Nevada Shared Radio System Existing System Analysis and P25 System Requirements Report

FINAL

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Executive Summary

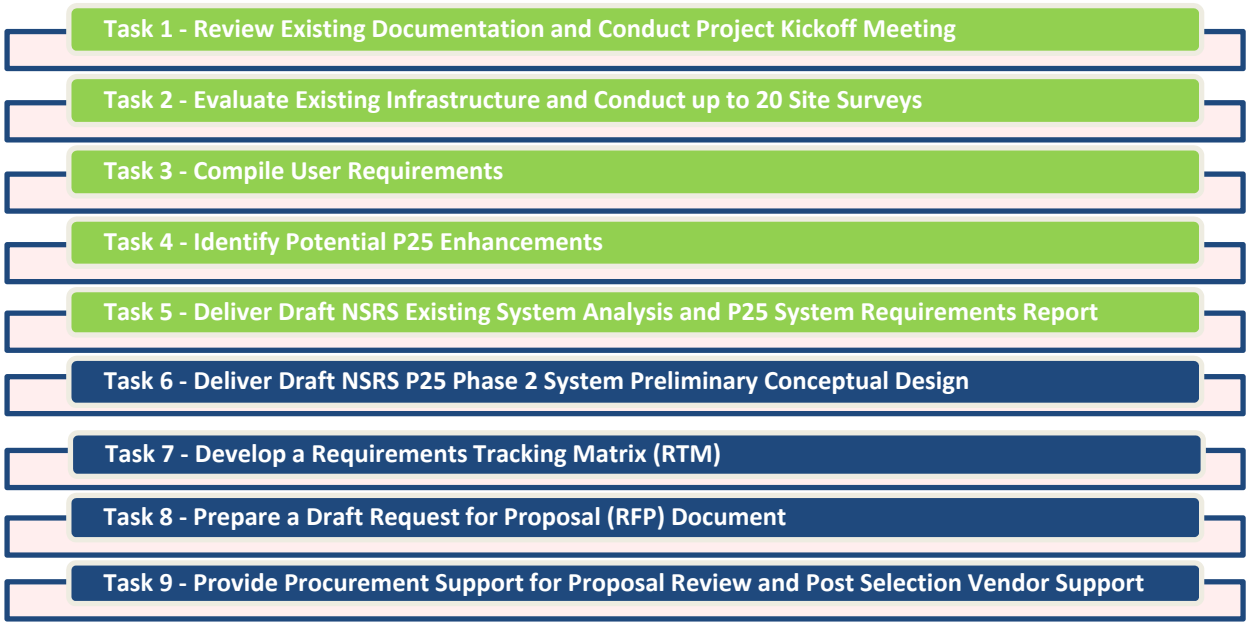
The Nevada Shared Radio System (NSRS) supports critical voice communications to thousands of public safety, utility and government employees across the State. The Nevada Department of Transportation (NDOT), Nevada Energy (NV Energy), and Washoe County are partners in the NSRS. Each entity in this partnership owns, operates, and maintains their own network, but combined, the three networks operate together to form a statewide system.

The manufacturer of key system components comprising the NSRS advises the products in use are nearing the end their lifecycle and as such, they will no longer provide support for the system beyond the end of calendar year 2017.

Without immediate action, this will make it very difficult for the NSRS partnership to operate and maintain the NSRS due to its pending obsolescence. Prompt selection, procurement and deployment of a new replacement system are imperative for the safety of the first responders and the citizens they serve.

To assist with this very important, complex undertaking, the Nevada Department of Transportation (NDOT), through a competitive procurement process, contracted Federal Engineering (***FE***).

FE is providing the engineering and procurement support required to replace the existing NSRS Land Mobile Radio (LMR) communication system. A Scope of Work, developed in collaboration with the NSRS partners, specifies nine tasks designed to lead the team through the process culminating in the release of a Request for Proposal (RFP) for the replacement of the NSRS with an APCO Project 25 (P25) Phase 2, standards-based system. The following graphic shows the tasks documented in this report.



NDOT LMR Procurement Support Project Tasks

As a first step in that process, ***FE*** conducted the following four key activities, documented in this report:

- Reviewed the existing system documentation
- Evaluated the existing system infrastructure, and performed 21 site surveys, to provide critical input into requirements definition, coverage analysis, and technical specifications
- Developed an assessment questionnaire that highlighted current system issues and concerns, captured future user requirements for the replacement LMR system and identified the gaps between the existing system analysis and the required replacement system
- Identified P25 features and enhancements that would enhance user capabilities and form the core functions for the new system.

Existing System Analysis

As mentioned earlier, although the existing NSRS operates reliably, system obsolescence is near. Therefore, immediate action to replace the system is required to avoid a potential interruption of mission-critical radio communications throughout the state due to an absence of manufacturer support.

FE evaluated the existing physical infrastructure to determine if it can accommodate both the EDACS and new P25 equipment for the initial installation and cutover operations, as well as suitability for long-term P25 operation. The current system evaluation included visits to 21 of the 66 NDOT owned and operated sites. ***FE*** provided NDOT with a complete and detailed site survey report for each site. Of the 21 site visits conducted, no major issues were identified that would prevent the re-use of any of these sites for the new NSRS. Some sites have access road challenges, space limitations in the shelters, and restricted space on the towers for the new cables and antennas. These issues must be addressed prior to the installation of the new equipment.

User and System Requirements

FE distributed an online survey questionnaire across all agencies, which generated 144 responses. ***FE*** conducted face-face interviews during 13 separate interview sessions with 55 participants. Following this activity, ***FE*** documented a number of user requirements currently provided by the NSRS as well as future requirements for consideration in the new system. The following table summarizes the analyzed feedback of a subset of these requirements presented to the integrated project team on March 14, 2016.

NSRS Key User and System Requirements		*FE* Findings and Analyses
1	System Coverage	The consensus is there are a large number of dead areas in the current system, particularly in rural areas and in buildings. Over 80% of system users surveyed expressed the need for improved mobile radio coverage, and over half of the system users expressed the need for improved portable radio coverage on street and in buildings Users would like to see the NSRS improved in the identified areas of poor or inadequate coverage as discussed in Section 4.1
2	System Capacity	Analysis of traffic and survey data shows that users have a requirement for improved system channel capacity given the system busies or delayed transmissions they experience under heavy loading conditions (see Section 4.2). The details of our analysis are in Section 3.5.2 and Appendix C.
3	System Reliability	Given that the current NSRS supports a number of user types, including public safety, users expressed the requirement that the NSRS be available 99.999% of the time (max. down 5.26 mins/year)

NSRS Key User and System Requirements		*FE* Findings and Analyses
4	System Features	Critical features required in the future system: Over-the-air programming (OTAP) Global Positioning System (GPS) Call alert Announcement group calls Status query Voice encryption Over-the-air rekeying (OTAR) Private calls Short Messaging Service (SMS) Dynamic Regrouping
5	System Interoperability	Users must have: • Direct operability with other state agencies, other private or public service agencies, and local (County) agencies • Interoperability with federal and tribal agencies, and surrounding state agencies
6	Subscriber Equipment	Users require improved reliability of mobiles & handhelds (including battery life).
7	Dispatch Equipment	There is a need for improved patching capabilities, localized audio recording, and support of NCORE, NDIP and configurable audio gateways. Top ten features required in new consoles are: Unit ID Display; Patches; Call Playback; Call History; Dispatch Priority; Display Connectivity Loss; Emergency Alarm; Emergency Call; Simulselect; RF (Control-Station) Backup
8	Equipment Maintenance	Users expressed a need for improved maintenance on user radios and dispatch consoles, noting that available staff hours of radio shop is limited and the scope of their operation is very large.
9	Network Management	Users identified the need for improved network management of system and end-user equipment, including secure and direct accessibility to monitor, diagnose and configure the system remotely.

NSRS Key User and System Requirements		*FE* Findings and Analyses
10	Training and Exercises	Users expressed the need for position-specific training. Examples of this training include operator training (both end-user and dispatcher); System configuration and administration training; and technical/maintenance training (technology specific). NSRS stakeholders validated the survey data and reiterated the need for regular (quarterly) communications exercises with more agencies involved

P25 Features and Enhancements

Following the User Requirement Meeting on March 14, 2016, ***FE*** conducted the P25 Enhancements Meeting with stakeholders to discuss P25 Phase 2 features and functions that will enhance or augment the features and functions of the existing system. ***FE***'s analysis of user needs for the new system shows NSRS users' needs align with most land mobile radio system users nationwide.

The current radio system features determined by the users as critical for the new system are:

Current Radio System Features Determined As Critical		NDOT	NV	WC
1	Group calls	Yes	Yes	Yes
2	Emergency calls	Yes	Yes	Yes
3	Emergency alarm	Yes	Yes	Yes
4	User authentication	Yes	Yes	Yes
5	Radio inhibit / uninhibit	Yes	Yes	Yes
	All standard P25 features			

FE incorporated the feedback gathered from stakeholders during the meeting into the recommended features critical for the future radio system.

Recommended Features Critical for the Future Radio System		NDOT	NV	WC
1	Over-the-air programming (OTAP)	Yes	Yes	Yes
2	Global Positioning System (GPS) *	Yes	Yes	Yes
3	Call alert *	Yes	Yes	Yes
4	Announcement group calls *	Yes	Yes	Yes
5	Status query *	Yes	Yes	Yes
6	Voice encryption *	Yes	Yes	Yes
7	Over-the-air rekeying (OTAR) *	Yes	Yes	Yes
8	Private calls *	Yes	Yes	Yes
9	Short Messaging Service (SMS)	Yes	Yes	Yes
10	Dynamic Regrouping	No	No	No
**** Standard P25 features***				

Conclusion

FE concludes that time is of the essence if the NSRS is to operate uninterrupted in the upcoming years. Manufacturer's product obsolescence, cessation of support for the current technology, and the challenges associated with sourcing of reliable 3rd-party parts will make it difficult, if not impossible to recover from a major NSRS outage after the year 2017. Mission-critical communications systems of this size and complexity require a substantial amount of time to plan, procure, implement, test, and cutover.

FE encourages the NSRS partnership to remain committed to providing the resources necessary to overcome the anticipated challenges and to proceed swiftly with the steps necessary to ensure the replacement of the NSRS in a timely manner.

Next Steps

This report outlines the user requirements for the NSRS partners and serves as the basis for development of the Preliminary Conceptual Design (PCD) for the replacement system. It is important for the partners to review this report and reach a consensus on the contents as soon as possible to permit ***FE*** to develop the PCD. ***FE*** currently plans to deliver the draft PCD in June 2016 pending a timely approval and acceptance of this report.

Upon receiving approval of the PCD from the NSRS partnership, ***FE*** will develop a detailed Request for Proposal (RFP) document that includes a detailed Statement of Work (SOW) and Deployment Plan for release by the NSRS partnership. The system specification will describe the radio system's functional requirements in sufficient detail for vendors to submit consistent proposals, verifiable through future acceptance testing. Vendors are responsible for the detailed design of the system to allow for innovative approaches and to ensure the vendor remains responsible for system performance in accordance with the specifications.

FE currently plans to deliver the draft RFP in August 2016.

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1. Introduction

Nevada Department of Transportation (NDOT), Nevada Energy (NV Energy), and Washoe County are the primary stakeholders and are partners in the Nevada Shared Radio System (NSRS). These partners previously operated their own separate Land Mobile Radio (LMR) networks but decided that a joint or shared system would best serve the interests of all system users. Each entity in this partnership owns, operates, and maintains their own network, but combined, the three networks form a statewide system. Combining NV Energy's coverage in many rural and remote areas, NDOT's coverage along the primary state highways, and Washoe County's coverage of Reno and Lake Tahoe, provides improved statewide coverage for all users.

The current NSRS has performed well over the years, but the radio network has reached the end of the product lifecycle. Because parts availability, technology obsolescence, and expiration of manufacturer support are areas of major concern, the partners require replacement of the NSRS. NDOT retained Federal Engineering, Inc. (***FE***) to perform the following functions relative to the existing system analysis, which is a subset of a larger Statement of Work (SOW) to replace the NSRS:

- Review previous studies, radio network configurations, Federal Communications Commission (FCC) licenses, site surveys, inventories, maintenance contracts, and other relevant documents
- Survey and assess up to 21 representative NDOT LMR sites throughout the state to evaluate LMR control equipment, repeaters, base stations, communications shelters, tower structures, power sources and grounding systems.
- Develop an online survey to identify gaps from the existing system analysis, highlight current issues and concerns, and capture future LMR requirements for the upgraded LMR system
- Conduct interviews with representatives from NDOT, NV Energy, Washoe County, the Nevada Highway Patrol, and the State of Nevada Enterprise IT Services to seek further input and clarification on concerns and requirements
- Identify Project 25 (P25) Phase 2 features and functions that will enhance or augment the features and functions of the existing system

This report summarizes the key findings from the documentation review, site surveys, and requirements gathering tasks, as well as potential P25 enhancements for consideration.

2. Methodology

The methodology used to develop this report follows the processes ***FE*** has used successfully in hundreds of similar projects across more than 32 years of experience. This section outlines these steps.

Project Initiation

On December 3, 2015, ***FE*** conducted a Project Initiation meeting with stakeholders from NDOT, NV Energy, and Washoe County. The purpose of the meeting was to confirm a common understanding of the project goals, objectives, and vision; items best understood through a close working relationship between the respective management teams and staffs.

Regular Project Status Meetings

FE maintains constant communication with the NSRS project team, including key personnel from NDOT, NV Energy, and Washoe County. ***FE*** hosts weekly project status meetings that cover project status overview, next key milestones, review of previous week's meeting, review of action item register, and scheduling of future meetings.

Existing System Analysis

FE employed four distinct data collection approaches: request for information, web-based surveys, stakeholder interviews, and physical site surveys.

On November 9, 2015, ***FE*** sent a Request for Information (RFI) to NDOT for the express purpose of gathering information about each stakeholder's portion of the network. The RFI contained the following sections:

- General radio information
- Tower site and fixed equipment information
- Quantity and type of subscriber equipment
- Dispatch center information
- Emergency operations center information

Upon receiving the requested information, ***FE*** cataloged and reviewed a number of documents including previous studies, radio network configurations, FCC licenses, inventories, maintenance contracts, and other relevant documents.

The ***FE*** team conducted physical site surveys at 21 representative radio sites over the course of four weeks in January 2016. The sites visited were a mix of locally, state, and federally owned sites. These site visits enabled us to identify any issues present at those specific sites and to use that information as representative of all sites in the corresponding system.

To gather feedback on system concerns and requirements, ***FE*** collaborated with the NSRS project team to develop an assessment questionnaire. Using the approved set of questions, ***FE*** launched a web-based survey that was available for NSRS users, dispatchers, technicians, and managers to complete between January 29, 2016, and February 12, 2016. We received 144 responses; however, 56 were incomplete and did not provide usable data.

To augment the web survey data, ***FE*** personnel conducted in-person interviews during the week of February 22, 2016. More than 50 participants took part in the 13 sessions scheduled for that week, including representatives from the following agencies:

- NDOT Headquarters
- Nevada Enterprise Information Technology (EITS)
- NDOT Districts 1 and 3
- Nevada Department of Health
- NV Energy (Northern and Southern regions)
- Washoe County
- Nevada Highway Patrol
- Elko County
- University of Las Vegas

Due to a scheduling conflict, ***FE*** conducted a telephone interview with NDOT District 2 during the week of February 29, 2016. To understand the current interoperability landscape with surrounding states, ***FE*** conducted telephone interviews with the Statewide Interoperability Coordinators (SWIC) for Arizona and California.

Data Analysis

FE performed a quantitative analysis on the survey and interview responses that yielded a numerical value. Open-ended responses and interview feedback became part of the qualitative data analysis. ***FE*** compiled the results of both analyses and grouped them by subject area, highlighting stakeholder-specific concerns and requirements.

User Requirements Meeting

FE analyzed the data collected, determined high-level user requirements, and discussed these with the stakeholders to validate the identified requirements. On March 14, 2016, ***FE*** conducted a *User Requirements Meeting* to provide an overview of the requirements discovered during the data collection and analysis tasks. Topics for discussion included:

- System coverage
- System capacity
- System reliability
- System features
- System interoperability
- Subscriber equipment
- Dispatch equipment
- Equipment maintenance
- Network management
- Training and exercises

This allowed us to gain consensus, acceptance, and a mutual understanding of user-defined requirements before developing P25 enhancements and recommendations to fulfill those requirements.

P25 Enhancements Meeting

Following the *User Requirements Meeting* on the afternoon of March 14, 2016, ***FE*** conducted the P25 Enhancements Meeting to discuss P25 Phase 2 features and functions that will enhance the capabilities of the users of the NSRS. Items of discussion included:

- Better coverage
- Less noise
- Encrypted voice quality comparable to non-encrypted (clear) operation
- Increase in voice channel efficiency
- Open data interface standards
- Greater product selection from multiple manufacturers
- Replacement of infrastructure vendor without subscriber equipment replacement

- More competitive vendor component pricing

FE incorporated the feedback gathered from stakeholders during the meeting into the recommended features critical for the future radio system.

3. Existing System Analysis

Based on documentation review and site surveys, ***FE*** provides the following existing system analysis, including a review of LMR and backhaul networks, lifecycle evaluation, site assessments, licensed spectrum, and system coverage and capacity.

3.1 System Overview

The core of the NSRS is a proprietary Harris Enhanced Digital Access Communications System (EDACS®) architecture with the following major system components:

- Integrated Multisite and Console Controller (IMC™)
- Global Positioning System (GPS) Simulcast and Voting
- MASTR® III Base Stations (or repeaters)
- C3 Maestro™ Dispatch Consoles

The NSRS is an 800 MHz trunked radio system with a mix of multicast and simulcast sites. The current NSRS configuration consists of 114 radio frequency (RF) sites with NDOT, NV Energy and Washoe County responsible for their own group of sites as follows:

- NDOT – 66 RF sites across three NDOT Districts in the state
- NV Energy – 37 sites between Northern and Southern regions of the state
- Washoe County – 11 sites with primary coverage in Reno and Lake Tahoe

The Las Vegas metropolitan area has a 5-site simulcast cell, and the Reno metropolitan area has a 2-site simulcast cell. All other RF sites operate in a multicast configuration. Figure 1 provides an overview of the NSRS, highlighting the NDOT, NV Energy and Washoe County site responsibility, as indicated in the legend provided in Figure 1.

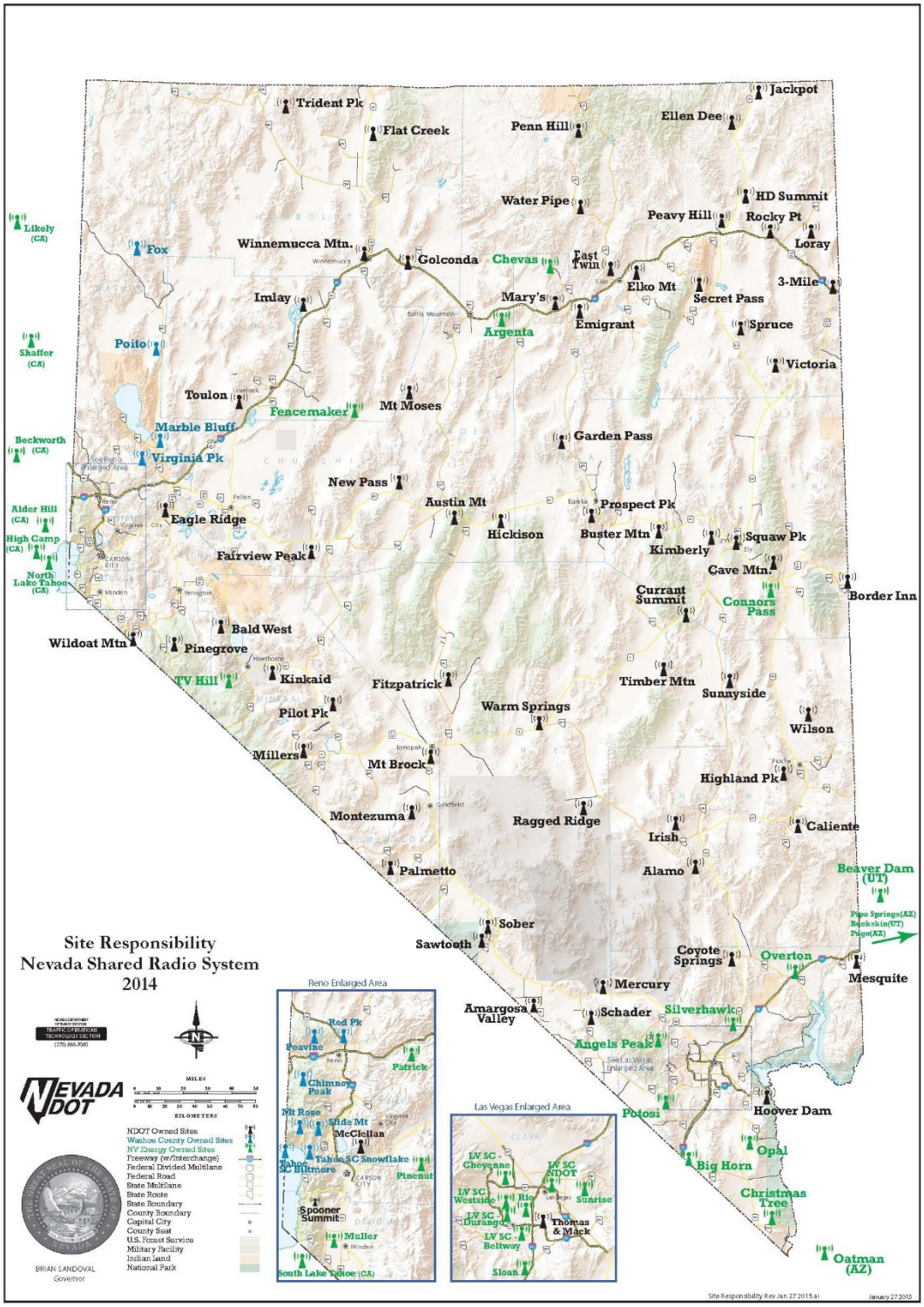

Figure 1 – Nevada Shared Radio System

Core Equipment

The system architecture for the existing radio system relies on EDACS® node equipment at the following locations:

- SP1 – NDOT, Neil Road, Reno
- SP2 – NV Energy, Neil Road, Reno
- WC1 – Washoe County, Spectrum Way, Reno
- NP1 – NV Energy, E. Lone Mt. Road, Las Vegas
- EK1 – NDOT, Idaho Street, Elko

Integral to the EDACS® nodes is the IMC™ equipment, which monitors activity at each of the connected sites and manages calls between sites and dispatch centers. Another component at each node is the Communications Systems Director (CSD). Each CSD has one group account that all users use. The CSD allows for managing communication parameters, executing special commands, and receiving activity and alarm communications.

The simulcast cells in Las Vegas and Reno have a simulcast control point, which consists of a signal audio distribution and synchronization system. This simulcast configuration allows for the simultaneous transmission and reception of identical audio and data information from the repeater sites with the same radio frequency to improve signal strength and increase coverage. This site also houses the voters for each of their respective channels. The voter system picks up signals from the repeater sites and automatically selects the signal with the best audio quality for retransmission.

Repeater Equipment

Within each stakeholder's area of operation, the existing radio system consists of strategically placed sites selected to provide the levels of coverage desired at the time of deployment. Section 3.4 of this document provides a complete list of RF site names and coordinates for each stakeholder.

The existing radio system has primary (or host) RF sites equipped with EDACS® MASTR® III repeaters, and extender RF sites equipped with FutureCom equipment. In operation, the extender site appears as a separate location to the user, and it has its own set of licensed frequencies. The host and extender sites have the same number of channel pairs. Appendix B of this document provides a complete list of RF site names and their respective channel counts.

The antenna networks typically consist of 800 MHz transmitter combiners, receiver multicouplers, transmit and receive antennas, transmission lines, system grounding and mounting hardware. RF sites within the simulcast cells have additional GPS equipment and antennas to support simulcast operation. Additionally, the Las Vegas simulcast cell has tower top amplifiers.

Dispatch Equipment

The existing radio system currently supports a number of C3 Maestro™ and Symphony dispatch consoles at various NDOT, NHP, NV Energy and Washoe County dispatch centers. Table 1 shows the quantities of existing dispatch consoles per EDACS® node.

Table 1 – Existing Dispatch Console Quantities

EDACS® Node	Console Quantity
NP1	20
EK1	10
WC1	23
SP1	10
SP2	5
Total	**68**

In addition to the above consoles, there are three new consoles attached to the VIDA switch (one at the state legislature and two at NV Energy).

The C3 Maestro™ dispatch consoles provide the following capabilities:

- Individual and group call handling
- Simultaneous monitoring of up to 112 groups
- Simulselect and Group Patching
- Calling Unit ID display
- Call history (shows who has called)
- Special handling of emergency calls
- Status/Message Display
- Paging functionality
- Handling of auxiliary inputs and outputs
- Customized and intuitive graphical user interface
- Support for a wide variety of user interfaces, including mouse, trackball, touchscreen, and a custom dispatch keyboard

- Support for a wide variety of microphones and headsets
- One speaker each for select and unselect audio

Some stakeholders, like NDOT, are in the process of replacing their C3 Maestro™ dispatch consoles with Harris Symphony consoles. Each stakeholder's voice logging recorders come from different manufacturers: NDOT uses Exacom; NV Energy uses CyberTek; and NHP and Washoe County uses Verint. Stakeholders also require interfacing of the future radio system with the existing computer aided dispatch (CAD) platforms including Spillman and Tiburon.

3.2 System Lifecycle

The current radio system has provided adequate service to the NSRS users, but multiple system components and many of the user radios are at end of the product lifecycle. A system migration or replacement strategy is crucial as the State risks irreparable failure of core system components. This could result in impaired NSRS services or system unavailability with minimal back up or alternate means of radio communications. Table 2 summarizes the current lifecycle status of key portions of the EDACS® infrastructure.

Table 2 – EDACS® Infrastructure Lifecycle Status

Item	Last Date of Manufacture	Planned End Date for Availability of Repair Parts
EDACS® IMC controller	March 2009	December 2014
GPS simulcast and voting	December 2010	December 2017
EDACS® MASTR® III Base Stations	December 2010	December 2017
EDACS® C3 Maestro Dispatch Consoles	March 2010	March 2015

Interim measures to expand or upgrade individual components or subsystems to address current short-term needs may result in stranded investments depending on the radio system alternative selected. For example, adding new dispatch consoles to the current system may require an investment in a Harris VIDA® Network Switching Center (NSC) and EDACS® IP Gateway. These components would not be reusable if the State were to select a vendor other than Harris for a replacement radio system.

The NSRS supports over 16,000 state, local agency, and utility and private sector users. Further analysis is required to determine the quantity of users' subscriber equipment

(mobiles, portables, control stations) that are P25 Phase 2 compatible and the quantity that requires replacement. New system migration strategies will also affect interim user radio replacements, as each user stakeholder must balance the need for backward compatibility with the proprietary EDACS® technology of the current radio system. Purchasing radios compatible with both P25 and EDACS® could result in a 30 to 35 percent increase in the cost of individual radios.

3.3 Site Surveys

The ***FE*** team conducted physical site surveys at 21 representative radio sites. The surveys included a mix of locally, state, and federally owned sites. The sites visited, as selected by NDOT, are the following:

- Border Inn
- Brock Mountain
- Elko Mountain
- Emigrant
- Golconda Summit
- HD Summit
- Hoover Dam
- Imlay
- Kinkaid Summit
- Loray
- Mary's Mountain
- Mercury
- Mount Moses
- Peavy Hill
- Pine Grove
- Schader
- Sober Mountain
- Sunny Side
- T&M at UNLV
- Three Mile
- Winnemucca Mountain

The purpose of performing site surveys was to assess whether the existing physical infrastructure can accommodate new/upgraded equipment, support both the EDACS and P25 equipment during testing and cutover, sustain long-term P25 system operation, and determine if site improvements to the shelter, tower, electrical, backup generator, and battery plant are required.

As part of the surveys, ***FE*** evaluated LMR control equipment, repeaters, base stations, dispatch equipment, and other critical LMR communications infrastructure installations. It is important to note that the assessment did not include structural analysis and tower climbs. ***FE*** provided NDOT with a complete and detailed site survey report for each site. ***FE*** provides the following summaries, identifying any issues that may affect the

modification and/or use of the surveyed NDOT's sites for a new/upgraded statewide system.

3.3.1 Border Inn

The Border Inn site is rather unique since it is at a small border town motel and casino in a high plains valley directly on the border with Utah. The property ownership is unknown. General construction methods were good, the site has easy access from the roadway, and there is a level of security due to the nearby Motel/Casino activity.

There are three wooden buildings built along the south portion of this site. The center building contains a specifically built site room identifiable by the short tower and mounted antenna. This is a small, purpose built site room, configurable for a third rack but has limited possibilities for further expansion without addition or modification to the entire site.

The site houses four MASTR® III repeaters in an EDACS® trunked repeater configuration. A Telco T1 or similar circuit brought in on a fiber or copper line provides backhaul to this site. A 30-foot stand-alone tower structure appears in good condition with available antenna locations. Due to the nearby high terrain, there are potential microwave paths obstructions.

3.3.2 Brock Mountain

Brock Mountain is located less than 1.5 miles south of Tonopah. Even in winter conditions, most four-wheel drive (4WD) vehicles can access the site. Property ownership is unknown. There are multiple sites with varying levels of security. The 2-story building is of older construction that may require some updating and maintenance if used for the new radio system. Most installations were generally compliant with best industry practices.

There are actually multiple towers on site belonging to other parties and space exists for an additional site structure or tower. The primary tower for the existing EDACS® installation is simply a pressure treated wood pole that might have additional capacity if verified by a proper study. Because of the tower structures onsite, there are potential microwave path obstructions. There is limited rack space available (footprint for 5-6 racks). An electrical utility and a backup generator serve this site.

3.3.3 Elko Mountain

The Elko Mountain site is located on a Bureau of Land Management (BLM)-owned mountaintop in a large wilderness highland. This site always requires a 4WD vehicle in

summer and fair weather conditions. Under certain winter conditions, access to the site requires over one hour transit time in a snowcat-type vehicle. The site serves as a prime EDACS® site with eight trunked channels currently in service, along with other VHF and 800 MHz interop channels.

The site building is aged but still serviceable. This multi-room building houses Nevada Enterprise IT Services backhaul equipment in an 8'x15' room. NDOT's and other agencies equipment resides in an 18'x40' room. Although there is expansion room available, space is limited to about five racks in the larger room only. A separate, two-room prefabricated 12'x18' shelter houses the backup generator in one room and battery system in the other room. Most installations were generally compliant with best practices.

There are actually two towers on site, and space exists for an additional site structure or tower. The 35' and 60' self-supporting structures appear to have 25+ total active antennas. There was substantial ice buildup on all exposed surfaces. Although available antenna locations are visible, a structural analysis would be necessary for additional loading or applications on either structure.

3.3.4 Emigrant

The Emigrant site is a State-owned site located approximately 34 miles southwest of the NDOT Elko yard. The site is accessible via a dirt road south of Interstate 80 on the Palisade exit. A two-wheel drive (2WD) vehicle may reach the site in summer months; however, winter months require 4WD or snowcat-type vehicle. The site has a perimeter fence that is approximately 20'x60' in good condition, gated and locked. There is surrounding land space available. However, there is a nearby U.S. Government radio site to the southeast and another radio site to the north across the interstate highway.

This is a newer site with new communications shelter and tower structure, both in good condition. The FutureCom equipment at this site provides NDOT with extended EDACS® coverage on Interstate 80 from Exit 265 to Exit 275. The site is equipped with commercial power and a propane generator. The 10'x20' prefabricated shelter has dedicated rooms for radio equipment and the backup generator. The equipment room currently houses an open rack, a closed cabinet, and a battery bank.

The site has a 60-ft monopole tower structure in good condition with visible available antenna locations. A structural analysis would be required to determine the usability of these locations. The tower currently has one fiberglass antenna at the 60-ft level, a microwave dish at the 39-ft level, and a Yagi directional antenna at the 30-ft level. Depending on the desired dish height and/or path direction, there may be potential microwave path obstructions. The shelter and tower grounding systems appear

consistent with industry best practices. Both shelter and tower also have potential space to accommodate both legacy and new equipment during transition.

3.3.5 Golconda Summit

Located approximately twenty mile east of Winnemucca, the Golconda Summit site provides EDACS® coverage in Golconda and a large surrounding area (between Battle Mountain and Winnemucca). This privately owned site is located approximately half-mile off I-80. A gravel road to the site enables high wheel 4WD vehicle to access it all year round. High Sierra Communications is the owner of this well-maintained site.

This is a shared site with multiple other users including cell carriers. High Sierra Communications provides NDOT with site space and backhaul. The 70' self-supported tower structure appears in good condition with visible available antenna locations. It is important to note that this site has multiple active and inactive antennas. Other structures on the same ridge could introduce interference and microwave path obstructions.

The 12'x28' shelter appears in good condition with rack footprint space available; 7-9 racks possible, depending on lease agreements and/or floor layout. There appears to be unused Coax and antennas at this site that if removed, may allow for additional useable space. The site is equipped with commercial power and backup generator. Building and tower installations appear consistent with industry best practices.

3.3.6 HD Summit

The HD Summit site is located approximately twenty miles north of Wells. This site is directly next to the Great Basin Highway on the elevated right of way, but it requires a 4WD vehicle in winter conditions. This State-owned site is also a virtual RF site equipped with FutureCom equipment that provides NDOT with extended EDACS® coverage.

The site uses some surplus and salvaged components but is still in serviceable condition. The 12'x26' shelter and has floor space available since it currently houses one open rack, one battery rack, and one 7' cabinet containing the actual radio system equipment. The shelter is an older Virginia Fiberglass Products design of glass over frame and plywood. The lightly loaded 60' monopole structure appears in good condition. The compound also contains a Supervisory Control and Data Acquisition (SCADA) system that reports road conditions, local temperature, and other data points located in an aged outside cabinet enclosure.

3.3.7 Hoover Dam

Located on the border between Nevada and Arizona, the Hoover Dam radio site is on a prominent hill top location. There is a well-maintained, paved road right to the tower site building. The Department of Energy owns this multiple user site with a large shared building and tower. The site serves as a prime EDACS® site with four trunked channels in service, along with other 800 MHz interop channels.

The site building is of recent construction that requires minimal updating and routine maintenance to support additional equipment. Most installations were generally compliant to best practices. There is substantial rack space still available (space for 10+ racks); however, there is limited space at this site for cable runs in cable trays. An electrical utility provides power to the site and the dam itself serves as a backup power source.

There are also numerous power transit towers on site. The static lines between them keep all towers at neutral bond due to very high voltages. The primary tower is a 250' self-supported tower that appears to have available antenna locations.

3.3.8 Imlay

The Imlay site is a full power 6-channel EDACS® site covering the surrounding area between Lovelock and Winnemucca. American Tower owns and maintains the site. Multiple users share this site, including cellular carriers. The site is accessible year round with a high-wheel 4WD vehicle.

Multiple systems co-locate within the 20'x40' single-story brick building. The building is also divided internally and the NDOT system is installed in a second room measuring 10'x20'x20'. NDOT shares this room with two cellular carriers. A space for another 2-3 rack footprints is available in this room. NDOT personnel on site were unable to gain access to the generator. Grounding systems appeared consistent with industry best practices.

The 100'+ guyed tower appears in good condition. There are multiple users of this site and varying antenna types. There were no roof-mounted antennas, but there were some mounted to the ice bridges. There appears to be space available on this tower, but additional loading of the tower would require a structural analysis. Current backhaul is to Winnemucca Mountain. Mountain ranges in the distance could interfere with other potential microwave paths.

3.3.9 Kinkaid Summit

Kinkaid Summit is a State-owned site on BLM land with access off Highway 95. This 10-channel FutureCom site extends the EDACS® coverage for this section of the nearby high plains highways serving the area Southeast of Reno. Access to the site requires a high-wheel, 4WD drive vehicle in all seasons. The site uses some surplus and salvaged components, but is still in serviceable condition.

The 8'x20' shelter structure is a converted aluminum truck body. There is limited rack and cabinet space, with room for an additional 2-4 racks. This is a standard three-corner Rohn type 45/55 tower with three guy-wire cables installed. There are several other tower sites at this location. The lightly loaded 60' tower appears in good condition.

3.3.10 Loray

The Loray site is a State-owned site located approximately nine miles Northwest of Oasis, NV. The site is accessible via a gravel driveway on an elevated right of way. A 2WD vehicle may reach the site in summer months; however, winter months require 4WD high-wheel vehicle.

This is a newer site with new communications shelter and tower structure in good condition. This FutureCom site provides NDOT with extended EDACS® coverage on Hwy 233 from Oasis to Montello. The equipment room currently houses an open rack, a closed cabinet, and a battery bank.

The site has a 60-ft monopole tower structure in good condition with visible available antenna locations. A structural analysis would be required to determine the usability of these locations. The tower currently has one fiberglass antenna at the 60' level and a reflector directional antenna at the 20' level. Depending on the desired dish height and/or path direction, there may be microwave path obstructions. Both shelter and tower also have potential space to accommodate both legacy and new equipment during transition.

3.3.11 Mary's Mountain

Mary's Mountain is a prime EDACS® site that currently covers a large segment of the "Crescent Valley" located west of Elko, NV. This site is located on a BLM owned mountain top site in a large wilderness highland. Even in summer and fair weather conditions, this site requires a 4WD vehicle. Under some winter conditions, it can require over two hour's transit time in a snowcat-type vehicle.

The 10'x30' shelter appears in good condition and houses 15 racks of radio equipment. In addition to the NDOT system, there are a number of collocated systems including broadcast, local, and federal agencies. Although there is expansion room available, space is limited to about five rack footprints. An electrical utility and a backup generator serve the site.

There are five towers on site, with some appearing to have additional capacity if verified by a proper study. Structure types vary and tower heights range from 20' to 60'. They do appear to suffer high snow and ice loading as witnessed by multiple failed antennas.

3.3.12 Mercury

This Mercury site is actually located very near the Nevada Test Site research facility. Well-maintained roads lead up to the actual mountaintop access but 4WD vehicles are highly advised. The site appears to be located on BLM land. The site serves as a prime EDACS® site with four trunked channels currently in service.

The 30'x80' site building is of older construction that would require some updating and maintenance. There is substantial rack space still available (space for 90-100 racks). Most installations were generally compliant with best industry practices.

The tower is a 60' self-supported structure that appears in good condition. Tower space and land space for an additional site structure appear available. It does not appear to suffer high snow and ice loading. Nearby mountains and another site might obstruct some microwave paths.

3.3.13 Mount Moses

Mount Moses is a prime EDACS® site that covers the basin just south of Battle Mountain. Per the NDOT crew, this site can become unreachable during winter conditions even in a snowcat. During summer months, a high wheel 4WD can reach this site if the road has not been washed out during the flood season, or with rockslides.

American Tower owns the building and tower that NDOT uses. Multiple users share this site, including cellular carriers. Due to the amount of tower loading on the existing 100' structure, guy wires were added last year to help support the load. Limited space on this tower would require a structural loading study before any additional loading of the tower.

The 12'x24' shelter appears in good condition and has some rack space available. However, the space is limited to four to five rack footprints. Currently only three racks in this shelter are NDOT, and the remaining five belong to two other tenants in the shelter.

NDOT personnel on site were unable to gain access to the generator building or the other two shelters near the tower. Due to winter weather conditions there was noticeable damage to microwave arrays and a ventilation system on the generator building due to ice falling from the tower. The shelter had an ice bridge covering the entire structure.

3.3.14 Peavy Hill

Located approximately 6.5 miles north of Wells, this prime EDACS® site currently covers a large segment of the region north of Wells and surrounding geography. During the summer months, the site is accessible by a 4WD vehicle; however, winter months require a snowcat-type vehicle to gain access.

The TV district owns the property, but NDOT owns the building and tower structures. The 12'x24' shelter is of recent vintage, actively updated with newer construction methods, and is generally compliant with best industry practices. Limited rack space still available would accommodate no more than three additional racks. An electrical utility and a backup generator serve this site.

There are actually two towers on site, one of which is scheduled for removal to allow for an additional site structure. The primary tower is a new 140' self-supported structure that appears to have additional space available. It does appear to suffer high snow and ice loading. There are multiple towers in the vicinity along with surrounding mountains and hills that might prevent certain microwave paths.

3.3.15 Pine Grove

The Pine Grove site is located on a prominent mountain top BLM location, approximately 45 miles southeast of Carson City. Access by 4WD vehicle during summer months is possible only on BLM maintained roads; however, access requires a snowcat-type vehicle during snow season. The site serves as a prime EDACS® site and supports other VHF and 800 MHz interop channels.

The 9'x21' site building is of unique construction having formerly been a military radar equipment room designed for vehicular transport. If it remains in service, it would require some updating and maintenance. There is limited rack space still available (space for 4-5 racks). Most installations were generally compliant with best industry practices. An electrical utility and shared backup generator serve this site. The generator was not accessible during the site visit. It is shared with the adjacent site, which also belongs to the State of Nevada.

There are other towers on site, and space available to allow for an additional site structure or tower. The primary 60’ self-supported tower currently supports multiple LMR antennas and microwave dishes, but appears to have additional space. It does appear to suffer high snow and ice loading.

3.3.16 Schader

Located on a prominent mountain top location approximately 55 miles northwest of Las Vegas, the Schader site serves as a prime EDACS® RF site. NDOT occasionally blades the access road, and the site is easily accessed using a standard 4WD pickup type truck. BLM leases land to Arizona Nevada Tower, and there is space for an additional site structure or tower.

The 10’x14’ site building is of new construction, and requires minimal maintenance. Most installations were generally compliant to best practices. This site is powered by a combination of solar power, and an automatic start generator that charges the batteries on cloudy days. There are multiple rooms in the site building, and there is rack space still available.

The primary tower is a 180’ self-supported structure that appears in good condition with visible available antenna locations. The structure does not appear overloaded, but a nearby site and surrounding landscape are potential microwave path obstructions.

3.3.17 Sober Mountain

Sober Mountain, located on a prominent mountain top location, is approximately 13 miles north of Beatty. An unimproved stone road allows 4WD high wheel clearance. The State-owned site houses EDACS® repeater equipment and other Mutual Aid and conventional resources.

The 10’x22’ shelter is of fiberglass construction that would require some updating and maintenance. There is limited rack space still available (space for 5-6 racks). Most installations were generally compliant with best industry practices. An electrical utility and a backup generator serve the site.

There are actually three towers on site, and space to allow for an additional site structure or tower. Only the substantial four corner steel structure serves the NDOT. That primary tower is 40’ and appears to have additional space if verified by a proper study.

3.3.18 Sunny Side

Sunny Side is a rather unique site located approximately 200 yards off the paved rest area. A gravel lot used by NDOT is also in front of this site (used for dirt and gravel). A 2WD vehicle should be able to get to this site year round. The site supports four full power MASTR® III repeaters in an EDACS® trunked repeater configuration and serves the White River Reservoir area in the Great Valley south of Ely, NV.

The land appears to be state owned and has adequate room for expansion on the facility or tower if needed. The 12'x16' shelter appears to be a re-use site. It appears to be in great shape and has expansion potential for 4-8 rack footprints, with a reconfiguration of existing racks.

The 60' tower structure appears to be recent and in good condition. The backhaul to this site appears to be served by a circuit brought in on a point-to-point microwave link repeater located in a nearby pasture having a line of sight path to the overall backhaul network. General construction methods were good, and the site has easy access from the roadway.

3.3.19 T&M at UNLV

This University of Nevada, Las Vegas (UNLV) stadium site situated on a metro area roof top location serves the larger Las Vegas area. Access is on well-maintained, City streets in an area of minimal snowfall. The site serves as a prime EDACS® trunked repeater site. This is the enclosed Thomas and Mack (T&M) arena facility. Equipment is in the top floor announcer area.

The site building is of very substantial construction that would survive a large weather or disaster incident with routine maintenance. This is a large complex, but the dimensions for the actual equipment room are 13'x22'. The antenna is mounted approximately at 100' on a roof access catwalk made of expanded steel. The installations were generally compliant with best industry practices. There is very limited rack space still available (space for 2-3 racks). An electrical utility and a backup generator serve this site.

3.3.20 Three Mile

The Three Mile site is well located and currently serves the eastern portion of this NDOT district. American Tower operates this site under contract. The site is reachable by a 4WD high wheel vehicle in most winter conditions. This is a full power site utilizing Harris MASTR® III repeaters as part of the EDACS® radio system.

The site has a 200’ tower structure built to support multiple microwave antennas. The structure could accommodate additional antenna loading, pending results from structural analysis.

The site is a well-constructed, former telephone facility. Access to this site is well protected, and the footprint of this site is substantial. The 46’x80’ concrete building has very substantial floor space available for lease from American Tower.

3.3.21 Winnemucca Mountain

Winnemucca Mountain is well located and covers a large area around Winnemucca. This site is accessible by a paved road during summer months by a 2WD or 4WD vehicle. During winter months, it is only reachable by snowcat. The site houses EDACS® repeater equipment and other interoperability resources.

Multiple users share this site, including cellular carriers. However, personnel on site were unable to gain full access to the building. EITS and NDOT maintain the building and towers on this compound. There are three tower structures utilizing this equipment building. NDOT utilizes two rooms inside this overall structure, and shares the power distribution, generator and tower with other users. There is rack footprint space available; however, that would be determined by lease agreements. The primary tower is an 80’ guyed structure that appears in good condition. Other multiple structures on the same ridge could introduce interference and microwave path obstructions.

3.4 Existing Coverage

The following maps display "as-is" coverage as predicted by the state of Nevada. ***FE*** makes no assertions regarding the accuracy of these predictions. We provide the following maps to establish a baseline of existing coverage when evaluating future system alternatives:

- Existing 800 MHz NSRS mobile radio talk-out coverage from NDOT sites
- Existing 800 MHz NSRS mobile radio talk-out coverage from NV Energy sites
- Existing 800 MHz NSRS mobile radio talk-out coverage from Washoe County sites
- Existing 800 MHz NSRS mobile radio talk-out coverage from all stakeholder sites

Figure 2 shows the existing 800 MHz NSRS mobile radio talk-out coverage from NDOT sites.

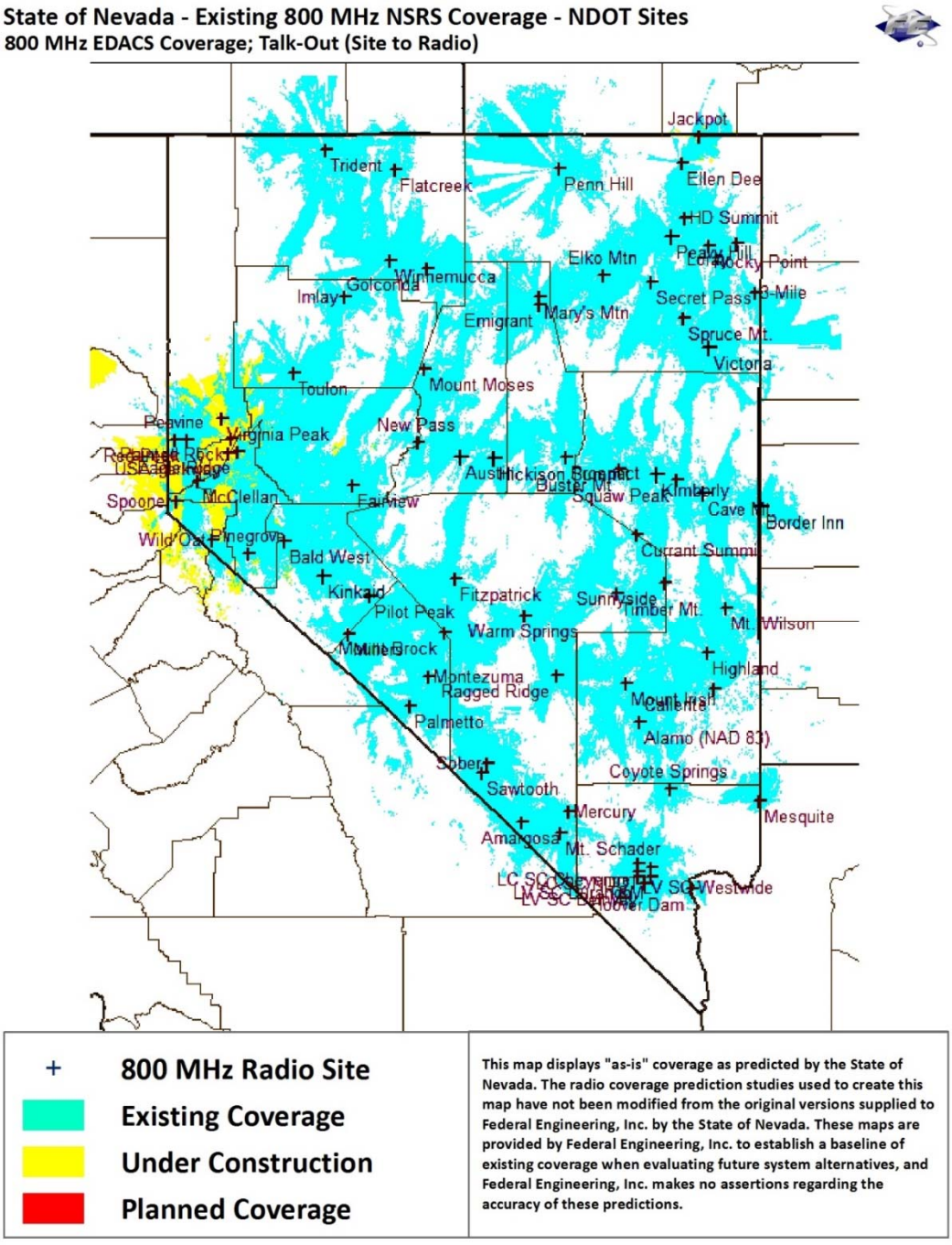

Figure 2 – Existing 800 MHz NSRS Mobile Radio Talk-out Coverage from NDOT sites

Figure 3 shows the existing 800 MHz NSRS mobile radio talk-out coverage from NV Energy sites.

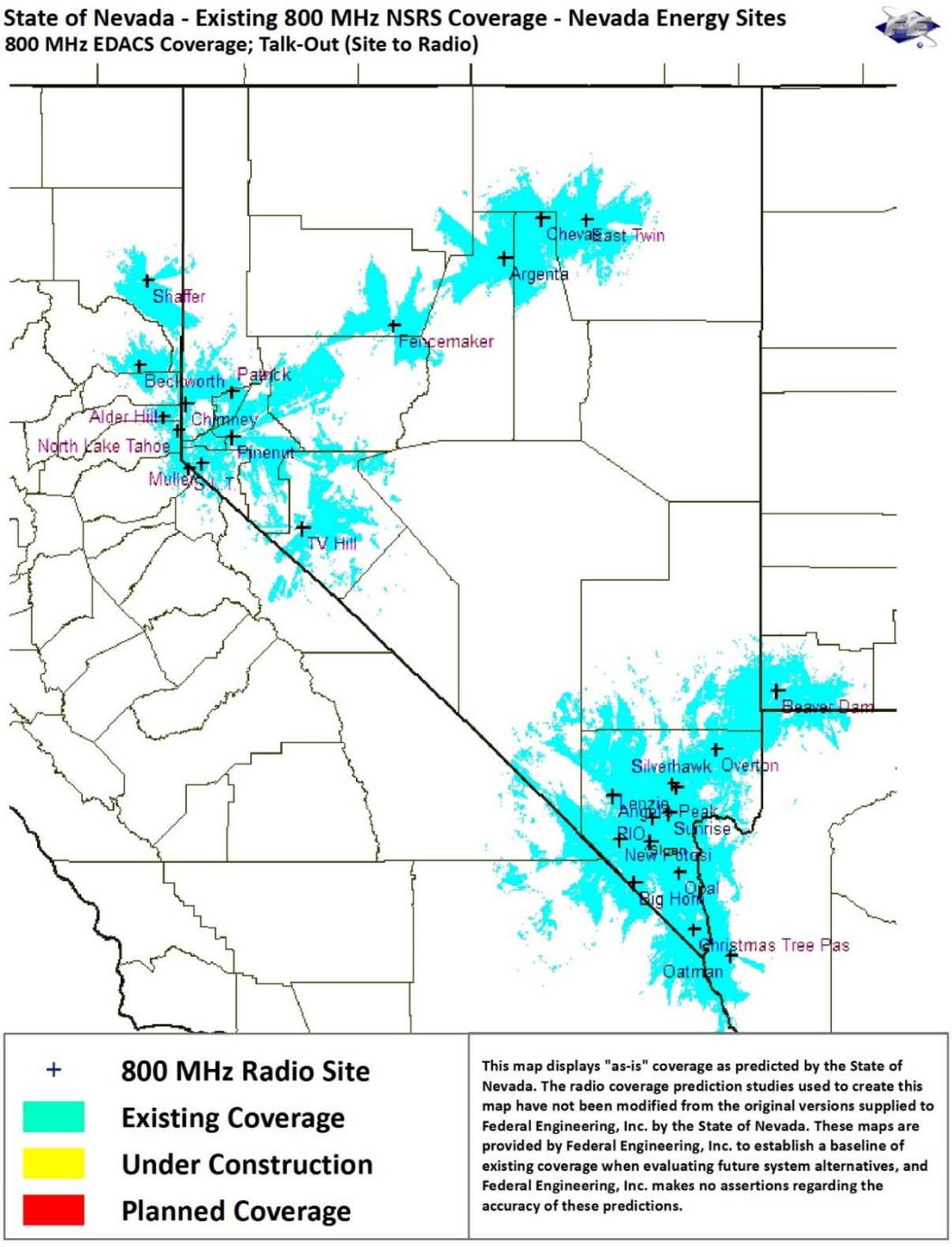

Figure 3 – Existing 800 MHz NSRS Mobile Radio Talk-out Coverage from NV Energy sites

Figure 4 shows the existing 800 MHz NSRS mobile radio talk-out coverage from Washoe County sites.

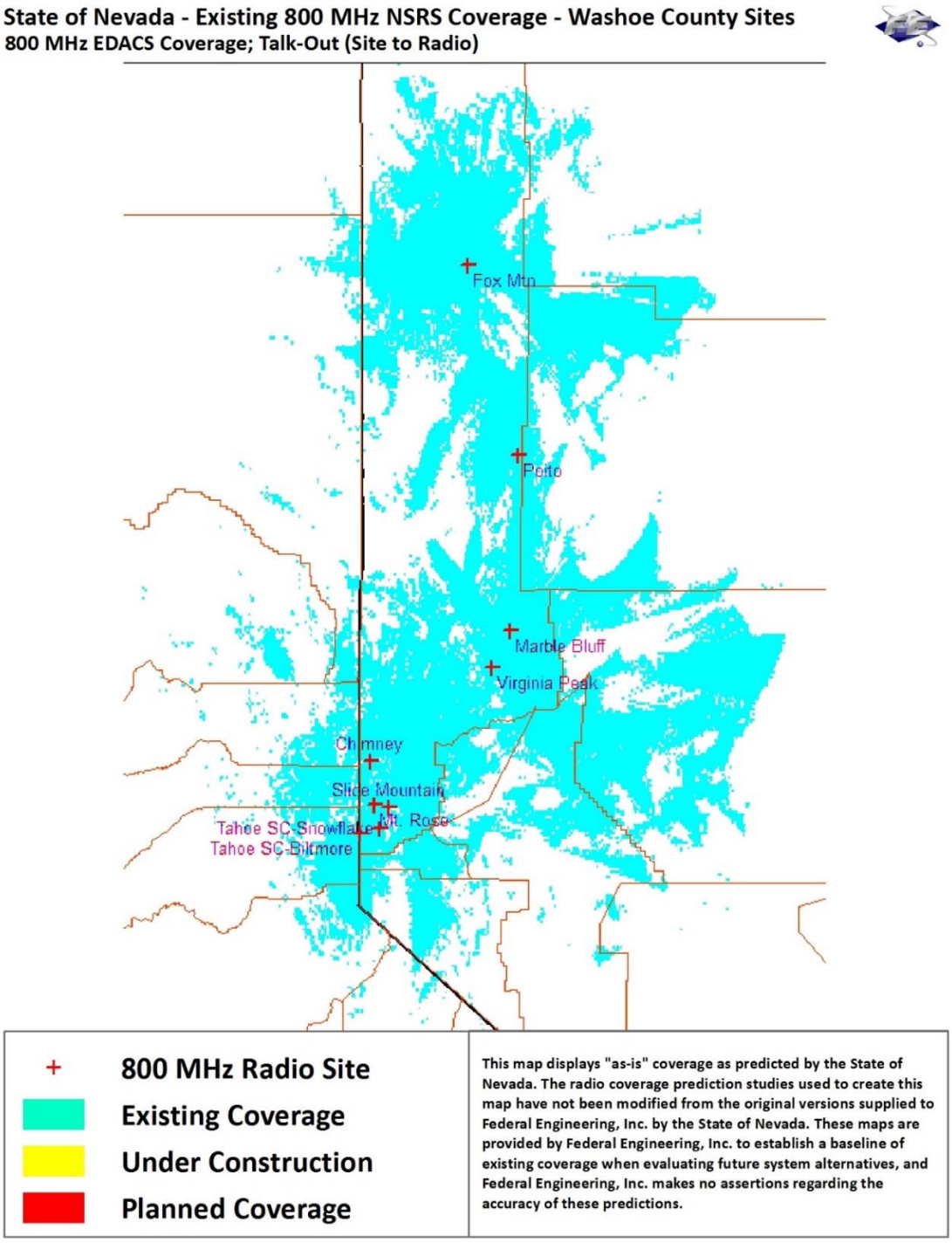

Figure 4 – Existing 800 MHz NSRS Mobile Radio Talk-out Coverage from Washoe County sites

Figure 5 shows the existing 800 MHz NSRS mobile radio talk-out coverage from all stakeholder sites.

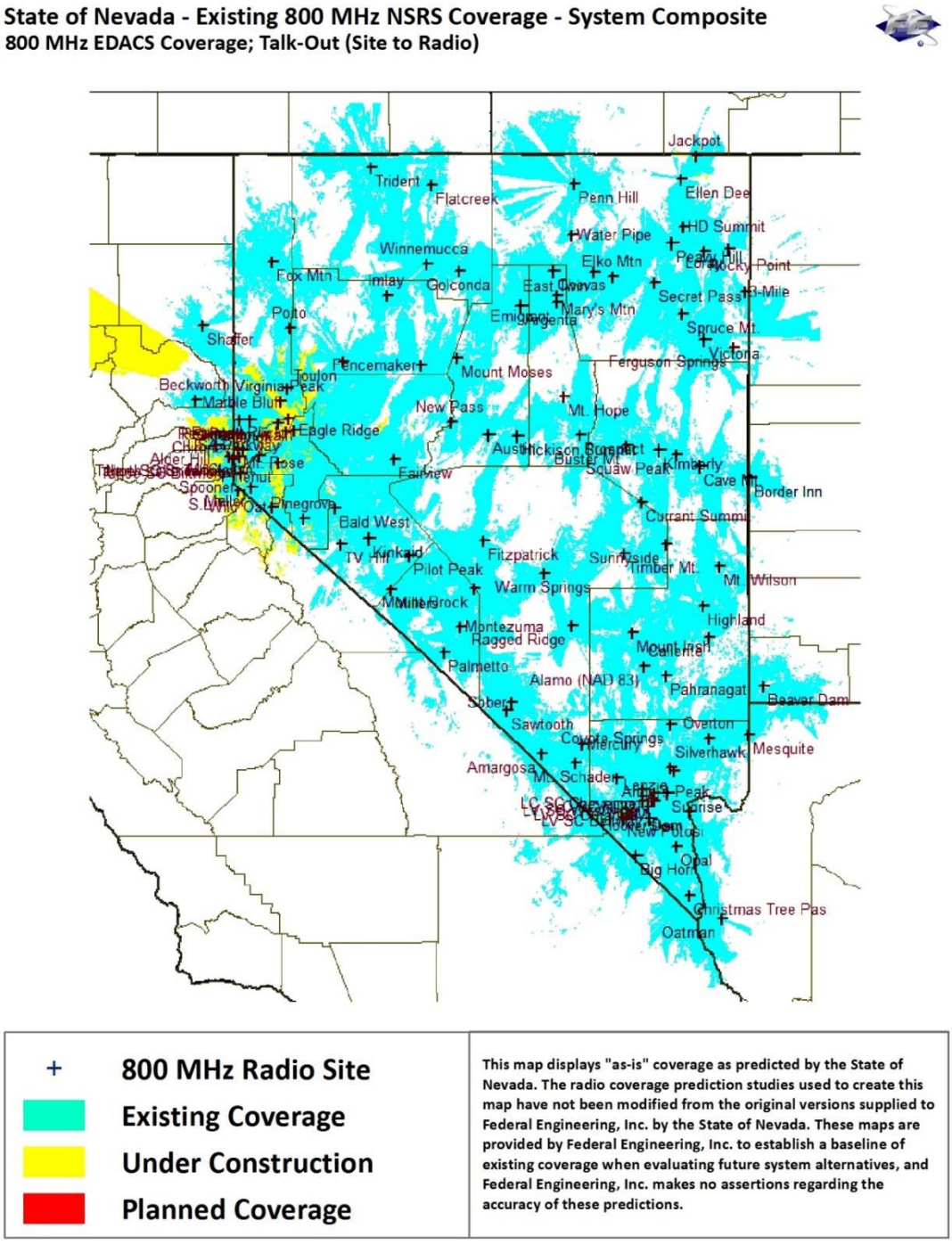

Figure 5 – Existing 800 MHz NSRS Mobile Radio Talk-out Coverage from all stakeholder sites

3.5 Capacity Analysis

The channel capacity analysis focused on reviewing the frequencies currently in use throughout the NSRS, and reviewing user traffic data provided by stakeholders. This section provides the results of the capacity analysis of the NSRS. ***FE*** used the following data provided by NSRS to perform the analysis:

- Current frequencies in use throughout the NSRS, including FCC call signs, for 108 NSRS radio sites in the following subsystems:
  - EK1
  - NP1
  - SP1
  - SP2
  - Washoe County (WC1)
  - FutureCom (FC)
- User traffic data for the year of 2015, including number of calls, call durations, and queued calls, on an hourly and monthly basis, for 88 of the NSRS radio sites.
  - No traffic data was supplied for the 17 FutureCom sites, nor was it supplied for three of the NSRS radio sites (Alamo, Coyote Springs, North Lake Tahoe)
  - The donor sites reflect traffic from their respective FutureCom extender sites

3.5.1 Existing Frequencies

Appendix A provides a summary of the number of frequencies in use at 108 sites throughout the NSRS, as well as their associated FCC call signs. Three of the sites listed (LV Simulcast, Metro Simulcast, and Tahoe Simulcast) are represented as a single entry due to the simulcast configuration of these sites. In actuality, these simulcast sites comprise multiple RF locations broadcasting the same frequency set.

Appendix B lists the licensed frequencies in use at 108 sites throughout the NSRS. Each frequency listed is actually a frequency pair (e.g., 857/812.8625 is a paired combination of 857.8625 MHz and 812.8625 MHz), where the higher frequency is the site's transmit frequency (downlink), and the lower frequency is the site's receive frequency (uplink).

3.5.2 Traffic Analysis

FE analyzed the supplied hourly and monthly user traffic data. The following graphs summarize pertinent traffic data metrics for the five NSRS subsystems and their respective sites. As noted previously, FutureCom sites are not part of this analysis.

Graphs for each of the five subsystems (EK1, NP1, SP1, SP2, WC1) are provided for each of the following traffic metrics:

- Voice Calls per Hour per Channel throughout 2015, by site
- Most Voice Calls in One Hour, by site
- Voice Calls Queued throughout 2015, by site
- % of Voice Calls Queued throughout 2015, by site
- Most Voice Calls Queued in One Hour, by site

Voice Calls per Hour per Channel throughout 2015, by site is included below, while Appendix C of this document includes the remaining metrics.

In the following graphs, ***FE*** calculates the **"Average" voice calls per hour per channel** by dividing the total number of voice calls, per site, by the number of hours of provided data for that site in 2015. The result is then divided by the number of voice channels / frequencies for each site as shown in Table A.1 in Appendix A. This metric provides a reasonable snapshot of the overall per-channel usage at each site within the NSRS.

The **"Peak" voice calls per hour per channel** is calculated for each site by determining which hour of the day (e.g., 2:00 p.m. to 3:00 p.m.) had the most calls for each site throughout the year. Once determined, the number of voice calls for just that peak hour (for each site) are averaged over the entire year. The result is divided by the number of voice channels at each site. This metric demonstrates channel capacity use during the busiest times of the day.

Figure 6 shows the EK1 average and peak voice calls per hour per channel in 2015.

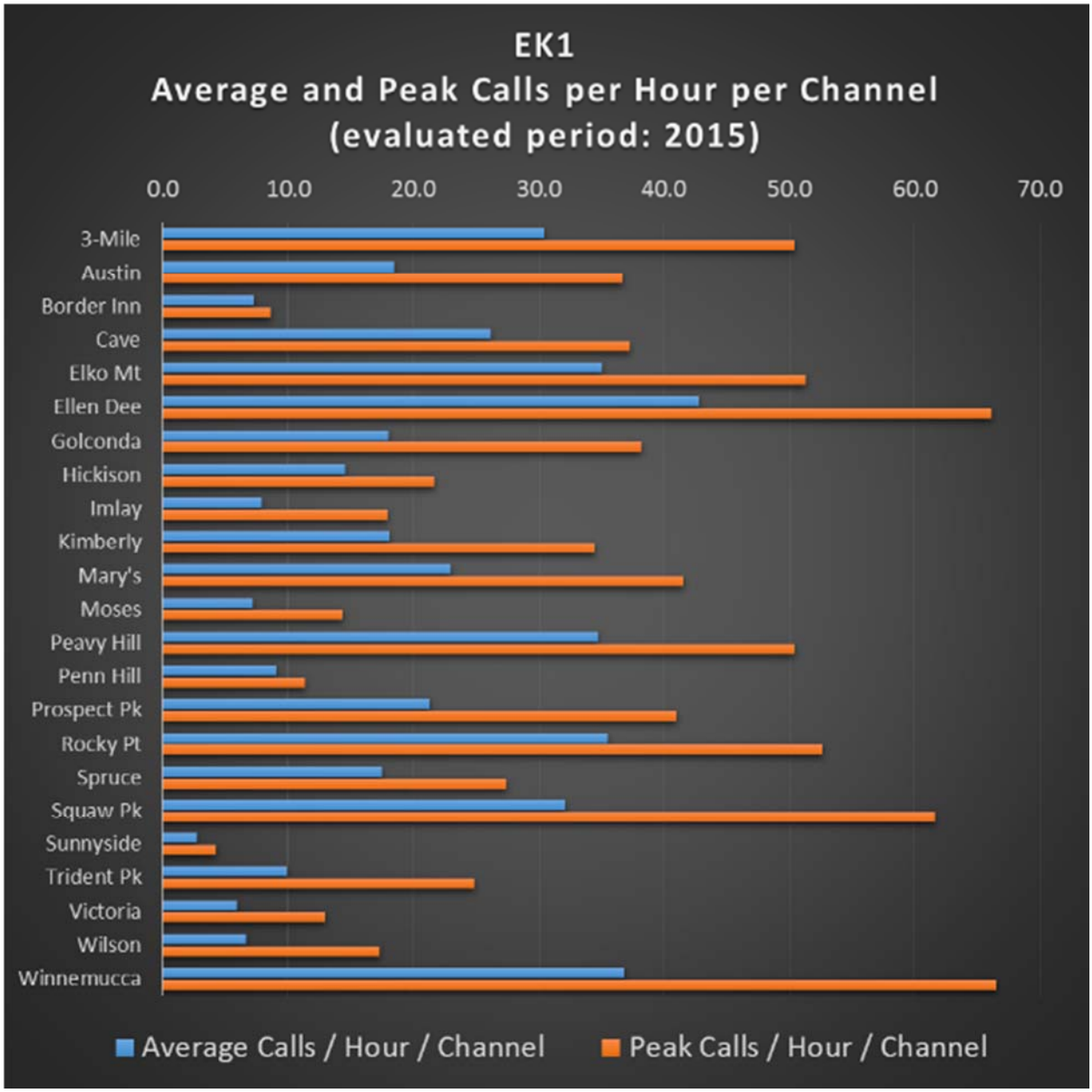

Figure 6 - EK1 – Average and Peak Voice Calls per Hour per Channel (evaluated period: 2015)

Figure 7 shows the NP1 average and peak voice calls per hour per channel in 2015.

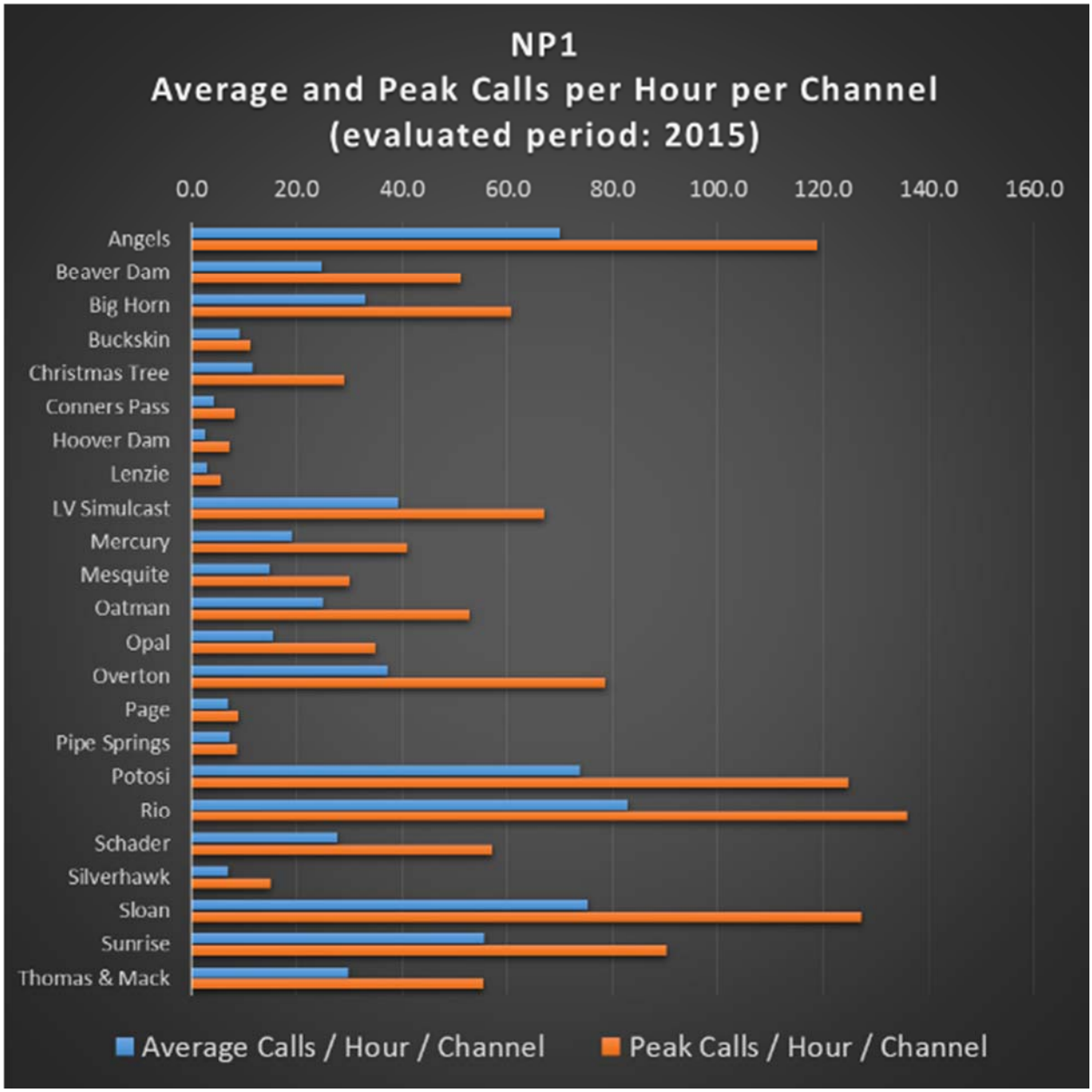

Figure 7 – NP1 – Average and Peak Voice Calls per Hour per Channel (evaluated period: 2015)

Figure 8 shows the SP1 average and peak voice calls per hour per channel in 2015.

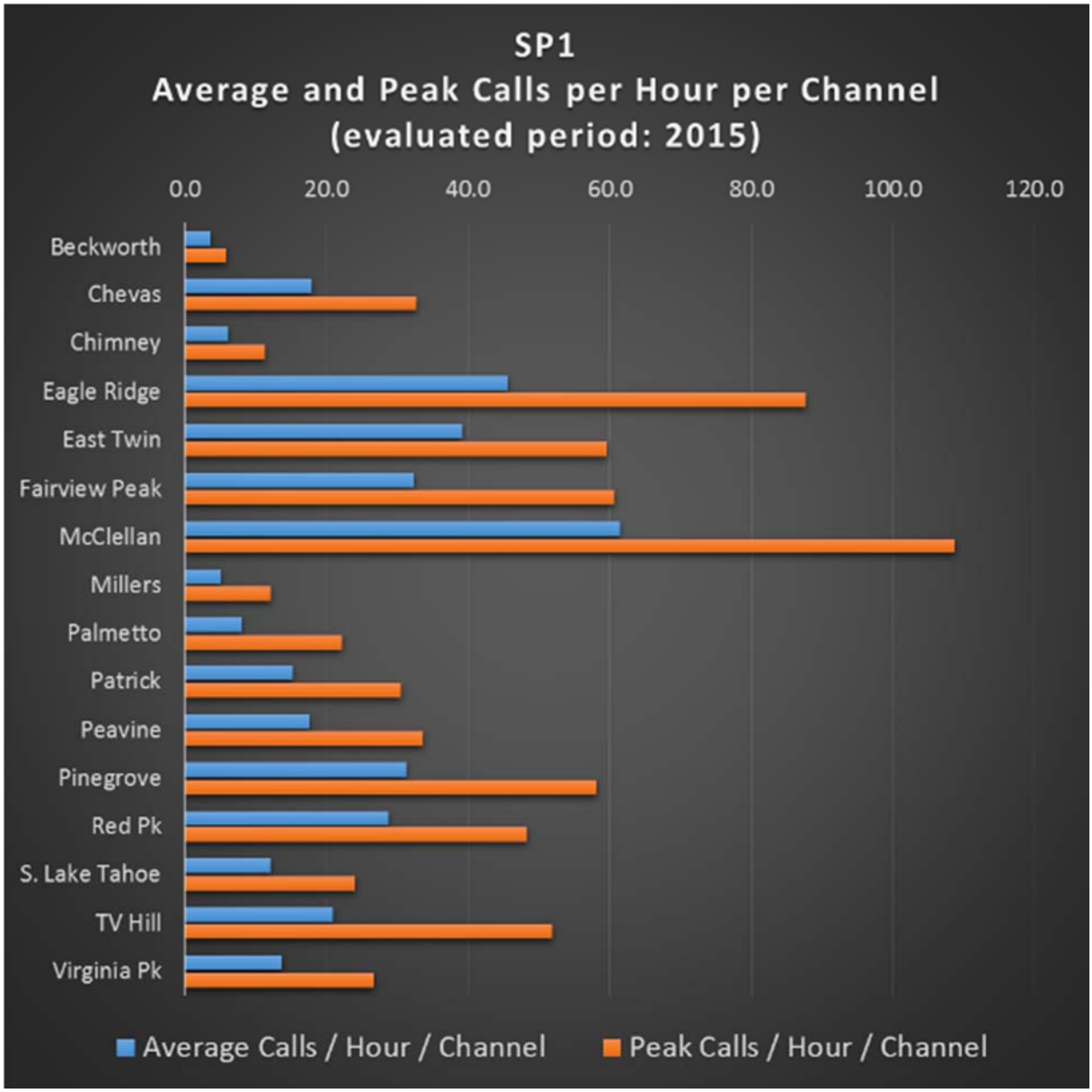

Figure 8 – SP1 – Average and Peak Voice Calls per Hour per Channel (evaluated period: 2015)

Figure 9 shows the SP2 average and peak voice calls per hour per channel in 2015.

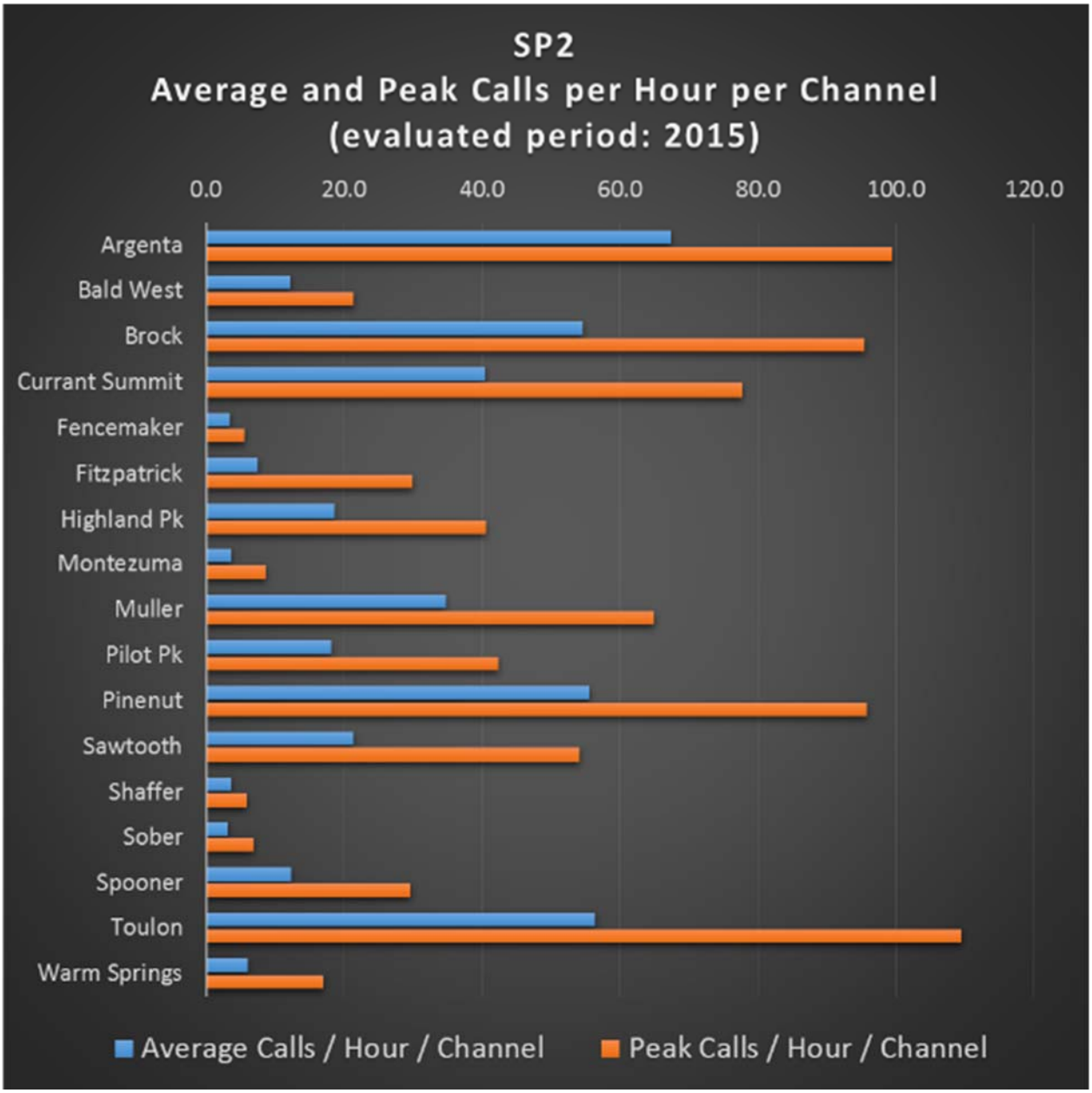

Figure 9 – SP2 – Average and Peak Voice Calls per Hour per Channel (evaluated period: 2015)

Figure 10 shows the WC1 average and peak voice calls per hour per channel in 2015.

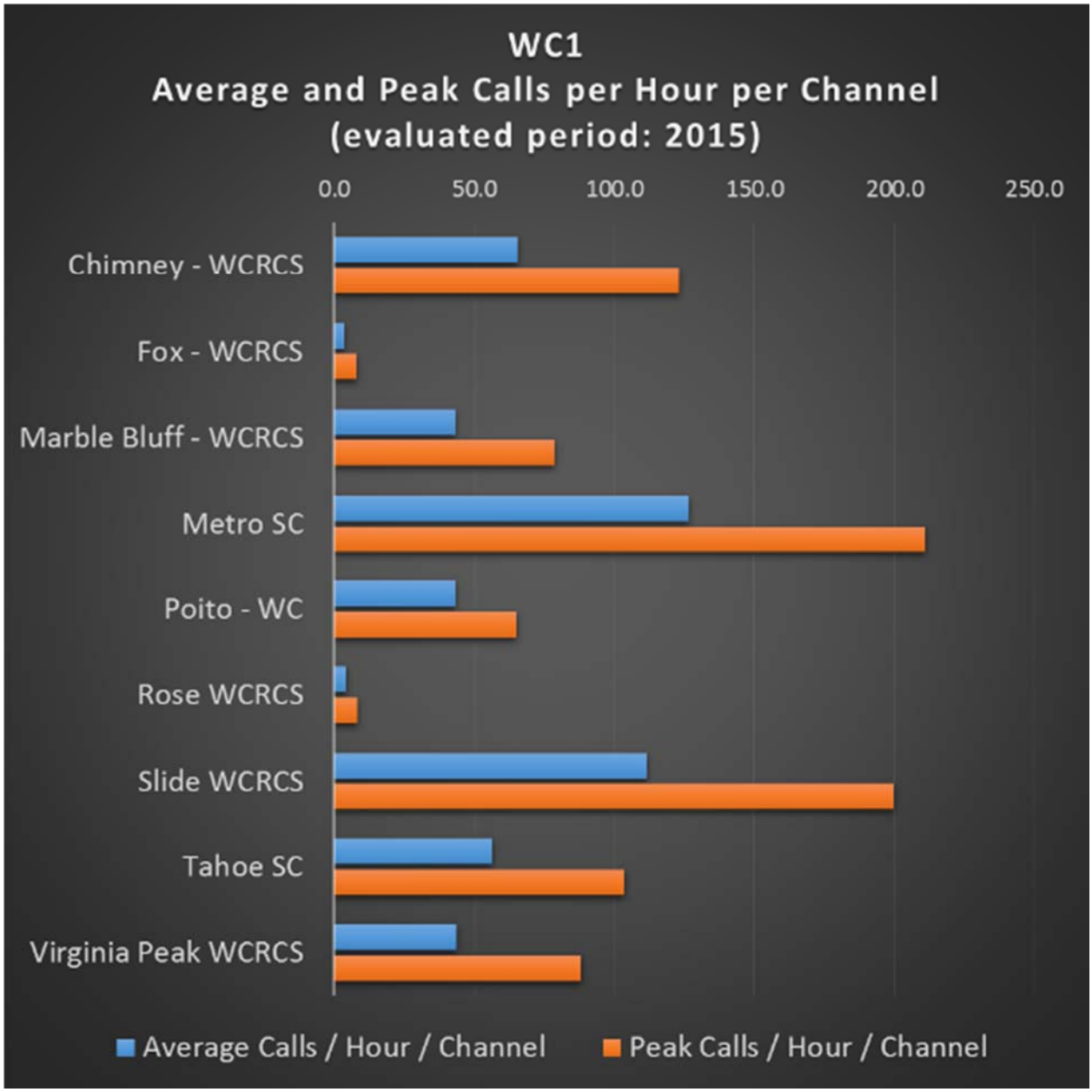

Figure 10 – WC1 – Average and Peak Voice Calls per Hour per Channel (evaluated period: 2015)

While Appendix C provides additional details, ***FE*** provides the following summary of key findings from the traffic analysis:

- The busiest sites are in the Washoe County subsystem (WC1), specifically the Metro Simulcast and Slide sites, where the average traffic is over 100 calls per

channel per hour, and the peak traffic is approximately 200 calls per channel per hour.

- The Cave and Winnemucca sites in the EK1 subsystem had the most calls per channel during an hour in 2015, which may be reflective of anomalous high-traffic incidents given they have relatively low average and peak traffic per channel.
- Several sites experienced queued calls in the thousands including Brock, Pilot Peak and Pinenut in the SP2 subsystem with more than 3,000 queued calls; however, the Potosi site in the NP1 subsystem had more than 6,000 queued calls.
- The Millers site in the SP1 subsystem was the only site with more than 1 of every 100 call attempts queued or blocked, thus exceeding the 1% Grade of Service (GoS) recommended for public safety. Most of the other sites in the NSRS have a much lower queuing rate.
- Sites with the most queued calls in one hour in their subsystem include Mary's (EK1), Potosi (NP1), Pinegrove (SP1), Spooner (SP2), and Metro SC (WC1). Despite having a relatively low GoS, this may be an indication of how a single incident caused the channel capacity to be insufficient at those sites.

3.5.3 Call Duration and Unit Totals

User traffic data provided by NSRS stakeholders included unit totals (number of subscriber units actively using the sites on an hourly basis), as well as the total duration of the calls on each site. ***FE*** will leverage this data when evaluating the necessary capacity for a future NSRS system alternative.

3.6 Backhaul Network

It is important to note that the assessment of existing microwave networks is not within the scope of this project. Under a separate project, the State has issued a request for proposals (RFP) from qualified vendors to provide turnkey replacement of its existing microwave network.

4. User Requirements Analysis

In order to assess satisfaction with the current system performance and identify the future system requirements, ***FE*** completed a qualitative and quantitative analysis of web-based surveys and in-person and telephone interviews. In addition to the cumulative data results from key stakeholders, we highlight any agency-specific comments or concerns.

4.1 System Coverage

Analysis of the web survey and user interview results concludes that existing system coverage is an area of concern for many users of the NSRS, as illustrated in Figure 11.

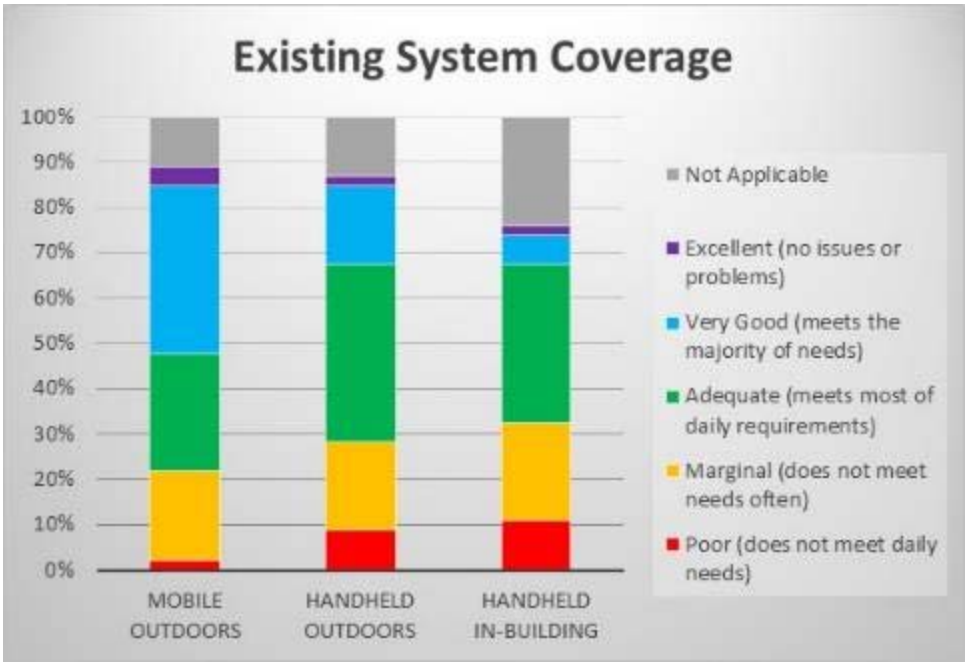

Figure 11 – Existing System Coverage

Not even half of the field users reported mobile coverage as good or excellent, and less than one-fourth of field users reported good or excellent coverage for portable radios on street or in building. According to field users, portable radios work better in single story buildings, and they very rarely work underground.

Field users, dispatchers, technical support, and management personnel from NDOT, NV Energy, Washoe County, and NHP identified the following known areas of poor or inadequate coverage unique to their areas of operation.

NDOT

- US 95 south of Schurz- SR 722 in both Churchill and Lander Counties
- SR 359- SR 338- IR 80 between Patrick and Wadsworth- SR 839, SR447
- US 395 @ MP 37.47 to 41.63
- SR 445 @ MP 26.88 to 44.01
- Mountainous region around Virginia City, NV
- I-580 between Mt. Rose and Washoe Valley
- I-80 corridor, some rural locations like Smith Valley
- I-80 between Vista and Mustang
- Few areas at Lake Tahoe
- South of Gardnerville, between Nixon and Gerlach
- Lincoln and Nye county areas
- Lockwood and Mustang
- West of Hawthorne
- Indian Springs area on State RT 95 just north of Las Vegas
- About half of State RT 163 between ST 95 and Laughlin (some blind curve areas with no radio or cell coverage)
- I80 EB around USA Parkway, Anchorite Pass, North/South Lake Tahoe, Incline Village
- In Laughlin, and Lincoln County there are many "dead" spots
- Jackpot, Wells, Ely, Eureka, Lovelock, Orvada, SR225, and SR227 MM4 to MM8
- US-95 between Lee Canyon and Indian Springs
- US-93 between I-15 and Parhanagat Valley

- Mountain Springs, heading west on SR160
- SR375, east of Rachel, to the Hancock Summit
- SR318, from mm 18 to the Nye County line
- Lovelock, Eureka, Jackpot, Wells, Ely Carlin Tunnel area and West Wendover, Winnemucca
- Parts of I-80 corridor between Sparks and Fernley
- Remote parts of Eastern Nevada
- More remote users particularly Ely, Austin area have limited coverage
- In building coverage is spotty at times, specifically the Capitol building in Carson City
- Some locations like West Kingsbury Grade maintenance station could use better coverage
- Capital Police have issues inside the Grant Sawyer building @ 555 E. Washington Ave. in Las Vegas
- Parole and Probation officers have issues inside their offices @ 215 E. Bonanza Rd. in Las Vegas

NV Energy

- Rural areas
- Frontier Sub, Coyote Sub, Gabbs and many more
- SR-28, SR-207, SR-431
- Laughlin, Lockwood, Mt. Charleston
- US 50 Spooner Summit
- Most buildings including substations and power plants
- Inside buildings downtown Reno especially in basements

- Generation Plants in the Apex Valley / Arrow Canyon
- Poor and spotty coverage all over the district areas in all areas of eastern Nevada and in the Truckee Meadows area along with Carson area as well
- In areas near Laughlin, there is diminished coverage when traveling from the 93 into Laughlin
- Indian Springs has sporadic coverage around the sub-station there
- The Alamo area has had persistent issues with coverage and sites not maintaining power during the winter months
- Parts of highway 50, highway 6, and highway 376
- Sandia or Tiads substation

Washoe County

- Canyons and mountains in the Gerlach/Vya area
- Hwy 34 is hit or miss coverage as far as transmit/receive
- Northern Washoe County (Potio repeater and Fox Mt. Repeater)
- Eastern Washoe County (Painted Rock area)
- Golden and Sun Valley areas
- Rancho Haven
- Red Rock Road
- Pyramid Hwy north at Axe Handle to include areas East and West
- Pyramid Lake
- Mt. Rose Hwy Corridor
- Incline Village (Third Creek area)
- I-80 corridor between Reno and Fernley
- Mustang; Palomino Valley; Fish Springs
- I-80 corridor from USA Pkwy to Painted Rock. Lockwood.
- Mount Rose Hwy-St Route 431
- Highland Ranch-Pyramid Hwy to Sun Valley
- East Shore of Lake Tahoe

- North of Spanish Springs
- North Valleys to California state line
- Verdi area
- Lemmon Valley - Far out
- Spanish Springs Region (Spanish Springs High School)
- Toll Road/Geiger Grade, SR 341
- Hidden Valley and area of Rattle Snake Mtn.-north side
- The Nugget is a massive problem, and has been for years
- Most of the Northern Washoe Area is poor inside buildings
- Bigger or multi-level buildings with basement
- Renown Regional Medical Center-main building on Mill St.
- Cold Springs and O'Brien Middle School
- Donner Springs Elementary School
- Majority of the major hotel/casinos of Reno/Sparks
- Reno/Sparks Convention Center
- Casinos, high-rise buildings, in the basement or below grade
- The canyon between Sparks and Wadsworth
- Cold Springs Middle School
- Damonte Ranch High School
- North Valleys, I-80 East, East Sparks/Spanish Springs
- Patrick area along I-80, Red Rock Rd. north of Stead, Pyramid Highway from McCarran Blvd. north to Spanish Springs.

- The Red Rock/Rancho Haven area north of Reno, the I-80 Canyon East of Reno, Lake Tahoe Basin, East to South East and areas on the west shore, the Black Rock Desert North East of Gerlach, NV, Northern Washoe County.
- Red Rock area
- Boomtown/Verdi, Mount Rose
- Downtown Reno, UNR campus
- A major building would be the Nugget Casino in Sparks
- Larger Casinos and Hospitals are problematic
- Reno Police Dept. Building, City Hall, airport plaza, Citi Center, Lawlor Events Center, downtown Event Center, 4th Street Station
- Sun Valley, Spanish Springs and other outlying areas

NHP

- I-80 corridor (Painted Rock)
- US 93 & 168 (Coyote Springs)
- I-15, areas East and West of Overton site
- I-15, mile marker 17 to 20 (Primm)
- Hwy 395, area North of US 50
- US 6, areas East and West of Warm Springs site
- HWY 50 between 28 and 395 Lake Tahoe area
- SR163 through pass between 95 and Laughlin Indian Springs area – Mt Charleston and Creech AFB
- 95 between markers 110cl -118 cl radios don't work
- SR156 Top 3/4 miles radios don't work
- SR158 between markers 5cl-8cl - radios are hit and miss

- 95 cl/ny county line - radios are hit and miss
- 95 1ny-12ny (the narrows) hit and miss
- SR 160 between markers 23cl-30cl radios don't work
- 93 1 ln-25 ln
- SR 318 22 ln - 19 ny
- 93 Caliente Area 83 ln - 95 ln radios hit or miss
- SR 375 39 ln - 32 ny radios hit or miss
- SR 319 5 ln eb to 20 ln radios hit or miss
- US93 near mm 70 Clark
- I-80 from Lockwood to Wadsworth
- I-80 between mm36 and mm40
- I-80 in the canyons between Reno, Sparks and Fernley
- 50w in area of junction sr28"
- WCSO Jail at Parr Blvd
- Inside most substations
- Capitol Building
- North Lake Tahoe
- Spooner summit
- Areas outside of Tonopah
- Maybe others in South NV

The consensus is that there are a large number of dead areas in the current system, particularly in rural areas and in buildings. Unless facilities have coverage extenders installed, there are a number of issues in different structure types, such as multi-story buildings, jails, hospitals, casinos and campuses.

Figure 12 shows that over 80% of system users surveyed expressed the need for improved mobile radio coverage, and over half of the system users expressed the need for improved portable radio coverage on street and in buildings.

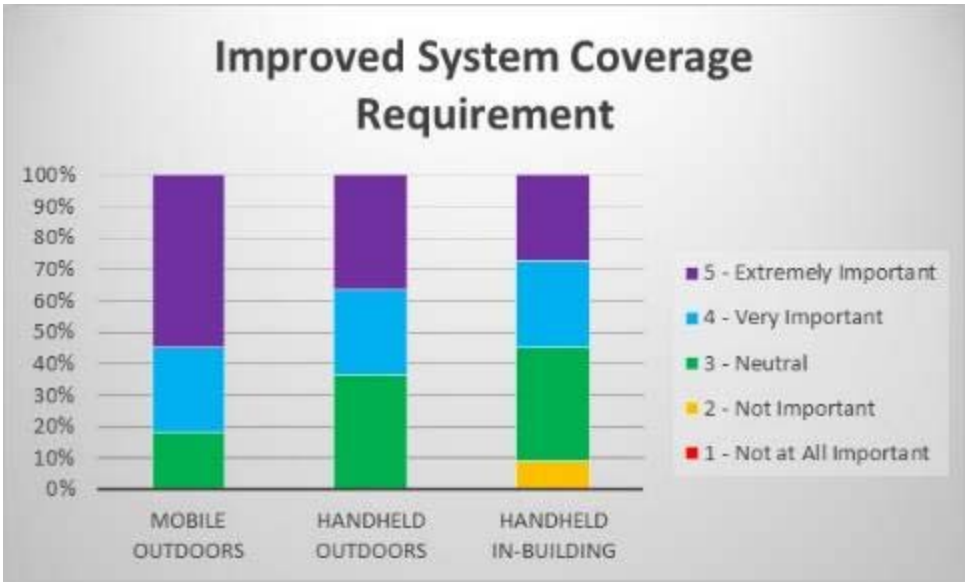

Figure 12 – Improved System Coverage Requirement

During the interviews, stakeholders reiterated the importance of additional tower locations construction to address the numerous areas of inadequate coverage for public service and public safety users.

Another concern communicated in the interviews is the impact of moving to a different frequency band and migrating to an all-digital radio system. As a result, all stakeholders agree that the new system shall provide, at a minimum, the equivalent coverage that exists today, but also address the areas of inadequate coverage. As stated by NDOT and other key stakeholders, system coverage is required on all State maintained highways of Nevada.

In addition to the previously identified areas, NDOT conveys that locations requiring improved coverage are in the fringe locations outside of the main state Core, such as highways approaching the neighboring states. NV Energy also expresses the need for radio coverage at future transmission lines and substations throughout the State. Washoe County emphasizes the need for better radio coverage in all of northern Washoe County, including existing and planned new schools and extended school trip zones.

4.2 System Capacity

Survey data shows that 70% of technical support staff feels that the current system meets the user needs for channel capacity. On a day-to-day basis, system users do not experience a significant number of system busies or channel congestion. However, in heavy loading conditions such as large emergency or weather-related incidents, system users do encounter system busies or delayed transmissions. While 48% of the users report current capacity as good or excellent, 52% of users report capacity as adequate or below, as shown in Figure 13.

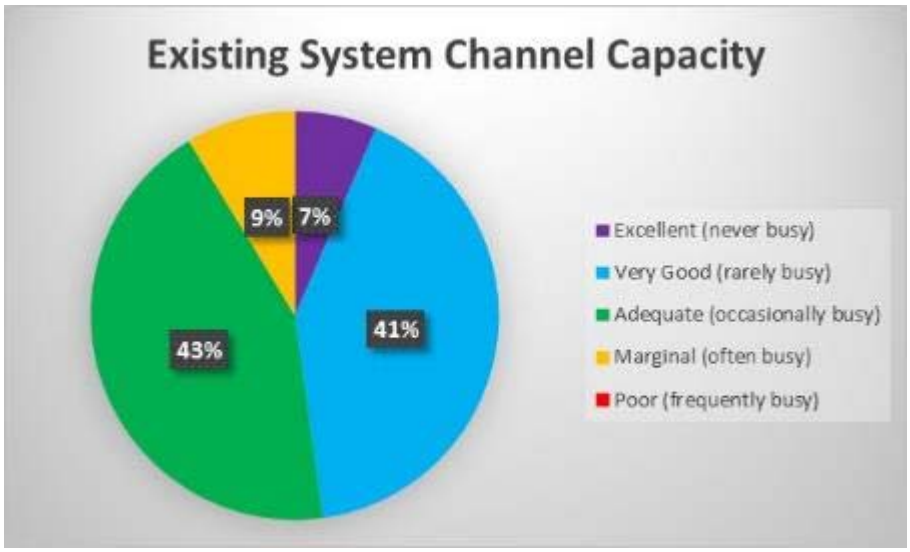

Figure 13 – Existing System Channel Capacity

Depending on the location and nature of an incident, as well as the number of agencies involved, those unusually high call volumes can occasionally affect system capacity. Given those occurrences of system busies and queues, slightly more than half of the system users request improved system channel capacity as illustrated Figure 14.

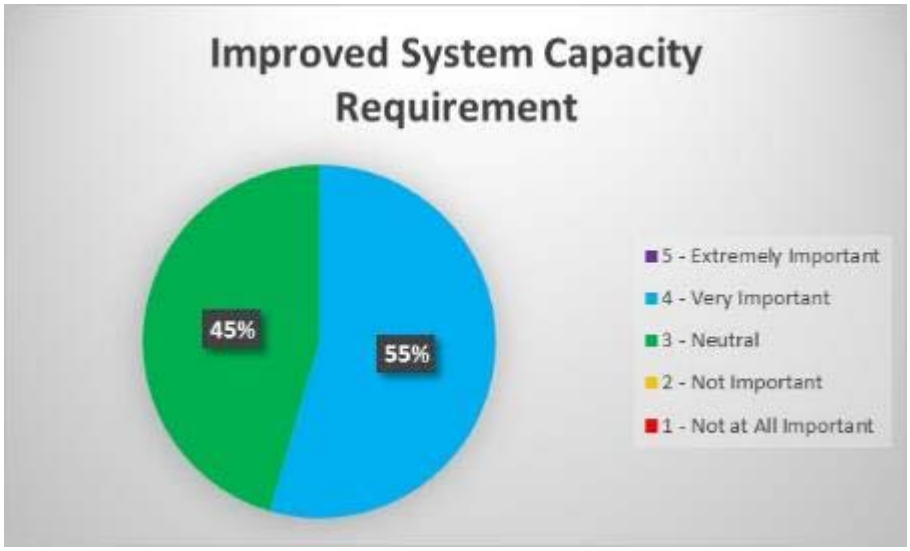

Figure 14 – Improved System Capacity Requirement

When asked to comment on channel capacity issues, the stakeholders provided the following discipline-specific remarks:

Field User

- Too many people on the same channel.
- When there is a snowstorm, there are often times that there are too many users on the "Reno Maintenance" channel.
- Multi agencies on same primary and secondary channels causes slowdowns at times.
- The WCSD would like to add more talk groups for each high school and middle school. The current capacity is restricted on the EDACS system.
- We utilize 5 channels within Transportation, though busy they are manageable
- N Tahoe and S Tahoe sites need more channels to work any incident in the Lake Tahoe Basin.
- Green has too many users. Better to have contract agencies on their own channel.
- Enough channels, not enough dispatchers.

- Some sites appear to be limited on number of channels, mostly out of the Las Vegas area.

Dispatcher

- Multiple units talking over each other -but I suspect those are on different repeater sites. If there is a delay to key up it is very infrequent.
- Dropped transmission, no service and static in areas such as:
  - Lockwood
  - Mustang
  - Through the canyon on I-80 heading EB to Fernley
  - I-80 and Robb Dr.
  - US395 S of Gardnerville
  - Nixon, NV

Technical Support

- In the Las Vegas area, towers need more capacity to handle more calls.
- Usually Very good, but during busy times can get a lot of queued calls.
- Only during times of unusually high use for an event or emergency.
- Issues only arise when site channels or sites go down, especially in rural areas with limited transmitter site channels and no redundancy.
- When a person from another area wants to hear what is going on 100 miles away, it ties up active channels for no good reason.

Management

- Current system is very old and fragile, and any type of serious problem could render it inoperable.
- Urban areas are very busy and system has nearly reached its capacity of users.
- Multi-agency calls.
- Key sites received additional channels to meet capacity needs when Highway Patrol joined the statewide system.

- With a new system, the likelihood of more users coming onto the system will require revisiting the loading over time.

- More primary channels, however limited by staffing.

It is important to note that the majority of system users **do not** anticipate expanding their use of the system (by expanding the number or users or increasing the degree to which radios are used). However, management conveyed the potential of adding more users to the new system, thus requiring the need to revisit system loading on a regular basis.

4.3 System Reliability

The core of the NSRS is a proprietary EDACS® architecture with aging system controllers, site repeaters, and dispatch consoles. The current NSRS has performed well over the years, but significant portions of the EDACS® components are at or near end of product lifecycle with limited support from the manufacturer over the next few years. Feedback from surveys and interviews indicate that parts availability, technology obsolescence, and expiration of vendor support are areas of major concern. Only a third of dispatchers and less than half of the field users and technical support staff believe that reliability of the current radio system equipment is good or excellent, as shown in Figure 15.

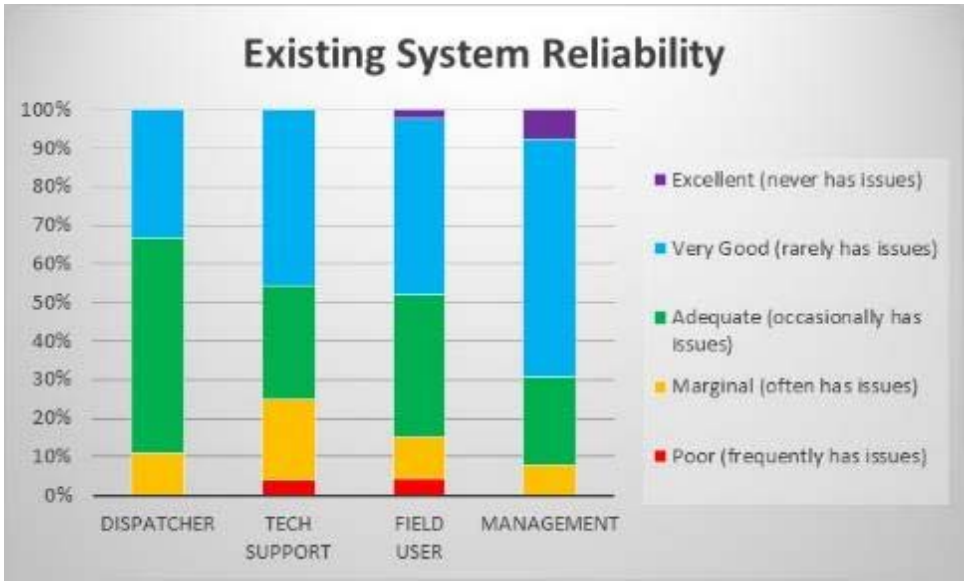

Figure 15 – Existing System Reliability

System reliability issues arise due to a number of issues, including lack of redundancy (system controllers and backhaul connectivity), level of spares and parts availability, and ownership of sites and infrastructure. According to technical support staff, sites and/or

facilities not owned by NSRS stakeholders have a detrimental impact to reliability of the NSRS. Access issues often affect the ability for maintenance personnel to repair and return a site to operation in a timely manner.

The stakeholders provided the following comments on specific system reliability issues:

Field User

- The Alamo and Irish sites are two of our main sites used in our area. They are frequently down and non-operational. Anytime there is cloud cover or storms the Highland site also becomes non-operational.
- Sometimes the radio can receive signal but cannot transmit out
- Seem to receive poor reception in the areas of Golden Valley and Sun Valley
- Unimpressed with the 10 second interval, from turning on the radio to being able to hear and use the radio
- Currently, the users (field units) cannot receive notifications when the Metro trunked system fails. Essentially all radio communications is lost and we do not have the ability to advise those units.
- Red Rock/Peavine area seems to drop on occasion
- Washoe County does a great job of repairs in a timely fashion, as well as NDOT. The system is up and available most of the time, on their towers.

Dispatcher

- I cannot think of a time the system was unavailable. However, we did have trouble with patching channels that lasted longer than 24 hours.
- Coverage issues again cause problems with radios breaking up and spotty reception

Technical Support

- End-of-life equipment reliability issues due to age of equipment and the ability to get replacement parts
- Uplink and downlink GETC issues from time to time

- General issues with patching, multi-sighting, and calls dropping
- Reliability of aging IMC and mountaintops; site and channels inoperative
- Power issues in the Alamo area are of concern during winter months
- The equipment has been in operation since 2002 and we are seeing an increase in failures
- IMC hardware items, such as CSD servers and MOM computers, are breaking down and no longer supported
- We are operating with greatly reduced troubleshooting, reporting and monitoring capabilities.
- A concern with the mobile-portable end user equipment is software updates and frequent need to touch each radio for updates. Difficult to manage and time consuming.
- Our Orion mobiles are antiquated and we are upgrading as funds are available to M7300s
- Site power outages and microwave connectivity. Many weather related outages are due to water issues or battery capacity / generator issues.
- We have 40 amps battery charger on a system that requires 50 amps when busy. Mercury and Hoover Dam and Coyote (when turned on)

Management

- Constant outages
- Inability for troopers to communicate with dispatch or each other
- Not much can be done to the current system as parts and upgrades are not provided by the manufacturer

Field users and dispatchers provided ratings on the current notification process for system outages (notices of planned and/or unplanned outages). Figure 16 shows that less than 50% of field users and dispatchers rate the notification process for system outages as very good or excellent.

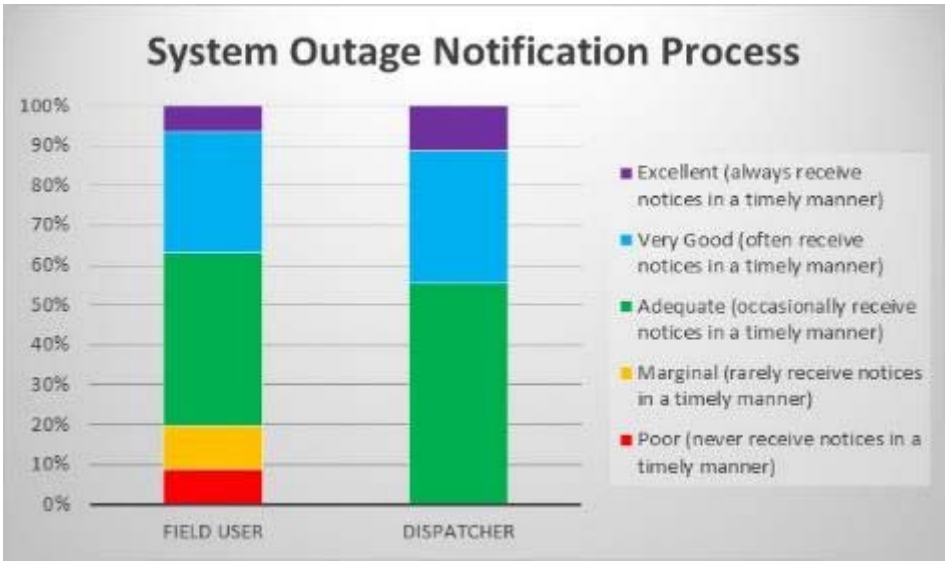

Figure 16 – System Outage Notification Process

Technical support staff provided the following feedback on improvements for notifying users of system outages:

- A mobile text message, distribution list could reach more people in a more timely fashion, without them having to check emails
- A more centralized portal would be helpful
- An email sent out to users of the system to notify them of the issues
- Better system alerting for technicians so they can notify users
- Faster and more detailed information
- New notification system is in development so a ticket can be generated online
- Schedule listed on whom is on call
- Training end users to notify via the NSRS help line through their respective liaison

Given that the current NSRS supports a number of user types, including public safety, stakeholders require a new system with 99.999% availability. This requirement translates to a maximum downtime of 5.26 minutes per year. Stakeholders express the need for a state-of-the-art system with geographic redundancy, vendor onsite and technical support, software upgrade agreements, and an increased level of spares (from 10% to 20-25%).

It is important to note that the desired response and repair times for the new system vary between stakeholders. However, the majority of technical staff conveyed the desired response times of 15-30 minutes for critical alarms, 1-2 hours for major alarms, and 24 hours for minor alarms. In terms of the desired repair time for the replacement system, the majority of technical staff conveyed the desired repair times of 24 hours for critical failures, 48 hours for major failures, and 72 hours for minor failures. Given the locations of some of the mountaintop sites, stakeholders understand the challenges with accessing those sites in certain times of the year.

4.4 System Features

The NSRS offers an array of system features. Some of which users remain unaware. System management decided to disable some features for several agencies. Survey results show that more than three-fourths of system users **do not** know all of the system features available. However, 60% of field users reported that they are satisfied or extremely satisfied with the current system features they know how to operate. Figure 17 provides a breakdown of the overall satisfaction with the current system features as reported by the different disciplines.

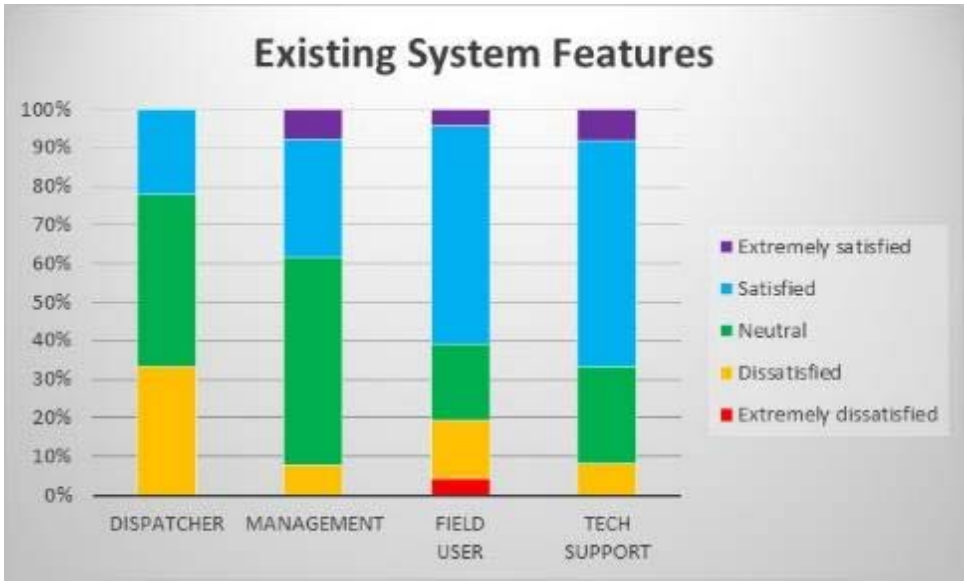

Figure 17 – Existing System Features

Of the features available in the current radio system, NSRS users identified the following as the top five critical features that are “must-haves” in a replacement system:

- Group calls
- Emergency calls

- Emergency alarm
- User authentication
- Radio inhibit / uninhibit

It is important to note that several agencies have disabled the emergency button on radios due to the number of false (or unintentional) activations of emergency alarms. In addition to the above current features, the list in Figure 18 identifies the critical features that users require in a future radio system.

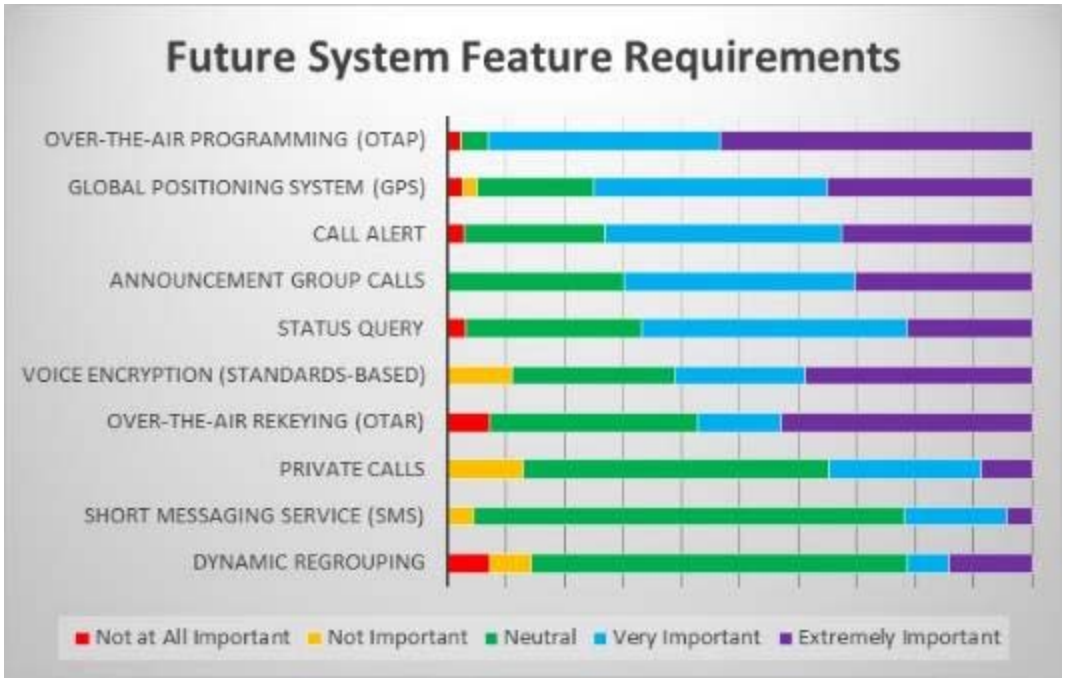

Figure 18 – Future System Feature Requirements

The feature requirements for the future system, listed by level of importance from most important to least important, are the following:

- Over-the-air programming (OTAP)
- Global Positioning System (GPS)
- Call alert
- Announcement group calls
- Status query
- Voice encryption (standards-based)
- Over-the-air rekeying (OTAR)
- Private calls

- Short Messaging Service (SMS)

Although only a few system users (mostly NHP) currently use GPS (separate from radio system), other stakeholders communicated that the capability could be beneficial and would be nice to have. Elko County requested encryption during their interview, and NDOT and Washoe County management requested encryption and OTAR in their web surveys. Users provided mixed ratings regarding the need for private calls and SMS (whether pre-canned or free form). Smartphone integration with the radio system is one other feature that some users communicated would be nice to have.

4.5 System Interoperability

System users interoperate with a number of law enforcement, Fire/EMS, public works and utilities agencies, including other state, federal and tribal agencies. The following list identifies the agencies that stakeholders interoperate with on a regular or emergency basis:

NDOT

- Carson City Sheriff's Office
- D2 Maintenance
- DEM
- Douglas County Sheriff's Office
- Douglas Emergency Communication Center
- Elko NHP
- EMS agencies
- Freeway Service Patrol
- Hospitals
- Las Vegas NHP
- Lincoln County Sheriff's Office
- Lyon County Sheriff's Office
- MUT AID
- NHP
- REMSA
- Reno PD
- Reno Road
- State EOC
- Storey County Sheriff's Office
- Other NDOT Districts
- Washoe County Roads
- Washoe County Sheriff's Office

NV Energy

- California Highway Patrol
- Carson City Fire Dept.
- Carson City Sheriff's Dept.
- NHP
- North Lake Tahoe Fire Dept.
- NV Energy ESCC operations

- City of Reno and Sparks
- Dispatch
- Douglas County Sheriff's Dept.
- East Fork Fire District
- Fire Department
- Internal Only - Security
- Metro
- NDOT
- NDOT Snowplow operations
- NV Energy Lines Construction
- NVE
- Reno Fire
- Sparks Fire
- Tahoe Douglas Fire Dept.
- Truckee Meadows Fire
- UNLV
- USA call before you dig
- Washoe County Sheriff's Office

Washoe County

- Airport Fire
- ATF
- BLM
- Carson City SO
- County Fire
- DEA
- Douglas County Agencies
- EMS
- FBI
- Fire
- Forestry
- Humboldt County Sheriff's Office
- Indian Police
- Modoc County Sheriff's Office
- NDOT
- NDOW
- NHP
- Pershing County Sheriff's Office
- Placer County (CA) Agencies
- Pyramid Lake Tribal Police
- REMSA
- Reno Fire
- Reno Police
- RSIC
- School Police
- Sparks Fire
- Sparks Police
- State EOC
- Storey County
- Truckee Meadows Fire
- USM
- Washoe County EOC
- Washoe County Roads Dept.
- WC School District Transportation Dept.
- WC School District Truancy Dept.
- Washoe County Sheriff's Office

NHP

- All Counties
- BIA
- California Highway Patrol
- DoD
- DoE
- Elko DPS Dispatch
- Las Vegas DPS Dispatch
- NDF
- NDIP Channels with state wide dispatch centers
- NDOW
- PSLE1 , PSLE2, PSEvent(s), PS Fire1, WCRCS
- REMSA
- Reno PD
- US Marshals
- USFS
- Washoe County SO

It is important to note that stakeholders may need to interoperate with many other agencies; however, the lists reflect only the agencies identified in the surveys. The most widely used communications method for interoperability consists of shared channels, followed by cell phone (or other), dispatch console, gateway equipment, or swapping of radios.

Survey results show that 56% of system users rate the communication methods as adequate or below, and 44% of system users rate the communication methods as good or excellent. As shown in Figure 19, user interviews confirmed the importance of improved interoperability capabilities in the future radio system.

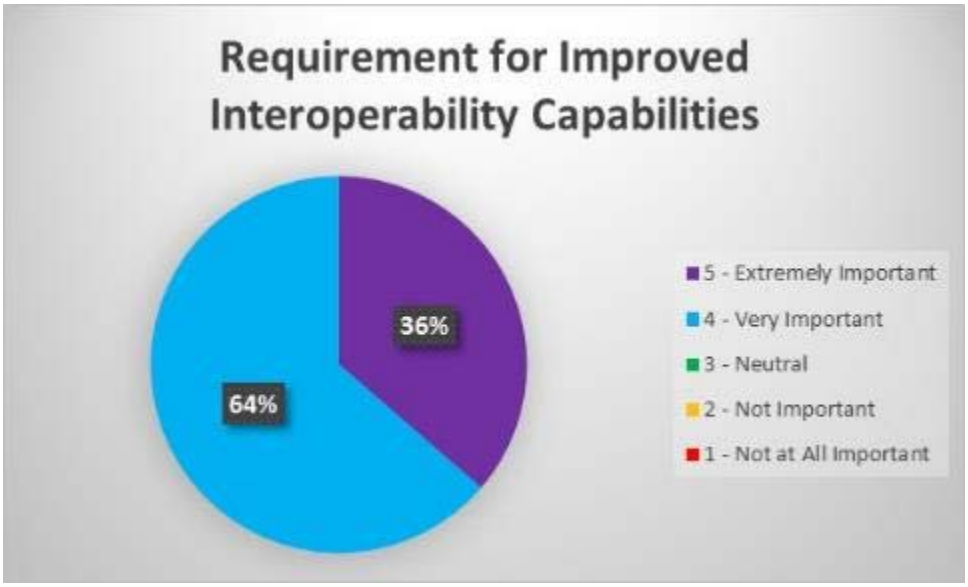

Figure 19 – Importance of Improved Interoperability

As highlighted in Figure 20, the majority of system users from all stakeholders express the need for the following interoperable communications capabilities:

- Direct operability with other State agencies
- Direct operability with other private or public service agencies
- Direct operability with local (County) agencies
- Interoperability with federal and tribal agencies
- Interoperability with surrounding state agencies

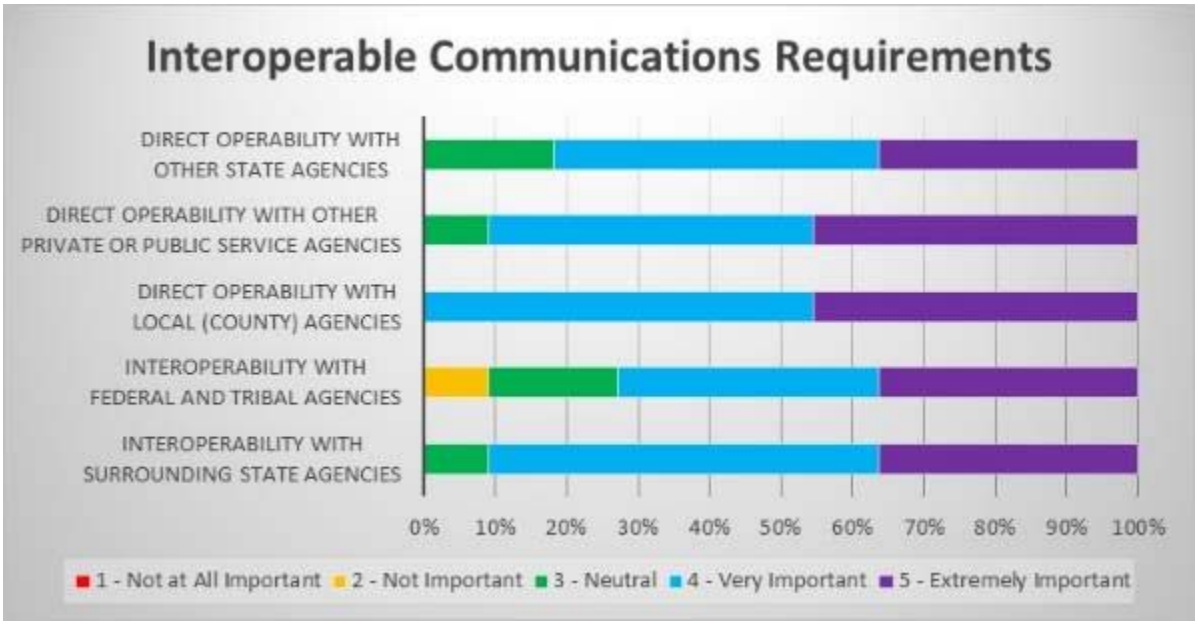

Figure 20 – Interoperable Communications Requirements

Technical and management staffs advise that some of the capabilities may exist, but lack of knowledge and training on how to access other systems is an issue for many users.

4.5.1 Arizona

According to the Arizona SWIC, there is currently not a lot of interoperable communications between Arizona and Nevada. Typically, when a requirement for ad hoc interoperability is necessary, the Arizona Interagency Radio System (AIRS), a VHF/UHF/800 MHz conventional cross band repeater, provides interoperable communications. In the case of the opening of the new highway bridge at Hoover Dam, Arizona set up a temporary cross band repeater near the dam for two weeks to support interoperable communications for that event.

Besides the Hoover dam border area, the Laughlin Nevada / Bullhead City Arizona area is an area where local police agencies interoperate. The SWIC was not knowledgeable on the interoperability solution used in these activities since they often do not include state agencies.

Expanding the Arizona P25 Phase 1 trunked system in the northwestern area of Arizona would be the next area to see expansion. However, the state has no firm plans or funding at this point. The SWIC communicated that ISSI capability between the Arizona and Nevada systems (after Arizona Northwest area expansion) would be useful, assuming the Nevada system will allow P25 Phase 1 roaming.

4.5.2 California

Interoperability in California is a complex mix of conventional unit-to-unit and repeated (including VHF/800 MHz cross-band) channels. The SWIC said that California agencies have no Nevada trunked system access programmed into their radios and vice versa. Eastern California areas are very rural and have no trunked systems, but San Bernardino County is the exception to this. San Bernardino County does use trunked radio systems, but the SWIC did not think there was any cross system programming between San Bernardino County, California, and the neighboring Nevada agencies.

California/Nevada interoperability is likely to occur via conventional channels. When asked about the potential of California moving to P25 trunked radio technology in the future, the SWIC conveyed that California would not move to trunked radio systems due to the cost of such a huge migration.

4.6 Subscriber Equipment

Based on an analysis of survey and interview data, ***FE*** concludes that NSRS users require improved mobile and handheld radio reliability and minimal requirements exist for improved form factor (size and weight) of mobile and handheld radios. Figure 21 provides a breakdown of the requirements for subscriber equipment improvements.

Figure 21 – Subscriber Equipment Improvement Requirements

Three-fourths of the users express the need for improved handheld battery life, and about half of the users express the need for improved handheld accessories. Feedback from users is that there is little need for supporting text messaging, unit-to-unit (private) calls, and man-down feature on the subscriber equipment. However, the majority of users do desire that subscriber equipment supports multiband operation and be intrinsically safe, water resistant and/or waterproof as illustrated in Figure 22.

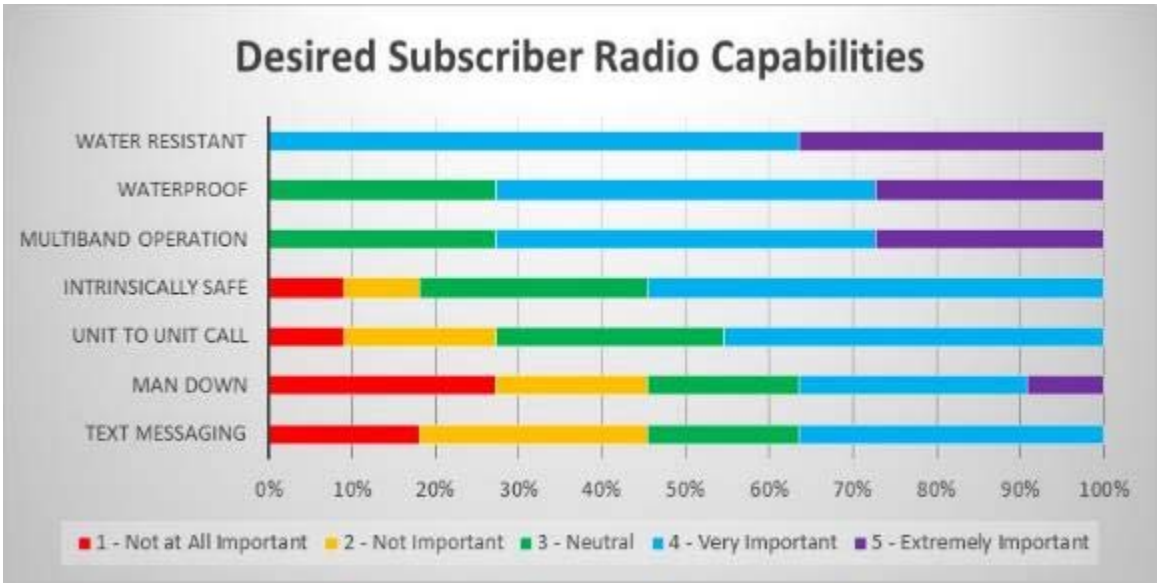

Figure 22 – Desired Subscriber Radio Capabilities

The following list identifies the accessories that users require in future handheld radios, shown by level of importance from most important to least important:

- Handheld high-capacity battery
- Handheld single unit charger
- Handheld configurable display screen
- Handheld Bluetooth remote speaker mics
- Handheld intrinsically safe battery
- Handheld multiple unit charger
- Handheld headset/wireless
- Handheld leather carrying case
- Handheld belt clip
- Handheld remote speaker mic
- Handheld swivel carry case
- Handheld vehicular charger
- Handheld headset/wired
- Handheld remote speaker mic with antenna

It is important to note that some agencies may only require a subset of the above accessories; however, the list reflects composite ratings of all NSRS users. The following list identifies the accessories that users require in future mobile radios, shown by level of importance from most important to least important:

- Mobile configurable display
- Mobile external speaker and mic
- Mobile dual control head
- Mobile cradle kit of handheld radio

4.7 Dispatch Equipment

Survey results show that only about a fourth of dispatchers are satisfied or extremely satisfied with current dispatch console functionality and features. According to dispatchers and technical staff, the biggest issues are parts availability and workstations operating on Windows NT and XP.

Figure 23 lists the top ten features required in new dispatch consoles as reported by dispatchers from different types of agencies.

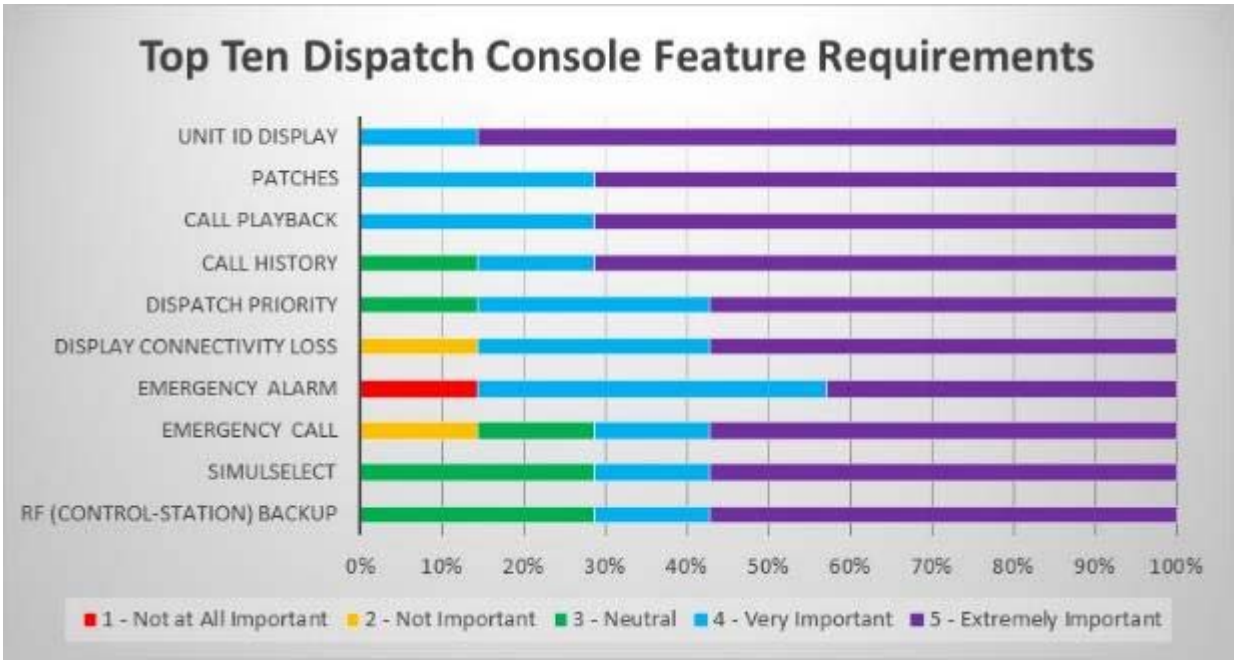

Figure 23 – Top Ten Dispatch Console Feature Requirements

The required dispatch console features, identified by level of importance from most important to least important, include:

- Unit ID Display
- Patches
- Call Playback
- Call History
- Dispatch Priority
- Display Connectivity Loss
- Emergency Alarm
- Emergency Call
- Simul-select
- RF (Control-Station) Backup

In addition to the above features, NSRS users reported the need for improved patching capabilities, localized audio recording, and support of NCORE, NDIP and configurable

audio gateways. Other desired capabilities, as shown in Figure 24, for future dispatch consoles include:

- One "select" speaker
- Channel Marker Messages
- Individual Calls
- Radio Unit Status Messages
- All-Call (system wide)
- Announcement Groups
- Intercom
- More than one "unselect" speaker
- Alert Tone(s)
- Radio Unit Monitoring

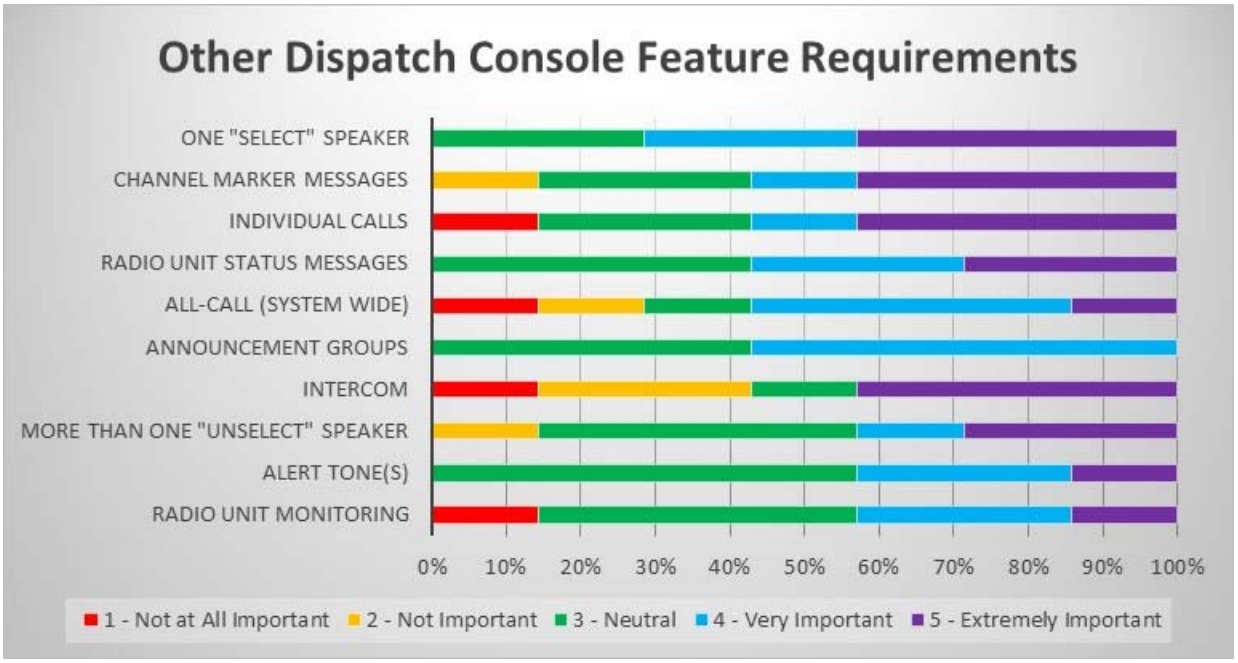

Figure 24 – Other Dispatch Console Feature Requirements

Some dispatchers communicated that they would like to have treadmill consoles, hands-free (wireless) headsets, and foot switches.

4.8 Equipment Maintenance

Figure 25 highlights the frequency of equipment maintenance as reported by field users and dispatchers.

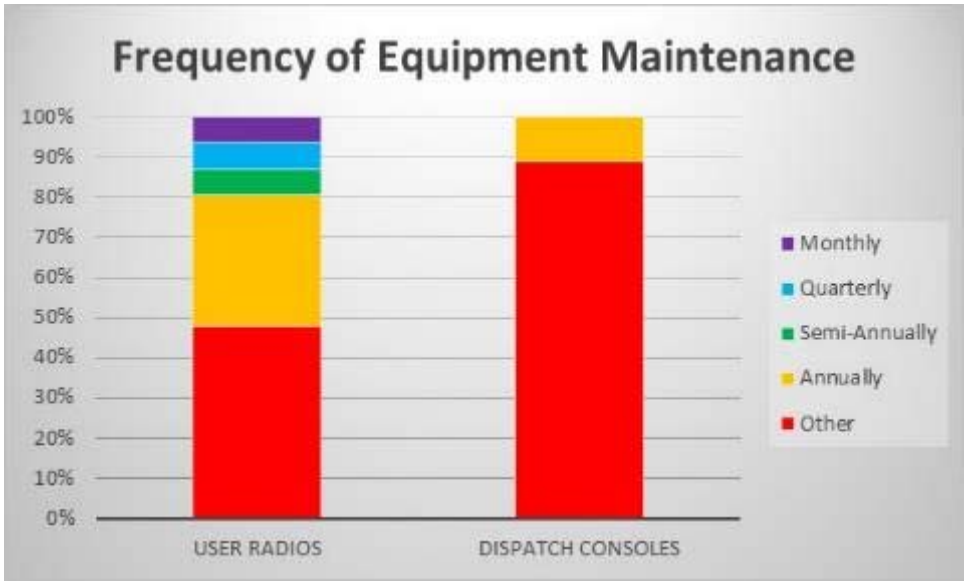

Figure 25 – Frequency of Equipment Maintenance

The majority of NSRS users report that maintenance does NOT occur on monthly, quarterly, semi- or annual basis. Regarding the frequency of maintenance activities, other responses from field users and dispatchers include “Don’t know because it’s been at least a year,” “Never,” “No maintenance agreement,” and “On as needed basis.” For this reason, users express the need for improved maintenance on user radios and dispatch consoles. However, they understand that radio shop resources are limited and the scope of their operation is very large.

Figure 26 shows that in-house (stakeholder) radio shops or other state or municipal radio shops are responsible for the maintenance/service on the following portions of the system infrastructure:

- System controllers
- Radio repeaters
- System networking
- Backhaul equipment
- Antenna systems
- Site power sources

- Site facilities and towers

Figure 26 – System Infrastructure Maintenance Responsibility

It is important to note the percentage of technical support staff, as illustrated in Figure 27, that do not know how often their radio shop(s) perform maintenance/service on all of the portions of the system infrastructure.

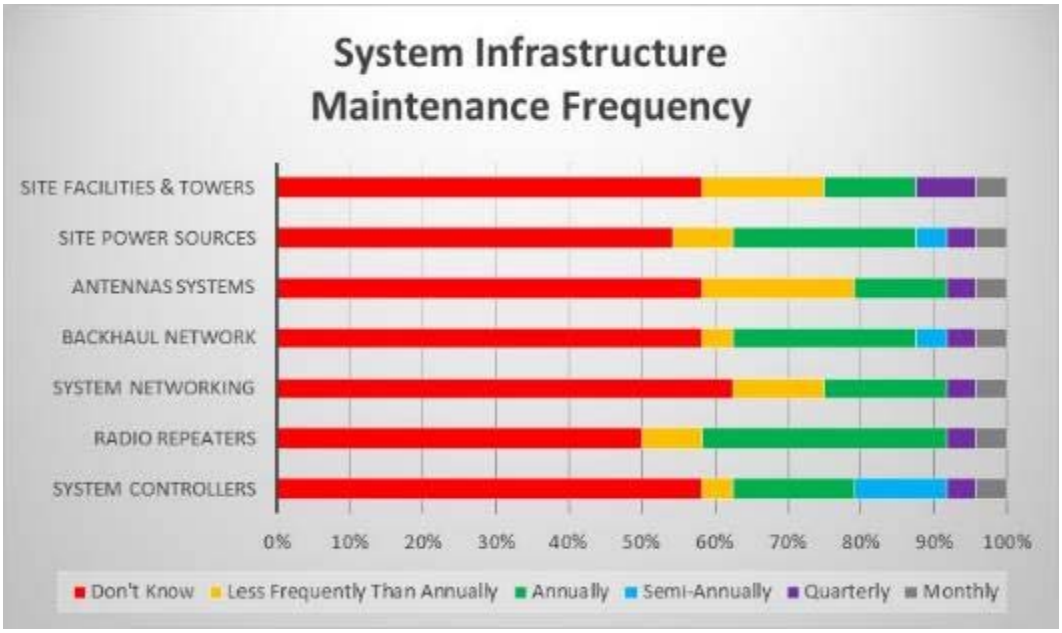

Figure 27 – Frequency of System Infrastructure Maintenance

Figure 28 shows that less than 40% of management personnel believe current maintenance policies and procedures are very good or excellent.

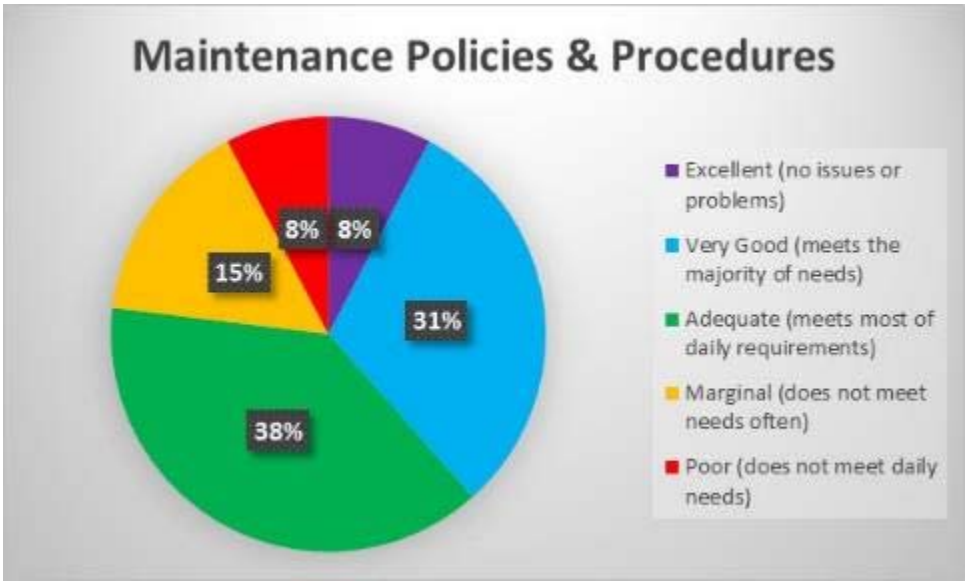

Figure 28 – Current maintenance policies and procedures

Management provided the following direct comments on current policies and procedures and potential improvements to the maintenance capabilities of the existing system:

- Maintenance is required as system is obsolete.
- Scheduled maintenance is not an issue. At time[s], unscheduled issues are not resolved in a timely manner.
- Since there is no periodic maintenance, the new system must establish a formal schedule for the maintenance of the system. One organization or location should be contacted for all maintenance to facilitate follow up to corrective actions.
- Staff needs training; management needs to prioritize the maintenance, system improvements.

4.9 Network Management

Based on feedback from system managers and technical support staff, there is an expressed need for improved network management of the radio system and end-user equipment. During the interviews, system managers and technical support staff specified the following requirements for the new Network Management System (NMS):

- The NMS shall provide secure and direct accessibility to monitor, diagnose, and configure system remotely.
- The NMS shall provide canned and custom performance reports, with as much granularity as possible.
- The NMS shall incorporate all aspects of site and component failures, in order to diagnose prior to onsite response.

NDOT and Washoe County requested ten NMS terminals each, and NVE Energy requested two NMS terminals. Other NSRS users (e.g., NHP, DOH, Elko and UNLV) did not specify their quantities. System managers and technical support staff requested that the future radio system include manufacturer recommended diagnostics and management tools for the proposed technology and architecture.

4.10 Training and Exercises

Three-fourths of field users indicate that they have adequate training on the operation of the current system and radios. Two-thirds of dispatchers report that they are NOT adequately trained on operation of the current system and consoles. Figure 29 also shows that only half of the technical support staff indicates that they have adequate training on operation and maintenance of the current radio system.

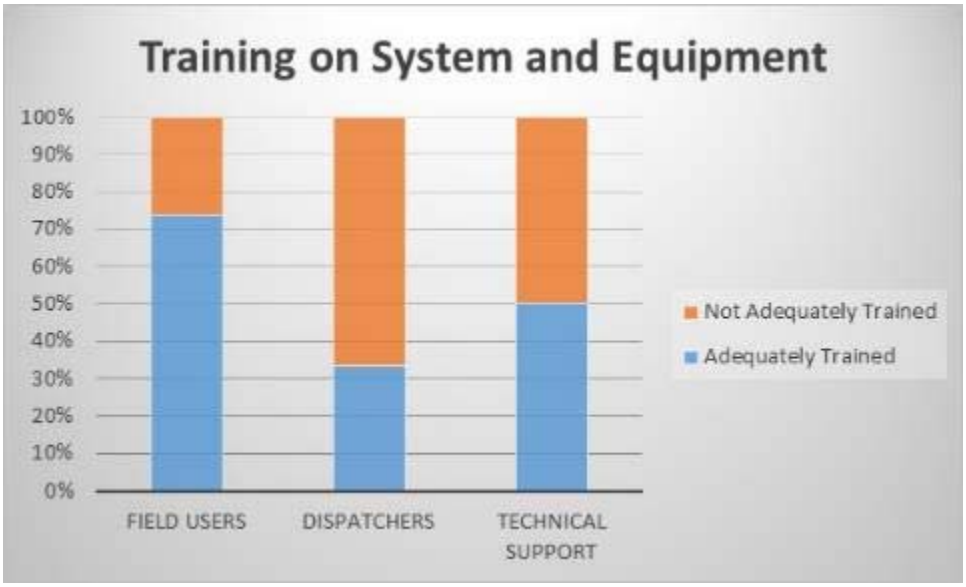

Figure 29 – Training on System and Equipment

Expressed needs for specific training include:

- Operator training (both end-user and dispatcher)
- System configuration and administration training
- Technical/maintenance training (technology specific)

The preferred methods of training as reported by field users, dispatchers, and technical support staff include the following, in order of importance:

1. Instructor-led training (train-the-trainer and hands-on)
2. Web-based or computer based training (CBT)
3. Video (conferencing)
4. Manual/reading (cheat sheets)

The survey and interviews asked stakeholders to provide their feedback on the level of participation and exercises that incorporate radio communications. Figure 30 illustrates the lack of participation and sufficient regular communications exercises as reported by the majority of field users and technical support staff.

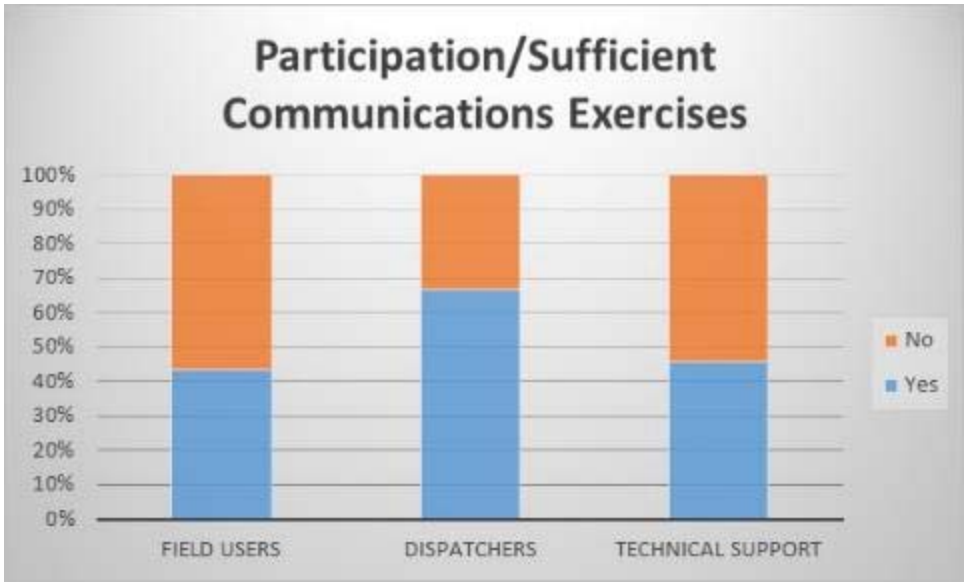

Figure 30 – Participation/Sufficient Communications Exercises

Regarding improvements to exercises to enhance the ability to use the system and radios, stakeholders provided the following specific comments:

- One-on-one hands-on training would probably work the best for us, conducted in the specific area that you are working.

- Practice scenarios where groups must exercise procedures and use different call groups and functionality.
- Locations of repeaters in case of manual switching.
- We have trouble talking from truck-to-truck and struggle with communicating to System Control.
- Have not been through a radio exercise for these radios since the first Macom radio.
- Each department and agency needs to provide quarterly training to allow all users of the system to know how to utilize all the features available.
- The WCSD Transportation participates in limited exercises.
- Need joint and structured training, exercises between agencies to identify and address weaknesses
- Keep those individuals who do not use the radio often more familiar with the functions of the radio so in the time of need they are not fumbling around trying to remember how to use it.
- Need better feedback from the leadership on what was done right and wrong after checking after action reports... and just to give the exercise personnel a warm and fuzzy that they care. For now, I do not even know if upper leadership looks at the after action reports. Better moral support would improve the communications.
- We need to practice interoperability, with more agencies involved.
- More user training on conventional Mutual Aid repeaters and how to access them in the event of a failure
- The number [of exercises] per year is low. I would like to see a higher frequency.
- Include more of the actual radio users, so that when the time comes they know how to switch and operate their radios and system capabilities.
- More training/more practice in real world scenarios based on local input of participating agencies.

- Need regional exercises at least yearly if not more to test user's abilities on system and ways to improve operation and use of system.

During the interviews, the NSRS stakeholders validated the survey data and reiterated the need for regular (quarterly) communications exercises with more agencies involved.

4.11 Requirements Summary

Analysis of the survey and interview feedback yields the following stakeholder-specified requirements outlined in Table 3.

Table 3 – Stakeholder Specified NSRS Requirements

NSRS Key User and System Requirements		*FE* Findings and Analyses
1	System Coverage	System Coverage desired was identified as a minimum to meet the coverage the current system provides and all Nevada State-maintained highways. The future radio system shall address, to the extent possible, the previously identified areas of poor or inadequate coverage, listed by network in Section 4.1.
2	System Capacity	Analysis of traffic and survey data shows that users have a requirement for improved system channel capacity given the system busies or delayed transmissions they experience under heavy loading conditions. The details of our analysis are in Section 3.5.2 and Appendix C.
3	System Reliability	System requirement is 99.999% availability (max. down 5.26 mins/year).

NSRS Key User and System Requirements		*FE* Findings and Analyses
4	System Features	Critical features required in the future system: Over-the-air programming (OTAP) Global Positioning System (GPS) * Call alert Announcement group calls Status query Voice encryption * Over-the-air rekeying (OTAR) * Private calls ** Short Messaging Service (SMS) ** Dynamic Regrouping **** Stakeholder specific required feature (In the user interviews, Elko County requested encryption. In the web survey, NDOT and Washoe Management requested encryption)*** ***** Users split on need for the feature, but in the Feature Section (Section 5), all agreed to include it in the requirements while the implementation would be controlled.***
5	System Interoperability	– Direct operability with other State agencies – Direct operability with other private or public service agencies – Direct operability with local (County) agencies – Interoperability with federal and tribal agencies – Interoperability with surrounding state agencies
6	Subscriber Equipment	Users require improved reliability of mobiles & handhelds (including battery life) (new replacement battery program may not have reached all participants yet). No requirement for improved form factor (size and weight) of mobiles or handhelds

NSRS Key User and System Requirements		*FE* Findings and Analyses
7	Dispatch Equipment	There is a need for improved patching capabilities, localized audio recording, and support of NCORE, NDIP and configurable audio gateways. Top ten features required in new consoles are: Unit ID Display; Patches; Call Playback; Call History; Dispatch Priority; Display Connectivity Loss; Emergency Alarm; Emergency Call; Simulselect; RF (Control-Station) Backup
8	Equipment Maintenance	Users identified the need for improved maintenance on user radios and dispatch consoles, noting that staffing resources of the radio shop is limited and the scope of their operation is very large.
9	Network Management	Users identified the need for improved network management of system and end-user equipment, including Secure and direct accessibility to monitor, diagnose, and configure system remotely, and canned and custom performance reports, with as much granularity as possible. The following quantities of NMS terminals were requested: NDOT Qty. 10; Washoe Qty. 10; NVE Qty. 2 All other NSRS users (i.e., NHP, DOH, Elko, UNLV) did not specify their quantities.
10	Training and Exercises	Users expressed the need for specific training - Operator training (both end-user and dispatcher); System Configuration and Administration training; and Technical/Maintenance training (technology specific). Preferred methods in order of importance: 1. Instructor-led training (train-the-trainer / hands-on) 2. Web-based or computer based training (CBT) 3. Video (conferencing) 4. Manual/reading (cheat sheets) NSRS stakeholders validated the survey data and reiterated the need for regular (quarterly) communications exercises with more agencies involved.

5. P25 Features and Enhancements

Analysis of user needs for the new system show that in general the users of the NSRS align with most land mobile radio system users nationwide. Furthermore, the requirements identified after analyzing the user feedback, align with the attributes provided by the P25 standard. The following are specific required P25 Phase 2 features and functions:

- Improved coverage
- Reduced noise
- Encrypted voice quality
- Increased voice channel efficiency
- Open data interface standards
- Open subscriber selection
- Multiple infrastructure manufacturers
- Competitive procurement and pricing
- Improved interoperability
- Multiple manufacturers driving development

As we address each of these items, ***FE*** provides comparisons with the existing EDACS® system to assist the reader in understanding the enhancements gained through the implementation of the new NSRS network with the P25 Phase 2 standards.

5.1 Improved Coverage, Reduced Noise

The current EDACS® system relies on analog FM modulation. While FM is relatively resistant to noise in areas with a moderately strong signal strength, the user will hear the desired signal mixed with the effects of noise in coverage areas where the signal is unable to block out all interference and noise. As the noise grows, the user listening to the radio must consciously separate the audio from the noise. A digital radio system is able to provide more noise free communications by leveraging two aspects of digital radio system design.

First, manufacturers design the Vocoder (Voice Coder) to encode the sounds related to understandable speech while providing some protection from transmission of non-voice sounds. Second, once the signal is digitized (turned into a string of digital bits). Forward Error Correction (FEC) is applied to the stream to help the receiving radio correct any errors that occur due to weak signal levels or external interference. The result of these

two processes is that the received signal quality is relatively consistent over the majority of the coverage area. This consistency allows the radio user to listen without the extra effort of separating audio from noise.

5.2 Encryption, Encrypted Voice Quality

While many radio systems, including EDACS®, have had encryption options, prior to P25 there was no standardized encryption system for Land Mobile Radio. P25 brings to the user a thorough set of encryption standards that go beyond the basis of the encryption protocol and include key distribution and key management.

Included in this set of specifications is OTAR (Over the Air Rekeying) that facilitates key system/subscriber management without the need to touch each radio physically. The digital encryption standard uses the same Vocoder and modulation as P25 non-encrypted voice; therefore, the use of encryption does not reduce either range or voice clarity.

5.3 Voice Channel Efficiency

P25 Phase 2 trunked systems use a 2-slot Time Division Multiple Access (TDMA) channel format. This allows two separate voice conversations to operate on a single radio channel, effectively doubling the voice capacity of the system. This becomes very important on a shared system where more separate user groups need to work within the same number of channels. Additionally, as sites are added to a system to increase coverage reliability, the capacity provided by the 2:1 increase allows channels to be redeployed in areas where previously there was a channel shortage (if frequency re-use is feasible).

5.4 Open Data Interfaces

P25 provides an open and standardized data interface at both the network and subscriber levels of the system. This simplifies development of third party data applications and prevents the sunk cost of application development from becoming a barrier to the use of new subscriber products.[1] The applications to which this applies vary widely from simple messaging to location and even over the air programming.

[1] A sunk cost is a cost already incurred that cannot be recovered. Sunk costs (also known as retrospective costs) are sometimes contrasted with prospective costs, which are future costs that may be incurred or changed if an action is taken.

5.5 Competitive Procurement

P25 standards have created a marketplace where multiple infrastructure manufacturers produce systems compatible with subscriber radios from multiple manufacturers.

Most major suppliers of radio systems, including current NSRS system vendors, supply P25 infrastructure systems or subscribers products. Some vendors supply both infrastructure and subscriber products. In addition, a number of specialty manufacturers supply standards-based equipment for specialized uses such as aircraft, surveillance, data, and receive only applications. The infrastructure products available span the full range, from trunked networks, conventional stations, to transportable systems. This range of suppliers fosters a truly competitive procurement process and therefore makes it easy to acquire comparable pricing sources from the multiple public contracts available.

5.6 Improved Interoperability

The requirements analysis indicated a need for interoperability, including direct operability with other state, local (County) and other private or public service agencies, and interoperability with federal, tribal and surrounding state agencies. P25 being the predominant U.S. public safety digital radio standard provides exactly this type of interoperability, provided users operate within the same spectrum or have multiband radios. Functional interoperability requires planning and coordination. This includes frequency and band planning as well as operational planning such as channel usage, ID coordination and even common terminology.

An important consideration with P25 is in its continued development. The standards are user driven, with users' agencies and manufacturers sharing management of the process. With multiple manufacturers driving development, no single manufacturer has exclusive control of any portion. This structure drives innovation into the standard and prevents stagnation.

5.7 Current Radio System Features Determined as Critical

Users identified the following features as critical to the users of the current system; these are mandatory in the new NSRS system. The P25 standard supports all of these features.

Group Calls

Group calls provides the ability to have multiple radios operate as a talkgroup, and appear to have their own channel.

Emergency Calls

Emergency calls allow a subscriber or dispatcher to declare an emergency for their group with a single button press. This feature assures that all users on the channel are informed of the emergency situation, and the talkgroup receives highest priority so no critical communications are blocked.

Emergency Alarm

With the Emergency Alarm feature, a unit may declare an emergency with a single button press. This feature assures that all users on the channel are informed of the emergency situation that may or may not need to be followed with voice traffic.

User Authentication

User Authentication ensures that only properly authorized subscriber radios may communicate on the system. This prevents both the unauthorized use of radio resources as well as preventing unauthorized (and potentially disruptive or fraudulent) communications with workgroups.

Radio Inhibit / Uninhibit

With Radio Inhibit / Uninhibit, the system manger may temporarily or permanently disable a lost, stolen, or misused radio to protect proper communications.

Table 4 identifies the current radio system features determined as critical for each of the stakeholders that are mandatory in the new NSRS system.

Table 4 – Current Radio System Features Determined As Critical

Current Radio System Features Determined As Critical		NDOT	NV	WC
1	Group calls	Yes	Yes	Yes
2	Emergency calls	Yes	Yes	Yes
3	Emergency alarm	Yes	Yes	Yes
4	User authentication	Yes	Yes	Yes
5	Radio inhibit / uninhibit	Yes	Yes	Yes
	All standard P25 features			

5.8 Recommended Features Critical For the Future Radio System

The NSRS project team recommended the following features as critical for any new system, based on the user requirements gathered from the data gathering process discussed earlier in this document. P25 supports most of these features directly, while various vendors support others by often using underlying standardized services.

- **Over-the-air programming (OTAP)** is proprietary to the specific subscriber user equipment being programmed. Additional infrastructure may be needed, depending on the vendor selected. However, by using the standardized underlying data services to transport the programming information, it is possible for maintenance personnel to install any vendor's subscriber programming equipment on their own or any other vendor's infrastructure.

- **Global Positioning System (GPS)** or AVL (Automatic Vehicle Location) systems typically use the standardized GPS protocol within the P25 standard. In some cases, vendors have also created higher efficiency proprietary protocols to improve system operation. The hope is that these extensions will become standardized in the future.

- **Call alert** is a standardized feature that allows a dispatcher or subscriber unit to send a page-like call to another subscriber unit.

- **Announcement group call** is a standardized feature that is much like a talkgroup call; however, it is usually used to make announcements to larger groups made up on two or more talkgroups.

- **Status query** is also a standardized feature that allows a user to set a status on his/her radio that can be displayed to a dispatcher or used by a Computer Aided Dispatch (CAD) system in directing calls.

- **Voice encryption** with **over-the-air rekeying (OTAR)** was requested since its use would no longer bring along the range and voice quality deficit of previous generation systems.

- **Private calls** allow users to talk in relative privacy between a dispatcher and single unit or between two units. While not encrypted, it does provide assurance that other users on the system are not included in the conversation.

- **Short Messaging Service (SMS)** allows transmission of short text messages between radio units or between a dispatch position and a radio unit. This message system while not currently incorporated into the standard uses the standardized data services to transport the message.

- **Dynamic Regrouping** allows units to be regrouped, or for multiple groups to be brought together for short-term activities. Often comprehensive talk-group planning minimizes the need for this feature.

Table 5 outlines the features recommended as critical for any new system, based on the user requirements gathered from each stakeholder.

Table 5 – Recommended Features Critical For the Future Radio System

Recommended Features Critical for the Future Radio System		NDOT	NV	WC
1	Over-the-air programming (OTAP)	Yes	Yes	Yes
2	Global Positioning System (GPS) *	Yes	Yes	Yes
3	Call alert *	Yes	Yes	Yes
4	Announcement group calls *	Yes	Yes	Yes
5	Status query *	Yes	Yes	Yes
6	Voice encryption *	Yes	Yes	Yes
7	Over-the-air rekeying (OTAR) *	Yes	Yes	Yes
8	Private calls *	Yes	Yes	Yes
9	Short Messaging Service (SMS)	Yes	Yes	Yes
10	Dynamic Regrouping	No	No	No
	All Standard P25 features			

6. Conclusion

FE concludes that time is of the essence if the NSRS is to operate uninterrupted in the upcoming years. Manufacturer's product obsolescence, cessation of support for the current technology, and the challenges associated with sourcing of reliable 3rd-party parts will make it difficult, if not impossible to recover from a major NSRS outage after the year 2017. Mission-critical communications systems of this size and complexity require a substantial amount of time to plan, procure, implement, test, and cutover.

FE encourages the NSRS partnership to remain committed to providing the resources necessary to overcome the anticipated challenges and to proceed swiftly with the steps necessary to ensure the replacement of the NSRS in a timely manner.

7. Next Steps

This report outlines the user requirements for the NSRS partners and shall serve as the basis for development of the Preliminary Conceptual Design (PCD) for the replacement system. The PCD is currently under development by ***FE*** with completion of the first draft expected in June 2016. The system specification will describe the radio system's functional requirements in sufficient detail for vendors to submit consistent proposals, verifiable through future acceptance testing. The detailed design of the system will be left to the radio system vendor to allow for innovative approaches and to ensure the vendor remains responsible for system performance in accordance with the specifications.

The approved PCD will be followed by the development of the Request for Proposal (RFP) that will describe the radio system's functional and performance requirements. The RFP will also include the requirements of a detailed Statement of Work (SOW) and Deployment Plan in the equipment vendor RFP. The draft RFP will be available in August 2016.

Table 6 shows the milestones that the project team are working hard to meet.

Table 6 – Key Milestones

Key Milestone	Planned Date
Deliver Draft NSRS Existing System Analysis and P25 Requirements Report	4/19/2016
Conduct Coverage and Spectrum Workshop	4/20/2016
Deliver Final NSRS Existing System Analysis and P25 Requirements Report	4/27/2016
Deliver Draft NSRS P25 Phase 2 System Preliminary Conceptual Design	6/9/2016
Deliver Final NSRS P25 Phase 2 System Preliminary Conceptual Design	6/24/2016
Deliver Draft LMR System RFP	8/5/2016
Deliver Final LMR System RFP	9/7/2016

Appendix A - Existing NSRS FCC Call Signs

Table A.1 is a summary of the number of frequencies in use at 108 sites throughout the NSRS, as well as their associated FCC call signs. Three of the sites listed (LV Simulcast, Metro Simulcast, and Tahoe Simulcast) are represented as a single entry due to the simulcast configuration of these sites. In actuality, these simulcast sites are composed of multiple RF locations broadcasting the same frequency set.

Table A.1 – Existing NSRS Frequency Counts and Associated FCC Call Signs

Site Name	NSRS Stakeholder	System	# of Frequencies	FCC Call Sign	Expiration Date
3-Mile	NDOT	EK1	4	WPRY226	3/15/2021
Austin	NDOT	EK1	4	WPQD805	6/6/2025
Border Inn	NDOT	EK1	4	WPZV280	3/22/2024
Cave	NDOT	EK1	4	WPTR307	11/28/2021
Elko Mt	NDOT	EK1	8	WPRY226	3/15/2021
Ellen Dee	NDOT	EK1	4	WQPB564	3/28/2022
Golconda	NDOT	EK1	5	WPQD805	6/6/2025
Hickison	NDOT	EK1	4	WQVK545	3/11/2025
Imlay	NDOT	EK1	6	WQLG501	1/13/2020
Kimberly	NDOT	EK1	4	WQTA996	12/23/2023
Mary's	NDOT	EK1	5	WPQD805	6/6/2025
Moses	NDOT	EK1	4	WPQZ715	12/19/2025
Peavy Hill	NDOT	EK1	6	WQAB207	4/26/2024
Penn Hill	NDOT	EK1	4	WQQN690	2/4/2023
Prospect Pk.	NDOT	EK1	4	WPTR307	11/28/2021
Rocky Pt.	NDOT	EK1	4	WPRY226	3/15/2021
Spruce	NDOT	EK1	5	WQLE317	12/23/2019
Squaw Pk.	NDOT	EK1	4	WPQZ715	12/19/2015
Sunnyside	NDOT	EK1	4	WQLF669	1/7/2020
Trident Pk.	NDOT	EK1	4	WPTR307	11/28/2021
Victoria	NDOT	EK1	4	WPRY226	3/15/2021
Wilson	NDOT	EK1	4	WPQZ715	12/19/2015

Site Name	NSRS Stakeholder	System	# of Frequencies	FCC Call Sign	Expiration Date
Winnemucca	NDOT	EK1	4	WPPV258	1/27/2025
Alder Hill	NV Energy North	FC	3	WPXS348	6/2/2023
Amargosa Valley	NDOT	FC	4	WPWX587	2/4/2023
Buster	NDOT	FC	5	WQTA924	12/20/2023
Caliente	NDOT	FC	4	WQBU615	12/16/2024
Emigrant	NDOT	FC	5	WQWF903	8/11/2025
Flatcreek	NDOT	FC	5	WQLP295	3/18/2020
HD Summit	NDOT	FC	5	WQLG500	1/13/2020
High Camp	NV Energy North	FC	3	WQAG531	5/26/2024
Irish	NDOT	FC	4	WQAV626	8/16/2024
Kinkaid	NDOT	FC	5	WPQZ376	12/12/2025
Likely	NV Energy North	FC	3	WQBH325	10/5/2024
Loray	NDOT	FC	5	WQLI538	1/29/2020
New Pass	NDOT	FC	3	WQAV629	8/16/2024
Ragged Ridge	NDOT	FC	4	WPXI416	4/10/2023
Secret Pass	NDOT	FC	4	WQAV278	8/12/2024
Timber	NDOT	FC	5	WQQB237	10/11/2022
Wildoat	NDOT	FC	5	WQLG499	1/13/2020
Angels	NV Energy South	NP1	8	WNZB252	12/31/2023
Beaver Dam	NV Energy South	NP1	4	WNZB252	12/31/2023
Big Horn	NV Energy South	NP1	6	WPWL702	12/16/2022
Buckskin	NV Energy South	NP1	1	WPKZ578	10/22/2012
Christmas Tree	NV Energy South	NP1	6	WQLG544	1/13/2020
Conners Pass	NV Energy South	NP1	5	WQUE758	6/18/2024
Coyote Springs	NDOT	NP1	6	WQLP425	3/19/2020

Site Name	NSRS Stakeholder	System	# of Frequencies	FCC Call Sign	Expiration Date
Hoover Dam	NDOT	NP1	4	WQLP447	3/19/2020
Lenzie	NV Energy South	NP1	4	WQLY897	6/1/2020
LV Simulcast	NDOT	NP1	8	WQKW310	10/5/2019
Mercury	NDOT	NP1	4	WQKV949	10/1/2019
Mesquite	NDOT	NP1	6	WQKV372	9/24/2019
Oatman	NV Energy South	NP1	4	WPRY297	3/15/2021
Opal	NV Energy South	NP1	6	WQCM784	4/11/2025
Overton	NV Energy South	NP1	4	WPKJ524	3/12/2022
Page	NV Energy South	NP1	1	WPKZ578	10/22/2012
Pipe Springs	NV Energy South	NP1	1	WPKZ578	10/12/2012
Potosi	NV Energy South	NP1	8	WPWL702	12/16/2022
Rio	NV Energy South	NP1	9	WPRY297	3/15/2021
Schader	NDOT	NP1	4	WQKV949	10/1/2019
Silverhawk	NV Energy South	NP1	4	WQLY898	6/1/2020
Sloan	NV Energy South	NP1	10	WPWL702	12/16/2022
Sunrise	NV Energy South	NP1	15	WPKJ254	3/12/2022
Thomas & Mack	NDOT	NP1	4	WQLP448	3/19/2020
Beckworth	NV Energy North	SP1	3	WPZX858	4/6/2024
Chevas	NV Energy North	SP1	5	WPVA511	6/6/2022
Chimney	NV Energy North	SP1	3	WPQZ447	12/13/2025
Eagle Ridge	NDOT	SP1	6	WQCC881	2/1/2025
East Twin	NV Energy North	SP1	6	WPOZ629	9/14/2024
Fairview Peak	NDOT	SP1	4	WPQZ376	12/12/2025

Site Name	NSRS Stakeholder	System	# of Frequencies	FCC Call Sign	Expiration Date
McClellan	NDOT	SP1	8	WPBS788	1/10/2022
Millers	NDOT	SP1	4	WPQZ372	12/12/2025
N. Lake Tahoe	NV Energy North	SP1	3	WPOZ630	9/14/2024
Palmetto	NDOT	SP1	4	WPBS788	1/10/2022
Patrick	NV Energy North	SP1	8	WPWC612	10/11/2022
Peavine	NDOT	SP1	4	WPKJ526	3/12/2022
Pinegrove	NDOT	SP1	4	WPKJ526	3/12/2022
Red Pk.	NDOT	SP1	5	WPKJ526	3/12/2022
S. Lake Tahoe	NV Energy North	SP1	4	WPRI292	9/27/2025
TV Hill	NV Energy North	SP1	5	WPOZ628	9/14/2024
Virginia Pk.	NDOT	SP1	4	WPQZ376	12/12/2025
Alamo	NDOT	SP2	4	WNZB252	12/13/2023
Argenta	NV Energy North	SP2	5	WPQD805	6/6/2025
Bald West	NDOT	SP2	5	WQLD660	12/15/2019
Brock	NDOT	SP2	5	WPKB391	3/22/2024
Currant Summit	NDOT	SP2	4	WPQD806	6/6/2025
Fencemaker	NV Energy North	SP2	3	WQFN731	8/25/2016
Fitzpatrick	NDOT	SP2	4	WQAV633	8/16/2024
Highland Pk.	NDOT	SP2	5	WNZB251	12/31/2023
Montezuma	NDOT	SP2	4	WPKB391	1/10/2022
Muller	NV Energy North	SP2	5	WQLZ663	6/7/2020
Pilot Pk.	NDOT	SP2	4	WPKB391	1/10/2022
Pinenut	NV Energy North	SP2	8	WPBS788	1/10/2022
Sawtooth	NDOT	SP2	4	WPWD259	10/17/2022
Shaffer	NV Energy North	SP2	3	WQBJ749	10/21/2024

Site Name	NSRS Stakeholder	System	# of Frequencies	FCC Call Sign	Expiration Date
Sober	NDOT	SP2	4	WPKB391	1/10/2022
Spooner	NDOT	SP2	3	WQKV372	9/24/2019
Toulon	NDOT	SP2	4	WPQZ376	12/12/2025
Warm Springs	NDOT	SP2	4	WPKB391	1/10/2022
Chimney - WCRCS	Washoe County	WC1	9	WPRX312	3/8/2021
Fox - WCRCS	Washoe County	WC1	5	WPRX313	3/8/2026
Marble Bluff - WCRCS	Washoe County	WC1	5	WPRX309	3/8/2026
Metro Simulcast	Washoe County	WC1	15	WPRX312	3/8/2021
Poito - WC	Washoe County	WC1	5	WPRX313	3/8/2026
Rose WCRCS	Washoe County	WC1	5	WQMA529	6/11/2020
Slide WCRCS	Washoe County	WC1	12	WPRX312	3/8/2021
Tahoe Simulcast	Washoe County	WC1	7	WPRX309	3/8/2026
Virginia Peak WCRCS	Washoe County	WC1	10	WPRX309	3/8/2026

Appendix B - Existing NSRS Licensed Frequencies

Table B.1 lists the licensed frequencies in use at 108 sites throughout the NSRS. Each frequency listed is actually a frequency pair (e.g., 857/812.8625 is paired combination of 857.8625 MHz and 812.8625 MHz), where the higher frequency is the site's transmit frequency (downlink), and the lower frequency is the site's receive frequency (uplink).

Table B.1 – Existing NSRS Licensed Frequencies

Site Name	System	Licensed Frequencies				
3-Mile	EK1	855/810.2125	856/811.2125	857/812.2125	858/813.7125	
Austin	EK1	856/811.9625	857/812.9625	858/813.9625	855/810.9625	
Border Inn	EK1	856/811.2625	857/812.2625	858/813.2625	859/814.4625	
Cave	EK1	856/811.7125	857/812.7125	858/813.7125	859/814.7125	
Elko Mt.	EK1	856/811.9625	857/812.9625	858/813.9625	855/810.9625	852/807.7250
		852/807.4000	851/806.2250	851/806.7375		
Ellen Dee	EK1	855/810.2125	856/811.2125	857/812.2125	859/814.4625	
Golconda	EK1	856/811.2625	857/812.2625	858/813.2625	851/806.4375	852/807.0500
Hickison	EK1	855/810.2375	856/811.2375	857/812.2375	858/813.2375	
Imlay	EK1	851/806.1125	851/806.5625	852/807.1125	852/807.8500	853/808.1125
		853/808.5625				
Kimberly	EK1	856/811.7375	857/812.7375	858/813.7375	860/815.7375	
Mary's	EK1	856/811.7125	857/812.7125	858/813.7125	859/814.7125	851/806.9500
Moses	EK1	855/810.2125	856/811.2125	857/812.2125	859/814.4625	
Peavy Hill	EK1	856/811.4625	857/812.4625	858/813.4625	859/814.2625	851/806.3500
		851/806.9875				
Penn Hill	EK1	858/813.9875	860/815.9375	856/811.9875	857/812.9875	
Prospect Pk.	EK1	855/810.2125	856/811.2125	857/812.2125	858/813.4625	
Rocky Pt.	EK1	856/811.2625	857/812.2625	858/813.2625	859/814.4625	
Spruce	EK1	851/806.3750	851/806.8875	852/807.3750	852/807.8750	853/808.3750
Squaw Pk.	EK1	856/811.9625	857/812.9625	858/813.9625	855/810.9625	
Sunnyside	EK1	851/806.3125	851/806.8125	853/808.3125	853/808.8125	
Trident Pk.	EK1	858/813.2125	859/814.2125	860/815.2125	860/815.9875	
Victoria	EK1	858/813.2125	859/814.2125	860/815.2125	860/815.9875	
Wilson	EK1	855/810.2125	856/811.2125	857/812.2125	858/813.4625	
Winnemucca	EK1	851/806.4750	851/806.8500	852/807.4750	853/808.1625	
Alder Hill	FC	856/811.7125	857/812.7125	858/813.7125		
Amargosa Valley	FC	856/811.2625	857/812.2625	858/813.2625	859/814.2625	
Buster	FC	851/806.4500	852/807.1500	852/807.6375	853/808.2500	853/808.8500
Caliente	FC	854/809.9625	855/810.9625	856/811.2625	857/812.2625	

Site Name	System	Licensed Frequencies				
Emigrant	FC	851/806.0625	851/806.6375	852/807.0625	852/807.6625	853/808.6625
Flatcreek	FC	851/806.9125	852/807.4125	852/807.9125	853/808.4250	853/808.9125
HD Summit	FC	851/806.2000	851/806.5375	852/807.0375	852/807.4875	853/808.0375
High Camp	FC	856/811.2375	856/811.9625	857/812.9625		
Irish	FC	856/811.4625	857/812.4625	858/813.4625	859/814.4625	
Kinkaid	FC	858/813.2125	859/814.2125	860/815.2125	860/815.4875	856/811.5125
Likely	FC	854/809.9375	856/811.4125	859/814.4125		
Loray	FC	851/806.4625	851/806.9625	852/807.4625	852/807.9625	853/808.4375
New Pass	FC	856/811.4625	857/812.4625	858/813.4625	859/814.2625	
Ragged Ridge	FC	855/810.2125	856/811.2125	857/812.2125	858/813.2125	
Secret Pass	FC	854/809.9625	851/806.0375	856/811.7625	857/812.7625	
Timber	FC	851/806.2500	851/806.7500	852/807.2500	852/807.7500	853/808.2500
Wildoat	FC	851/806.4125	851/806.9000	853/808.3625	852/807.8625	853/808.8500
Angels	NP1	856/811.4625	857/812.4625	858/813.4625	852/807.2000	852/807.4250
		853/808.1000	853/808.3625	853/808.6250		
Beaver Dam	NP1	856/811.4625	857/812.4625	858/813.4625	859/814.4625	
Big Horn	NP1	851/806.0750	851/806.4250	851/806.8250	852/807.4250	853/808.1000
		853/808.6250				
Buckskin	NP1	856/811.3625				
Christmas Tree	NP1	851/806.3375	851/806.9875	852/807.1250	852/807.6750	853/808.1250
		853/808.6000				
Conners Pass	NP1	851/806.0500	851/806.4875	852/807.1750	852/807.7625	853/808.8000
Coyote Springs	NP1	851/806.0375	851/806.6000	852/807.1750	852/807.6625	853/808.4250
		853/808.8625				
Hoover Dam	NP1	851/806.3250	852/807.1375	853/808.2750	853/808.6875	
Lenzie	NP1	851/806.2125	851/806.6750	852/807.2750	853/808.3875	
LV Simulcast	NP1	851/806.4250	852/807.0500	852/807.7250	853/808.1625	853/808.7625
		851/806.1750	851/806.7625	852/807.3500		
Mercury	NP1	851/806.0625	852/807.0875	853/808.0875	853/808.7000	
Mesquite	NP1	851/806.0875	851/806.4750	851/806.9250	852/807.3875	852/807.8875
		853/808.3125				
Oatman	NP1	856/811.7375	857/812.7375	858/813.7375	860/815.7375	
Opal	NP1	858/813.7125	857/812.7125	859/814.7125	851/806.3125	851/806.8625
		852/807.2375				
Overton	NP1	857/812.7125	858/813.7125	855/810.2125	857/812.2625	
Page	NP1	858/813.3625				
Pipe Springs	NP1	858/813.3625				
Potosi	NP1	856/811.9375	857/812.9375	858/813.9375	851/806.2250	851/806.7000
		852/807.7500	853/808.1125	853/808.7125		

Site Name	System	Licensed Frequencies				
Rio	NP1	851/806.7375	852/807.0750	851/806.0750	853/808.0750	855/810.2375
		857/812.2625	859/814.4875	859/814.9875	860/815.4625	
Schader	NP1	851/806.4875	851/806.9375	852/807.6375	853/808.2500	
Silverhawk	NP1	851/806.2875	851/806.8750	852/807.3375	852/807.8125	
Sloan	NP1	855/810.7375	857/812.4375	858/813.2625	860/815.2375	851/806.2875
		851/806.8750	853/808.2375	853/808.5250	852/807.3250	853/808.8000
Sunrise	NP1	854/809.9625	855/810.4625	855/810.9875	856/811.4875	857/812.2125
		858/813.2125	859/814.2125	859/814.7125	860/815.2125	860/815.7125
		856/811.2375	856/811.9625	858/813.4375	859/814.4375	860/815.9625
Thomas & Mack	NP1	851/806.4875	853/808.3750	852/807.7750	851/806.9875	
Beckworth	SP1	857/812.9625	858/813.9625	859/814.9625		
Chevas	SP1	856/811.4625	857/812.4625	858/813.4625	859/814.4625	860/815.1625
Chimney	SP1	856/811.4625	857/812.4625	858/813.4625		
Eagle Ridge	SP1	854/809.9875	856/811.7625	858/813.7625	852/807.3875	852/807.8625
		853/808.1375				
East Twin	SP1	851/806.2875	851/806.8625	852/807.4250	853/808.1250	853/808.6875
		852/807.7000				
Fairview Peak	SP1	854/809.0125	856/811.9375	859/814.2125	860/815.4625	
McClellan	SP1	856/811.9625	857/812.9625	858/813.9625	855/810.9625	859/814.9625
		852/807.0875	852/807.3375	852/807.7125		
Millers	SP1	856/811.7125	857/812.7125	858/813.7125	859/814.7125	
N. Lake Tahoe	SP1	856/811.7125	857/812.7125	858/813.7125		
Palmetto	SP1	856/811.9625	857/812.9625	858/813.9625	855/810.9625	
Patrick	SP1	854/809.3875	857/812.4375	856/811.7125	857/812.7125	858/813.7125
		851/806.5375	852/807.0375	852/807.6375		
Peavine	SP1	855/810.4625	856/811.4875	858/813.4375	853/808.6625	
Pinegrove	SP1	856/811.4625	857/812.4625	858/813.4625	860/815.4625	
Red Pk.	SP1	855/810.9875	859/814.4375	860/815.9625	855/810.7125	860/815.7375
S. Lake Tahoe	SP1	855/810.7375	856/811.7375	857/812.7375	858/813.7375	
TV Hill	SP1	856/811.9375	857/812.9375	858/813.9375	854/809.0375	854/809.4875
Virginia Pk.	SP1	855/810.7375	856/811.7375	851/806.0750	851/806.5500	
Alamo	SP2	856/811.7125	857/812.7125	858/813.7125	859/814.9375	
Argenta	SP2	856/811.9375	857/812.9375	858/813.9375	854/809.9625	853/808.6125
Bald West	SP2	851/806.2500	851/806.7500	852/807.2500	852/807.8000	853/808.2500
Brock	SP2	856/811.7375	857/812.7375	858/813.7375	859/814.7375	860/815.7375
Currant Summit	SP2	858/813.2125	859/814.2125	860/815.2125	860/815.9875	
Fencemaker	SP2	854/809.7875	855/810.5625	859/814.7875		
Fitzpatrick	SP2	856/811.7125	857/812.7125	858/813.7125	859/814.7125	
Highland Pk.	SP2	856/811.7375	857/812.7375	858/813.7375	859/814.7375	860/815.7375

Site Name	System	Licensed Frequencies				
Montezuma	SP2	856/811.4625	857/812.4625	858/813.4625	859/814.4625	
Muller	SP2	851/806.0500	851/806.6500	852/807.1625	852/807.6875	853/808.3250
Pilot Pk.	SP2	856/811.2625	857/812.2625	858/813.2625	859/814.4625	
Pinenut	SP2	851/806.1875	851/806.4625	851/806.8625	856/811.7125	857/812.7125
		858/813.7125	852/807.2750	852/807.8250		
Sawtooth	SP2	855/810.7375	856/811.7375	857/812.7375	858/813.7375	
Shaffer	SP2	854/809.8375	855/810.2625	855/810.7875		
Sober	SP2	856/811.2625	857/812.2625	858/813.2625	859/814.2625	
Spooner	SP2	853/808.3375	853/808.8250	852/807.7375		
Toulon	SP2	858/813.2125	859/814.2125	860/815.2125	860/815.9875	
Warm Springs	SP2	856/811.9375	857/812.9375	858/813.9375	859/814.9875	
Chimney - WCRCS	WC1	855/810.2375	856/811.9375	857/812.2625	857/812.9375	858/813.2625
		859/814.2625	860/815.2375	860/815.4875	860/815.9875	
Fox - WCRCS	WC1	856/811.2125	857/812.2125	858/813.2125	859/814.2125	851/806.0875
Marble Bluff - WCRCS	WC1	851/806.7000	851/806.9500	852/807.2250	853/808.1125	853/808.4000
Metro Simulcast	WC1	851/806.2750	851/806.5750	851/806.9000	853/808.2500	853/808.5000
		851/806.3000	851/806.6250	853/808.2000	853/808.4500	853/808.7000
		851/806.3250	851/806.6000	853/808.1750	853/808.4250	853/808.9125
Poito - WC	WC1	856/811.7125	857/812.7125	858/813.7125	859/814.7125	860/815.7625
Rose WCRCS	WC1	851/806.1000	851/806.8125	852/807.6250	853/808.3625	853/808.9375
Slide WCRCS	WC1	854/809.9625	857/812.4875	857/812.9875	859/814.2375	859/814.7625
		860/815.2625	851/806.7250	851/806.9750	852/807.9000	851/806.7500
		860/815.7625	859/814.4625			
Tahoe Simulcast	WC1	855/810.2375	856/811.2125	857/812.2125	858/813.2125	859/814.2125
		860/815.2125	860/815.4875			
Virginia Peak WCRCS	WC1	851/806.1250	851/806.3750	851/806.8375	852/807.1125	853/808.0750
		853/808.3250	853/808.8375	852/807.4500	852/807.7750	853/808.0750

Appendix C - Traffic Analysis

Most Voice Calls in One Hour

In the following graphs, the **"Most" voice calls per hour per channel** is calculated by determining the busiest single hour (in terms of voice calls made) for each site throughout the entire year of 2015. From there, the number of calls made during that hour are divided by the number of voice channels at each site. This metric provides an indication of each site's traffic at its busiest.

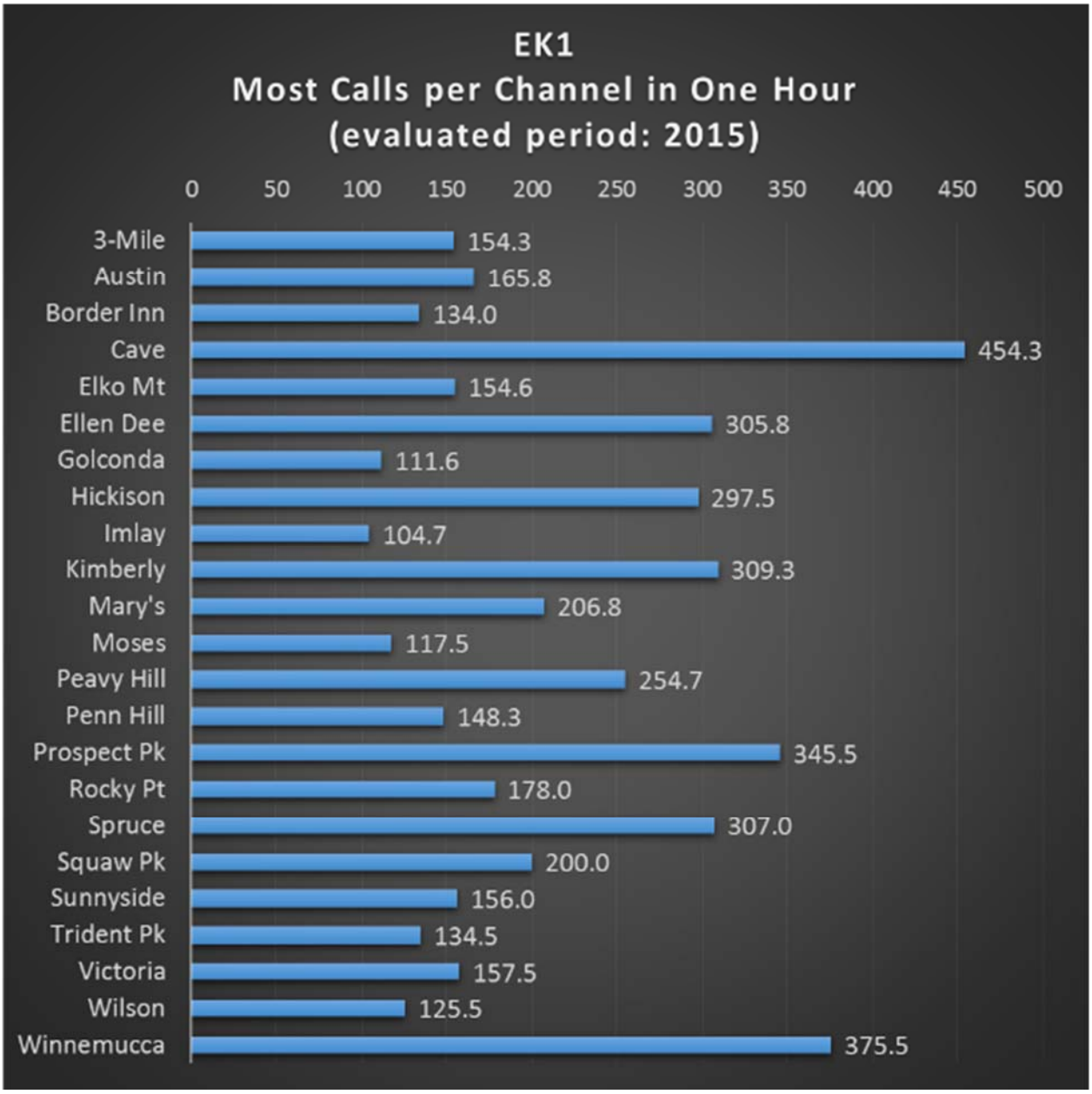

Figure C.1 – EK1 – Most Calls per Channel in One Hour (evaluated period: 2015)

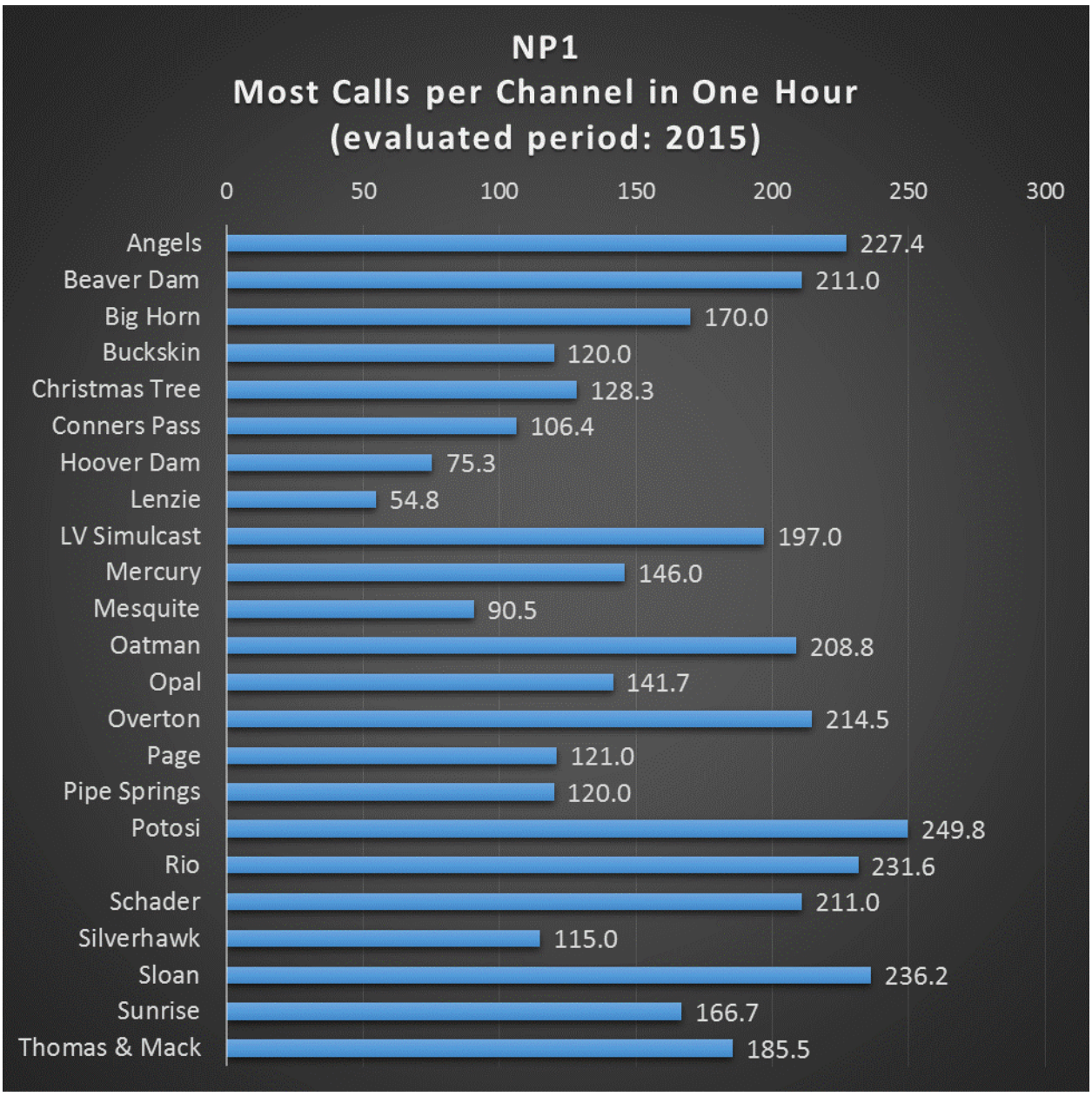

Figure C.2 – NP1 – Most Calls per Channel in One Hour (evaluated period: 2015)

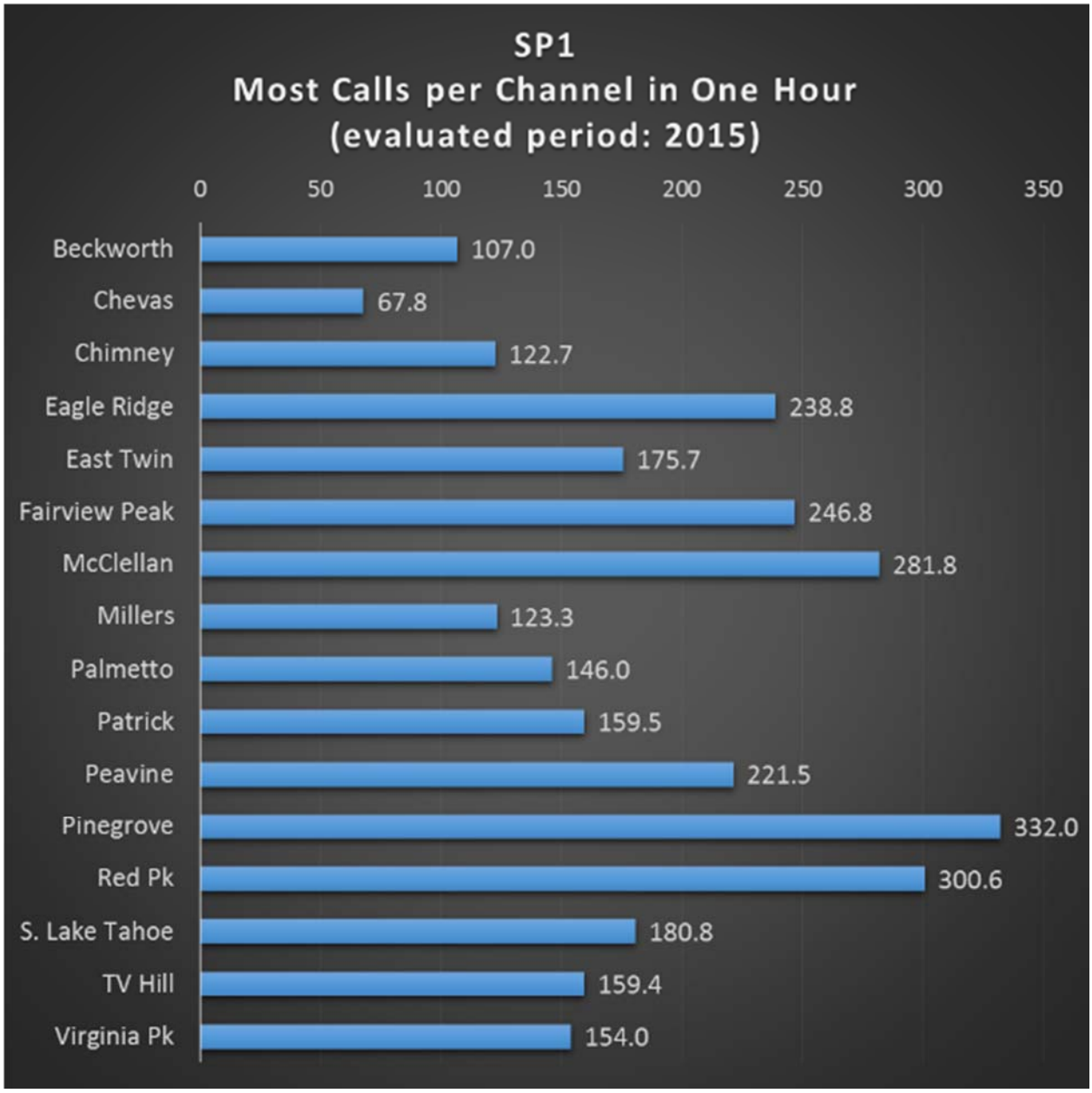

Figure C.3 – SP1 – Most Calls per Channel in One Hour (evaluated period: 2015)

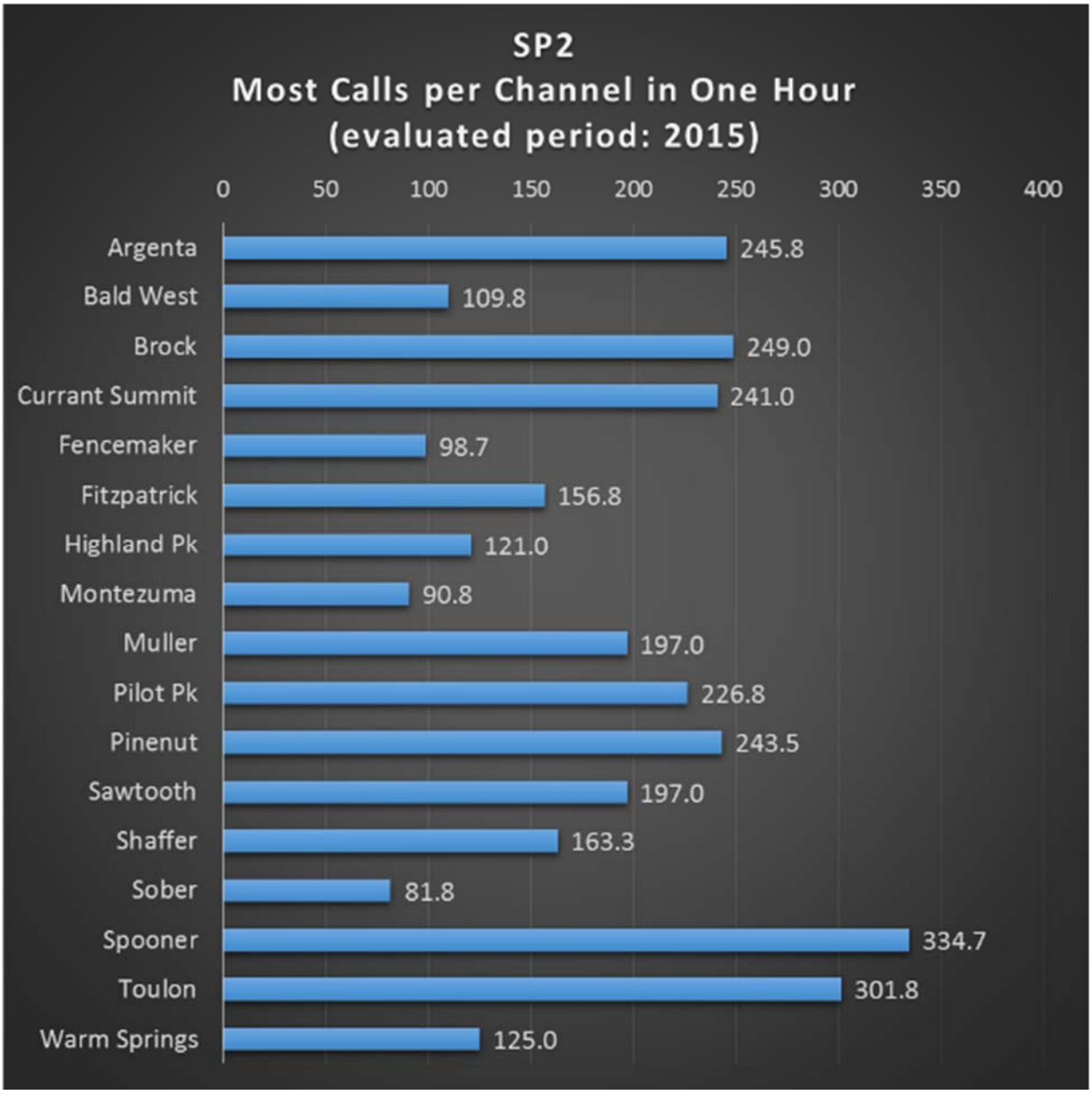

Figure C.4 – SP2 – Most Calls per Channel in One Hour (evaluated period: 2015)

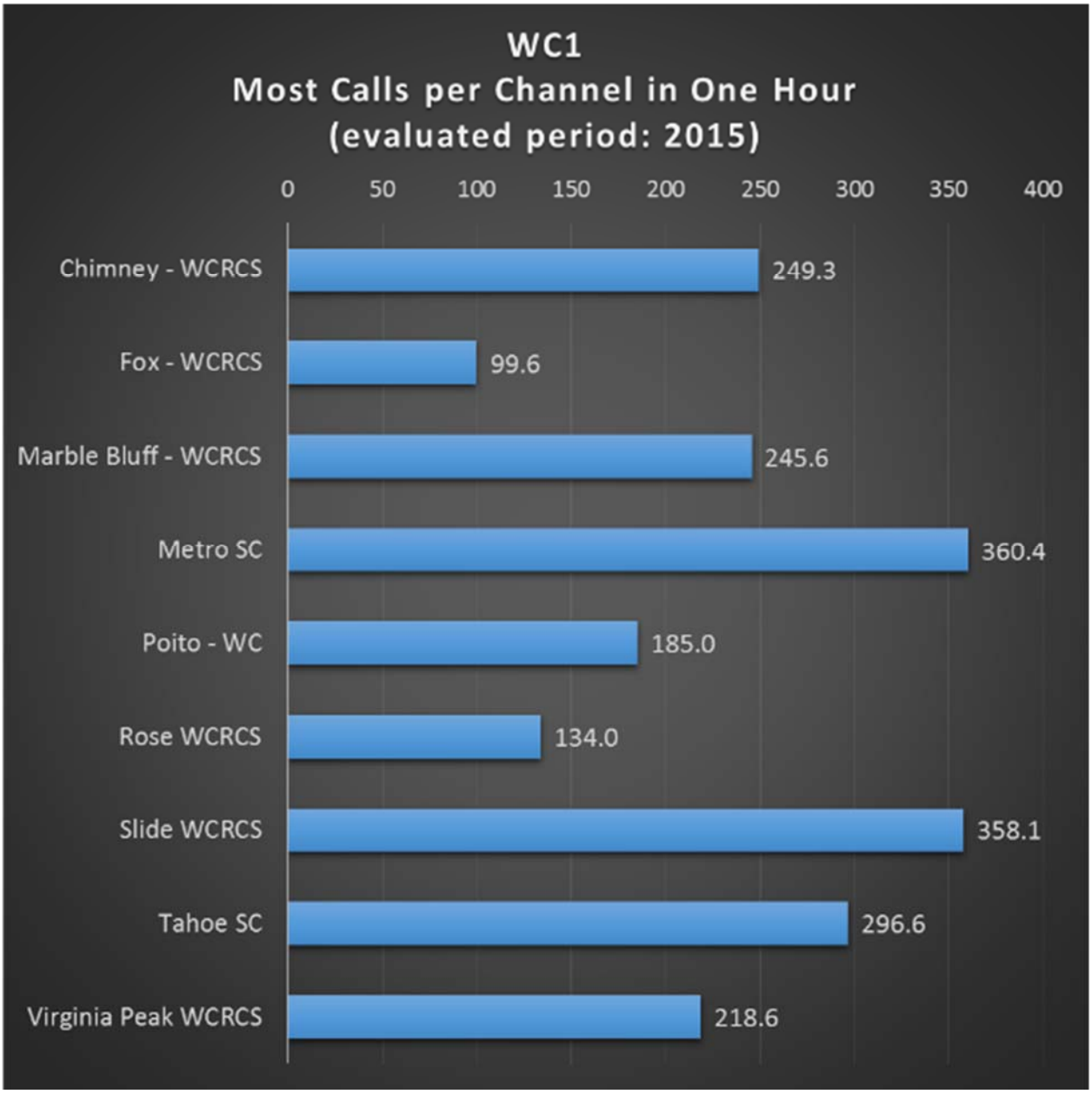

Figure C.5 – WC1 – Most Calls per Channel in One Hour (evaluated period: 2015)

Reviewing the preceding graphs, the two WC1 sites (Metro Simulcast and Slide) that had the highest average and peak traffic from the previous section were also shown to have a high number of calls during the busiest hour of 2015. However, the sites that had the most calls per channel during an hour in 2015 were the Cave and Winnemuca sites in the EK1 subsystem. Those sites, as well as other sites in EK1, where previously shown to have relatively low average and peak traffic per channel, so these high single-hour totals may be reflective of anomalous high-traffic incidents that may have occurred at these sites in 2015.

Voice Calls Queued throughout 2015

The graphs in this section present the total number of voice call attempts, at each site, which were queued prior to being granted a channel. This queuing occurs when all traffic channels at a site are occupied with traffic, and new call attempts are placed in a queue until a channel becomes available. This metric is a good demonstration of which sites are frequently being taxed beyond their available channel capacity.

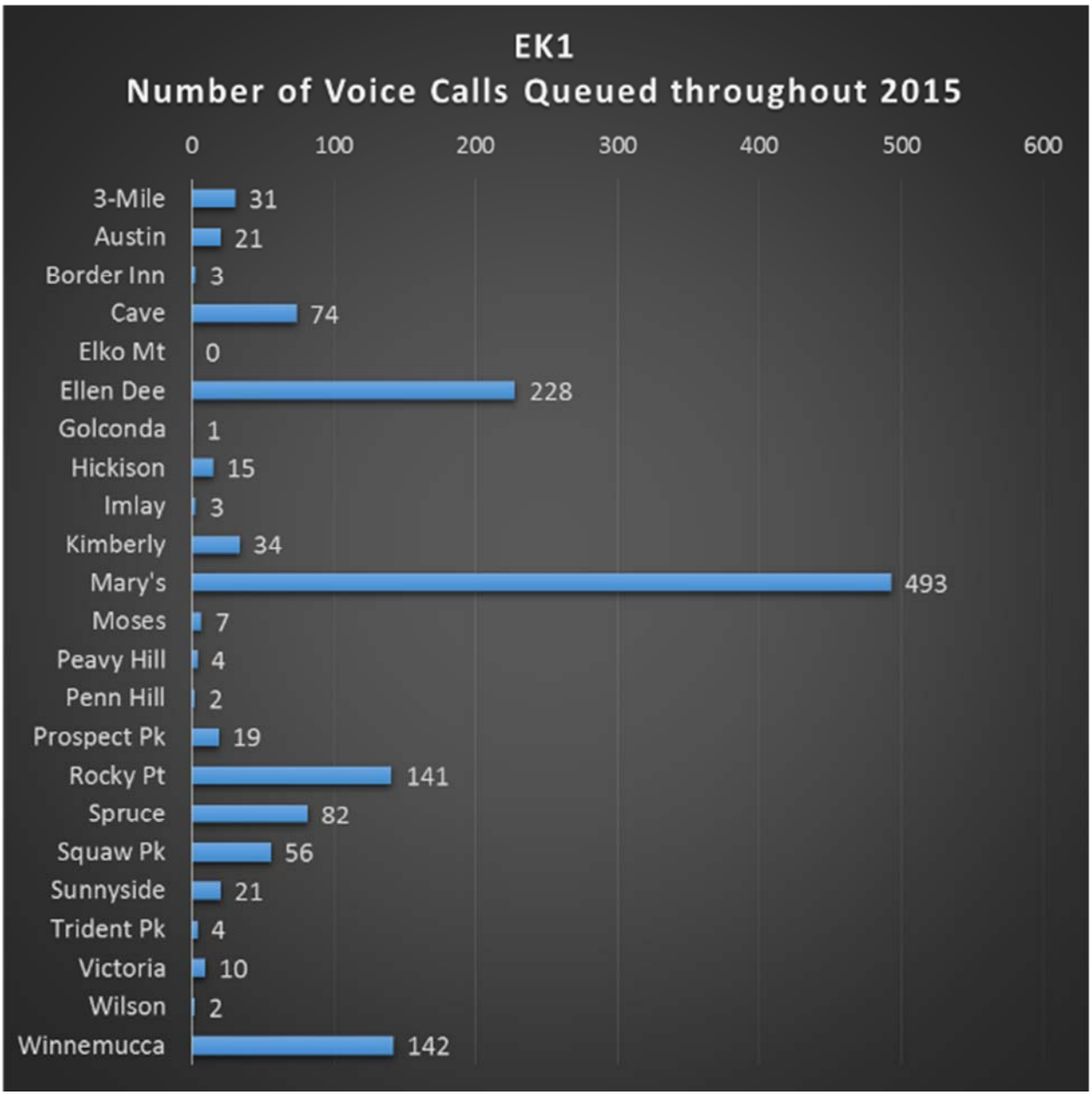

Figure C.6 – EK1 – Number of Voice Calls Queued throughout 2015

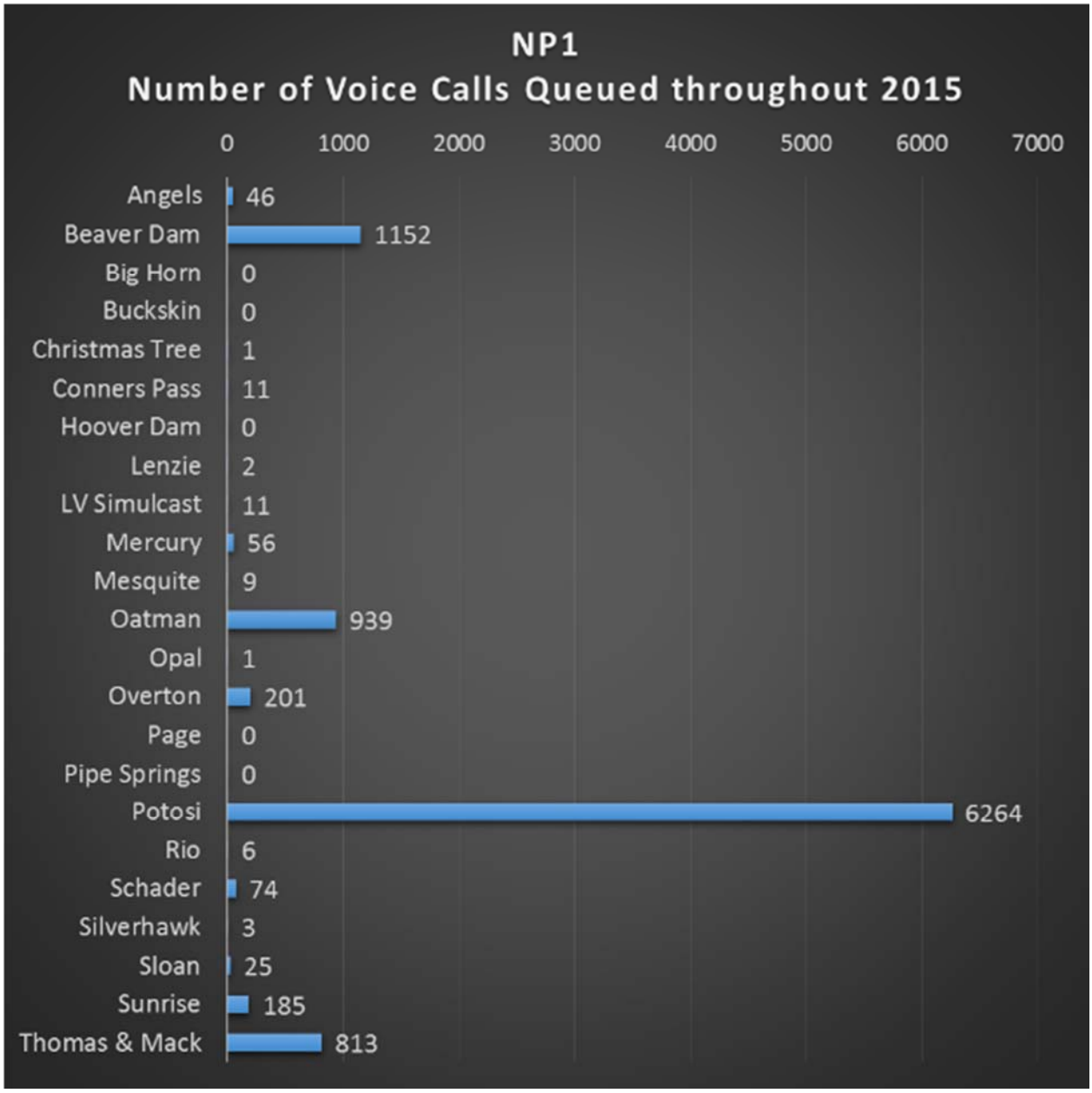

Figure C.7 – NP1 – Number of Voice Calls Queued throughout 2015

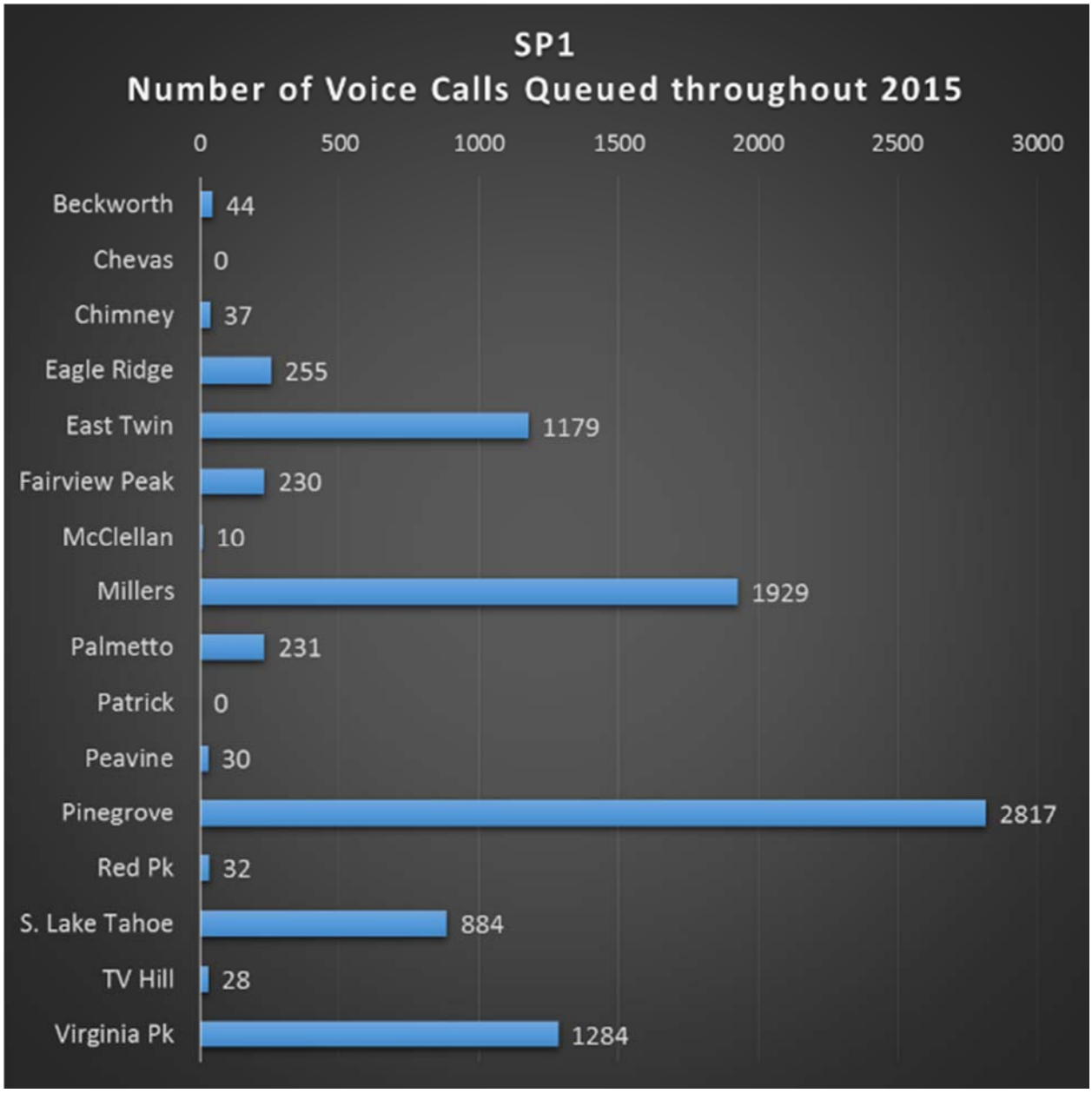

Figure C.8 – SP1 – Number of Voice Calls Queued throughout 2015

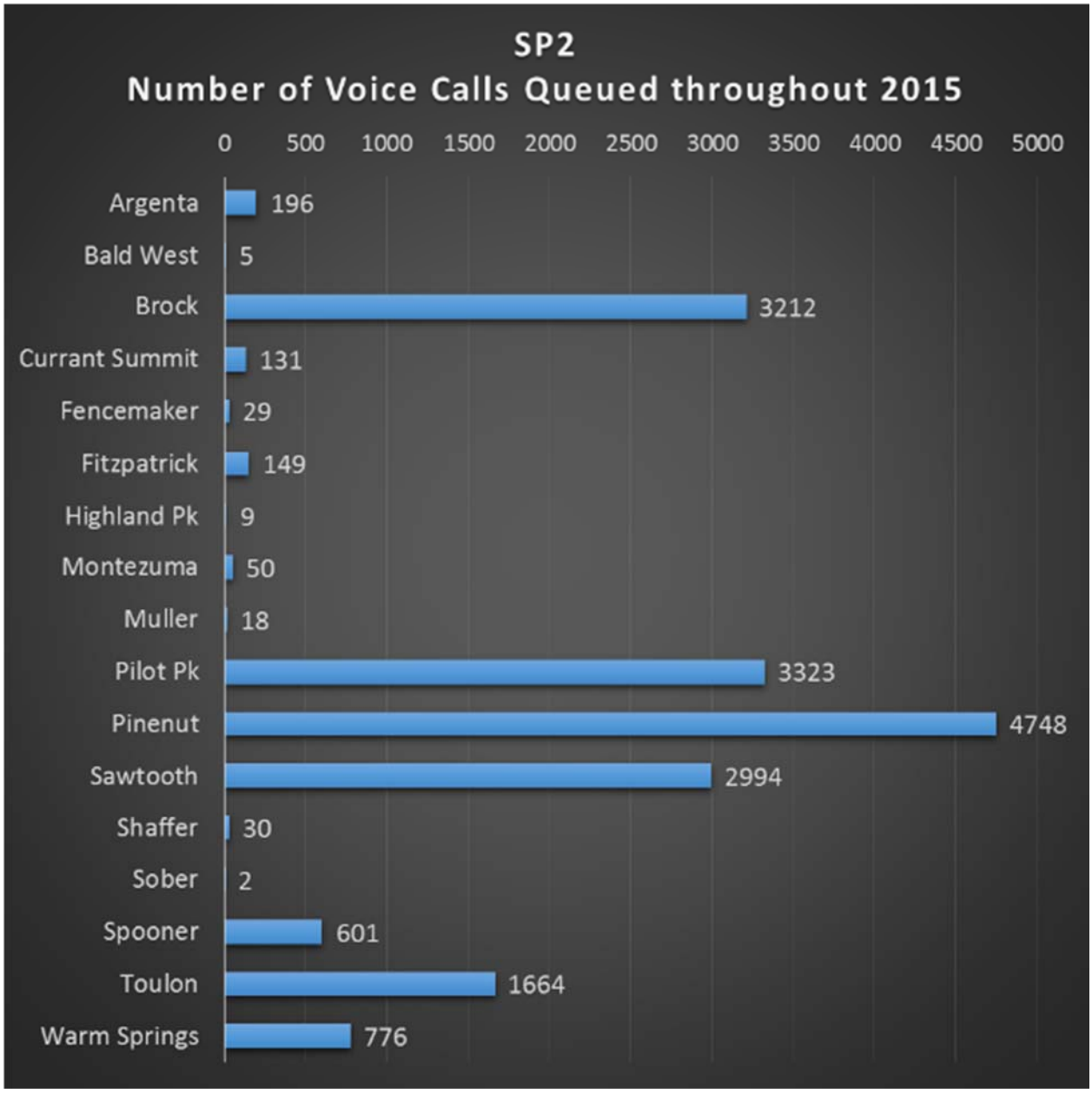

Figure C.9 – SP2 – Number of Voice Calls Queued throughout 2015

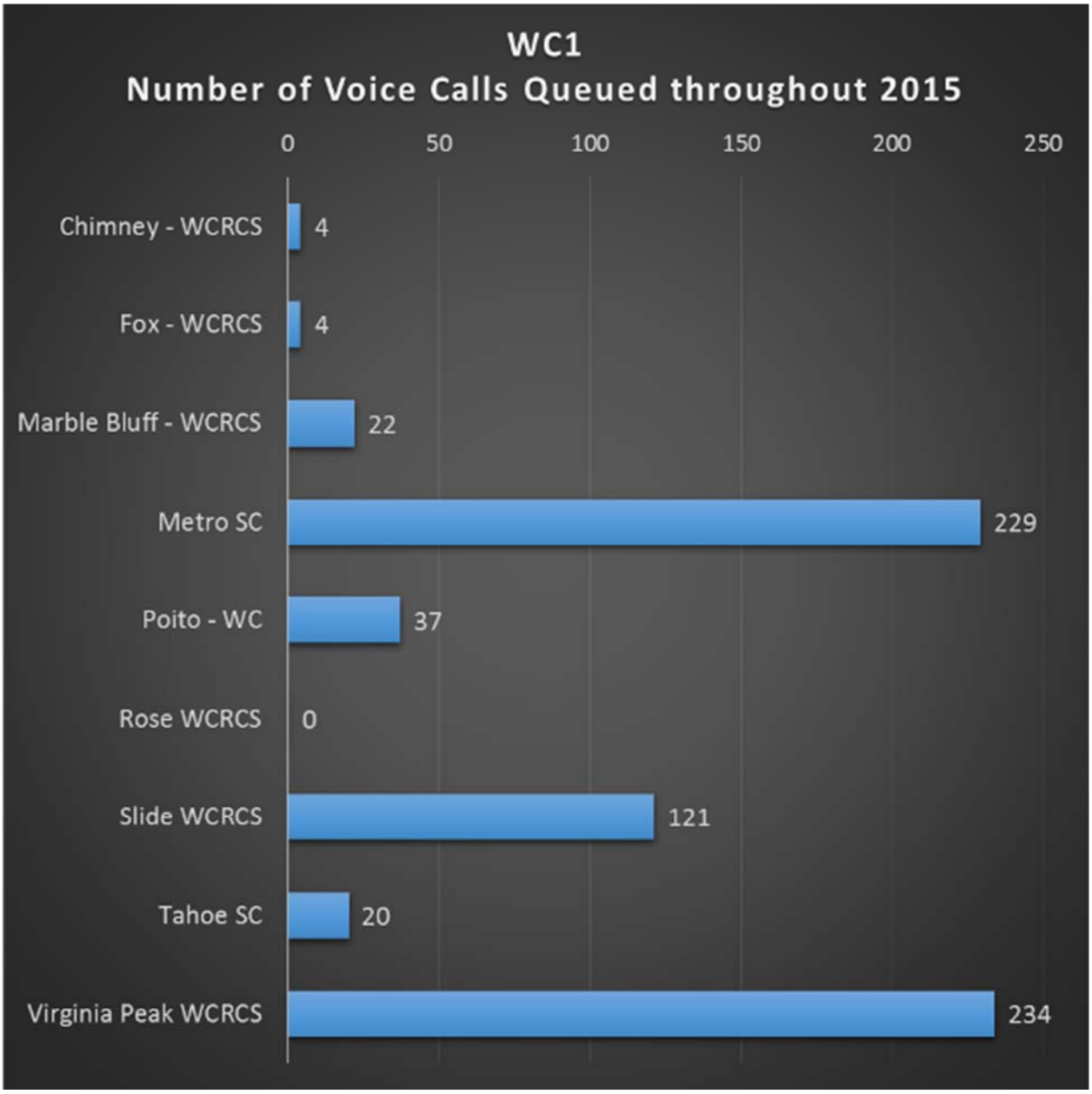

Figure C.10 – WC1 – Number of Voice Calls Queued throughout 2015

Several sites experienced queued calls in the thousands. More specifically, three sites in the SP2 subsystem had more than 3,000 call attempts queued during 2015, and the busiest site in the NSRS was the Potosi site in the NP1 subsystem, which had more than 6,000 calls queued. Additionally, while the WC1 sites were shown in previous sections to have some of the highest traffic sites when evaluating calls per hour per channel, their queuing totals were not as high as sites in other subsystems.

Percent of Voice Calls Queued throughout 2015

When evaluating queueing, it is important to not just consider queuing totals (as shown in the last section), but also to consider what percentage of total call attempts those queued calls represent at each site. The graphs in this section present the percentage of total voice call attempts that were queued at each site in the NSRS. For example, if a site is listed as having 0.5% of its calls queued, then that translates to one of every 200 call attempts being queued.

Often, when evaluating capacity, the percentage of calls queued (or blocked) is expressed as the **Grade of Service** (GoS) of that site or system. In public safety radio systems, a frequently-used recommendation is providing sufficient capacity so that the GoS of any site does not exceed 1% (i.e., no more than 1 of every 100 call attempts are queued or blocked). Each of the following graphs shows this 1% GoS threshold as a red line in.

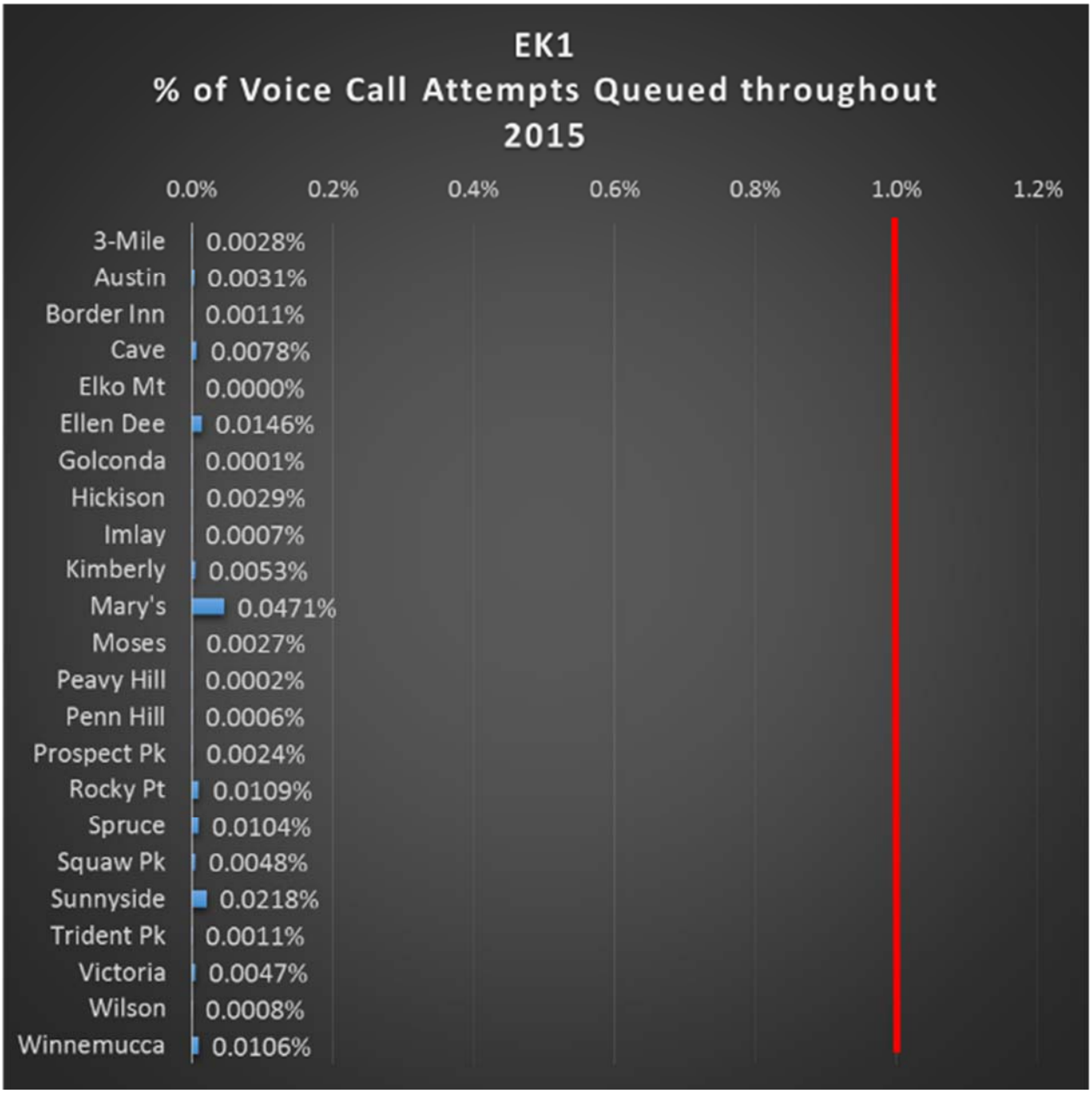

Figure C.11 – EK1 – Percentage of Voice Call Attempts Queued throughout 2015

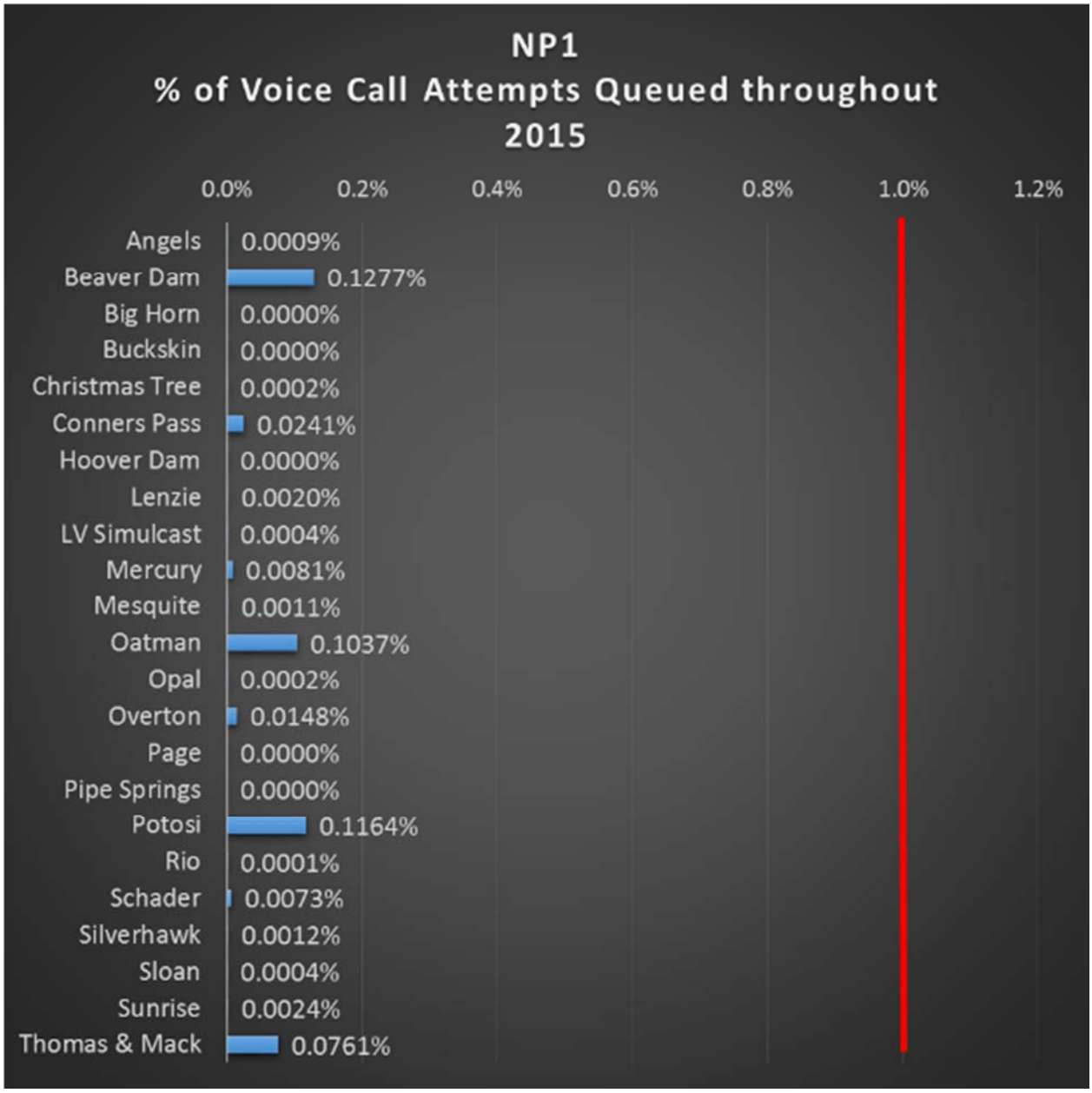

Figure C.12 – NP1 – Percentage of Voice Call Attempts Queued throughout 2015

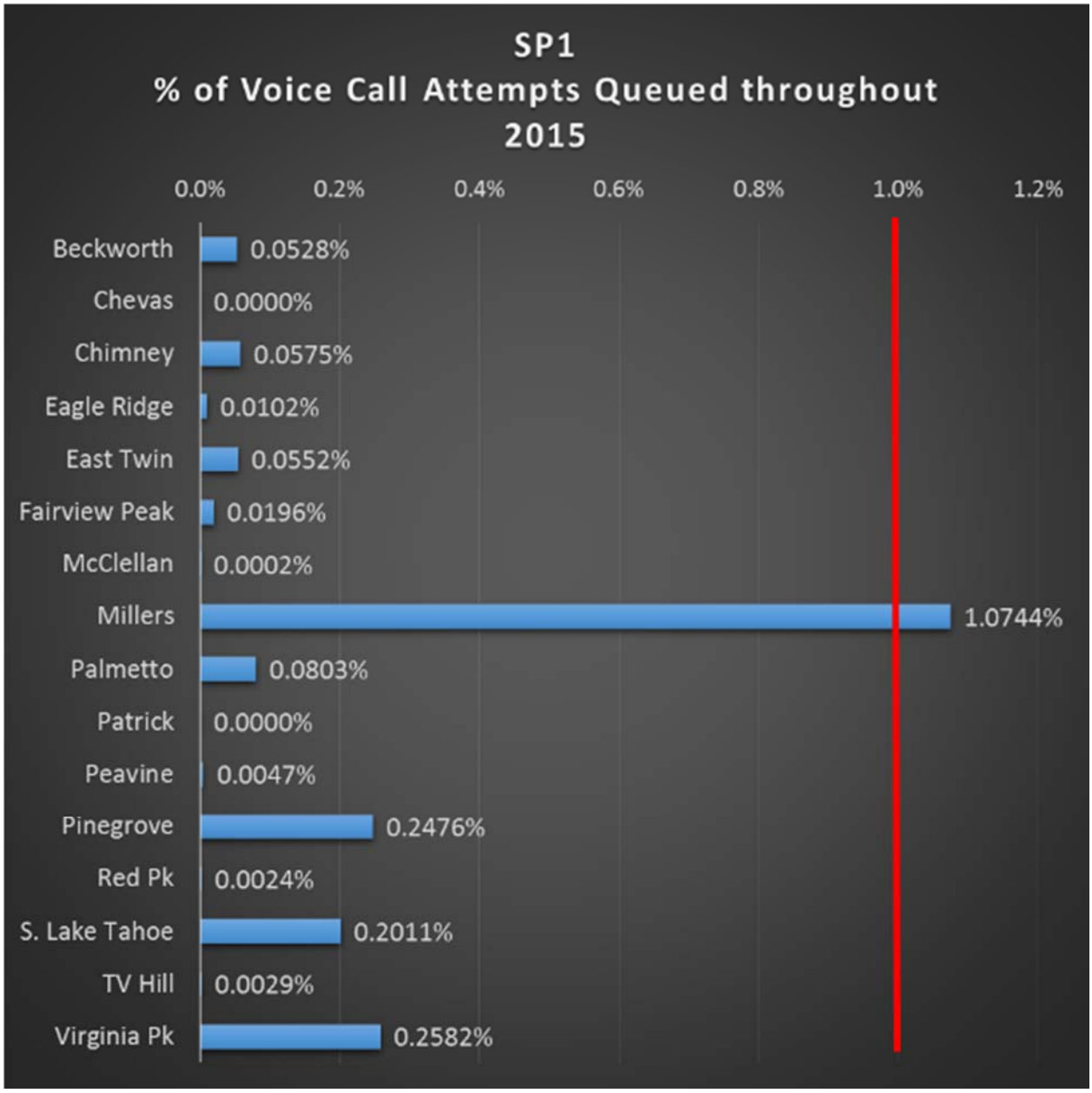

Figure C.13 – SP1 – Percentage of Voice Call Attempts Queued throughout 2015

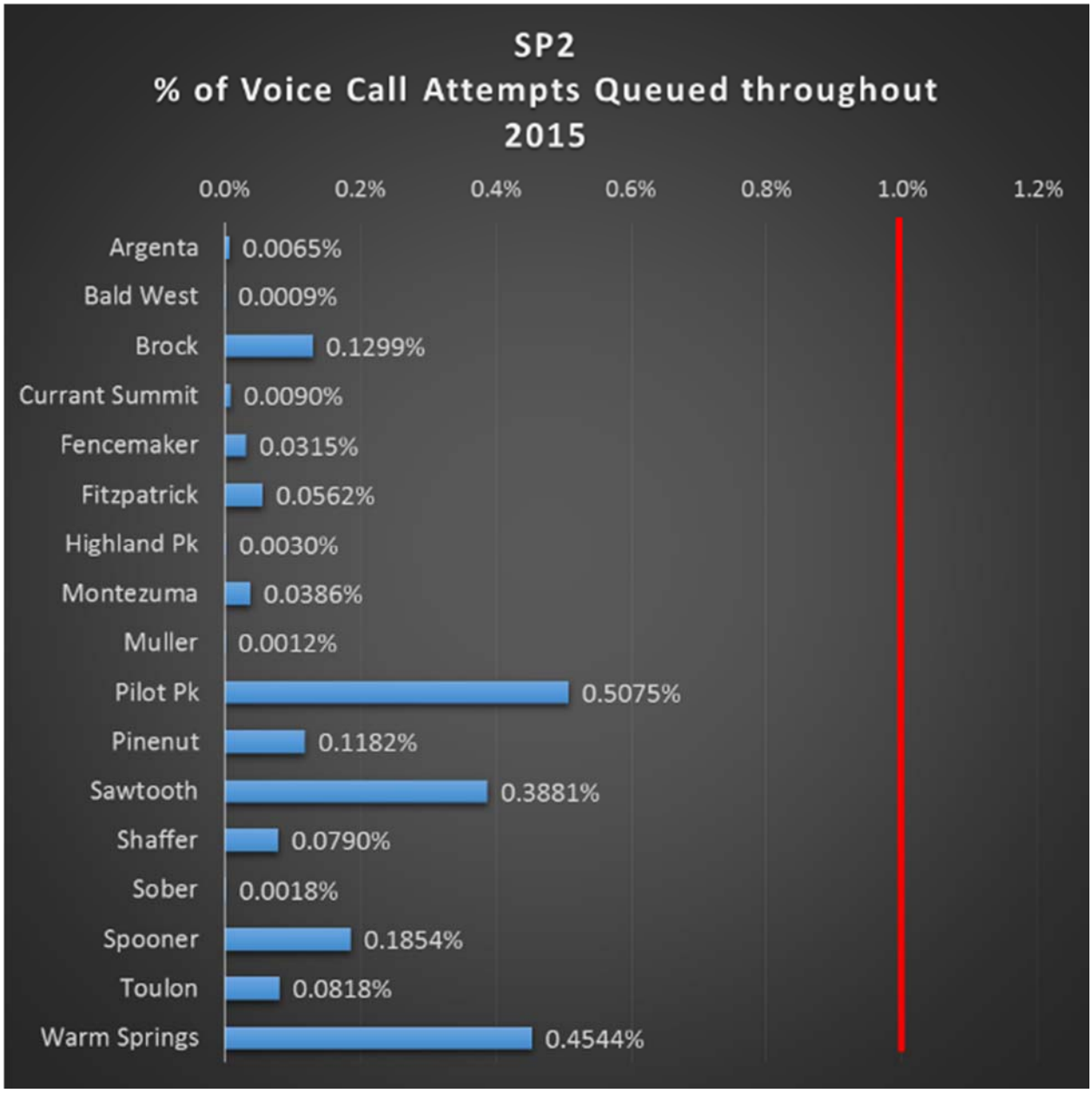

Figure C.14 – SP2 – Percentage of Voice Call Attempts Queued throughout 2015

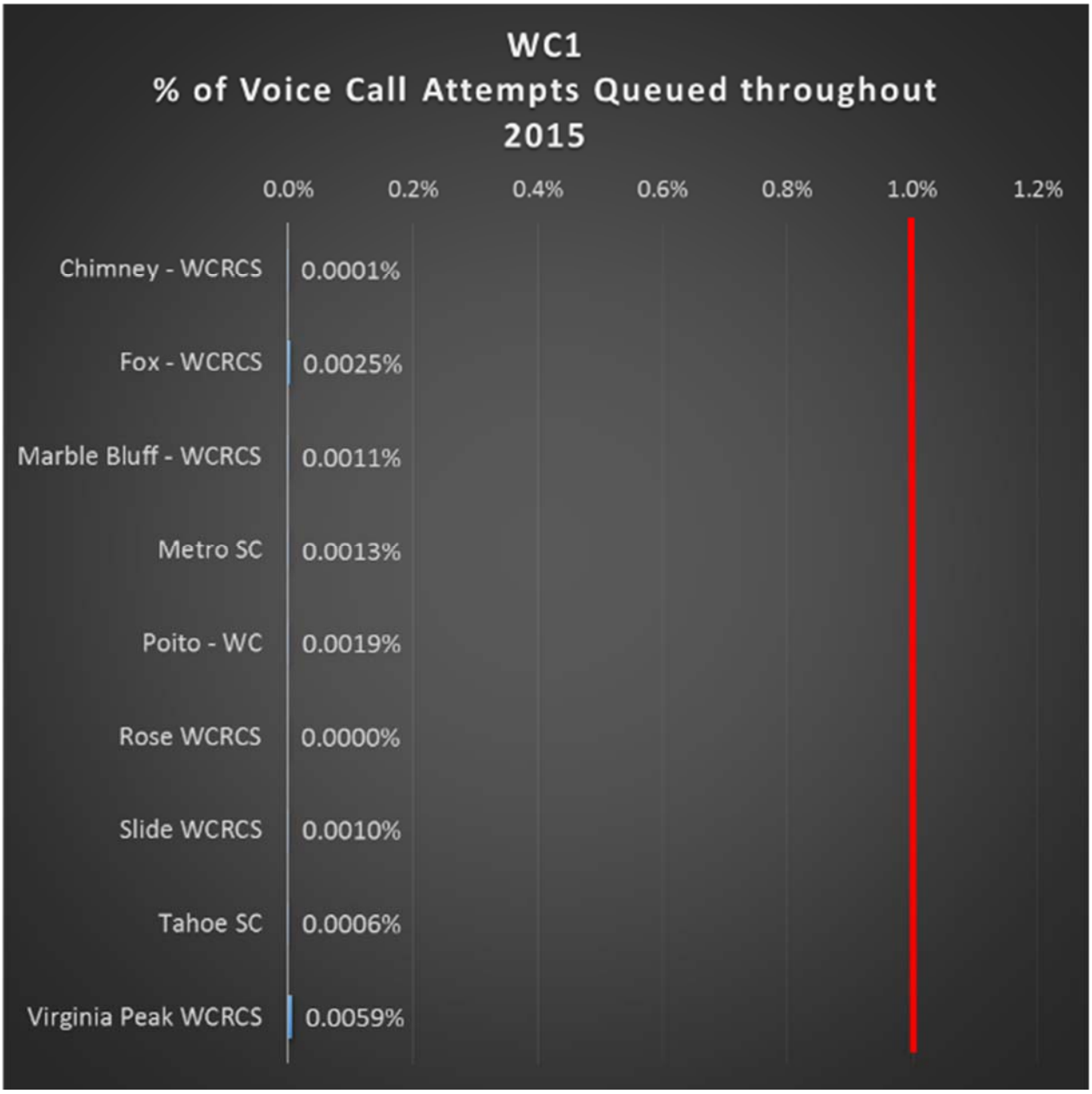

Figure C.15 – WC1 – Percentage of Voice Call Attempts Queued throughout 2015

Of all 88 NSRS sites, only one site, the Millers site in SP1, was shown to have queuing occur above the rate of 1%. Most of the other sites in the NSRS have a much lower queuing rate.

Most Queued Voice Calls in One Hour

While a site may have sufficient capacity for less than 1% GoS, there may still be high-traffic incidents that result in a large number of queuing in a small amount of time. The

graphs in this section present each site's highest single-hour number of queues experienced during 2015.

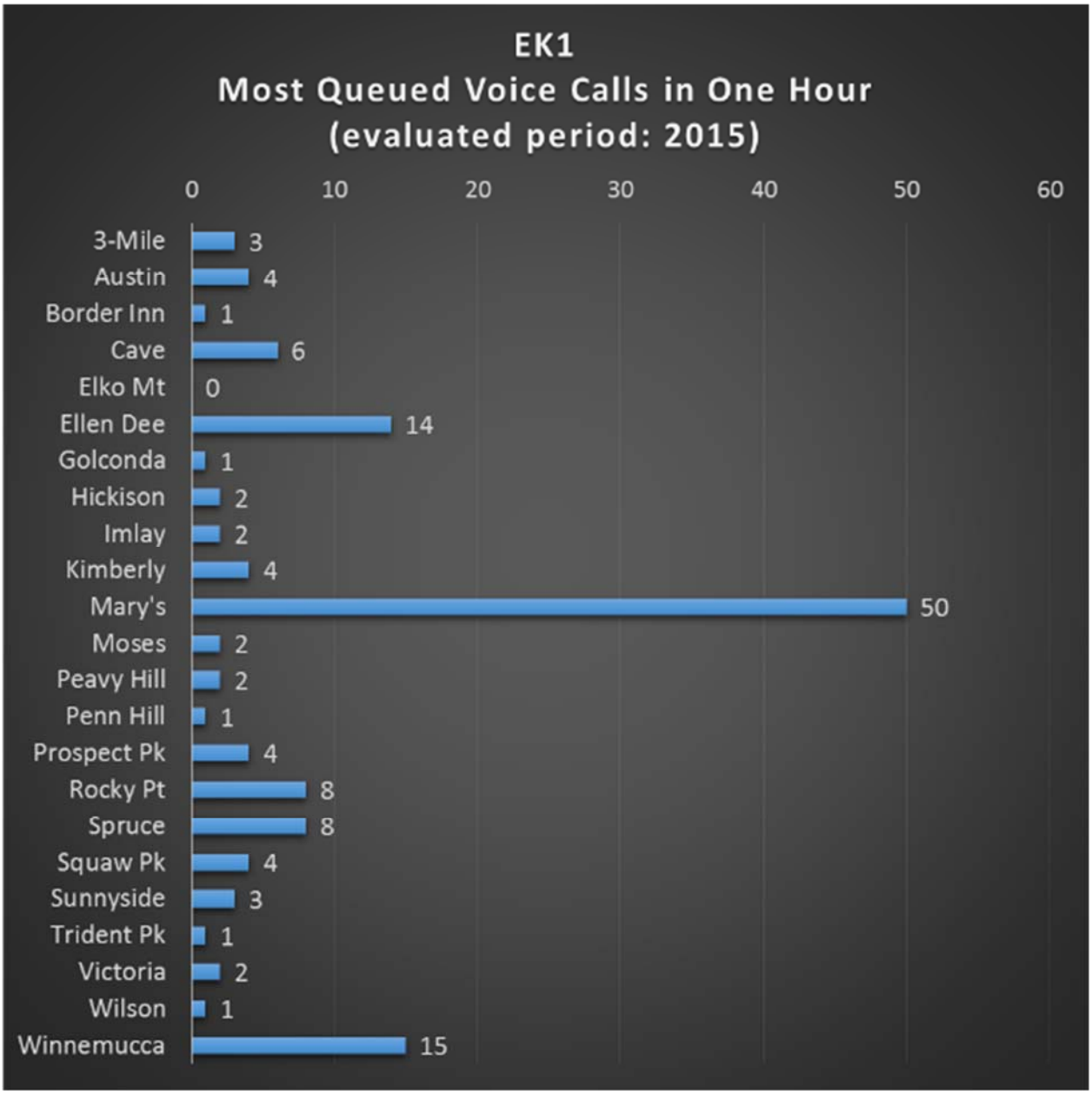

Figure C.16 – EK1 – Most Queued Voice Calls in One Hour (evaluated period: 2015)

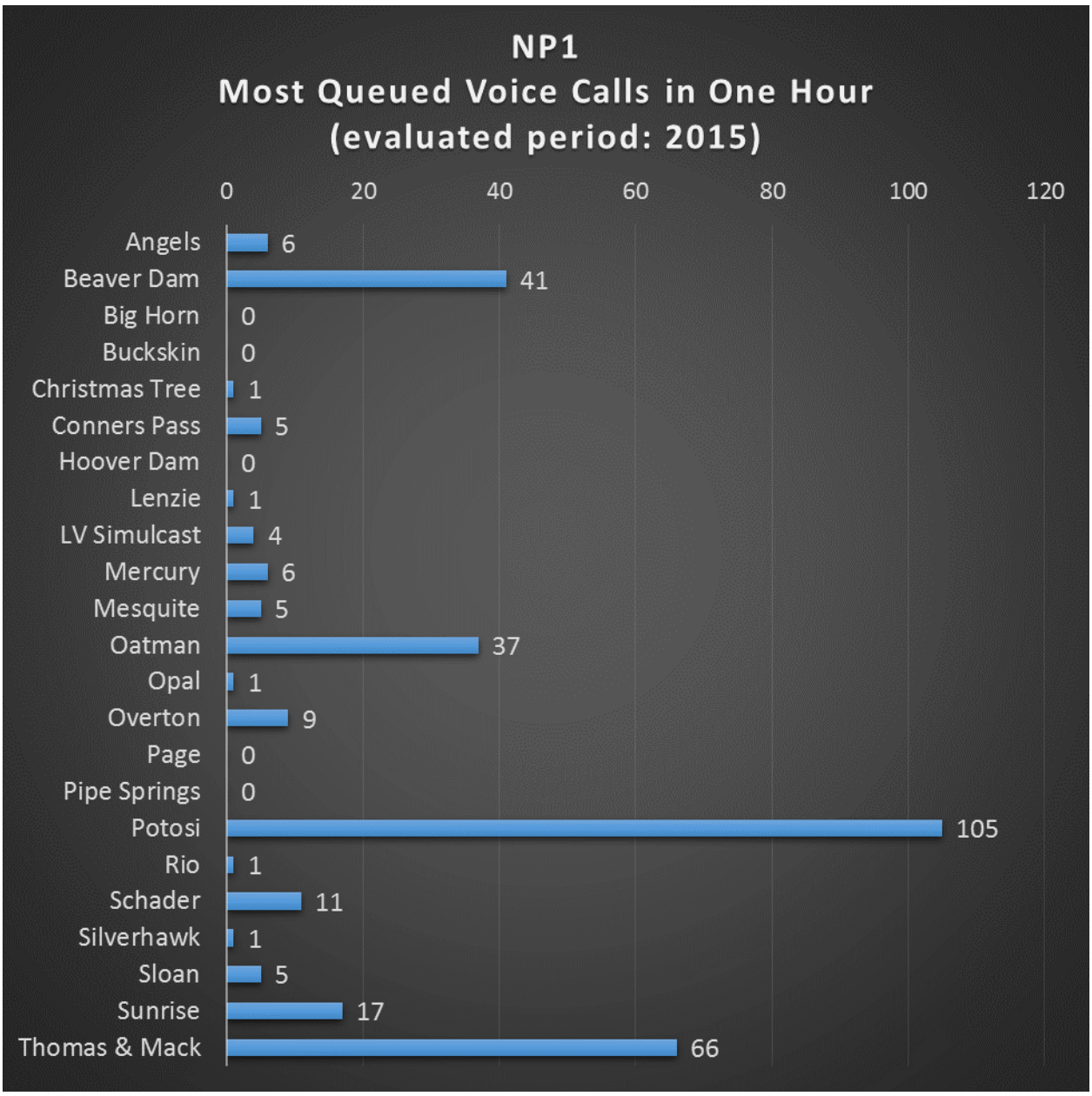

Figure C.17 – NP1 – Most Queued Voice Calls in One Hour (evaluated period: 2015)

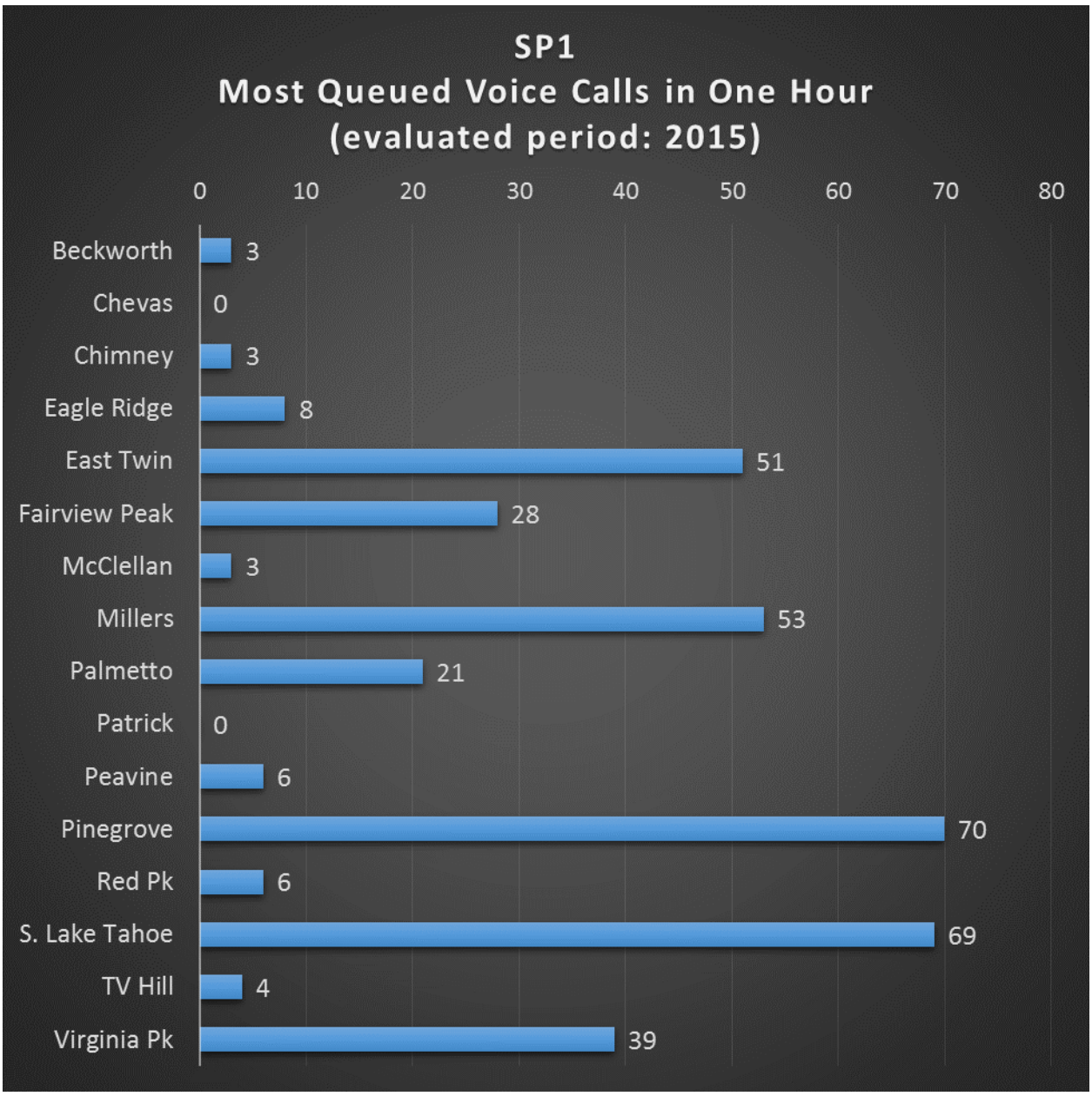

Figure C.18 – SP1 – Most Queued Voice Calls in One Hour (evaluated period: 2015)

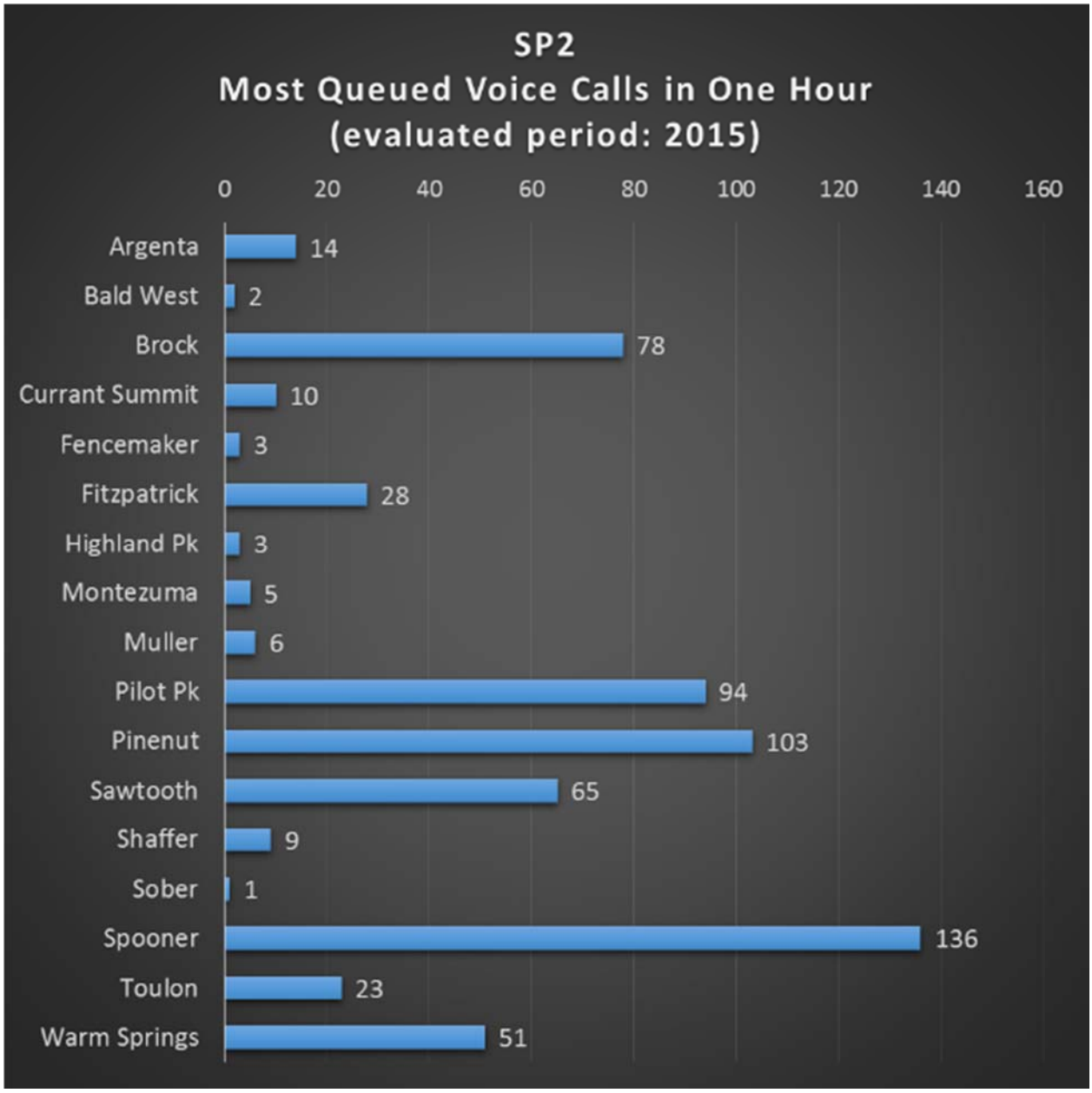

Figure C.19 – SP2 – Most Queued Voice Calls in One Hour (evaluated period: 2015)

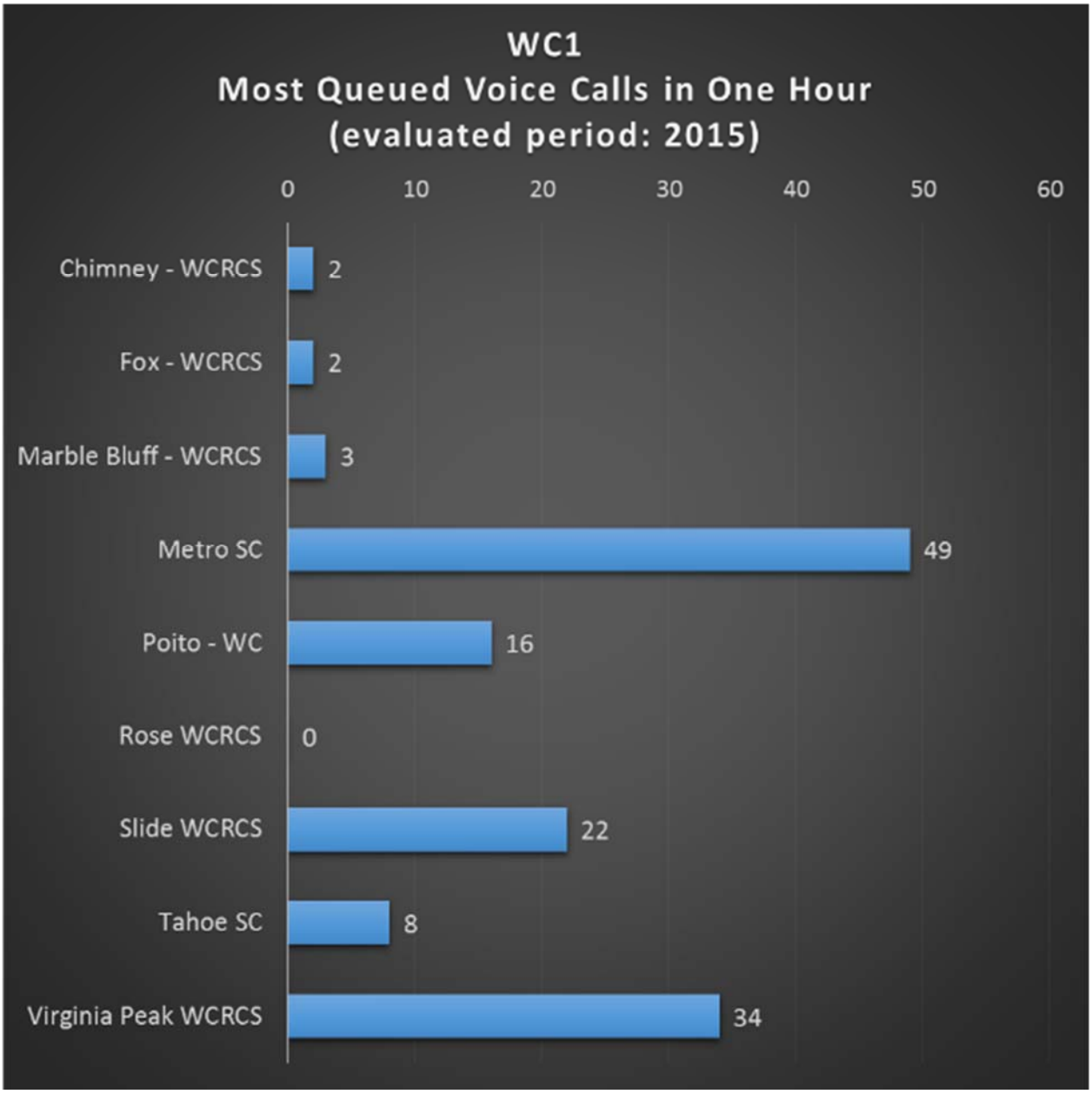

Figure C.20 – WC1 – Most Queued Voice Calls in One Hour (evaluated period: 2015)

Several of the sites which had relatively high GoS percentages (e.g., Millers, which exceeded 1% Grade of Service) also, expectedly, had a large number of queues during its busiest single hour in 2015. However, sites like Mary's in EK1, had a relatively large number of queues (50) during one hour in 2015, while still having a low GoS. This may be an indication of how a single incident caused the channel capacity to be insufficient at that site.