] A number of highly qualified service organizations around the country developed extensive experience in rebanding complex 800 MHz systems. That expertise will be available for interested 900 MHz incumbents.

[65] *See* n. 49.

[66] https://www.harris.com/press-releases/2016/10/harris-corporation-and-florida-power-light-partner-to-advance-communications.

Public Safety Planning Advisory Committee (“NPSPAC”) systems to move down. While there were some Public Safety systems operating in this 3/3 megahertz 1-120 block, the majority of systems were operated by the same mixture of site-based PE/CII and SMR entities that exist in the 3/3 megahertz proposed for the PEBB allocation. The negotiation of rebanding agreements and the physical relocation of those approximately 1,000 systems – more than twice as many as all 900 MHz Band systems, only some of which will require realignment – took approximately three years.

The much more time-consuming step has been relocating exclusively Public Safety systems from the upper portion of the band down to the now-vacated 3/3 megahertz at the bottom. A very significant factor in the time needed to move these systems is the extensive *ad hoc* interoperability arrangements in this community. It was not uncommon to find that a single Public Safety entity had added the frequencies of a dozen or more other Public Safety systems into its radios and vice versa. Maintaining this interoperability throughout the rebanding process required the development of a precise sequence of steps so that infrastructure was not rebanded until all radios with the associated frequencies were able to be touched, whoever owned and operated them. Many Public Safety systems also required a second touch of their radios at the end of the process to remove “old” conventional mutual aid channels. Each of these steps was necessary, but collectively they required a substantial amount of time. While some percentage of 900 MHz Band systems may be of a size and complexity comparable to the largest 800 MHz networks, the great majority more closely resemble the 1-120 systems that were rebanded on a timely basis.

As important to 900 MHz incumbents, and as stated in the EWA/PDV Comments, fewer than a handful of the more than 2,000 rebanded 800 MHz incumbents have alleged that they did not receive comparable facilities on their replacement channels. It is believed that the single ongoing issue involves a municipality whose system was under-built and less able to reject interfering signals. In no instance were additional sites needed to achieve comparability, even though replacement channels sometimes were spaced closer both in the CBRs and in systems whose 1-120 channels were replaced with interleaved channels closely spaced to already authorized channels.

Contrary to the opinions of some who are less familiar with its details, 800 MHz rebanding is a success story. Interference from cellular to Public Safety has largely been resolved, and there is a process in place to address it if it occurs. Many licensees took advantage of the process to upgrade or replace aging systems, using the monies that otherwise would have been paid to reband their legacy facilities. Consumers were given another broadband option in the 1.9 GHz band. Operational disruption was kept to a minimum, and there were no unplanned system outages.

This is not to say that modernizing a band is a simple task or one that should be undertaken absent a compelling public interest in allowing the introduction of new technologies, technologies that many incumbents and other PE/CII entities have declared essential for their future uses. That is the case with the 900 MHz Band.

IV. THE RECORD OUTLINES A PATH FORWARD BASED ON THE TECHNICAL AND OPERATIONAL APPROACHES DESCRIBED ABOVE.

The record clearly reflects an urgent need for broadband spectrum on which systems can be designed to the particular, often demanding specifications of PE/CII users. Some PE/CII entities favor the PEBB approach as proposed and urge the FCC to move promptly to adopt it.[67] Other commenters work with PE/CII users in providing equipment and/or services and are aware of their need for build-to-suit broadband systems, or see the public interest in facilitating CII

[67] *See, e.g.*, Comments of UPS, Victory Propane, and WFEC.

broadband use for smart grid and other applications and/or maximizing spectrum utilization. They also endorse a PEBB allocation.[68] The first choice of other parties still would be a broadband allocation exclusively for utilities or perhaps for CII generally but, barring that, they are willing to consider the PEBB option, provided it satisfies certain conditions.[69] EWA/PDV appreciate the willingness of the latter companies to work cooperatively in an attempt to address both their narrowband PLMR and broadband needs.

For example, Duke Energy has argued in favor of an FCC set-aside of broadband spectrum below 1 GHz for electric utilities.[70] This position is based, at least in part, on its investigation of currently available commercial broadband options. It explained that it has considered, but rejected, the option of using (presumably leasing) spectrum from commercial cellular carriers:

> …accessing spectrum greater than 2 GHz, as is being offered by these commercial carriers, would severely restrict Duke Energy's ability to deploy a system-wide private broadband LTE system in a cost-effective manner;"[71] and Crucial to the evaluation of potentially developing a private broadband LTE system is the availability of broadband spectrum suitable for building out a *cost-effective* private LTE system. In order to be cost-effective, this potential LTE system must have access to broadband spectrum in the sub-one GHz range to minimize the number of LTE tower sites required to provide the necessary coverage, capacity, and reliability.[72]

While pressing for a utility-only allocation, Duke Energy also lays out a plan for realignment with the objective of deploying its own 900 MHz broadband network, should the Commission adopt the PEBB concept.[73] An essential element in that plan is that incumbents, or at least those

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[68] *See, e.g.*, Comments of Ericsson, Motorola Solutions, Inc., Texas A &M University Internet2 Technology, A Beep LLC, TeleWorld, Intercept, Assured Wireless, Puloli, Inc., dBSpectra, Inc., Comtronics Corporation, and General Dynamics Mission System.
[69] *See, e.g.*, Comments of Ad Hoc Refiners Group ("Ad Hoc Refiners"), Duke Energy, EEI, NextEra, The GridWise Alliance, UTC, and Westar.
[70] Duke Energy Comments at 1.
[71] *Id*. at 3.
[72] *Id.* at 3-4 (original emphasis).
[73] *Id*. at 7-8.

incumbents intending to deploy a broadband system, first be moved temporarily to channels compatible with their existing PLMR system while broadband spectrum is cleared for their use. Once their operations are migrated to a private LTE network, the temporary channels would become available for narrowband incumbent realignment. It suggests that this would offer a path to create a 5/5 megahertz private LTE network, an outcome that EWA/PDV agree could be achievable given Duke Energy's dominant spectrum position in its market. They would be pleased to work with Duke Energy in developing a plan consistent with that company's broadband objectives.

For the most part, the conditions proposed by other incumbents for developing a 900 MHz broadband path forward are conditions to which EWA/PDV already have committed and are typically included in band repurposings.[74] Those 900 MHz Band incumbents whose systems would need to be realigned to create the PEBB allocation would be compensated fully by the PEBB licensee for all reasonable costs incurred and would receive comparable facilities as that term is defined in Rule Section 90.699, proposed Rule Section 90.1409, or any modified version thereof adopted by the FCC. To be clear, incumbents would not be limited to replacement 900 MHz spectrum. As at 800 MHz, some incumbents might elect a solution that involves moving to other spectrum, migrating to newer technology, or executing an option agreement for later exercise, with consideration from the PEBB licensee that typically would have a correlation with the cost that would have been incurred to realign the existing system. All narrowband PLMR licensees also would be entitled to interference protection pursuant to whatever technical rules the FCC adopts.

[74] Some commenters include expansion capacity as one criterion for supporting a path forward. In reality, however, there has been no 900 MHz Band expansion capacity in major markets for many years, while the supply remains ample outside those areas. To the extent some narrowband incumbents elect to upgrade to more technically efficient systems, move to other bands, or abandon their 900 MHz systems entirely as a result of realignment, it is possible that additional channels will become available in the 2/2 megahertz allocation.

EEI states that a realignment decision by the FCC must include a detailed migration plan.[75] Incumbents, of course, need to know their replacement channels in advance so they can identify any issues with them and plan for their move. However, no such condition has ever been required in a spectrum rebanding or repurposing for good reason. As EWA/PDV have explained, it is not possible to develop a definitive plan without actual information about each system, information beyond what appears in the FCC's Universal Licensing System database. Replacement frequency plans also will be affected by the number of incumbents that choose to contribute their spectrum to the PEBB rather than be realigned, as well as those that choose to move to another band or take the cash equivalent of their realignment costs and address their communications needs as they wish. Depending on the Commission's decisions regarding the 800 MHz Expansion and Guard Bands, a matter currently pending before the FCC,[76] some licensees may elect to be moved to that band rather than remain at 900 MHz. Others could select full-power 12.5 kHz 800 MHz "interstitial" channels that are expected to be authorized in the near-term future.[77] Indeed, in some parts of the country, it is possible that 800 MHz interleaved and/or "Sprint-vacated" channels could be available for certain incumbents. Thus, while no incumbent can be required to realign its system without having full information about its replacement spectrum, and a right to challenge the proposed channels for good cause, it is not possible to provide such a plan in advance.

A few parties suggest that the realignment process be entirely voluntary.[78] PDV has successfully pursued 900 MHz Band spectrum acquisitions and channel swaps since the original

[75] EEI Comments at 18.

[76] *See* Amendment of Part 90 of the Commission's Rules to Improve Access to Private Land Mobile Radio Spectrum, WP Docket No. 16-261, *Notice of Proposed Rulemaking*, 31 FCC Rcd 9431 (2016).

[77] *See* Creation of Interstitial 12.5 kHz Channels in the 800 MHz Band Between 809-817/854-862 MHz, WP Docket No. 15-32, *Notice of Proposed Rulemaking*, 30 FCC Rcd 1663 (2015).

[78] *See, e.g.*, Ad Hoc Refiners, API, and NextEra.

PEBB proposal was submitted.[79] It will continue to do so whenever feasible. But no band with more than a handful of licensees has ever been cleared successfully on a voluntary basis. The reality is that there always will be a holdout or holdouts who either refuse to relocate because they will not tolerate any disruption of their operations, however minimal and manageable, or who make unreasonable economic or technical demands.

The rules proposed by EWA/PDV, including proposed Rule Section 90.1409, are based on a process that has worked effectively in other bands.[80] EWA/PDV have suggested a one-year voluntary negotiation period to be followed by a one-year period of mandatory negotiations. By comparison, some relocation provisions provided for no voluntary period at all, while others included a mandatory right, not simply to negotiate with, but to relocate incumbents.[81] EWA/PDV are willing to consider reasonable variations on their recommended approach, but, as the FCC recognized in the NOI, purely voluntary negotiations will not achieve the objective of creating a PEBB allocation for the deployment of PE/CII broadband systems.[82]

V. REALIGNING THE 900 MHz BAND WILL ALLOW A MORE ROBUST USE OF THIS ALLOCATION AND ADVANCE OTHER KEY FCC AND PE/CII OBJECTIVES.

The EWA/PDV Comments identified public policy benefits that would flow from the proposed realignment of the 900 MHz Band and the creation of a PEBB allocation:

- Ensuring the evolution of less than fully utilized spectrum, while protecting incumbents;[83]

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[79] *See, e.g.,* n. 49.
[80] *See* 47 C.F.R. §§ 90.677 and 90.699.
[81] *See* 47 C.F.R. §§ 101.69 and 101.91.
[82] NOI at ¶ 37.
[83] In their Comments, the National Association of Manufacturers and MRFAC, Inc. ("NAM/MRFAC") state there has been "steady growth" in 900 MHz licensing from 2008 through 2016, with anywhere between 2,000 and 3,300 license grants per year. Comments of NAM/MRFAC at 3-4. Those figures may be correct, but it is not clear what authorizations NAM/MRFAC included in the license grant category, which could include renewals and various types of changes that do not signify growth in use of the 900 MHz Band. EWA found a nationwide average of only 118

- Stimulating private investment in infrastructure;
- Accelerating deployment of innovative and cyber-secure broadband technologies;
- Acting in a timely manner on items with benefit to the public good;
- Promoting rural broadband deployment;
- Generating new and significant job growth;
- Injecting new competition in the delivery of broadband; and
- Removing regulatory impediments.

In addition to those important purposes, a number of commenting parties have identified specific operational improvements they expect to achieve through access to a build-to-suit broadband option.

For example, UPS noted that for purposes of mission-critical communications at its larger facilities, "no existing LTE service provider to date has been willing or able to guarantee contractually the service levels we require."[84] It also expressed an interest in allowing vehicles equipped to operate on its private trunked radio facilities to roam onto a wide-area commercial broadband network and believes that "the PEBB concept offers a great opportunity for the development of dual-mode devices and related services providing exactly this kind of capability."[85]

API, representing more than 600 companies engaged in activities related to the petroleum and natural gas industries, explained that its members operate "critical systems…that cannot be trusted to common carrier infrastructure not controlled by the end user, and worse, not optimized around the CII mission, and, even worse, not appropriately secure from cyber threats."[86] It specifically identified the IoT revolution and the great interest among its members in the "high performing push-to-talk services delivered over IP/LTE platforms."[87]

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license grants for new systems or modifications to add sites or frequencies for the nine-year period from 2008 through 2016. By comparison, applications for new or expanded VHF and UHF systems during that same period averaged in the tens of thousands.

[84] UPS Comments at 4.

[85] *Id*. at 5.

[86] API Comments at 4.

[87] *Id.* at 3.

It also observed the following:

> One of the reasons it makes sense to consider the 900 MH band as part of a potential rule change is that the band has evolved differently over time than, for example, the 800 MHz band. This has resulted in more white space opportunity in certain areas at 900 MHz than in other bands. Some of the reasons for this includes the absence of public safety licensees, and the corresponding lessor investment which has somewhat stunted product availability at 900 MHz, not to mention years of a band freeze during the 800 MHz re-banding. These circumstances have contributed to the current opportunity to look at doing something novel with the 900 MHz band.[88]

The Comments filed by WFEC are a blueprint for growing PE/CII broadband needs. As it explained:

> The systems used by utilities to address existing and future regulatory requirements in their efforts to increase availability and reliability will require telecommunications and networks that support data planes as well as management planes. The networks of the future will be unified and will carry data related to control, telemetry, metering, voice, video, network and security management, and cyber security monitoring…Reliability is the driving force behind the need for broadband networks dedicated to critical infrastructure operators, especially utilities.[89]

As a company operating in rural Oklahoma and in rural parts of New Mexico, Kansas and Texas, WFEC faces additional challenges:

> …we do not enjoy the same access to telecommunications infrastructure and much of our service territory is underserved or unserved by common carriers and non-regulated telecommunications companies. For WFEC to achieve a broadband network to all required resources within our service territory we would have to privately build a telecommunications infrastructure comprised of licensed fixed microwave and fiber optics…A broadband radio frequency network with favorable propagation characteristics such that 900 Mhz spectrum has, is a highly desirable option for utilities.[90]

Ericsson also described the use cases to which CII entities, in particular, will be able to put broadband technology:

> LTE will provide more functionality than critical infrastructure operators experience on their communications networks today, which typically support only

[88] *Id*. at 8.
[89] WFEC Comments at 2.
[90] *Id*. at 2-3.

> narrowband data or voice communications. LTE will support a multitude of services on the same network platform, such as broadband data, voice services, text messaging, push to talk, and the capability to handle communications from massive numbers of small IoT devices, such as sensors. LTE network functionality can even be extended to non-LTE radio access networks such as Wi-Fi and short-range radio technologies, which enables consistent device management and seamless mobility across multiple radio technologies.
>
> Finally, LTE will address the improved communications necessary to make many industrial IoT cases viable and it can provide the necessary levels of security that critical infrastructure entities need. LTE networks have well-defined performance indicators for accessibility, predictability and reliability, making LTE an excellent choice for critical communications, which the Commission recognized in adopting LTE to be the common air interface for FirstNet.[91]

The 900 MHz Band realignment proposal represents the only near-term means of addressing this need for PE/CII broadband access that the record confirms is real and is now.

VI. CONCLUSION

The path forward to a 900 MHz PEBB allocation is not without challenges. But while it may not be easy, the record confirms that many PE/CII entities consider it essential for the future of industries whose day-to-day and emergency operations are the infrastructure without which this nation could not function. EWA/PDV urge the Commission to adopt a Notice of Proposed Rulemaking consistent with the positions herein at the earliest opportunity.

[91] Ericsson Comments at 4.

ATTACHMENT 1

EXHIBIT A

Technical Response to Sensus Comments

Robert Burkhardt, BSE
Director, Strategy & Government Affairs, PDV Wireless

Arif Ansari, Ph.D
Advanced Mobile Technologies (AMT), Advisor to PDV Wireless

Section I

Rebuttal of
Real Wireless Report:
Co-existence Between
Proposed PEBB LTE systems
and
Existing Sensus FlexNet™ systems
in the
900MHz Band

Summary of PDV Rebuttal Comments

- PDV has reviewed the Sensus/Real Wireless (S/RW) comments regarding PDV's co-existence modeling and analysis
- S/RW agree with PDV's model construct and analysis methodology but disagree with the parameter values assumed by PDV
- PDV submits that for reliable communication systems that require robust links, operating at an effective noise floor equal to thermal noise floor (-170 dBm/Hz) is unrealistic
- PDV believes that Sensus, in its designs, routinely deploys systems higher than the stated -170dBm/Hz effective noise floor and leverages other techniques (space, time, and cell-overlap diversity) to operate at or about a -160 dBm/Hz effective noise floor to accommodate interference above thermal noise[1]
- In these rebuttal comments, PDV justifies the parameters used in its methodology and shows that its model reflects no interference to Sensus systems deploying links with fade margins to meet their QoS/SLAs
- Finally, PDV notes that the test conditions (e.g., measurement resolution bandwidth) for specifying emission limits have not been selected by PDV, as asserted by S/RW, but rather exist in the rules and guidelines that the FCC OET has stipulated to measure emissions[2]

1: PDV calculated the Sensus Effective Noise Floor using methods outlined in the Sensus White Paper 300: Developing a Framework of System Performance Prior to Purchasing and Deploying Assets

2: FCC OET - Laboratory Division MEASUREMENT GUIDANCE FOR CERTIFICATION OF LICENSED DIGITAL TRANSMITTERS / 10.17.14

Introduction and Scope

- S/RW identified 10 parameters in the uplink (UL) and 6 parameters in the downlink (DL) that they stated have been miscalculated in the PDV model and analysis.
- Three of the issue cases were the same for both UL/DL.

Uplink

1. UE Antenna Gain and Body Loss	
2. LTE UE power backoff	
3. Effect of UE power control on OOBE	
4. NB-BTS Cable Loss	
5. No. of simultaneously transmitting PDV devices	
6. Environmental noise margin	Duplicate in DL
7. Base Station antenna radiation pattern and gain	
8. Base Station antenna height	
9. Propagation model	Duplicate in DL
10. Maximum attenuation due to antenna pattern	Duplicate in DL

Introduction and Scope

- Downlink
  1. eNodeB antenna gain and losses
  2. Environmental noise margin — Duplicate in UL
  3. FlexNet Endpoint antenna gain and cable loss
  4. Base Station antenna height
  5. Propagation model — Duplicate in UL
  6. Maximum attenuation due to antenna pattern — Duplicate in UL

- In the following we:
  - provide an explanation of and justification for the contested values
  - demonstrate the validity of the parameters

- Note: eNode B implies LTE BTS and NB-BTS implies Narrowband BTS

UL 1 UE Antenna Gain and Body Loss

- S/RW Claim - PDV has over-estimated the value for body loss:
  - PDV used the FCC accepted UE antenna gain and head/body loss for a composite gain of -10 dBi [1]
  - Head/body loss is an accepted line item in commercial link budgets as well as in interference and co-existence analysis
  - ETSI/3GPP have regularly used head/body loss in their analysis[2]
  - Note that no other losses are assumed such as vehicle and in-building penetration, hence PDV has been conservative in loss estimation

- [1]FCC 12-151 Para 142
  [2]3GPP TR 36.844 V13.2.0 (2015-03); ETSI TR 143 030 V9.0.0 (2010-02); 3GPP TR 36.824 V11.0.0 (2012-06); 3GPP TS 45.050 v. 8.1.0

UL 2 LTE UE Power Backoff

- S/RW Claim - LTE UE Power Backoff is an "irrelevant statistic":
  - UE power backoff from the maximum will result in lower power transmissions and will directly reduce interference potential in the uplink
  - PDV uses a finding by the CSMAC simulations that 98.3% of UEs in an LTE cell by design backed-off 9 dB or more. This is designed to conserve battery power and promote timely handoff. Advanced techniques such as CoMP and eICIC are likely to maintain or even further reduce UE transmit powers
  - PDV models assume a full buffer and hence a constantly transmitting UE with no duty cycle

UL 3 Effect of UE Power Control on OOBE

- S/RW Claim - No reference is cited for relationship between reduction in fundamental power and OOBE:
  - 1 dB reduction in OOBE for 1 dB reduction in fundamental power has been consistently recognized by standards bodies and industry experts [1,2]
  - Regarding OOBE caused by spurious emissions or linearized PAs, it is expected that reduction in OOBE would be more than 1 dB for 1 dB reduction in fundamental power, as these are dominated by transmit intermodulation (IM) components with non-linear power relationship to the fundamental power

[1] CEPT ECC Report: Lab measurement results of 800 MHz band LTE UE unwanted emissions, Doc. SE21(13)29
[2] Nokia Corporation, "LTE band 28 UE emissions to DTT frequencies"

UL 4 NB-BTS Cable Loss

- S/RW Claim - Cable loss is a “UE feeder loss”:
  - BTS cable loss is the loss attributed to the RF cable connecting the antenna to the transceiver in the BTS and therefore is a valid loss contribution
  - Cable loss applies to both the receive and the transmit path in the BTS, and hence figures in both models: PEBB-UE to NB-BTS and PEBB-BTS to NB-UE
  - PDV has assumed 4 dB value for this parameter for both Sensus and PEBB (LTE) BTS
  - These are standard values, taller sites will only increase this cable loss

UL 5 No. of Simultaneously Transmitting UEs

- S/RW Claim - PDV did not include the effect of multiple UEs active and simultaneously transmitting in eNodeB sector:
  - A sector can handle many active UEs
  - For a 3 MHz channel, number of UEs transmitting per sub-frame is 1, as calculated below
  - Only the UEs allocated within one TTI (sub-frame) are considered to be transmitting simultaneously
  - The typical number of Resource Block allocations within a TTI, and hence number of UEs per TTI, depends on cell load
  - 3GPP TR 36.942 (Section 12.1.2) defines a framework to calculate typical number of UEs per TTI per sector and corroborates PDV's calculation of single UE transmitting per TTI in a 3MHz channel

UL 6 and DL 2 Environmental Noise Margin

S/RW Claim - Low confidence in the PDV-attributed level of environmental noise:

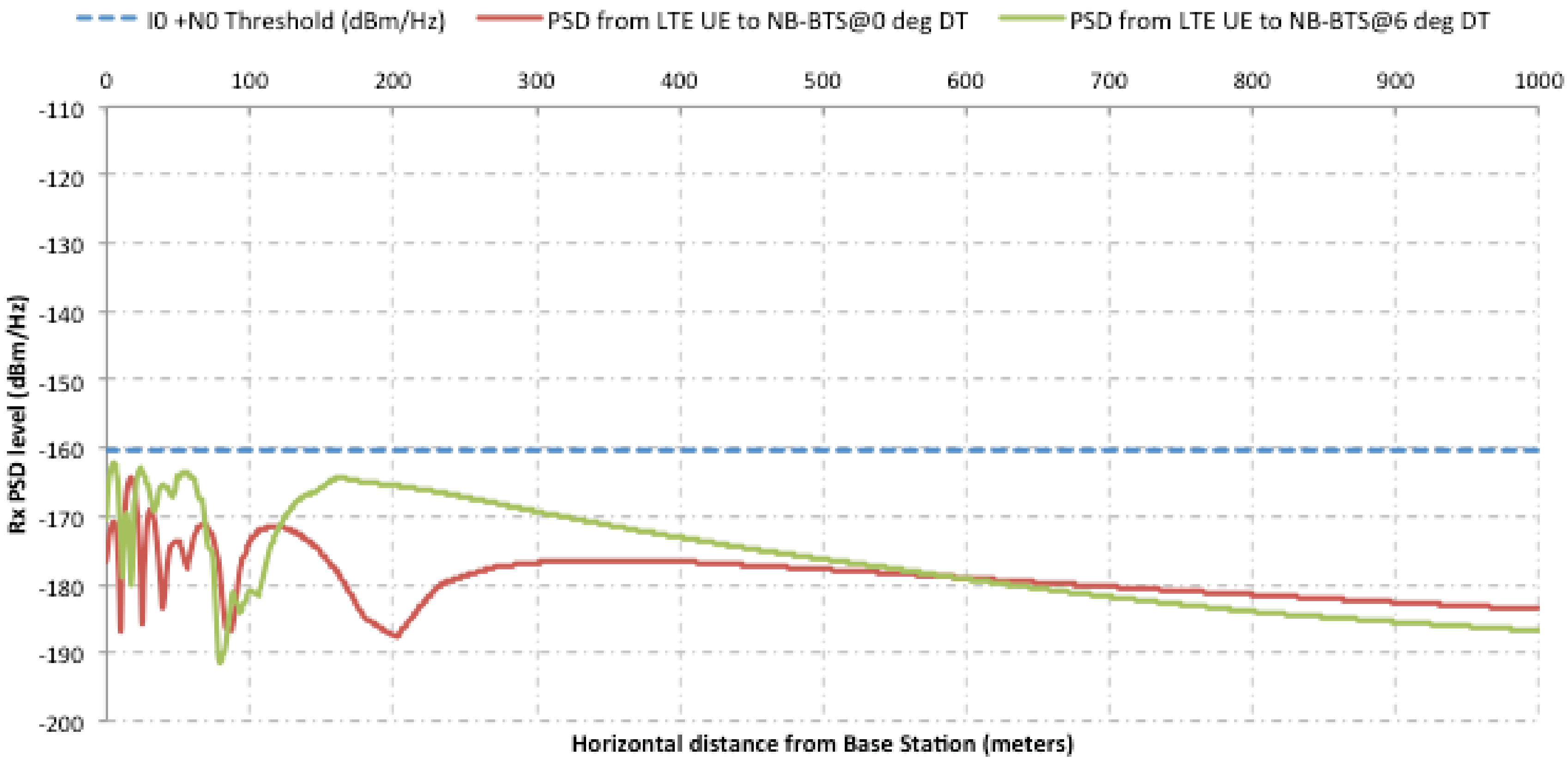
- S/RW has misinterpreted the dearth of measurement studies *in the specific band* to imply a low confidence in the stated environmental noise measure
- There is no evidence that Sensus' empirical noise floor measurements were obtained using standardized methodology and instruments and acceptable collection procedures for environmental noise characterization as defined by such standard bodies as IEEE, URSI, CEPT, and WMO etc.
- There is ample best-practices evidence in the industry of accounting for environmental noise ***by incorporating fade margins***, typically 10-12 dB, in the design of reliable wireless communication links
- Sensus utilizes a number of enhancements in their link budget to overcome fading and noise above the thermal noise, but has not shared their actual link budget calculations to allow PDV to assess the interference mitigated in the Sensus RF design
- Based on PDV's information and belief, Sensus designs its systems to overcome the interference noise margin

UL 7 Base Station Antenna Pattern and Gain

- S/RW Claim - Model used the wrong antenna pattern for NB-BTS:
  - PDV used an antenna from a list of commonly used antennas provided by Sensus with a downtilt of 0 degree: BCD-87010-EDIN-1-25
  - It should be noted that only the vertical antenna pattern is relevant to this exercise, which has been obtained from the manufacturer's website
  - It should be further noted that if only the vertical pattern is changed keeping the maximum gain the same, the peak interference points will remain unchanged; only the low points will be slightly elevated due to an incorrect pattern
  - Finally, using the antenna preferred by S/RW[1] the peak interference levels remains approximately the same, only this peak effect is observed at larger distances from the base station

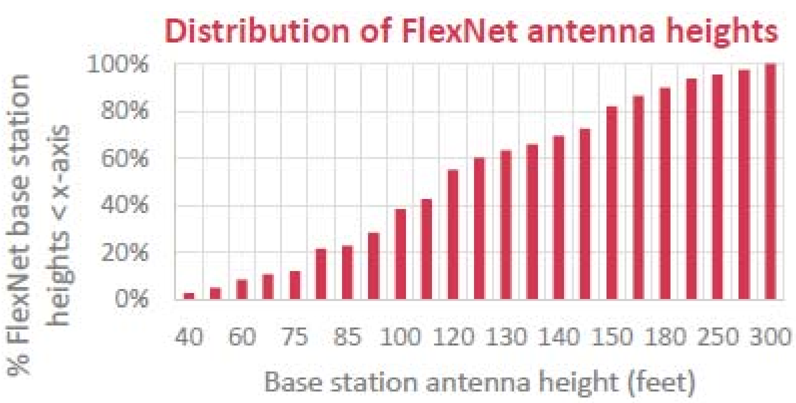
[1] BCD-87010-6-25 (6 degrees downtilt) which is the same manufacturer/model antenna that we have used except for the downtilt

UL 7 - Downtilt Comparison
LTE UE OOBE at NB-BTS - 0 and 6 deg Downtilt



UL 8 Base Station Antenna Height

- S/RW Claim - Model overestimated Sensus system antenna heights:
  - S/RW analysis included the bar chart (below) but used an almost worst case of 60’ for its analysis
  - Consistent with FCC practice, PDV has selected a closer to average 148’ for purposes of its analysis; neither the best case nor the worst case used by Sensus



UL 9 and DL 5 Propagation Model

- S/RW Claim – WI-LOS model is not a valid path loss model for this analysis:
  - S/RW did not clearly propose an alternative “acceptable” model
  - The WI-LOS model is the appropriate model, as opposed to either a WI-NLOS or a Free-Space model
  - WI-NLOS is conservative in estimating interference
  - Free-Space over-estimates interference by ignoring ground/building clutter
  - WI-LOS reverts to a free space model from 0 to 20m from the base station
  - If the alternative suggestion is to use the Free Space model even beyond 20m, PDV does not agree as ground-clutter plays a role in propagation except in extreme wide-open rural spaces
  - Consistent with FCC practice, PDV has used probabilistic objectives rather than extreme conditions

UL 10 and DL 6
Attenuation Due to Antenna Pattern

- S/RW Claim - In real-world deployments, antenna patterns see a reduction of nulls:

  - If only the vertical pattern is changed and the maximum gain remains the same, the peak interference points will remain unchanged; only the low points will be slightly elevated due to the effect described by S/RW

  - The impact of this attribute on interference modeling is inconsequential

DL 1 eNodeB Antenna Pattern

- S/RW Claim - Model underestimated vertical beam width for eNode Bs antennas:

  - PDV has assumed an antenna pattern with relevant parameters, including gain, vertical beam width, downtilt, and other attributes that are applicable to LTE deployment in 900 MHz band

  - The antenna proposed by RW for use in modeling for LTE is a 1.1 dBd gain omni antenna and though applicable for narrowband system is not applicable to cellular LTE base station deployments

  - A partial list of applicable LTE antennas from the same manufacturer, Amphenol, with more relevant vertical beam widths of 7-10 degrees and variable tilts as assumed: Model No.: 5880200, 6880200, 5888100, 6876300, 6878300, 6888300…….

  - Finally, it is not clear how assuming a different vertical beam width would result in 18 dB worse interference if RW agrees with the maximum gain of the antenna

DL 3. FlexNet Endpoint Antenna Gain/Cable Loss

- S/RW Claim – Model underestimate Sensus' endpoint antenna gain:
  - Sensus has not shared with PDV their system link budget parameters that would include the specifications of endpoint antenna gains and connector losses
  - PDV has assumed a -1 dBd or +1.15 dBi antenna gain and a 1.9 dB cable/connector loss based on specifications of endpoints in the band for similar applications, resulting in a total endpoint loss of -0.75 dB
  - PDV believes these assumptions are reasonable given the size and function of Sensus' endpoint

DL 4 PDV eNodeB Antenna Height

- S/RW Claim – Model used higher than average eNode B antenna heights:
  - PDV's intent is to model a median environment rather than an absolute worst/best case scenario which may be statistically insignificant, following FCC's guidelines on interference thresholds
  - Under these guidelines, an LTE eNodeB height assumption of 30m is reasonable, given the typical LTE deployments currently being rolled out and what it assumes will be the average antenna height of its deployed eNodeB base station sites

Real Wireless UL Issues - PDV Rebuttal

Parameter	Sensus RW Issue	PDV Comment
1. UE antenna gain and body loss	Body loss does not always protect from interference	Body loss very often reduces interference
2. LTE UE power backoff	LTE UE power backoff is an irrelevant statistic	98% of the time, LTE UE transmits less than 14 dB
3. Effect of UE power control on OOBE	OOBE is not reduced dB-for-dB with fundamental power	Relevant simulations show at least dB-for-dB reduction
4. NB-BTS cable loss	UE cable loss seems to be mistakenly included	This is BTS cable loss and is relevant to interference
5. No. of simultaneously transmitting PDV devices	Assumed only 1 UE active	Assumed only 1 UE transmitting per sub-frame
6. Environmental noise margin	No measurements to support environmental noise	Sufficient evidence from best practices for design of reliable links
7. Base Station antenna radiation pattern and gain	Used an unrealistic antenna pattern	Used an antenna type provided by Sensus
8. Base Station antenna height	Overestimated antenna height	Used median antenna height rather than low end
9. Propagation model	WI-LOS not applicable	WI_LOS with Free-Space in first 20 m, is applicable
10. Maximum attenuation due to antenna pattern	No consideration for null impacts	Null-filling does not affect the worst case interference scenario

Real Wireless DL Issues - PDV Rebuttal

Parameter	Sensus RW Issue	PDV Comment
1. eNodeB antenna pattern and gain	Vertical beam width has been underestimated	Vertical beam width of 7-10 degrees is standard for LTE deployments
2. Environmental noise margin	No measurements to support environmental noise	Sufficient evidence from best practices for design of reliable links
3. Flexnet endpoint antenna gain and cable loss	Antenna gain underestimated and cable loss overestimated	Composite antenna gain+cable loss of -0.75 dB is reasonable
4. Base Station antenna height	Underestimated LTE BTS antenna height	Antenna height of 30m is certainly median and likely represents a substantial percentage of facilities
5. Propagation model	WI-LOS not applicable	WI_LOS with Free-Space in first 20 m, is applicable
6. Maximum attenuation due to antenna pattern	No consideration for null impacts	Null-filling does not affect the worst case interference scenario

Specified Emission Limits: ERP or EiRP?

- S/RW questioned whether emission power should be specified as ERP or EiRP

  - Neither. Emission limits or masks have always been defined at the transmitter PA power

  - In PDV's model, the certification process is emulated, i.e. antenna gain and cable losses are applied to the OOBE at the transmitter PA (-55 dBW/30 kHz = -70 dBm/Hz)

  - Using an antenna of 16 dBi gain and 4 dB cable loss, this results in a OOB EiRP of -58 dBm/Hz

ANNEX I Reply Comments

LTE user equipment out of band emission measurements

- S/RW Claim – LTE OET UE device certification analysis by RW concluded that the LTE device produced levels of OOBE that would be harmful to the Sensus Flexnet system performance
  - RW analyzed the wrong band class of device
  - Instead of BC26 which uses a 55+10log(P) mask, RW analyzed CMRS / Part 27 compliant devices which use a 48+10log(P) mask and is therefore less stringent

Section II

S/RW Exhibits

S/RW Exhibit 2: FlexNet Base Station Noise Floor

- PDV questions the measurements submitted in S/RW Exhibit 2
  - It is unclear if Sensus is referring to "N" (kt+NF or thermal noise), the effective noise floor (Noise +Interference) or the FlexNet receiver instrument calibrated noise floor.
  - The graph Exhibit 2 - Page 3 is confusing and misleading as two -170dBm references are shown: PDV is unclear as to what the slide was meant to portray
  - PDV reiterates its position that there is ample evidence that there is a significant noise rise above thermal due to environmental interference
  - Noise floor research of such standard bodies as IEEE, URSI, CEPT, WMO etc. using standardized methodology and instruments and acceptable collection procedures for environmental noise characterization have corroborated this position

Exhibit 3 & 4 : Interference Illustrations

- PDV believes that Exhibits 3 and 4 provide reinforcing examples of the merits of interference resolution procedures

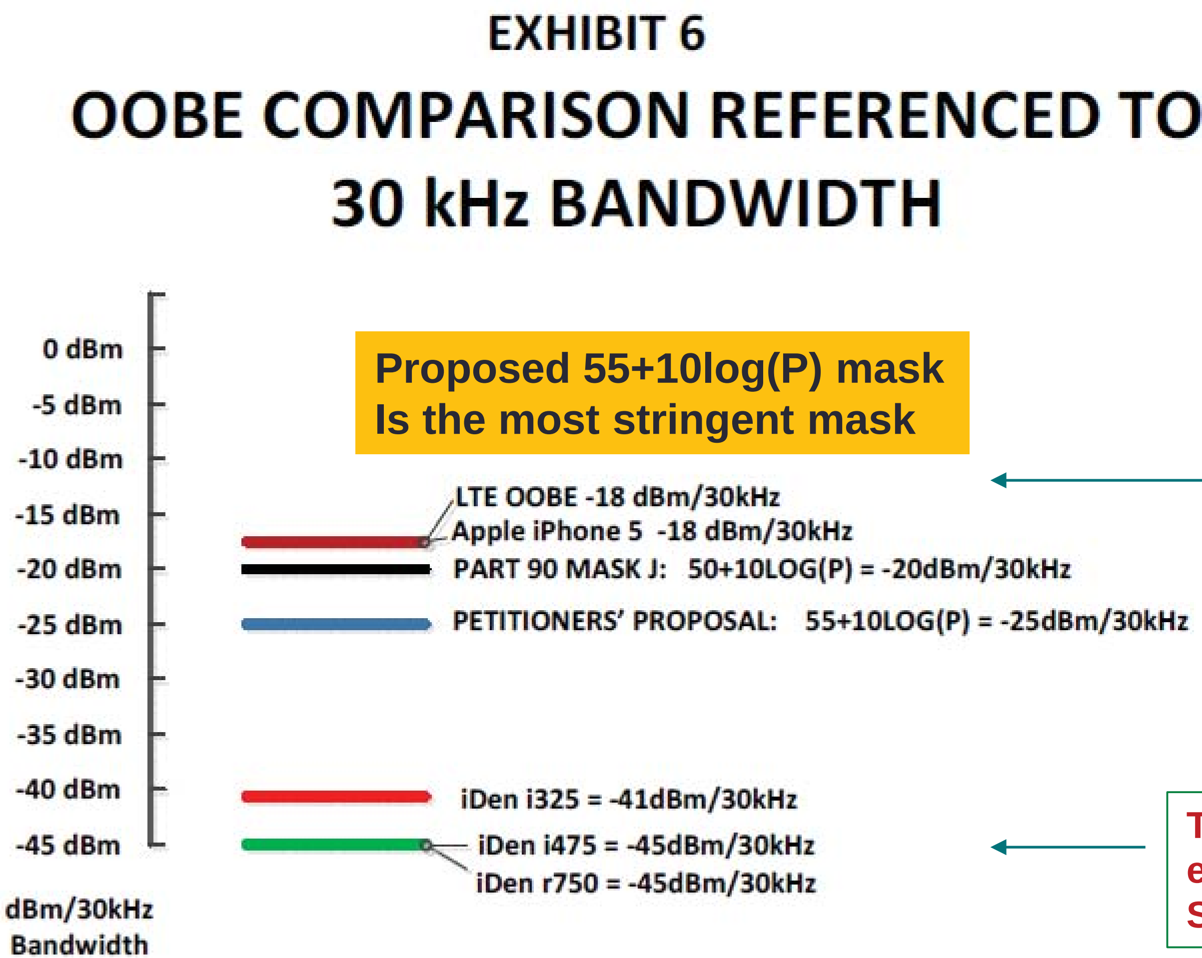
- However, without reference values of the X and Y axis on both charts, it is difficult to relate this occurrence to the results of the PDV interference analysis

- These exhibits highlight the issue of identification of the interfering parties into the Flexnet System as Sensus is operating between 900MHz SMR/B/ILT and Part 15 operators

Exhibit 5 : Incumbent SMR

- In Exhibit 5, S/RW contends that Nextel required their device suppliers to produce UEs that exceeded the mandated emission mask specifications
- While Sensus offers no support for this supposition, the noise floor that existed when iDEN was a primary user in the band is not relevant; what is relevant is the emission mask adopted by the FCC
- PDV's proposed emission mask is designed to provide Sensus with the interference protection to which it is entitled under the rules applicable to the 900 MHz band in its current narrowband configuration

Exhibit 6 : OOBE Illustration



Proposed 55+10log(P) mask Is the most stringent mask

This reflects the Emission mask specifications

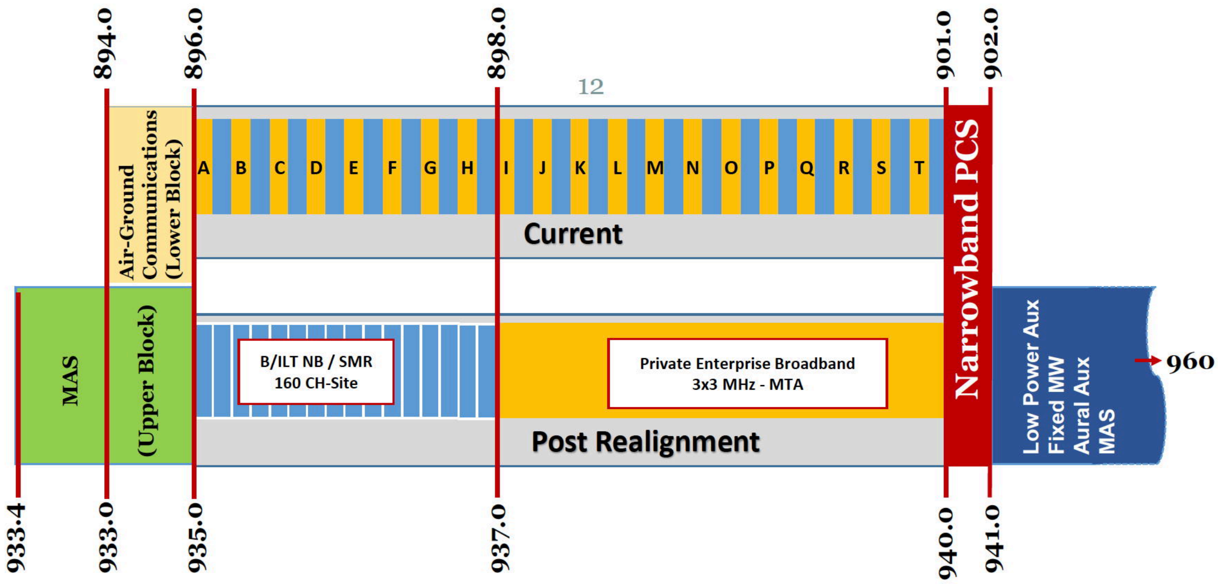
Apples to Oranges Comparison

This reflects the measured emissions as interpreted by Sensus

PDV is unclear as to the intent of this exhibit

ATTACHMENT 2

Comparison of Downlink Out-of-Band Emissions (OOBE) Between a Notional LTE Network and a Full or Partially Built-Out Part 90 Narrowband System



November 1, 2017

Prepared for:

pdvWireless

3 Garret Mountain Plaza, Suite 401
Woodland Park, NJ 07424

PERICLE COMMUNICATIONS COMPANY

Jay M. Jacobsmeyer, P.E.
7222 Commerce Center Drive, Suite 180
Colorado Springs, CO 80919
(303) 759-5111
jacobsmeyer@pericle.com

Comparison of Downlink Out-of-Band Emissions (OOBE) Between a Notional LTE Network and a Full or Partially Built-Out Part 90 Narrowband System

November 1, 2017

1.0 Background. Some commenters on the WT Docket 17-200 have expressed concern that downlink OOBE from a new 3 MHz LTE radio carrier operating between 937 and 940 MHz will create harmful interference to either Part 90 incumbents operating in the 935-937 MHz sub band or Narrowband PCS incumbents operating in the 940-941 MHz band, interference which some incumbents claim does not exist today. But comparison between the prospective LTE carrier and the artificially quiet conditions existing today in the band is not valid in the long term nor is such a quiet state guaranteed by the FCC. Rather than compare to the interference environment of today, one should compare to a fully built-out 900 MHz band because such a state is the logical best use of the band in the absence of a rule change to allow broadband use. Accordingly, this study computes the *C/(I+N)* for two cases and compares the difference in potentially affected area for both cases:

- Case 1 is identical to the Pericle LTE white paper case [1] and based on an emission mask limit of 55+10log(*P*) (measured in 30 kHz) at the 3 MHz channel edge for three markets: San Antonio, Orlando and San Diego. This emission limit is equivalent to -25 dBm.

- Case 2 is a prospective fully built-out network with three tall sites assuming protection based on the § 90.210 Mask I with an OOBE limit of 43+10log(*P*), 12 dB greater than the LTE case, for the same three markets. This emission limit is equivalent to -13 dBm.

At a high level, the LTE network operates from more sites than typical Part 90 systems (6 or 7 versus 3) and operates from lower antenna height (30 meters versus 64.9 meters), but the emission mask is 12 dB lower. On the other hand, the narrowband Part 90 network(s) operate with many more carriers (there are 399 channels in the band). Also, the emission mask proposed by PDV requires emissions 12 dB lower for the LTE carrier as compared to the Part 90 transmission.

This modeling study weights each analysis factor in accordance with real-world conditions to quantify the potential interference in each case, using the three markets as case studies.

2.0 Assumptions. The following assumptions are used:

LTE carrier emission mask limit = 55 + 10log(*P*) measured in 30 kHz
Other LTE network assumptions, including propagation model = per white paper [1]

Part 90 narrowband (12.5 kHz) emission mask limit = 43 + 10log(*P*) in 30 kHz[1]
Number of narrowband sites = 3
Active transmitters per site = 50 (150 total in the market out of 399 available channels in the band)
Narrowband antenna height = 64.9 meters AGL (average height of incumbents in the markets)
Minimum required $C/(I+N)$ = 17 dB (from § 90.672).

Note that there are 399 12.5 kHz-wide channels in the 935-940 MHz band. We are assuming 50 channels per site (e.g., 16-17 channels per sector for a sectorized system) as a simplified model of *all* active transmitters in the market. We believe this assumption is conservative, even accounting for trunking inefficiencies, because these 150 total channels account for less than 38% of the available channels in the market.

3.0 Results. In addition to analyzing the effect of 50 active transmitters per site, we also computed other cases to determine the number of active transmitters required to create roughly the same downlink interference impact as the single LTE carrier (from the white paper [1]). Results are shown in Table 1. We see from Table 1 that a fully built-out Part 90 narrowband system creates an order of magnitude (factor of 10) or more interference in terms of area affected than an LTE system. Furthermore, the breakeven point with the LTE network in terms of potential area affected is much lower than the fully built-out assumption of 50 channels per site. It is between 3 and 8 channels per site, equivalent to a very lightly loaded network. In other words, a network well less than a fully built-out state will create greater downlink OOBE interference than the prospective LTE network.

Table 1 - C/(I+N) Less Than 17 dB Due to Downlink OOBE

		LTE Carrier (white paper)	Active TX for Part 90 Mask I Equivalent (Breakeven)	Fully Built-Out Part 90 Network (50 TX/Site)
Market	**Incumbent**	**Area Affected**	**Number of Transmitters**	**Area Affected**
San Antonio, TX	LCRA	0.65%	5	5.6%
Orlando, FL	Duke Energy	0.041%	8	0.71%
San Diego, CA	SDG&E	0.11%	3	3.3%

Plots of $C/(I+N)$ for the LTE case and the fully built-out narrowband case are found in Appendix A. A list of Part 90 900 MHz incumbent licensees in each market is found in Appendix B. Note from Appendix B that there are a significant number of emitters already operating in each market, each creating potential downlink OOBE interference even today.

[1] We are assuming a minimally compliant system in each case with the emission mask limit applying to the channel edge for the LTE radio carrier and at 15 kHz from channel center for the narrowband radio carrier.

4.0 Uplink OOBE. We expect the uplink conclusions to be similar. One additional factor in LTE's favor as compared to the Part 90 narrowband system is that the LTE system uses power control in the handsets with at least a 9 dB back off over 98% of the time (urban/suburban) [2] while the narrowband user handset typically operates at full power whenever keyed. Because there is an equivalent reduction in OOBE directly proportional (in dB) to the power back-off [3], in most cases the OOBE from an LTE handset will be no worse and in many cases less than that from a Part 90 handset.

5.0 Conclusion. A fully built-out narrowband network is the only valid state for incumbents to compare to because it is the economically best use of the band in the absence of a broadband allocation. When we compare the prospective LTE network to a fully built-out narrowband system (or systems) we see that the narrowband system creates more downlink out-of-band emissions interference than the LTE system by a wide margin. But even a lightly-loaded network (well less than a full build out) creates as much interference as the LTE network. Thus, we can conclude that the LTE network is likely to create *less* interference than the next best alternative, not more.

This conclusion holds even after the band is reconfigured. Although Part 90 narrowband systems will occupy a smaller portion of the band, the rules would continue to allow full loading of all available channels. And as shown here, the out-of-band emissions from the LTE network would be less than that created by only a handful of Part 90 transmitters operating in that same spectrum.

6.0 References

[1] J. M. Jacobsmeyer, "Technical Impacts of a 900 MHz Private Enterprise Broadband Allocation," September 29, 2017, submitted comments on WT 17-200.

[2] Commerce Spectrum Management Advisory Committee (CSMAC) Final Report: Working Group 1 – 1695-1710 MHz Meteorological-Satellite, Appendix 3: Baseline LTE Uplink Characteristics, January 22, 2013.

[3] 3GPP TSG-RAN4 #59AH, R4-113745, B26 Uplink LTE UE to PS BS co-existence, Bucharest, Romania, 27th June to 1st July, 2011.

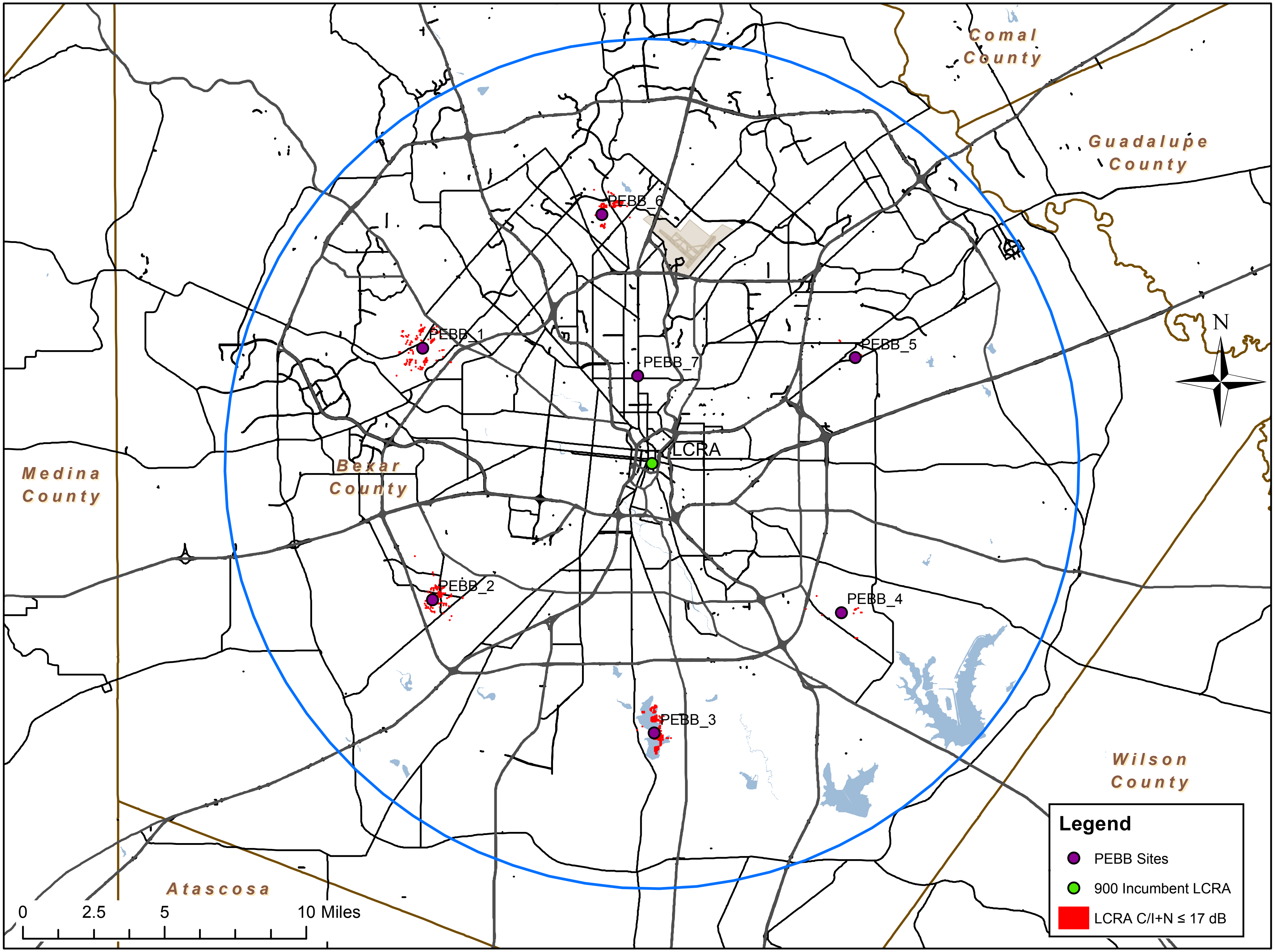
Appendices:

Appendix A - Plots of $C/(I+N) \leq 17$ dB in each market for each emission mask case (3 markets, 6 plots total). Note that incumbent sites other than victim sites not shown for clarity of presentation.

Appendix B - List of incumbent 900 MHz licensees within 15 miles of city center for each of three markets.

Appendix A - Downlink OOBE Interference Plots for Two Cases in Three Markets

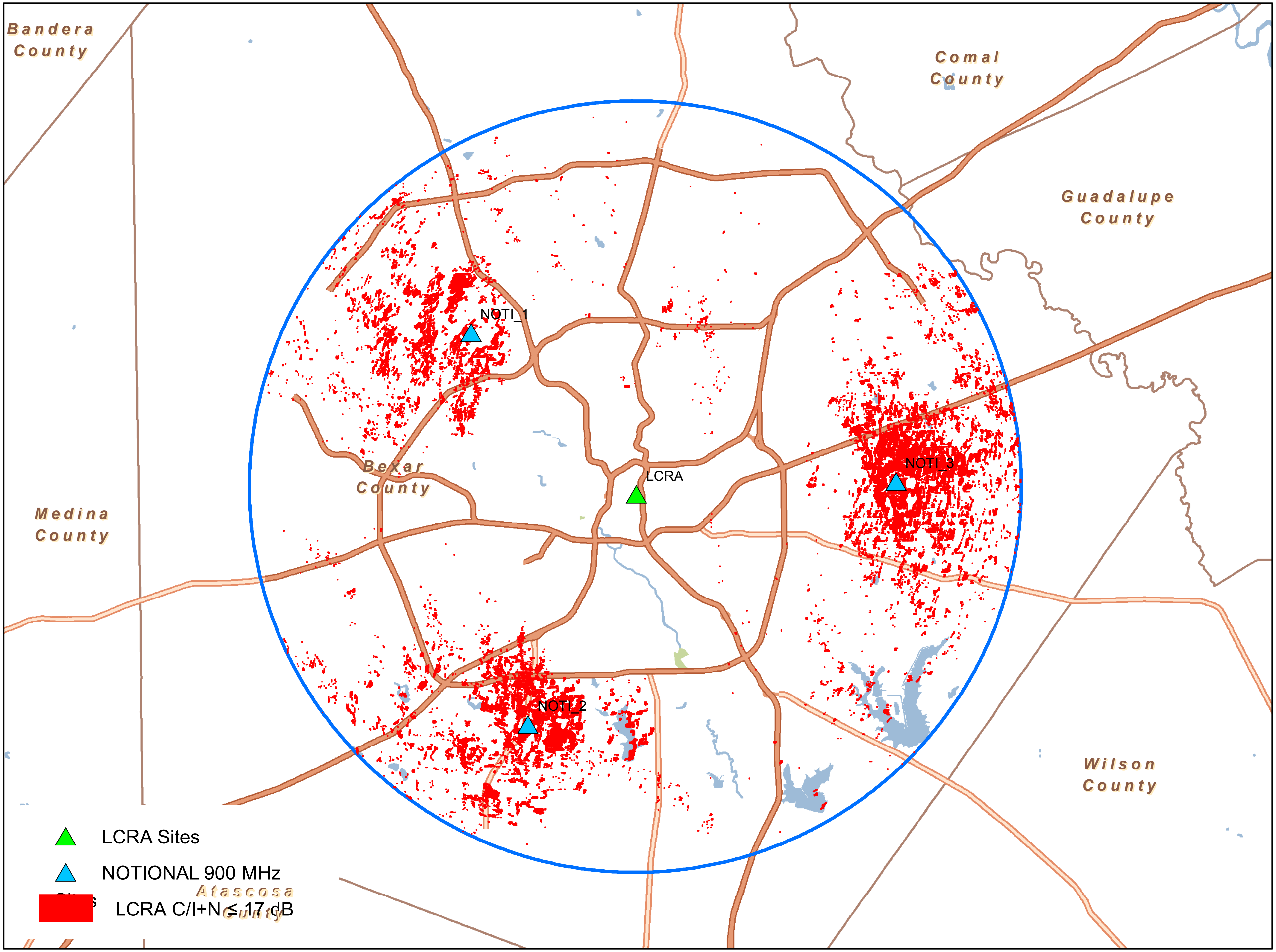
LCRA LTE Downlink Interference



Pericle Communications Company

May 3, 2017

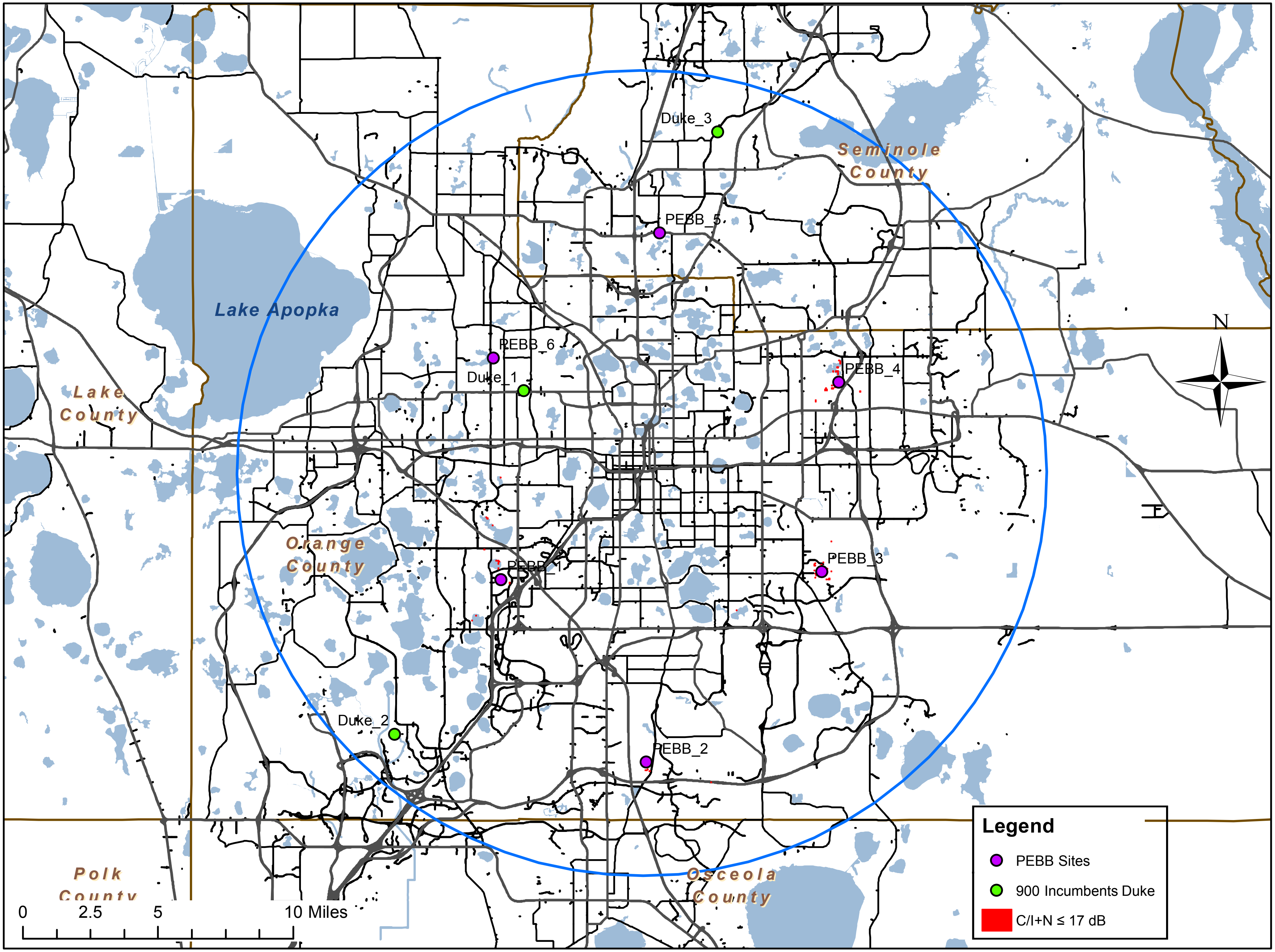
50 Channel Notional 900 MHz NB 3 Site Interference to LCRA



Pericle Communications Company

October 30, 2017

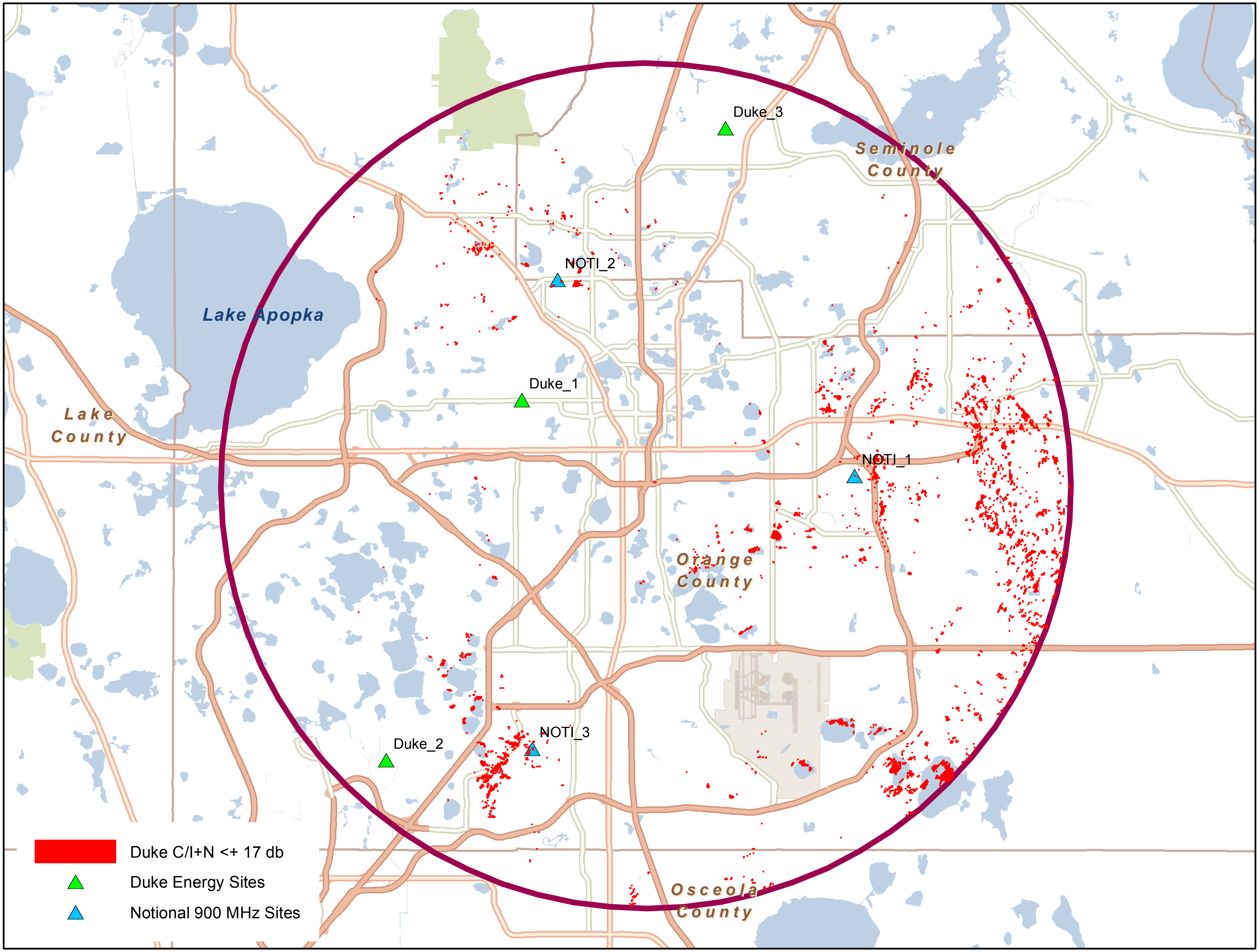
Duke Energy LTE Downlink Interference



Pericle Communications Company

May 3, 2017

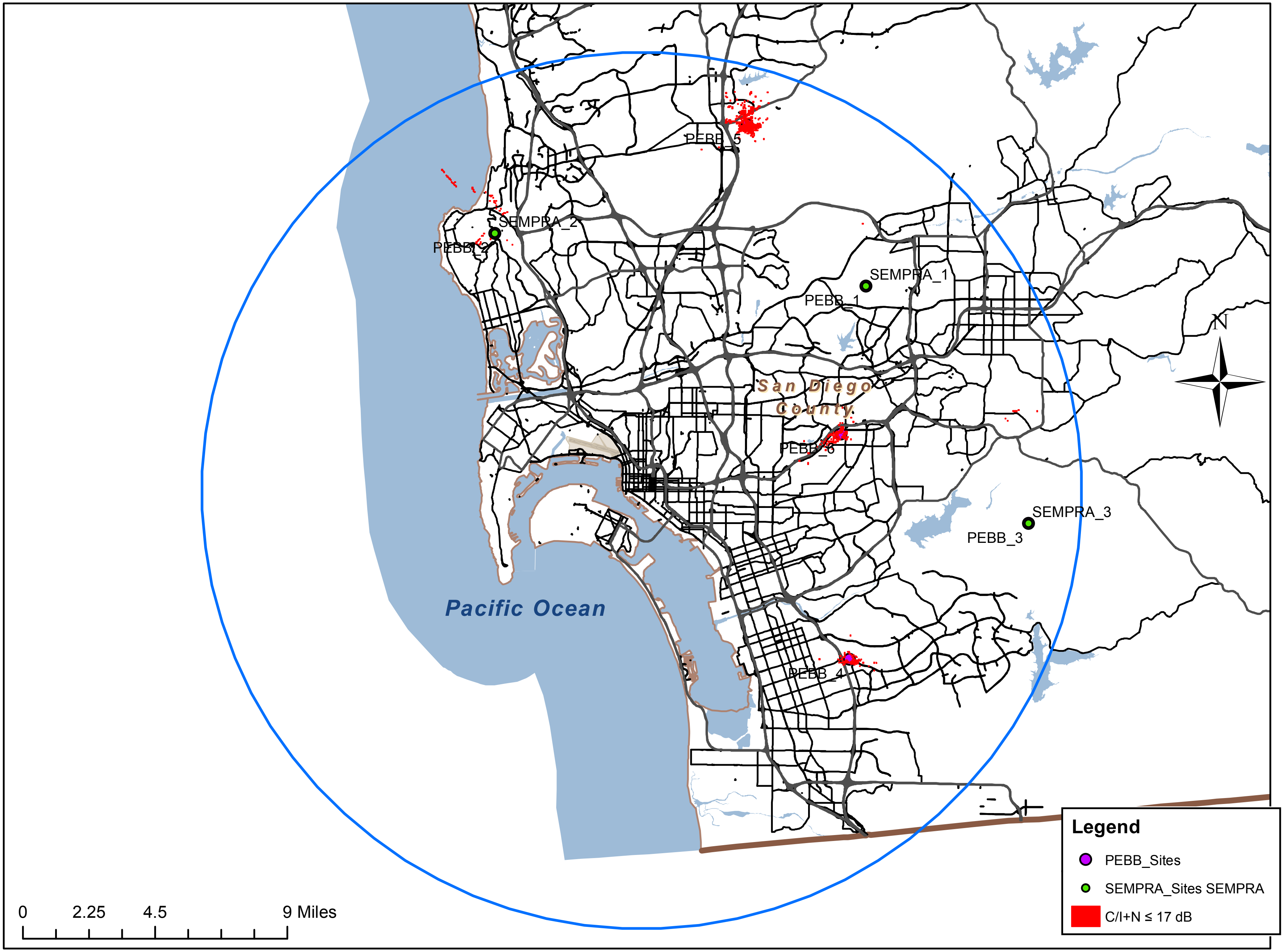
50 Channel Notional 900 MHz NB 3 Site Interference to Duke Energy



Pericle Communications Company

October 30, 2017

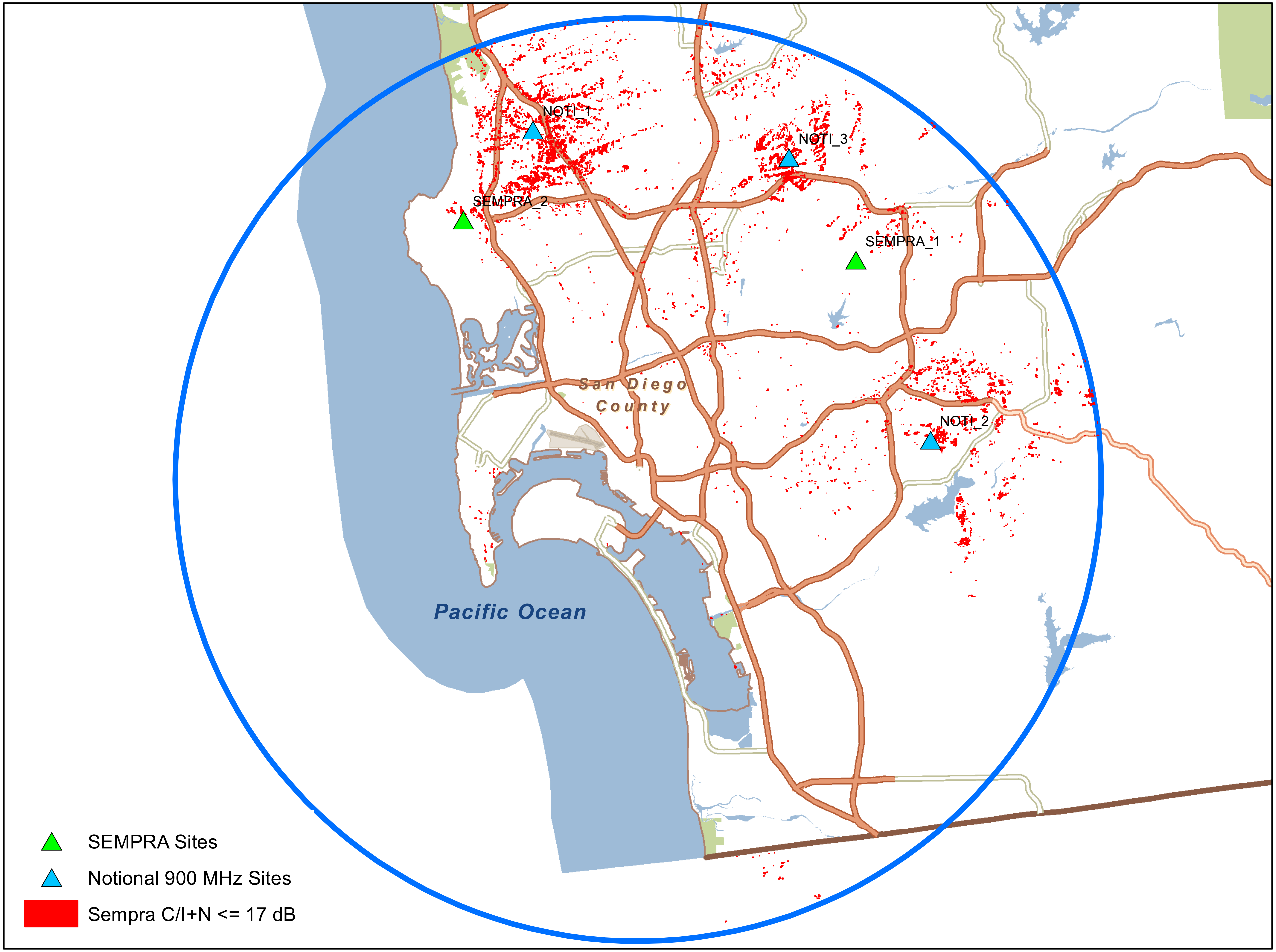
SEMPRA LTE Downlink Interference



Pericle Communications Company

May 3, 2017

50 Channel Notional 900 MHz NB 3 Site Interference to SEMPRA



Pericle Communications Company

October 30, 2017

Appendix B - Part 90 900 MHz Incumbent Licensees in Three Markets

San Antonio, TX 900 MHz Licensees within 15 miles of City Center

4/23/17

Callsign	Licensee	Radio Service	Freq	Loc Address	Lo City	LatDeg	LatMin	LatSec	LonDeg	LonMin	LonSec	Miles to Core San Antonio (mi)
WPWW828	AAA TEXAS LLC	GU	935.1875	310 S SAINT MARYS ST	SAN ANTONIO	29	25	22	98	29	29	0.140000001
WPWW828	AAA TEXAS LLC	GU	935.1875	310 S SAINT MARYS ST	SAN ANTONIO	29	25	22	98	29	29	0.140000001
WQBB243	PDV Spectrum Holding Company, LLC	GR	936.1375	310 S SAINT MARYS ST	SAN ANTONIO	29	25	22	98	29	29	0.140000001
WPWW828	AAA TEXAS LLC	GU	935.1875	112 EAST PECAN BLVD.	SAN ANTONIO	29	25	42	98	29	33	0.310000002
WPWW828	AAA TEXAS LLC	GU	935.1875	112 EAST PECAN BLVD.	SAN ANTONIO	29	25	42	98	29	33	0.310000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	935.15	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	935.2125	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	935.2375	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	935.7125	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	936.4375	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	938.225	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.4	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.4375	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.4875	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.6375	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.65	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.6625	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.7	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.7375	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.75	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WPXU562	LOWER COLORADO RIVER AUTHORITY	YI	939.95	889 E. MARKET STREET	SAN ANTONIO	29	25	19.3	98	29	3.6	0.560000002
WQTC271	Dailey and Wells Communications Inc	YS	935.9125	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTC271	Dailey and Wells Communications Inc	YS	936.25	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTC271	Dailey and Wells Communications Inc	YS	936.4875	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTC271	Dailey and Wells Communications Inc	YS	936.975	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTC271	Dailey and Wells Communications Inc	YS	937.7125	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTC271	Dailey and Wells Communications Inc	YS	937.9375	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTC271	Dailey and Wells Communications Inc	YS	938.725	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTC271	Dailey and Wells Communications Inc	YS	938.9	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTC271	Dailey and Wells Communications Inc	YS	939.1375	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTC271	Dailey and Wells Communications Inc	YS	939.9	610 East Market St	San Antonio	29	25	18.5	98	29	0	0.620000005
WQTX719	Community Arena Management	YS	935.225	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WQTX719	Community Arena Management	YS	935.4	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WQTX719	Community Arena Management	YS	935.7375	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WQTX719	Community Arena Management	YS	936.5	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WQTX719	Community Arena Management	YS	937.4625	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WQTX719	Community Arena Management	YS	937.65	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WQTX719	Community Arena Management	YS	938.4125	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WQTX719	Community Arena Management	YS	938.7375	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WQTX719	Community Arena Management	YS	938.9375	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WQTX719	Community Arena Management	YS	939.2375	1 AT&T CENTER PKWY	SAN ANTONIO	29	25	39.2	98	26	16.7	3.349999905
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.5125	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.525	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.5375	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.55	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.5625	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.575	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.5875	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.6	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.6125	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WNPS264	PDV Spectrum Holding Company, LLC	YS	935.625	.7 MI W IH 10 2.6 MI B HWT	SAN ANTONIO	29	38	0.8	98	37	51.1	16.64999962
WPWW828	AAA TEXAS LLC	GU	935.1875	8023 VANTAGE	SAN ANTONIO	29	39	41.8	98	32	46.1	16.68000031
WPWW828	AAA TEXAS LLC	GU	935.1875	8023 VANTAGE	SAN ANTONIO	29	39	41.8	98	32	46.1	16.68000031

Orlando, FL 900 MHz Licensees within 15 miles of City Center

4/23/17

Callsign	Licensee	Radio Service	Loc Type	Loc Address	Lo City	Loc ST	LatDeg	LatMin	LatSec	LonDeg	LonMin	LonSec	Miles to Core Orlando (mi)
WPTP846	FleetTalk Partners, Ltd.	GR	F	633 N Orange Ave	Orlando	FL	28	32	54	81	22	45	0.709999979
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4781 W COLONIAL DR	ORLANDO	FL	28	33	20	81	26	32.3	4.010000229
WPTQ574	Duke Energy Business Services, LLC	YI	F	WOODSMERE MW BLDG	ORLANDO	FL	28	34	42	81	27	21	5.409999847
WPTQ574	Duke Energy Business Services, LLC	YI	F	WOODSMERE MW BLDG	ORLANDO	FL	28	34	42	81	27	21	5.409999847
WPTQ574	Duke Energy Business Services, LLC	YI	F	WOODSMERE MW BLDG	ORLANDO	FL	28	34	42	81	27	21	5.409999847
WPTQ574	Duke Energy Business Services, LLC	YI	F	WOODSMERE MW BLDG	ORLANDO	FL	28	34	42	81	27	21	5.409999847
WPTQ574	Duke Energy Business Services, LLC	YI	F	WOODSMERE MW BLDG	ORLANDO	FL	28	34	42	81	27	21	5.409999847
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	N SIDE OF 6003 PERSHING AVE	ORLANDO	FL	28	30	5	81	17	59.2	5.460000038
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	4850 WEST OAKRIDGE ROAD	ORLANDO	FL	28	28	15.3	81	26	30.6	5.980000019
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WQSI773	UNIVERSAL CITY DEVELOPMENT PARTNERS, LTD	YI	F	1000 UNIVERSAL STUDIOS PLZ KING BLDG	ORLANDO	FL	28	29	0	81	27	59.3	6.5
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	1000 Universal Blvd	Orlando	FL	28	28	36.1	81	28	8.7	6.900000095
WQTE755	RADIO UNLIMITED	GI	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29	7.070000172
WQWB739	TAMO LLC	GI	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29	7.070000172
WQWB739	TAMO LLC	GI	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29	7.070000172

Orlando, FL 900 MHz Licensees within 15 miles of City Center

4/23/17

Callsign	Licensee	Radio Service	Loc Type	Loc Address	Lo City	Loc ST	LatDeg	LatMin	LatSec	LonDeg	LonMin	LonSec	Miles to Core Orlando (mi)
WQWB739	TAMO LLC	GI	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29	7.070000172
WQWB739	TAMO LLC	GI	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29	7.070000172
WQWB739	TAMO LLC	GI	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29	7.070000172
WNVR752	Orlando Utilities Commission	YU	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29.3	7.079999924
WNVR752	Orlando Utilities Commission	YU	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29.3	7.079999924
WNVR752	Orlando Utilities Commission	YU	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29.3	7.079999924
WNVR752	Orlando Utilities Commission	YU	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29.3	7.079999924
WNVR752	Orlando Utilities Commission	YU	F	4765 SAND LAKE RD	ORLANDO	FL	28	27	4	81	26	29.3	7.079999924
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	Orlando International Airport	Orlando	FL	28	25	54	81	18	34.2	8.470000267
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	Orlando International Airport	Orlando	FL	28	25	54	81	18	34.2	8.470000267
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	Orlando International Airport	Orlando	FL	28	25	54	81	18	34.2	8.470000267
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	Orlando International Airport	Orlando	FL	28	25	54	81	18	34.2	8.470000267
WQYE328	COMMUNICATIONS SERVICE CO OF DAYTONA INC	GR	F	Orlando International Airport	Orlando	FL	28	25	54	81	18	34.2	8.470000267
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	Orlando International Airport	Orlando	FL	28	25	54	81	18	34.2	8.470000267
WPTP846	FleetTalk Partners, Ltd.	GR	F	Orlando Airport	Orlando	FL	28	25	54	81	18	34.2	8.470000267
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WPNT620	DELTA AIR LINES INC	YU	F	ORLANDO INTERNATIONAL AIRPORT	ORLANDO	FL	28	25	37	81	18	29.2	8.800000191
WQIC487	PDV Spectrum Holding Company, LLC	YS	F	450 SANFORD AVE	ALTAMONTE SPRINGS	FL	28	40	9	81	21	29.2	9.119999886
WQIC487	PDV Spectrum Holding Company, LLC	YS	F	450 SANFORD AVE	ALTAMONTE SPRINGS	FL	28	40	9	81	21	29.2	9.119999886
WQYD545	FleetTalk Partners, Ltd	GR	F	Canal Road	Orlando	FL	28	24	54	81	18	31	9.510000229
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	9840 International Drive	Orlando	FL	28	25	23	81	28	34.3	9.869999886
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	9840 International Drive	Orlando	FL	28	25	23	81	28	34.3	9.869999886
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	9840 International Drive	Orlando	FL	28	25	23	81	28	34.3	9.869999886
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	9840 International Drive	Orlando	FL	28	25	23	81	28	34.3	9.869999886
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	9840 International Drive	Orlando	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPRK694	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR.	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPRW669	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPRW669	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPRW670	PDV Spectrum Holding Company, LLC	GR	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886

Orlando, FL 900 MHz Licensees within 15 miles of City Center

4/23/17

Callsign	Licensee	Radio Service	Loc Type	Loc Address	Lo City	Loc ST	LatDeg	LatMin	LatSec	LonDeg	LonMin	LonSec	Miles to Core Orlando (mi)
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPRW669	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WPRW669	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPSF725	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPSF725	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WPSF725	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPSF725	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WPSF725	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPRW669	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPRW669	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPSF725	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPSF725	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WPSF725	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WQSU780	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	1	81	20	5	9.869999886
WPRW669	PDV Spectrum Holding Company, LLC	YS	F	9840 INTERNATIONAL DR	ORLANDO	FL	28	25	23	81	28	34.3	9.869999886
WQSY913	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	0	81	20	5	9.890000343
WQSY913	PDV Spectrum Holding Company, LLC	YS	F	11622 BOGGY CREEK ROAD	ORLANDO	FL	28	24	0	81	20	5	9.890000343
WPTQ570	Duke Energy Business Services, LLC	YI	F	NORTH LONGWOOD MW BLDG	LONGWOOD	FL	28	43	4.9	81	20	16.7	12.64999962
WPTQ570	Duke Energy Business Services, LLC	YI	F	NORTH LONGWOOD MW BLDG	LONGWOOD	FL	28	43	4.9	81	20	16.7	12.64999962
WPTQ570	Duke Energy Business Services, LLC	YI	F	NORTH LONGWOOD MW BLDG	LONGWOOD	FL	28	43	4.9	81	20	16.7	12.64999962
WPTQ570	Duke Energy Business Services, LLC	YI	F	NORTH LONGWOOD MW BLDG	LONGWOOD	FL	28	43	4.9	81	20	16.7	12.64999962
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004

Orlando, FL 900 MHz Licensees within 15 miles of City Center
4/23/17

Callsign	Licensee	Radio Service	Loc Type	Loc Address	Lo City	Loc ST	LatDeg	LatMin	LatSec	LonDeg	LonMin	LonSec	Miles to Core Orlando (mi)
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPBJ820	ORLANDO UTILITIES COMMISSION	YI	F	5100 S ALFAYA TRL SEC	ORLANDO	FL	28	28	58	81	10	2.2	13.46000004
WPTQ576	Duke Energy Business Services, LLC	YI	F	LAKE BUENA VISTA OPS CTR	Lake Buena Vista	FL	28	23	36	81	32	1	13.68999958
WPTQ576	Duke Energy Business Services, LLC	YI	F	LAKE BUENA VISTA OPS CTR	Lake Buena Vista	FL	28	23	36	81	32	1	13.68999958
WPTQ576	Duke Energy Business Services, LLC	YI	F	LAKE BUENA VISTA OPS CTR	Lake Buena Vista	FL	28	23	36	81	32	1	13.68999958
WPTQ576	Duke Energy Business Services, LLC	YI	F	LAKE BUENA VISTA OPS CTR	Lake Buena Vista	FL	28	23	36	81	32	1	13.68999958
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	1850 HOTEL PLAZA BLVD	LAKE BUENA VISTA	FL	28	22	10	81	30	29.3	14.01000023
WQYE328	COMMUNICATIONS SERVICE CO OF DAYTONA INC	GR	F	1850 Hotel Plaza Blvd	Lake Buena Vista	FL	28	22	10	81	30	29.3	14.01000023
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	1850 HOTEL PLAZA BLVD	LAKE BUENA VISTA	FL	28	22	10	81	30	29.3	14.01000023
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	1850 HOTEL PLAZA BLVD	LAKE BUENA VISTA	FL	28	22	10	81	30	29.3	14.01000023
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	1850 HOTEL PLAZA BLVD	LAKE BUENA VISTA	FL	28	22	10	81	30	29.3	14.01000023
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	1850 HOTEL PLAZA BLVD	LAKE BUENA VISTA	FL	28	22	10	81	30	29.3	14.01000023
WPQH294	PDV Spectrum Holding Company, LLC	YS	F	1850 HOTEL PLAZA BLVD	LAKE BUENA VISTA	FL	28	22	10	81	30	29.3	14.01000023
WPQH294	PDV Spectrum Holding Company, LLC	YS	F	1850 HOTEL PLAZA BLVD	LAKE BUENA VISTA	FL	28	22	10	81	30	29.3	14.01000023
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WPXB478	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WPXB478	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WPXB478	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WQFW743	PDV Spectrum Holding Company, LLC	YS	F	900 N THEATRE OF THE STARS DRIVE	BAY LAKE	FL	28	21	37	81	33	35.3	16.44000053
WPPC924	COMMUNICATIONS SERVICE CO OF DAYTONA INC	YS	F	Theater of the Stars Drive	Lake Buena Vista	FL	28	21	34.8	81	33	43.2	16.55999947
WPXG726	Duke Energy Business Services, LLC	YI	F	12.773NM FROM 8FD NAVAL HOSPITAL ORLANDO	CHRISTMAS	FL	28	32	12	81	5	5	17.92000008
WPXG726	Duke Energy Business Services, LLC	YI	F	12.773NM FROM 8FD NAVAL HOSPITAL ORLANDO	CHRISTMAS	FL	28	32	12	81	5	5	17.92000008
WPXG726	Duke Energy Business Services, LLC	YI	F	12.773NM FROM 8FD NAVAL HOSPITAL ORLANDO	CHRISTMAS	FL	28	32	12	81	5	5	17.92000008
WPXG726	Duke Energy Business Services, LLC	YI	F	12.773NM FROM 8FD NAVAL HOSPITAL ORLANDO	CHRISTMAS	FL	28	32	12	81	5	5	17.92000008
WPXG726	Duke Energy Business Services, LLC	YI	F	12.773NM FROM 8FD NAVAL HOSPITAL ORLANDO	CHRISTMAS	FL	28	32	12	81	5	5	17.92000008

San Diego, CA 900 MHz Licensees within 15 miles of City Center

4/23/17

Callsign	Licensee	Radio Service	Freq	LO_Address	LO_City	LO_ST	LatDeg	LatMin	LatSec	LonDeg	LonMin	LonSec	Miles to Core San Deigo (mi)
WPNS268	PDV Spectrum Holding Company, LLC	GR	935.675	CORONADO SHORES	CORONADO	CA	32	40	33.2	117	10	25.1	2.890000105
WPNS268	PDV Spectrum Holding Company, LLC	GR	938.2125	CORONADO SHORES	CORONADO	CA	32	40	33.2	117	10	25.1	2.890000105
WPRL243	PDV Spectrum Holding Company, LLC	GR	938.7	CORONADO SHORES	CORONADO	CA	32	40	33.2	117	10	25.1	2.890000105
WPNP203	PDV Spectrum Holding Company, LLC	GR	938.7125	CORONADO SHORES	CORONADO	CA	32	40	33.2	117	10	25.1	2.890000105
WPRJ760	PDV Spectrum Holding Company, LLC	GR	937.75	MT SOLEDAD-PRIMARY	LA JOLLA	CA	32	49	59.2	117	15	1.1	9.789999962
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.1375	6902 BARKER WAY	SAN DIEGO	CA	32	48	49	117	1	53	9.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.15	6902 BARKER WAY	SAN DIEGO	CA	32	48	49	117	1	53	9.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.1625	6902 BARKER WAY	SAN DIEGO	CA	32	48	49	117	1	53	9.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.175	6902 BARKER WAY	SAN DIEGO	CA	32	48	49	117	1	53	9.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.1875	6902 BARKER WAY	SAN DIEGO	CA	32	48	49	117	1	53	9.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.2	6902 BARKER WAY	SAN DIEGO	CA	32	48	49	117	1	53	9.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.225	6902 BARKER WAY	SAN DIEGO	CA	32	48	49	117	1	53	9.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.675	6902 BARKER WAY	SAN DIEGO	CA	32	48	49	117	1	53	9.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	937.3875	6902 BARKER WAY	SAN DIEGO	CA	32	48	49	117	1	53	9.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.1375	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.15	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.1625	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.175	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUC840	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.175	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.1875	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUC840	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.2	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.2	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUC840	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.225	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.225	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUC840	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.2375	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUC840	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.25	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUC840	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.675	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.675	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUC840	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.725	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	937.3875	7700 LA JOLLA SCENIC DRIVE SOUTH	LA JOLLA	CA	32	50	17	117	14	57	10.03999996
WPMM989	MANHOLE ADJUSTING CONTRACTORS	GU	937.2	ATOP MT SAN MIGUEL	SPRING VALLEY	CA	32	41	46.2	116	56	12.1	12.86999989
WPDA453	AUTOMOBILE CLUB OF SOUTHERN CALIFORNIA	GU	937.675	ATOP MOUNT SAN MIGUEL	SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	935.3875	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WPJG607	PDV Spectrum Holding Company, LLC	GR	935.475	MOUNT SAN MIGUEL	SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985
WQBJ574	PDV Spectrum Holding Company, LLC	YS	935.6875	Atop San Miguel Mtn.	San Diego	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	935.7125	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	935.725	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WQBJ574	PDV Spectrum Holding Company, LLC	YS	935.7375	Atop San Miguel Mtn.	San Diego	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	936.4375	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	936.45	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	936.4625	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	936.475	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	936.4875	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	936.5	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WQBJ574	PDV Spectrum Holding Company, LLC	YS	936.6875	Atop San Miguel Mtn.	San Diego	CA	32	41	47.2	116	56	9.1	12.90999985
WQBJ574	PDV Spectrum Holding Company, LLC	YS	936.7	Atop San Miguel Mtn.	San Diego	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	936.925	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WQBJ574	PDV Spectrum Holding Company, LLC	YS	937.15	Atop San Miguel Mtn.	San Diego	CA	32	41	47.2	116	56	9.1	12.90999985
WQBJ574	PDV Spectrum Holding Company, LLC	YS	937.1625	Atop San Miguel Mtn.	San Diego	CA	32	41	47.2	116	56	9.1	12.90999985
WQBJ574	PDV Spectrum Holding Company, LLC	YS	937.2125	Atop San Miguel Mtn.	San Diego	CA	32	41	47.2	116	56	9.1	12.90999985
WPPU369	PDV Spectrum Holding Company, LLC	GR	937.425	SAN MIGUEL	S SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985
WPPU370	PDV Spectrum Holding Company, LLC	GR	937.425	SAN MIGUEL	S SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	937.45	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	937.4625	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WPKT732	PDV Spectrum Holding Company, LLC	YS	937.475	MOUNT SAN MIGUEL	POWAY	CA	32	41	47.2	116	56	9.1	12.90999985
WQBJ574	PDV Spectrum Holding Company, LLC	YS	937.6625	Atop San Miguel Mtn.	San Diego	CA	32	41	47.2	116	56	9.1	12.90999985
WPPA341	PDV Spectrum Holding Company, LLC	GR	938.7125	ATOP SAN MIGUEL	SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985
WQUW935	VEGAS WIRELESS LLC	YI	938.975	SAN MIGUEL MOUNTAIN	SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985
WQUW935	VEGAS WIRELESS LLC	YI	938.9875	SAN MIGUEL MOUNTAIN	SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985
WQUW935	VEGAS WIRELESS LLC	YI	939.15	SAN MIGUEL MOUNTAIN	SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985
WQUW935	VEGAS WIRELESS LLC	YI	939.175	SAN MIGUEL MOUNTAIN	SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985
WQUW935	VEGAS WIRELESS LLC	YI	939.9	SAN MIGUEL MOUNTAIN	SAN DIEGO	CA	32	41	47.2	116	56	9.1	12.90999985

San Diego, CA 900 MHz Licensees within 15 miles of City Center

4/23/17

Callsign	Licensee	Radio Service	Freq	LO_Address	LO_City	LO_ST	LatDeg	LatMin	LatSec	LonDeg	LonMin	LonSec	Miles to Core San Deigo (mi)
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.1375	MOUNT SAN MIGUEL	ESCONDIDO	CA	32	41	49	116	56	7	12.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.15	MOUNT SAN MIGUEL	ESCONDIDO	CA	32	41	49	116	56	7	12.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.1625	MOUNT SAN MIGUEL	ESCONDIDO	CA	32	41	49	116	56	7	12.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.175	MOUNT SAN MIGUEL	ESCONDIDO	CA	32	41	49	116	56	7	12.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.1875	MOUNT SAN MIGUEL	ESCONDIDO	CA	32	41	49	116	56	7	12.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.2	MOUNT SAN MIGUEL	ESCONDIDO	CA	32	41	49	116	56	7	12.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.225	MOUNT SAN MIGUEL	ESCONDIDO	CA	32	41	49	116	56	7	12.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	936.675	MOUNT SAN MIGUEL	ESCONDIDO	CA	32	41	49	116	56	7	12.93999958
WPUG643	SAN DIEGO GAS & ELECTRIC COMPANY	YI	937.3875	MOUNT SAN MIGUEL	ESCONDIDO	CA	32	41	49	116	56	7	12.93999958
WQBH646	PDV Spectrum Holding Company	YI	936.9625	ATOP SANMIGUEL MTN	SAN DIEGO	CA	32	41	47.2	116	56	6.1	12.96000004
WQBH646	PDV Spectrum Holding Company	YI	937.9625	ATOP SANMIGUEL MTN	SAN DIEGO	CA	32	41	47.2	116	56	6.1	12.96000004
WQBH646	PDV Spectrum Holding Company	YI	938.4375	ATOP SANMIGUEL MTN	SAN DIEGO	CA	32	41	47.2	116	56	6.1	12.96000004
WQBH646	PDV Spectrum Holding Company	YI	939.45	ATOP SANMIGUEL MTN	SAN DIEGO	CA	32	41	47.2	116	56	6.1	12.96000004
WQBH646	PDV Spectrum Holding Company	YI	939.8875	ATOP SANMIGUEL MTN	SAN DIEGO	CA	32	41	47.2	116	56	6.1	12.96000004
WPKE327	PDV Spectrum Holding Company, LLC	GR	935.2125	SAN MIGUEL	SOUTH SAN DIEGO	CA	32	41	47.2	116	56	6.1	12.96000004
WPRL472	PDV Spectrum Holding Company, LLC	GR	936.2125	ATOP SAN MIGUEL	SAN DIEGO	CA	32	41	47.2	116	56	6.1	12.96000004
WPKE327	PDV Spectrum Holding Company, LLC	GR	935.225	ATOP RATTLESNAKE PEAK	SANTEE	CA	32	49	45.2	116	56	33.1	14.72000027
WPKE327	PDV Spectrum Holding Company, LLC	GR	935.25	ATOP RATTLESNAKE PEAK	SANTEE	CA	32	49	45.2	116	56	33.1	14.72000027