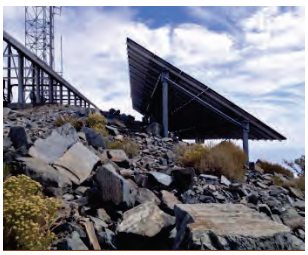

Improve and Replace Rogers Peak Communication Infrastructure

Phase I Feasibility Study

National Park Service
Death Valley National Park

Task Order P13PD01624
Contract Number P09PC60878

March 19, 2014

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Contents

Tables

Figures

Appendices

1 Executive Summary

Originally proclaimed as a national monument in 1933, Death Valley National Park (DEVA) was formally established in 1994 and covers approximately 3,336,000 acres in east central California, with nearly 90 percent of the park formally designated as wilderness. Within DEVA, the National Park Service (NPS) has an existing telecommunication site located at the sloped summit area of Rogers Peak with elevations between 9962 feet and 9990 feet above sea level. The Rogers Peak site currently contains two telecommunication towers, one owned by the California Department of Transportation (Caltrans) and the other owned by the U.S. Air Force, along with supporting structures within a 2.75 acre area that is surrounded by designated wilderness on four sides. The towers and supporting structures are generally in the southeast quarter of the site.

Currently, AT&T has long-line telecommunications equipment on a tower located within an existing NPS telecommunications site atop Mormon Peak. Mormon Peak lies approximately 14 miles southeast of Rogers Peak at the edge of DEVA and within the designated wilderness area. As such, NPS may be required to remove all non-NPS telecommunications equipment (AT&T) from the Mormon Peak site.

The primary goal of this study is to determine if it is feasible to consider applications for use of the Rogers Peak site by non-governmental telecommunication entities such as AT&T. Based on the analysis conducted in this Phase 1 Feasibility Study, the first step in this process, the following conclusions and recommendations were developed.

Existing Shelter and Tower Space

Existing shelter and tower space is near capacity. Space does remain for tenants operating private or internal radio systems serving a limited number of users, such as small two-way radio companies or most government agencies. Equipment used by such entities requires limited space and power. Further equipment and antenna consolidation may provide an incremental increase in space.

It is unlikely that enough space is available for commercial tenants that provide services to consumers and business, such as commercial cellular or microwave carriers. Expanding existing or constructing new facilities would be required.

We also note that some systems supported by the Caltrans shelter and tower do not meet certain U.S. Department of Interior (DOI) standards related to lightning protection and grounding, or equipment seismic support.

The majority of the existing tenants are government agencies having life-safety missions that require extremely reliable radio systems and proper access security. As commercial system operators have different missions and priorities, conflict can arise when equipment shelters and utilities are shared unless some isolation is provided. This applies to a lesser degree to shared antenna towers, but it can occur if antenna system standards are not established and enforced for all parties.

Structural Analysis – Caltrans Tower

The tower has much equipment already connected to it, some of which was added after it was initially built. This includes both antennae and microwave dishes. The tower appeared to be in reasonable condition given its age but did show some signs of age or deterioration, which included corrosion and minor damage at some members and hairline cracks in the concrete foundation.

If additional equipment were added to the tower, a detailed structural analysis should be performed conforming to the latest building code (ANSI/TIA-222-G). Complete structural drawings are required to sizes of all members, details for all connections, and foundation details. If this information is not available, a detailed site survey is required to gather this information. Access to every structural member of the tower is required in order to measure sizes and thicknesses of members and document any deterioration that must be accounted for in the analysis. Close-up access often requires a man-lift or rope access.

Electric Power

Neither the existing Southern California Edison solar photovoltaic (PV) system nor the U.S. Air Force PV system should be considered as a potential power source for any future commercial installations. It is recommended that any commercial interests that wish to place equipment on Rogers Peak provide their own power source and electrical infrastructure.

Access Road

The existing access road to the Rogers Peak site is approximately 10 feet wide and can generally accommodate any construction equipment needed. During the site visit, the road had been severely damaged due to erosion following a storm event.

Restoring normal access to the site will involve significant maintenance to the road. In order to restore normal access to the site, it is recommended that the road be reshaped using a motor grader to smooth and remove the larger rocks from the roadway surface. The access road essentially serves as a storm water conveyance channel, therefore it is essential to provide adequate drainage along the road to minimize future damage. Careful consideration should be given to ensure that any grading does not potentially direct stormwater towards archaeological and cultural sites. It is recommended that a cultural resources survey be completed along the entire length of the access road prior to completing any drainage improvements.

Radio and Microwave Interference Potential

There is always a potential for electromagnetic interference between radio systems that could degrade or disable their operation. In general, microwave radio systems operate at relatively lower power levels, use highly directional antennas, and operate in a separate part of the radio spectrum from cellular and two-way radio, which limits interference potential to and from other systems. However, cellular, two-way radio and some types of military systems operate with greater power levels and on adjacent radio spectrum segments, and therefore have a greater potential to interact. Such potential can be significantly reduced or eliminated through a holistic approach to planning and prevention. A more significant concern is whether such antennas would physically obstruct other antennas and impact their service coverage. Thus, antenna and tower placement can be more critical.

AT&T Wireless Services

ATTWS's proposal for the use of the Rogers Peak site does not appear to have a major impact on known existing communications systems.[1] Electromagnetic incompatibility is best reduced by proper pre-planning and coordination of tower and antenna placement considering all existing and potential site users. However, most remaining compatibility issues are best mitigated through flexible agreements that provide for shared-use of antenna towers and possibly shelter space (provided proper access security exists) when necessary.

AT&T Long Line

No information or proposal was provided by ATTLL. However, should their equipment at Mormon Peak be relocated to Rogers Peak, , given our current understanding of ATTLL's business line, we would anticipate a minimum of two to four large diameter microwave dish antennas to be proposed, as well as multiple racks of indoor equipment and related power requirements. It is unlikely that all such antennas could be accommodated using the existing Caltrans tower, not only from a structural loading perspective, but also considering physical tower space and placement since such directional antennas must have unobstructed views in very specific directions to provide their service.[2]

[1] Limited information was available on existing Air Force systems. HDR/FTE recommends that Air Force also review all proposals for use of Rogers Peak.

[2] HDR/FTE have not considered commercial use of the NPS/Air Force tower as we understand that space there has already been allocated to both agencies.

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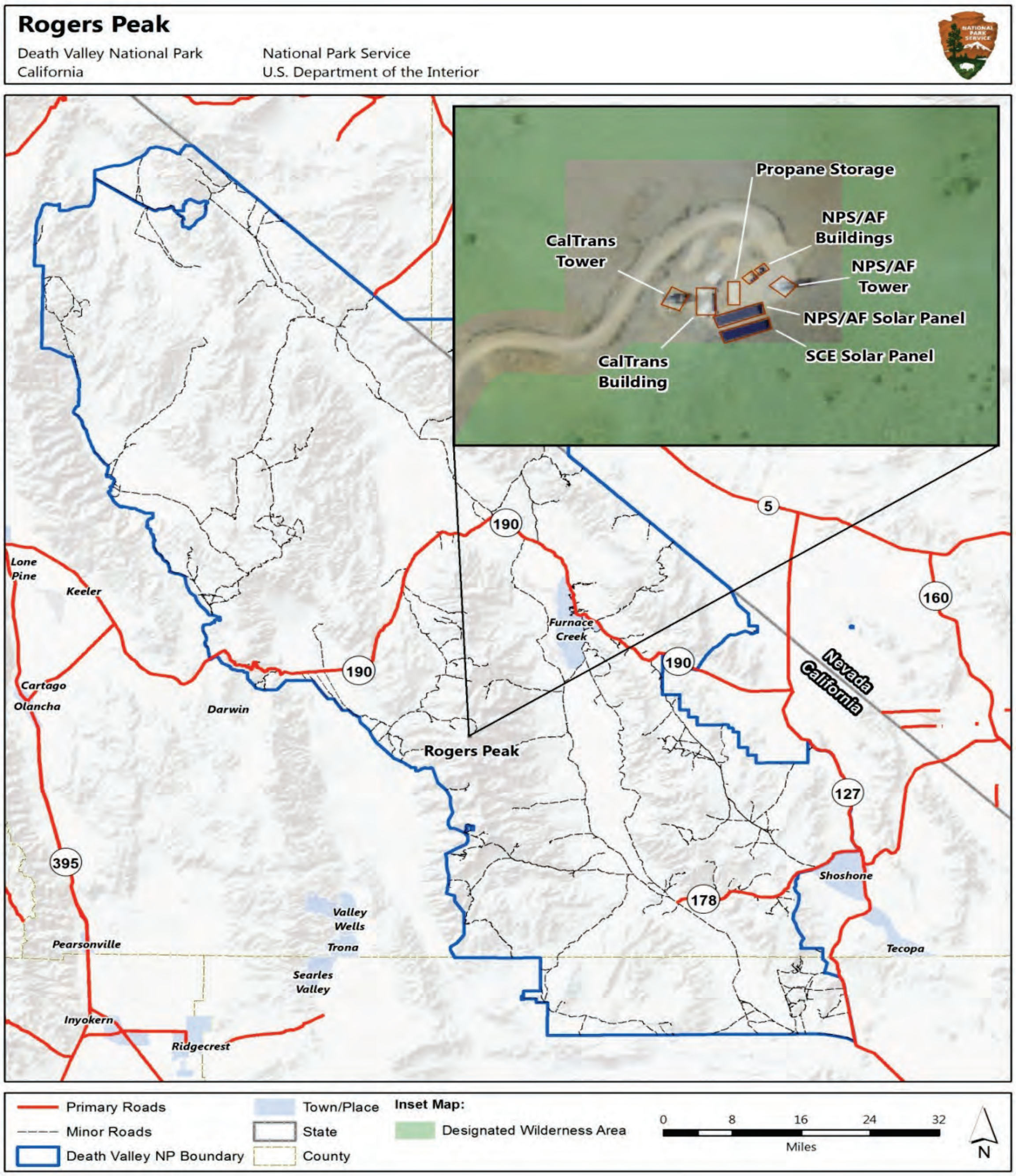
2 Background and Project Understanding

Originally proclaimed as a national monument in 1933, Death Valley National Park (DEVA) was formally established in 1994 and covers approximately 3,336,000 acres in east central California, with nearly 90 percent of the park formally designated as wilderness. The general location of DEVA is illustrated in Figure 1 below.

Figure 2-1. Death Valley National Park, Rogers Peak Site



Within DEVA, the National Park Service (NPS) has an existing telecommunication site located at the sloped summit area of Rogers Peak with elevations between 9962 feet and 9990 feet above sea level. As shown on the inset map within Figure 2-1, the Rogers Peak site currently contains two telecommunication towers and supporting structures within an area of 300' x 400' (120,000 square feet or 2.75 acres) that is surrounded by designated wilderness on four sides. The towers and supporting structures are generally in the southeast quarter of the site.

Currently, AT&T long-lines (or "ATTLL") telecommunications equipment on a tower located within an existing NPS telecommunications site atop Mormon Peak. Mormon Peak lies approximately 14 miles southeast of Rogers Peak at the edge of DEVA and within the designated wilderness area. As such, NPS may be required to remove all non-NPS telecommunications equipment (ATTLL) from the Mormon Peak site.

Concurrently, AT&T Wireless Services (or "ATTWS") has also expressed interest in deploying cellular base stations and supporting microwave radio equipment at Rogers Peak.

The primary goal of this study is to determine if it is feasible to consider applications for use of the Rogers Peak site by non-governmental telecommunication entities such as AT&T.

2.1 Design and Purpose of High-Elevation Radio Sites

Radio equipment is often located on high-elevation points to reduce obstructions or signal corruption between a transmitting station and its intended receiving station. Obstructions can impact radio signals through a combination of absorption, reflection and diffraction, to a point where the information being conveyed becomes corrupted and/or indiscernible at the receiving station. Typical obstructions include hills, mountains, foliage and manmade structures such as buildings. The degree of attenuation or corruption is primarily a function of the radio frequency (wavelength) of the transmitted signal, and the location, size, shape and properties of the obstruction material, among other things.

Signal corruption can also occur when a portion of the transmitted signal is reflected or diffracted off of another object, while the remaining portion of the signal travels directly to its destination. The reflected signal travels a slightly longer distance then the direct signal, and arrives at the receiver delayed in time (similar to an echo). This can corrupt the signal to various degrees.

Localized obstructions or those at the same tower site or immediately nearby can cause the greatest impact on radio signals from a transmission or reception standpoint. Examples include antennas placed at or below the elevation of a nearby equipment shelter or below other terrain, at a level on the tower that is blocked by antennas having large surface areas (such a microwave dishes). We note, however, that a localized obstruction is of limited consequence if it obstructs signals to or from an area of no interest to the carrier or radio system operator.

There are several ways to mitigate an obstructed or corrupted radio path. The most obvious is to relocate the transmitter, receiver, or both, so that they have an unobstructed path, or at least a path with less signal attenuation. Alternatively, an intermediate "relay" point can be selected that has better visibility or a more reliable path to both end points. The relay point is usually equipped with a receiver and transmitter that allow it to detect, amplify and retransmit the signals around or over the obstruction. These sites are often called “repeater” sites since they effectively “repeat” the information received with little to no signal degradation, and add no other information to the signal.

Engineers can sometimes increase the reliability of a radio path by using greater transmitter power, or physically larger antennas, or a combination of both. However, the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA), who regulate all national radio communications, place strict limits on radiated signal levels, primarily to allow for maximum spectrum reuse. Therefore, it is not usually possible to increase radiated power in all cases. Increasing transmitter power can also become impractical at sites with limited power generation. In these cases, engineers often raise radiated power levels, or increase received signal levels by increasing the gain of an antenna instead. This has a similar affect to raising transmitter power, without placing a greater demand on the power generation. However, “gain” or directional-type antennas can be physically larger than lower-gain models and can have a negative impact on tower wind loading and aesthetics. This is particularly true for parabolic microwave antennas.

In general, radio frequencies lower in the electromagnetic spectrum are less affected by natural obstructions (e.g., AM/FM broadcast, two-way radio and common cellular telephone frequencies can still operate with obstructed radio paths). However, radio frequencies higher in the electromagnetic spectrum can be severely attenuated by structures, foliage and even rain. Examples include typical microwave radio links, which are most often used for point-to-point communications. Rain can affect microwave paths operating at a frequency of 10 GHz and higher.

Constructing and maintaining unnecessary tower sites is costly and can complicate a carrier’s network. Also, the greater number of intermediate sites can reduce overall network reliability.

However, higher-population suburban and metropolitan areas are an exception to this. Cellular carriers often desire lower-elevation sites in these areas because signals from these tower sites travel much shorter distances due to obstructions; this is desirable as it this allows the carrier reuse its limited radio spectrum in a nearby or adjacent area without interference. This allows for simultaneous calls to be placed by different customers at the same time, maximizing revenue through extensive reuse of the radio spectrum the carrier has purchased.

Due to the limited population in the Death Valley area, call capacity is of little concern for cellular telephone and two-way radio carriers. Therefore, it is in their interest to maximize the coverage provided by each tower site to minimize costs. High elevation sites can fill this need.

3 Site and Existing Conditions Assessment

3.1 Site Visit

A visit was conducted to the Rogers Peak telecommunications site on Wednesday September 11, 2013. The purpose of the site visit was to gather relevant technical data for this feasibility study. The participants in this visit are summarized in Table 3-1 below.

Table 3-1. Rogers Peak Site Visit Participants – 9/11/2013

Name	Organization
Matt Cook, P.E.	HDR Engineering, Inc.
Travis Moore, P.E.	HDR Engineering, Inc.
Jon Holbrook	HDR Engineering, Inc.
Greg Forrest, P.E.	Forrest Telecom Engineering, Inc. (FTE)
Andrea Vaughn	NPS, Project Manager
Phil Lawrence	NPS, Assistant Project Manager
Kathy Billings	NPS/DEVA, Superintendent
Mike Cipra	NPS/DEVA, Environmental Specialist
Jim Klassen	NPS/DEVA
Pete Avena	NPS/DEVA
JD Updegraff	NPS/DEVA
Karen McKinlay-Jones	NPS/DEVA

3.2 Existing Conditions

Rogers Peak presents a unique environment.

- **Space**: Designated wilderness surrounds the Rogers Peak telecommunications site. The non-wilderness site has a small footprint and slopes in many areas. All construction activities – including laydown and staging areas – must be within the non-wilderness site boundary.
- **Soil**: Similar to many mountain peaks, there is very little soil on Rogers Peak. Much of the site is rock under a thin layer of soil or broken stone. All excavations can be expected to encounter significant quantities of stone. Most electrical cables outside of buildings are installed underground in conduits, except for a short section of waveguide bridge at the US Air Force tower. Installation of underground conduits was laborious due to the subsurface stone.
- **Wind**: Wind speeds can be high on the peak. All constructions must be properly braced for the expected wind loads.

3.2.1 Telecommunications Equipment

A variety of equipment, owned by a number of parties, is currently in place within the non-wilderness area on Rogers Peak. A summary of the equipment and ownership is presented in the following table. The inset within Figure 2-1 shows the physical layout of the communications infrastructure.

Table 3-2. Existing Equipment on Rogers Peak Site

Equipment	Owner	Notes
Tower #1	California Department of Transportation (Caltrans)	Tower supports antennae owned by various governmental parties.
Tower #2	U.S. Air Force	Tower support USAF, BLM, and NPS antennae.
Building #1	Caltrans	Building houses battery systems, electrical systems, and radio equipment racks supporting antennae on Tower #1.
Building #2	U.S. Air Force	Building houses UASF battery system and radio equipment. Access to this building is not permitted to non-military personnel.
Building #3	NPS	Building houses NPS and BLM radio equipment.
Solar PV Array #1	SCE	The original photovoltaic array charges the battery systems in Building #1.
Solar PV Array #2	US Air Force	The newest photovoltaic array charges the batteries in the USAF building.
Propane Tanks and Generator	SCE	The propane-fueled generator charges the batteries in Building #1 during periods of inclement weather or when the photovoltaic array is not producing sufficient output to charge the batteries.

3.2.2 Electrical Power Systems and Configuration

Rogers Peak is surrounded by designated wilderness and is not supplied by any electric or other fixed utility services. All electricity used on site is generated on site. There are two distinct electrical systems in place.

3.2.2.1 Southern California Edison System

Figure 3-1. SCE and USAF Solar Arrays

Southern California Edison (SCE) owns and operates the oldest electrical system on the peak. The system comprises a solar photovoltaic array (bottom array within Figure 3-1), two battery storage systems, a propane generator with five associated propane tanks, and ancillary electrical AC and DC distribution equipment. The equipment is housed in a building that is owned by the California Department of Transportation (Caltrans).

The solar array appears visually as a single array, but is arranged electrically into two separate arrays – one large and one small. Each array charges a proportionally-sized bank of batteries to provide ongoing electrical power to the radio equipment housed in the Caltrans building. Performance data for both systems calculated for SCE is included in Appendix A.

A 35kW (240VAC) propane-fuelled generator provides backup generation to charge the batteries if the solar array is unable to keep the batteries charged due to inclement weather or other operational factors. Five 1000 gallon propane tanks store fuel for the generator. SCE information indicates that annual propane consumption with a new battery on site is approximately 2,000 gallons. Annual propane consumption with an older battery can exceed 3,000 gallons per year. A large quantity of on-site propane storage is required because propane is delivered to the site by truck and the peak is often accessible for only limited periods each year.

SCE provides the electricity for all radio equipment housed in the Caltrans building, plus the NPS radio equipment housed in a separate building. Antennae for all tenants in the Caltrans building are located on the Caltrans tower.

Correspondence with SCE indicates that both solar arrays/battery systems are operating at or near their design capacity, and that both systems were designed for their specific loads. Additionally, the loads cannot be increased without an expansion of the system, which would include a building expansion, battery expansion, and PV array expansion/upgrade. These load limitations influenced the US Air Force to construct their own PV array and battery system.

3.2.2.2 US Air Force System

The US Air Force (UASF) owns and operates the newest electrical system on the peak. The system comprises a solar photovoltaic array north and uphill from the SCE array (see Figure 3-1), and a battery system. The battery system is located in the secure USAF building and powers USAF equipment. There is no associated backup generation system, therefore if the USAF batteries are depleted then the USAF radio systems stop operating. No access to the USAF building is permitted due to the sensitive nature of the equipment installed in the building.

NPS is the land owner and coordinator of the site and owns a radio equipment building on the peak. The NPS does not own or operate any electrical generation or storage systems on the peak. The NPS antennae are supported on the USAF tower, and power for the NPS building and equipment is supplied by the battery systems in the Caltrans building. The NPS agreement with the USAF provides an option for the NPS to obtain power from the USAF PV/battery system. The NPS has not exercised that option, preferring to obtain power at present from the SCE system in the Caltrans building because it is supported by a backup generator.

All communications equipment in the Caltrans and NPS facilities operate from DC power. However, there is significant variation in power consumption and efficiencies among the equipment models. We note that NPS, BLM and State Fish and Wildlife equipment, as well as some SCE models are specifically designed for low power consumption and are well-suited for the existing power systems. However, the microwave radio models, as well as some other two-way models were likely deployed for compatibility reasons as these likely connect with other system or networks.

The majority of equipment in the NPS Caltrans shelters is related to two-way voice communications. This equipment imposes a varying load on the power systems, which is a function of radio activity and resulting transmitter activation. Therefore, load measurements must be taken over long time periods to accurately reflect usage. For this reason, FTE did not attempt to calculate the anticipated load. However, SCE supplied information indicating that all power systems are operating at or near their design capacity. Increasing the load on the existing systems would require expansion of the particular power system.

3.2.3 Caltrans Communications Shelter

This structure is a single story with a concrete foundation and concrete brick walls. It consists of two rooms, each with outdoor access. The largest portion is for equipment and battery systems, while the other area houses the propane-fueled generator. HDR/FTE could not gain access to the generator room during the site visit.

Figure 3-2. Caltrans Shelter

Source: FTE

The shelter appears to be in good condition and has no apparent rodent problems. However, NPS staff indicates that snow can accumulate against the doors and create moisture problems indoors as it thaws.[3] It is equipped with small floor-board heating, but is not cooled. However, a fan and damper venting system is present and of nominal size. Based on our visual inspection, all communications equipment operates from DC power, from one or two

[3] Caltrans has also recently sealed the coaxial cables chase to reduce moisture ingress.

large shared battery banks. However, lighting is operated only from AC power and requires the propane fueled generator to be running.

The only significant deficiency FTE identified is the limited seismic bracing of the equipment racks, and lack of transient voltage surge suppression (TVSS), or lightning protection devices on many of the antenna transmission lines routing from the tower. This is not in compliance with current DOI radio sites standards.[4]

Communications equipment space is typically characterized by how many equipment rack positions can be accommodated, and maximum rack height. Communications equipment is typically built to fit in 19” equipment racks (24” X 24” floor “footprint” size), and stand-alone backup battery systems are often supplied in 23” wide racks (26” X 26” footprint). Typical rack heights range from 6-1/2’ to over 8’. Equipment racks in this shelter are 7-1/2’.

The table below provides an overview of the Caltrans shelter.

Table 3-3. Caltrans Facility Statistics

Attribute	Value
Equipment Facility Indoor Dimensions:	34’W X 16.5’D X 8’9”H” (~561 sq. ft.)
Generator Room Indoor Dimensions: [5]	8.5’W X 16.5’D X 8’9”H” (~140 sq. ft.)
Total Existing Rack Positions:	~26
Qty. of Unused Rack Positions:	~5
Available Space in Existing Racks:	Equivalent to 6.75 Racks (sum of all unused rack space)

Not included in the rack positions above are the two large battery banks (SCE Banks A & B) on the east side of the equipment space. Also, there are various other devices and a cabinet mounted along the indoor walls.

Rack assignments and the room layout are shown in Appendix B, Exhibits B1 and B2. Exhibit B2 has also been annotated to show where the other devices are positioned in the equipment room.

The Caltrans shelter has five empty rack positions. If the existing equipment could be consolidated, another six to seven rack positions could be cleared for a total of 11 to 12 positions. However, consolidation is highly unlikely since entire rack positions are typically leased, and it can be impractical to combine some types of equipment.

Figure 3-3. Example Equipment Racks - Caltrans Shelter

[4] See OCIO Directive 2010-008, December 11, 2009, which requires such facilities adhere to guidelines developed by the Motorola R56 Committee. These are defined in the document titled "R56 - STANDARDS AND GUIDELINES FOR COMMUNICATION SITES" (2005).

[5] Approximate dimensions.

Also, it is not unusual for tenants to purchase spare rack positions for future expansion, and leave them empty. Therefore, the site manager should be consulted to determine the available rack positions.

For these reasons, FTE suggests that only up to five positions may be considered unused. Therefore, this shelter is approaching maximum practical utilization.

There must be clearance between the front and rear rack areas for maintenance and National Electrical Codes require clearances in front of electrical circuit breaker panels. No additional space appears available.

3.2.4 Caltrans Tower

Figure 3-4. Caltrans Tower

The existing tower supports only radio equipment located in the Caltrans communications structure. The tower appears to have been designed to support the two eight to ten foot diameter, high-performance microwave dish antennas given its base width and height, and 1994 Caltrans tower documentation indicates that future microwave antennas may have been planned as well.[6] It has limited formal accommodations for other types of antennas. Figure 3-4 shows the various antenna systems on the tower. The tower is 50 feet in height, with one 20’ antenna extending the overall height to 70’.

The tower supports three general types of antennas: omni-directional, broad directional and highly-directional (dish) types. See Table 4-1 for a description of each type. Approximately eighteen separate antennas exist.

FTE found no current documentation of antenna assignments. However, Table 3-4. Antenna Assignments on Caltrans Tower #1 lists twelve entities that utilize the Caltrans tower and shelter based on visual inspection and FCC license records.

[6] See File: CAL TRANS Tower Drawings.pdf, containing Drawing No. 414210-069 dated 6-24-94. This suggests that at one time, this tower may have been designed to support additional antenna loading.

Table 3-4. Antenna Assignments on Caltrans Tower #1

FCC Licensee	Antenna Types
California, State of Southern California Edison Company	Highly-Directional (Microwave)
California, State of (Caltrans) California, State of (CHP) California, State of (Fish & Wildlife) Federal Bureau of Investigation (FBI) Inyo County of Public Works Department Inyo, County of (EMS) Inyo, County of (Roads Dept.) Inyo, County of (Sheriff's Office) New Cingular Wireless PCS, LLC[7] Southern California Edison Company	Omni-Directional (vertical) Broad-Directional (Panel/Fin type)

It appears that many of the omni and broad-directional antennas have been installed at different times with little planning or forethought. Based on the number of antennas and transmission lines, very few, if any of the antennas are being used by more than a single radio transceiver. This is most cost-effective initially when adequate antenna and equipment space exists. However, it can present challenges when expansion is necessary. Limited antenna consolidation may be possible among agencies that operate omni-directional antennas in the same radio band and have the same operational coverage requirements. Inspection of the antennas and the radio frequency bands in use, FTE estimates the total number of antennas could be reduced from approximately 18 to 16.

Limited space remains for additional lower-frequency gain antennas (30-174 MHz) unless some of these are combined and shared. Such systems would likely be other governmental agencies. However, space is available for individual broad-directional antennas as these are physically smaller. If a significant number of new antennas are planned, even if directional, the tower manufacturer should be consulted to verify whether the tower height could be increased for installation of a proper horizontal deck for mounting additional antennas. However, we note that the tower may not support this additional loading. A general structural analysis of the tower is provided in section 3.2.4.1 below.

Five non-metallic conduits ranging from 4” to 6” diameter have been installed below ground between the tower and Caltrans shelter. Each conduit has been used for transmission lines. However, while several are not filled to their maximum capacity, it would be extremely difficult to pull additional cable without potentially damaging others in the same conduit. Nylon pull strings exist in one of more conduits, however. For these reasons, FTE considers these conduits effectively filled. Additional conduits could be installed underground to support additional transmission lines between the tower and shelter. However, unlike the current conduit that was installed in the concrete foundation of the tower and shelter, new conduit would terminate beside the tower foundation, and would likely enter through a wall of the equipment shelter. Alternatively, a raceway could be installed above-ground between

[7] This licensee has no agreement with the Park and may no longer operate equipment here.

the tower and shelter, similar to the approach taken by the NPS/Air Force. Figure 3-5 below shows how this was accomplished on the NPS/Air Force tower. A metal ice shield above the transmission lines would be required to protect them from falling ice from the tower.

Figure 3-5. Above-Ground Raceway

While the Caltrans tower is bonded to ground for lightning protection, few of the transmission lines have been properly grounded. In general, the tower is in average condition, and transmission lines have been properly supported and protected from falling ice. An ice shield has been installed over the lower microwave antenna, and a section of cable support ladder has been positioned to protect the rear of this antenna. Some existing antennas have become misaligned due to wind, and some models are not appropriate for such a harsh environment and appear damaged.

3.2.4.1 Structural Analysis

A general structural analysis was performed of the Caltrans Tower based on the information available. Information included non-structural drawings dated 1994 and field observations during the site visit.

The tower has much equipment already connected to it, some of which was added after it was initially built. This includes both antennae and microwave dishes. The tower appeared to be in reasonable condition given its age but did show some signs of age or deterioration, which included corrosion and minor damage at some members and hairline cracks in the concrete foundation.

If additional equipment were added to the tower, a detailed structural analysis should be performed conforming to the latest building code (ANSI/TIA-222-G). Complete structural drawings are required to sizes of all members, details for all connections, and foundation details. If this information is not available, a detailed site survey is required to gather this information. Access to every structural member of the tower is required in order to measure sizes and thicknesses of members and document any deterioration that must be accounted for in the analysis. Close-up access often requires a man-lift or rope access.

Building codes have changed substantially since this tower was built. Research on structural behavior in seismic events has led to many changes in required strength and ductility. Ground motion parameters have also changed, and the current codes use different criteria for ground motion than the 1994 codes. Wind provisions of the new codes are also substantially different than previous codes and in many cases wind demands are greater. It is often determined that, when structures built under legacy codes require a change in use or additional load, they do not meet requirements of current codes and require strengthening. It is difficult to say whether that would be true for this structure, but given that the tower already carries more equipment than when first built, there is a strong likelihood that the addition of more equipment would lead to such findings. If strengthening is required, one might find that the cost of analysis combined with the cost to design and perform strengthening may not be substantially less (and in fact might be greater) than the cost of providing a new tower for the new equipment.

3.2.5 NPS Communications Shelter

This structure is a pre-manufactured concrete/aggregate shelter on a concrete foundation (see Figure 3-6). It only supports NPS and BLM communications equipment.

Figure 3-6. NPS Shelter

Figure 3-7. Example Equipment Racks NPS Shelter

The shelter was manufactured in 2011 and is in excellent condition. There is no apparent moisture or rodent problems. It is equipped with a small cooling system but no heating or passive venting exists. Based on our visual inspection, all communications equipment and lighting operate from DC power.

All equipment racks (see Figure 3-7) are seismically braced and proper transient voltage surge suppression (TVSS), or lightning protection devices have been installed on the antenna transmission lines routing from the tower. Some communications circuits exist between this shelter and the Caltrans shelter. These connect through fiber-optic cable.[8]

FTE found no significant deficiencies associated with this shelter. The table below provides an overview of the NPS shelter.

[8] Use of fiber between building reduces the chance that transient voltage surges, such as from a lightning strike, will travel between shelters.

Table 3-5. NPS Shelter Statistics

Attribute	Value
Equipment Facility Indoor Dimensions:	7'W X 9'D X 9'H (63 sq. ft.)
Total Existing Rack Positions:	4
Qty. of Unused Rack Positions:	0
Available Space in Existing Racks:	Equivalent to 0.5 Racks (sum of all unused rack space)

The NPS shelter has no empty rack positions. If the existing equipment could be consolidated, only a maximum of a half-rack space could be gained. However, consolidation is impractical since most every rack supports one large set of antenna system filters that cannot be separated or broken up. Additional equipment space could be made available if a different style of equipment racks is used, such as "zero-clearance" types.

The shelter also supports one antenna mounted on the south side of the shelter's roof.

3.2.6 NPS/Air Force Tower

This tower is 62.5 feet tall, with one top antenna extending it to an overall height of approximately 66 feet. Its base elevation is higher than the Caltrans tower; the upper portion of the NPS/Air Force tower is above the Caltrans tower. The existing tower only supports radio equipment located in the NPS and Air Force communications shelters. Park staff indicates that a formal agreement exists to permit Air Force and NPS to use different portions of the tower for their antennas. From inspection, Air Force is occupying the top portion of the tower, and NPS and BLM antennas are side-mounted below. Several cameras also exist on this tower. Figure 3-8. NPS/Air Force Tower shows the various antenna systems on the tower.

Figure 3-8. NPS/Air Force Tower

FTE found no current documentation of antenna assignments. However, Table 3-4. Antenna Assignments on Caltrans Tower #1 estimates the potential users based on visual inspection and other documentation provided by NPS.

Table 3-6. Antenna Assignments on NPS/Air Force Tower

Agency	Antenna Types
United States Air Force	Highly-Directional (Microwave) Omni-Directional (qty. 2)
National Park Service/DOI Bureau of Land Management/DOI	Omni-Directional (vertical)

Antenna placement and mounting arrangements have been well-planned. Based on inspection of antennas and equipment in the NPS shelter, some antennas may be shared among multiple stations. Antenna mounting space remains for additional lower-frequency gain antennas (30-174 MHz) as well as others.

Transmission lines route slightly above ground level to two converted site "work-boxes", where the lines transition to underground, non-metallic conduits to the NPS and Air Force Shelters. A galvanized ice-shield exists over the horizontal line runs. Space exists for approximately two or three additional transmission line runs on the tower cable ladder, horizontal raceway and into the work-boxes. However, both the tower cable ladder and raceway could be easily expanded. However, FTE was unable to verify whether spare conduit space exists between the work-boxes and the NPS (or Air Force) shelter. This may be the limiting factor.

The tower appears to be electrically grounded for lightning protection, and most transmission lines have been bonded to ground as recommended by various communications site best-practices. In general, the tower is in excellent condition, and transmission lines have been properly supported and routed and protected from falling ice.

3.2.7 Access Road

The existing access road to the Rogers Peak site is approximately 10 feet wide and can generally accommodate any construction equipment needed but is restricted to one way traffic at some locations.

Figure 3-9. Rogers Peak Access Road – September

During the site visit, it was immediately apparent that the access road was not suitable for access of construction and maintenance vehicles. Due to a storm event that occurred a few days prior to the site visit, the road sustained significant damage making travel slow and difficult for even four-wheel drive vehicles. Severe erosion occurred along the sides of the road removing nearly two feet of soil from the roadside ditch in some areas. The road bench was littered with medium to large size cobble and showed signs of potholes and rutting.

Restoring normal access to the site will involve significant maintenance to the road. In order to restore normal access to the site, it is recommended that the road be reshaped using a motor grader to smooth and remove the larger rocks from the roadway surface. The access road essentially serves as a storm water conveyance channel, therefore it is essential to provide adequate drainage along the road to minimize future damage. Careful consideration should be given to ensure that any grading does not potentially direct stormwater towards archaeological and cultural sites. It is recommended that a cultural resources survey be completed along the entire length of the access road prior to completing any drainage improvements.

The storm event that occurred prior to the site visit was estimated to be a 5 year event. If a storm of greater or equal magnitude were to occur during a construction project, significant delays to the project schedule would be likely. The road would need to be re-graded to repair any damage that occurs. The roadside ditch should be regularly maintained to ensure that that it is free of debris that could block flow and cause erosion.

3.3 Planned Additions

NPS has advised that a remote automated weather station (RAWS) with associated directional radio-telemetry link is planned in the southwest portion of the site. Additionally, the Park may install several directional radio links to support its two-way radio system in the near future. Limited information was available on these other systems. Any new radio shelter and tower placement should also consider these planned systems to reduce or eliminate radio path obstructions when possible.

4 Analysis - Use of Rogers Peak by Non-Governmental Entities

Non-governmental entities that typically use tower sites include the well-known wireless "cellular" carriers (both common-carrier and commercial-carrier), commercial and general mobile radio services (CMRS, GMRS, two-way radio operators, etc.), and licensed amateur radio operators. Paging services (e.g., "pocket-pagers") also used such sites in the past, but has largely been replaced by mobile telephones. Rural telephone companies often use these sites as a relay point to connect central switching offices together and to others.

Over the last decade, Wireless Internet Service Providers (WISPs) have begun to distribute Internet access from high-elevation tower sites to reduce infrastructure and maintenance costs. While the previous wireless carriers provided voice or data services primarily to mobile or portable devices, WISPs typically provide service to fixed or "non-moving" devices, such as residences or offices. They most often operate at the fringes of populated areas and in rural environments primarily because of limited competition; wired Digital Subscriber Line (DSL) and Cable internet and telephone services are not offered in many fringe and rural communities, and internet service from the mobile carriers can be slow and unreliable. WISPs can often provide better internet and telephone performance than satellite services, at a similar price point.

4.1 Carrier Equipment and Antennas

With the possible exception of WISPs, most all carriers utilize indoor transceiver equipment that is mounted in open equipment racks or cabinets.[9] Relatively large diameter (1/2" to 3") semi-flexible cables (known as transmission lines) connect the indoor equipment to its associated antenna(s). Transmission lines are kept as short as possible to reduce the signal attenuation between the equipment and its antenna; longer distances (> 300 feet) are possible with the use of large diameter transmission lines.

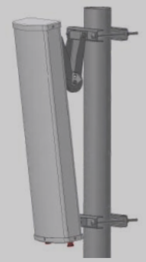
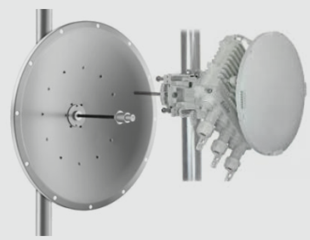
While WISPs also place some equipment indoors in racks or cabinets, their actual radio transceiver devices are usually mounted on or near their antennas on the tower. Minimal indoor equipment is usually required. This eliminates the use of costly transmission lines between the transceiver and its antenna. Both the internet signal, as well as the power to

[9] A Transceiver is a general terms for combination transmitter/receiver device. A two-way radio or handheld cellular telephones are transceivers, for example.

operate the outdoor transceivers, is sent over inexpensive copper cables that are less than ½" in diameter.

While most carrier equipment can appear similar, antenna styles significantly differ. See Table 4-1 for a brief overview of different antenna types.

Table 4-1. Typical Antenna Types for Communications Carriers

Antenna Type	Used By (Carrier Type)	Examples
Omni-Directional	CMRS, GMRS, Amateur Some rural cellular carriers Paging	 Vertical Antenna
Broad-Directional	Cellular Carriers WISPS	 Panel Antenna
Highly Directional	Cellular Carriers WISPs Rural Telephone	 Microwave Antenna

Source: Telewave. Inc.; Tessco Inc.

In general, antennas are not often shared. The primary reason is that antennas are designed for a specific band of radio frequencies, or frequency, and carriers do not share bands or frequencies at the same tower site. Also, antennas are designed as omni-directional or directional. Omni-types radiated energy in all directions (360-degrees), while directional antennas focus signals in a specific direction (or azimuth), or multiple azimuths. Wireless carriers often provide service to different areas as dictated by their business plan and technology; thus, antenna sharing in these cases is not practical.[10] For these carriers, antenna placement is crucial.

As noted above, the vast majority of carrier equipment and antennas cannot be practically shared to reduce space in a communications shelter or on a tower. However, most other components of a communications site, such as the shelter, tower, power and access, are most often shared.[11]

4.2 Communications Site Attributes

Table 4-2 lists the key requirements that non-governmental entities, including commercial carriers, consider when considering use of a given communications site.

Table 4-2. Key Site Attributes

Attribute	Comment
Reliable Radio Paths to Intended Customers or Target(s)	Line-of-sight/minimum obstructions between tower site and customer or other target "node"
Radio Spectrum Authorization (held by carrier)	Carrier's FCC spectrum licenses are often geographically-limited; site must be located in a permissible area, and not at edge of designated spectrum border (signal spill-over concern).
Capital and Recurring Cost	Decision point is based on costs to construct at one or more alternate sites to attain similar service coverage.
Power Sources	Reliable power under carrier control
Reliable Access	Cost of construction; road access quality; revenue loss due to system downtime.
Security	Downtime due to theft or vandalism from competitor, technician or general public.
Equipment Space	Dry, clean and conditioned indoor space for equipment; adequate service access. Or construct own.
Antenna Tower Space	Vertical space availability; space on side of tower facing customer/targets. Or construct own.

Source: FTE

[10] The usual exception is CMRS, GMRS, and similar two-way radio services that use omni-directional antennas and that operate in the same radio frequency band. These carriers and services can share a common antenna system with proper filtering equipment. Such equipment is always rack-mounted indoors, and can be more costly than operating a dedicated antenna. Such sharing or "combining" systems slightly degrade radio performance.

[11] The most common exceptions to shared-use can be power and equipment space. Power is so critical to carrier equipment that most want to be in complete control of its operation and maintenance. Space-sharing issues often relate to physical equipment security (from tampering, theft, etc.), as well as operation and maintenance of the HVAC systems.

Antenna support structures become important to provide clear line-of-sight (LOS) paths when localized obstructions exist (terrain, trees, buildings, etc.), and to physically separate antennas (vertically) to avoid interaction than can result in radio interference and service interruptions.[12]

In the past, some entities also required copper telephone and/or data services cables between the communications site and a main telephone switching office to connect with a dispatch point, or to another communications site. However, the cost of reliable, high-capacity microwave radio links (which provide the same function as copper lines) have dropped over the past 20 year to the point where they are preferred over copper. Roger's Peak is not equipped with copper telephone service in any case, so most (but not all) entities may also install some form of microwave link for their own use; these are referred to as "point-to-point" (PTP) or "backhaul" links or paths.

These links connect the entities radio equipment with one other specific point; the chance that another entity needs to connect with that same point is rare. For this reason, these links are not normally shared.

The possible exception are the traditional wireline telephone carriers, including those known as "Long-Line" or long-distance telephone carriers. These entities often use a high-elevation site as a relay point between public telephone switching offices. They can sometimes offer leased telephone and data services to other co-located entities.

4.3 Equipment and Siting Requirements

This section assesses AT&T Wireless Systems (ATTWS) proposed cellular facilities as described in their October 22, 2013 response to FTE's questions in our September 13th, 2013 *Request for Additional Information from AT&T Wireless.*[13] A copy of this response is provided within Appendix C. NPS has not yet received a response from AT&T "long-line" (ATTLL) to their request for additional information.

4.3.1 ATTWS Antenna Tower Placement

ATTWS has proposed to construct a new 60-foot tall self-supporting antenna tower and foundation approximately 18 feet north of the existing Caltrans 50-foot tall tower, at the same elevation. Self-supporting towers do not require any additional supporting members, such as aerial guy-wires, etc. The tower would support six, eight-foot panel antennas and a single microwave antenna with an apparent shroud (See Table 4-1 for antenna descriptions).[14] It is unclear if the dish would be equipped with a radome.[15] Transmission lines would likely route

[12] Antenna separation to provide electromagnetic isolation is important for most types of communications systems, with the possible exception of microwave radio. Vertical separation is preferred over horizontal as it is much more effective as provide the required isolation; horizontal separation needs to be approximately six times that of vertical to provide the same isolation. This is one reason why higher towers are often preferred.

[13] AT&T's response was from their contractor Bluewave Deployment.

[14] The shroud is a cylindrical device that surrounds the open end of the dish; it is sometimes required by the Federal Communications Commission (FCC).

[15] A radome is a solid fiberglass or fabric cover over the open end of the dish to keep snow and birds out, and can reduce wind loading.

from each antenna to underground conduit, and to their proposed shelter. The top of all proposed ATTWS antennas would be below the top of the tower. However, towers are often equipped with a ¾" outside diameter (OD) lightning suppression post that can extend about 5 feet above the top of the tower.

It is noted that ATTWS has proposed adding their tower immediately adjacent to the existing Caltrans tower. They have not proposed to modify or remove the Caltrans tower, or relocate any existing antennas to their new tower. Thus, both towers would be present.

The proposed tower is the same height as the NPS/Air Force tower to the east, but will be approximately 21 feet lower in elevation.

Comments on ATTWS Proposed Antenna Tower Placement

- FTE considered whether the proposed new AT&T tower or its appurtenances would significantly obstruct signals from existing antennas on the Caltrans tower or the Federal/NPS tower.
- Existing microwave radio paths are most sensitive to obstructions. Known existing microwave paths are shown within Appendix D. State of California and/or SCE microwave antennas exist on the Caltrans tower, and one microwave antenna exists on the Federal/NPS tower.[16] FTE finds that the proposed ATTWS tower location does not obstruct these existing microwave paths based on current antenna placement.
- Most of the omni-directional and broad-directional antennas located on the top of the Caltrans tower are positioned at the same level as the proposed ATTWS microwave antenna. Thus, ATTWS's microwave antenna will have some affect on the radio coverage provided by these antennas, in the direction of the microwave antenna (roughly due north). However, Rogers Peak provides limited service coverage to areas directly north due to terrain shielding (see Section 4.3.2, Optimal Wireless Service Areas). While the impact could be measurable in the northern direction, natural terrain shielding prevents highly reliable coverage in this direction anyways.
- Most of the other omni-directional antennas located on the Caltrans tower actually will fall below the proposed ATTWS dish. FTE sees limited impact to coverage provided by these antennas.
- FTE believes that the proposed tower may have little to no impact to the top-most antennas on the Federal/NPS tower (likely Air Force) as the top of the proposed tower will be lower.[17] Impact to NPS and BLM antennas lower on the Federal/NPS tower may be greater, but is not expected to significantly degrade coverage or prevent use of these systems as these towers are separated by about 140 feet, limiting the impact.

[16] FTE assumed that these antennas are in use. State of California /SCE stations and antennas are currently licensed by the FCC. Federal license authorizations are not published preventing FTE from verifying operation of the Federal microwave path and its exact antenna azimuth.

[17] Limited information was available on the Air Force systems using these antennas. However, we believe these were designed to primarily support aircraft operations where the communications paths would be at or above the horizon.

- Impact to the antenna installed on the NPS shelter would likely be insignificant due to the distance separation between them.

The proposed ATTWS microwave antenna is likely used to connect cellular customers to the greater AT&T network through a Mobile Switching Office (MSO). NPS staff indicates that the existing microwave radio link operated by Southern California Edison (SCE) may have spare capacity to support ATTWS, thereby eliminating the need for ATTWS (or others) to install their own microwave links and associated large dish antennas. It is unclear if SCE or ATTWS would support such an idea, or if enough capacity exists.

FTE has no information on what ATTLL would propose for Roger's Peak. However, from discussions with Park staff, ATTLL primarily uses its Mormon Peak site as a microwave radio relay or repeater site. Thus, ATTLL could require a minimum of two to four additional microwave antennas, or possibly more, depending on the need. The physical size of these antennas cannot be determined at this time, but could vary between six feet and twelve feet in diameter. Depending on the structural design and current wind load on the existing Caltrans tower, some space exists to support one or two antennas of this size. However, this space would only be useful if the required azimuths of the antennas happen to be on an available side of the tower. Only two sides are available that are not obstructed by the top of the Rogers Peak, and one would likely be blocked by the new proposed ATTWS tower. In either case, a climbing ladder or the cable ladder on the tower may also require relocation. Therefore, it is unlikely that the spare tower space could be practical for ATTLL.

We also note that ATTLL's presence could potentially reduce the future dishes at Rogers Peak if the company offered to lease telephone and/or broadband internet capacity to other site tenants. However, these services would have to be reasonably cost-effective as the cost of private microwave radio links has dropped significantly, and most tenants will prefer to own, operate and maintain their own microwave links.

4.3.2 Optimal Wireless Service Areas

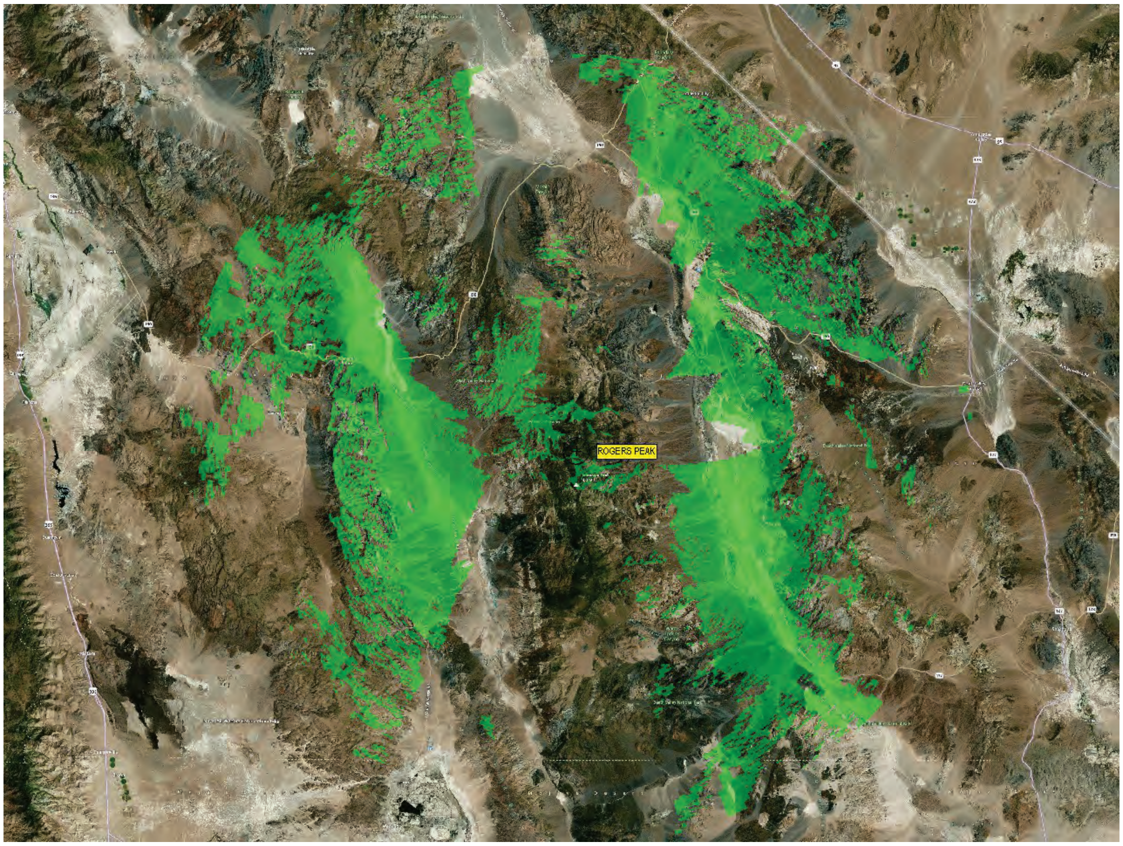
Rogers Peak primarily provides radio coverage to mobile and portable radios on the valley floor and surrounding peaks.[18] Its coverage potential can be assessed generally by considering which areas have line-of-sight (LOS) from the top of Rogers Peak. Areas having clear line-of-sight will usually receive reliable radio signals from Rogers Peak. Conversely, areas blocked by terrain, foliage and/or man-made structures will have degraded or no radio coverage.

If the proposed tower or its antennas obstruct signals from existing antennas in a direction that Roger's Peak cannot provide coverage to, the impact on the existing systems is of little consequence. Figure 4-1 below shows which areas have a direct line-of-sight path from Rogers Peak. These are shown in GREEN and Rogers Peak is shown by the yellow label.[19]

[18] The major exception is microwave and highly-directional antenna which communicate a fixed (stationary) point.

[19] While some radio frequency bands can provide Non-Line-of-Sight (NLOS) coverage, such a radio system design is not preferred. The 150 MHz NPS radio system may provide some NLOS coverage, while cellular telephones systems (700 to 2100 MHz) are limited.

Figure 4-1. Areas with Line-of-Sight (LOS) to Rogers Peak (60 km radius)



Source: FTE, Inc.

An example of this concept is shown in the figure above. Rogers Peak does not have LOS to a large portion of Highway 190 due north of the Peak, as demonstrated by the lack of the green shading there. Thus, current Rogers Peak radio systems cannot provide radio coverage along this portion of Highway 190 today. If a large physical obstruction was placed north of any existing Roger's Peak antenna (such as a building, wall, etc.), it would have no practical impact on the coverage of that antenna or radio system since the local obstruction is not the only obstruction in that direction.

The proposed ATTWS tower would be positioned due north of antennas on the Caltrans tower. Since some areas north of the Caltrans tower are already blocked by terrain, coverage impacts in this particular direction are of little consequence. Or presented another way, portions of Highway 190 would likely be unreliable, even without the presence of the ATTWS tower or its antennas.

The placement of ATTWS antennas on their proposed tower provides additional confirmation that Roger's is unable to provide coverage over the northern portion of Highway 190. Appendix D presents a site plan showing where the proposed tower would be placed. ATTWS's antennas are shown as three pairs of red rectangles surrounding their proposed tower. Signals from these antennas travel away from the tower, perpendicular to each set of antennas. Note that none of these antennas are positioned facing north, indicating that

ATTWS likely had the same findings. FTE also notes that even increasing transmitter power or antenna gain may not significantly improve service coverage in such obstructed areas.[20]

4.3.3 Conclusions – Equipment and Siting Requirements

The impact of ATTWS tower on existing radio systems could be limited. However, should there be concern, certain antennas on the Caltrans tower could be relocated to the higher ATTWS tower, assuming an agreement exists and the affected entity agrees to such a change. Transmission lines could be run between the towers above ground if needed. However, usually entirely new transmission line runs are needed as splicing cable can degrade performance and cause reliability problems.

ATTWS noted that they are "…*also seeking to construct a new, 60', self-support tower… to… provide location for future users in the Rogers Peak area*." Flexibility at shared communications sites is important. It would be beneficial to reach some agreement for joint use of tower space should an obstruction problem occur, or to resolve electromagnetic compatibility issues should they occur in the future (see 4.4, Radio Interference Potential and Compatibility).

ATTWS also noted that "…*The proposed microwave will support AT&T, but the site will have space for others to add backhaul equipment*." This comment indicates that its proposed microwave radio link will be for its own use, but suggests that the proposed shelter will be sized to support other's backhaul equipment. It is not clear why they limited this proposal to backhaul (presumably microwave) equipment, and not two-way or other radio, unless possibly they are referring to ATTLL.

4.4 Radio Interference Potential and Compatibility

The potential for destructive interference can exist when transmitters co-exist with receivers at the same tower site. ATTWS has proposed to deploy UMTS (Universal Mobile Telecommunications System) and LTE (Long Term Evolution) technologies in the 850 MHz and 700 MHz bands. These are for voice and data communications services.

The potential for interference has less to do with the technology and is more affected by physical proximity of transmit to receive antennas, frequency separation, transmitter power levels, equipment susceptibility and the duration that transmitters are activated (time). Changing any one of these factors can have a significant effect on the degree of interference. A formal interference analysis often referred to as a Co-Location Study, can only be conducted once all of the specific information is known. ATTWS did not provide enough specific information, and not enough information was available from the federal users or others at the site. Thus, more detailed information would be needed for the study to be conclusive.

In lieu of a formal analysis, FTE performed a query of the FCC license authorization database to establish what frequencies and radio bands are in use by non-federal government and most commercial entities at Rogers Peak.[21] These licenses are shown within Appendix E.

[20] Raising the tower height can sometimes overcome obstructions that are near the tower. However, these obstructions are too distant, which would require an impractically tall tower.

FTE found that ATTWS will be operating on adjacent frequencies to New Cingular Wireless PCS, LLC (FCC callsign KNKN209) and the State of California (FCC Callsign KNFD839). However, as long as the various antenna systems are properly positioned or isolated from one another, the most common forms of interference can be reduced or eliminated using additional filtering on or near the radio equipment of one or both entities.[22] Other potential interference paths exist due to the fact that a majority of the existing and planned antennas operate at similar elevations on the proposed and existing Caltrans tower. Interaction between systems on the Federal/NPS tower and the others is less likely due to their distance separation.

4.4.1 Conclusions – Radio Interference Potential and Compatibility

FTE sees no obvious incompatibilities among the existing and proposed ATTWS systems that could not be resolved through proper planning and design of the antenna systems (this may also require that existing tenants make changes to their antenna systems). Once the details are known, have a qualified firm perform an electromagnetic Co-Location Study to identify potential problems and solutions.

Interference potential is best avoided by proper site antenna planning and design from the beginning, followed by oversight and enforcement of site standards. For these reasons, FTE recommends that any agreement require compliance with written site standards.[23] The proposed and existing Caltrans towers are close enough to each other and must be considered together.

If an ATTLL proposal is limited to microwave radio, the interference potential between this and other microwave systems, and other services is usually limited. FTE does not anticipate interference levels related to microwave radio systems to be a major concern.

A Site Manager often develops an antenna placement plan and guidelines for all site participants, and may also install a shared or common antenna system for certain tenants when practical. Each new entrant must either use the common antenna systems, or meet specific site guidelines for placement of their dedicated antennas. Finally, the Co-Location Study is conducted by the Site Manager (or outside contractor).

While NPS could be responsible for general site management and outsource specific functions, independent and professional site management companies exist that could develop specific site standards and guidelines, provide site engineering services, perform Co-Location Studies and administer site leases. It would be unusual for ATTWS or ATTLL to perform such services unless they owned the tower site. The costs of such professional services is usually supported by monthly or annual tenant lease charges, and new site entrants usually pay an initial fee to cover the cost of engineering, a Co-Location Study and a portion of any

[21] While representative, this database cannot identify commercial geographic licenses that are not site-specific, or federal agency authorizations as these are not public. However, our site survey determined that NPS operates 150 MHz frequencies here.

[22] FTE notes that New Cingular Wireless PCS does not appear to be operating at this time and would not need to be considered.

[23] FTE is aware that some state agencies require such studies, but we found that enforcement is lacking in most cases.

shared or common antenna system they may use. Tenant lease charges are usually based on shelter and tower space utilization.

4.4.2 Equipment Shelters

ATTWS has proposed a new 11’6” x 24’ shelter with a 4’ x 4’ stoop. It would be configured similar to that of Caltrans (except smaller), with dedicated spaces for equipment and a propane-fueled generator.

4.5 Electrical Power Requirements

Any future radio or telecommunications equipment installed on Rogers Peak will require an electrical power source. There are several considerations that will guide future equipment installations on Rogers Peak.

- The USAF will not support equipment owned by private/commercial enterprises.
- In correspondence, SCE has advised that no additional equipment can be added to their photovoltaic (PV)/battery system without a major upgrade.
- Even if the SCE PV system had capacity for additional equipment, it is common practice to separate energy systems that support private/commercial interests from the energy infrastructure operating governmental telecommunications equipment.

Neither the existing SCE system nor the USAF PV system should be considered as a potential power source for any future commercial installations. It is recommended that any commercial interests that wish to place equipment on Rogers Peak provide their own power source and electrical infrastructure.

5 Conclusions and Recommendations

The following conclusions and recommendations are provided regarding the potential use of the Rogers Peak telecommunications site by non-governmental entities.

Existing Shelter and Tower Space

Existing shelter and tower space is near capacity. Space does remain for tenants operating private or internal radio systems serving a limited number of users, such as small two-way radio companies or most government agencies. Further equipment and antenna consolidation may provide a small incremental increase in space.

It is unlikely that enough space is available for commercial tenants that provide services to consumers and businesses, such as commercial cellular or microwave carriers. Expanding existing or constructing new facilities would be required.

It is noted that the majority of the existing tenants are government agencies having life-safety missions that require extremely reliable radio systems and proper access security. As commercial system operators have different missions and priorities, conflict can arise when equipment shelters and utilities are shared unless some isolation is provided. This applies to a lesser degree to shared antenna towers, but is can occur if antenna system standards are not established and enforced for all parties.

Structural Analysis – Caltrans Tower

The tower has much equipment already connected to it, some of which was added after it was initially built. This includes both antennae and microwave dishes. The tower appeared to be in reasonable condition given its age but did show some signs of age or deterioration, which included corrosion and minor damage at some members and hairline cracks in the concrete foundation.

If additional equipment were added to the tower, a detailed structural analysis should be performed conforming to the latest building code (ANSI/TIA-222-G). Complete structural drawings are required to sizes of all members, details for all connections, and foundation details. If this information is not available, a detailed site survey is required to gather this information. Access to every structural member of the tower is required in order to measure sizes and thicknesses of members and document any deterioration that must be accounted for in the analysis. Close-up access often requires a man-lift or rope access.

Electric Power

Neither the existing SCE solar PV system nor the USAF PV system should be considered as a potential power source for any future commercial installations. It is recommended that any commercial interests that wish to place equipment on Rogers Peak provide their own power source and electrical infrastructure.

Access Road

The existing access road to the Rogers Peak site is approximately 10 feet wide and can generally accommodate any construction equipment needed but is restricted to one way traffic at some locations. During the site visit, the road had been severely damaged due to erosion following a storm event.

Restoring normal access to the site will involve significant maintenance to the road. In order to restore normal access to the site, it is recommended that the road be reshaped using a motor grader to smooth and remove the larger rocks from the roadway surface. The access road essentially serves as a storm water conveyance channel, therefore it is essential to provide adequate drainage along the road to minimize future damage. Careful consideration should be given to ensure that any grading does not potentially direct stormwater towards archaeological and cultural sites. It is recommended that a cultural resources survey be completed along the entire length of the access road prior to completing any drainage improvements.

Radio and Microwave Interference Potential

There is limited potential for electromagnetic interference between microwave radio systems, or with two-way or cellular systems due to the nature of the technology. A more significant concern is whether such antennas would physically obstruct other antennas and impact their service coverage. As noted earlier, comprehensive pre-planning could reduce most of these complications.

AT&T Wireless Services

ATTWS's summary proposal as outlined in Appendix C does not appear to have a major impact on known existing communications systems.[24] Electromagnetic incompatibility is best reduced by proper pre-planning and coordination of tower and antenna placement considering all existing and potential site users. However, most remaining compatibility issues are best mitigated through flexible agreements that provide for shared-use of antenna towers and possibly shelter space (provided proper access security exists) when necessary.

AT&T Long Line

No information was available from ATTLL. However, given ATTLL's business line we would anticipate a minimum of two to four large diameter microwave dish antennas to be proposed, as well as multiple racks of indoor equipment and related power requirements. It is unlikely that all such antennas could be accommodated using the existing Caltrans tower, not only from a structural loading perspective, but also considering physical tower space and placement since such directional antennas must have unobstructed views in very specific directions to provide their service.[25]

5.1 Next Steps

The following summarizes next steps for further assessment efforts:

- No information was available on ATTLL's requirements should they relocate to Rogers Peak. Have ATTLL's detail their equipment, power, space, antenna and tower requirements as soon as possible so NPS can then assess whether ATTLL and ATTWS could potentially consolidate their facilities.
- While the potential for interference between the Air Force systems and others on the existing Caltrans and proposed ATTWS tower is lower due to physical antenna separation, it should still be assessed initially, at least from a high level. Detailed technical information on existing or any planned Air Force radio systems on Rogers Peak was not available but should be requested and assessed.
- Continue to assess physical antenna blockage (obstruction) and interference potential, as well as site planning holistically. This better positions the NPS to avoid complications later and allows for more cost-effective solutions when challenges inevitably occur.
- To properly assess whether a new structure or object(s) could significantly impact the radio coverage provided by an existing radio system, NPS must first understand the coverage requirements and expectation of the users of each radio system there, and the ultimate coverage potential of Rogers Peak to verify these coverage claims. Users operating mobile or handheld devices (two-way radio or cellular phones) generally expect coverage of the valley floor, and maybe within popular mountainous areas. However, microwave and highly-directional radio links (or "point-to-point"

[24] Limited information was available on existing Air Force systems. HDR/FTE recommends that Air Force also review all proposals for use of Rogers Peak.

[25] HDR/FTE have not considered commercial use of the NPS/Air Force tower as we understand that space there has already been allocated to both agencies.

radios) often only connect to a single distant point, but this point can be another mountain top, the valley floor, or any point in between. However, most any radio system requires line-of-sight (LOS) for reliable operation.[26]

- Once the technical details and coverage requirements of all the site users are known, and the positions of the future towers and structures are known, have an experienced engineering or site management firm position all the proposed antennas on paper to avoid physical blockage and reduce the potential for interference. A Co-Location Study, which considers only radio interference, is typically conducted as the last step in the antenna layout process.
- Some existing antennas, particularly if they are on the Caltrans tower, may need repositioning or relocation. However, as most support critical public safety or power utility operations, these cannot be deactivated while a change is made. A temporary or new antenna and transmission line may be needed to affect the change. The temporary or old antennas and lines are then removed once the replacement is in use. Costs of changes to incumbent radio systems need to be considered by NPS; incumbent site users will not have anticipated these costs.
- While the impact of physical (localized) antenna obstructions on radio coverage could be roughly predicted before construction, it is rarely performed for microwave, two-way radio and cellular type systems.[27] It is usually more cost-effective to plan and avoid blockage in the first place. If coverage concerns remain, the best method to assess their impact is to perform field signal measurements before and after installation of any new structure or objects.[28] Statistical signal measurements are performed in a moving vehicle over a very large area (over representative highways, streets and park), or at a remote microwave or link radio receiver site.[29] Finally, ensure that site use agreements permit some flexibility to share antenna space under certain conditions should any significant coverage impacts be experienced and antenna relocation or repositioning is desired.

[26] Radio systems operating at frequencies below 300 MHz and particularly those below 150 MHz, can still provide a reduced quality of coverage without line-of-sight. These should be separately considered.

[27] It is unknown whether existing Air Force systems fall into these categories, however.

[28] Field testing for signal degradation is best performed using the wireless technology planned in the future, to the extent practical and possible. For example, the DEVA radio system may eventually convert to APCO Phase II technology, which may be more sensitive to signal corruption then the current technology. Some coverage benchmark testing was performed prior (~2005) and may be available at the Park.

[29] For statistically-valid portable or mobile coverage measurements, hundreds if not several thousand individual measurements are taken using automated test equipment over the intended measurement area. A localized median or average of these measurements is calculated and compared with the same locality using the other set of measurements data. Before-and-after measurements must be conducted very close in time and under similar weather and temperature conditions to be comparable.

Appendix A. SCE Solar Array Performance Data

SCE Battery Bank A Data:

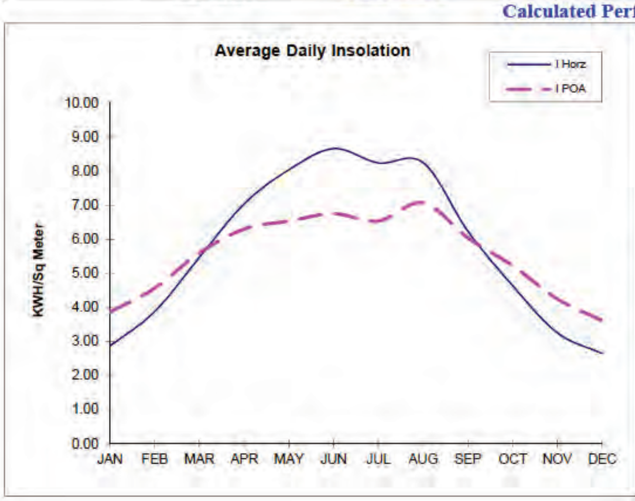
Nexgen Energy, Inc PVCALC rev 9.5 Photovoltaic/Hybrid Performance Program

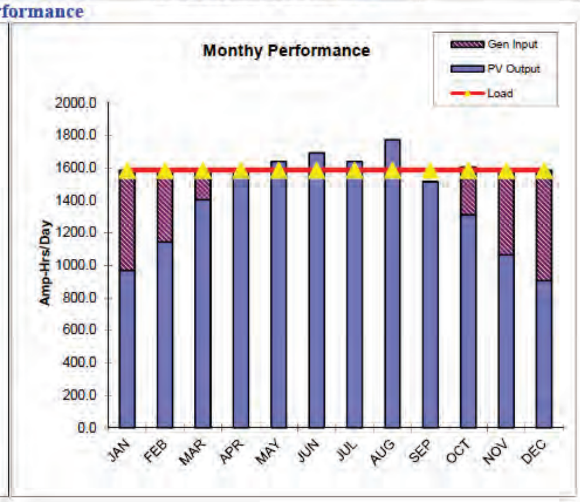
Calculated System Perfomance for SCE

Design By: Mike M **Date:** 11/4/2013

Site	**Client**	Ken Mc Crimmon		**Climate File**	INYOKERN
	Company	SCE		**Latitude**	35.7
	Project Name	Rogers Pk		**Longitude**	117.7
Load	**Average Load**	1584	Amp-Hrs/day	**Peak Current**	148.0
	Average Load	38.016	KWhrs/day	**Peak Wattage**	3552
Array	**Array Wpeak**	10320		**Selected Module**	MSX 120
	Array Amps	250.87		**Total Qty**	86
Battery	**Battery Ahrs**	7777.5		**Selected Battery**	1-100G87
	Battery Kwhrs	186.66		**Total Qty**	24
	Autonomy	3.9	Days to 80% Discharge	**Nominal Voltage**	24
Generator	**Generator KW**	35.0		**Charging Current**	240
	Estimated Run	348	Hrs/year	**Rectifier KW**	7
Results	**Total Load**	580988.4	Ahrs/yr		
	PV Output	508000	Ahrs/yr	**Load Provided by PV**	86%
	Gen. Input	83481	Ahrs/yr	**Load Provided by Genset**	14%

Calculated Performance





SCE Battery Bank B Data:

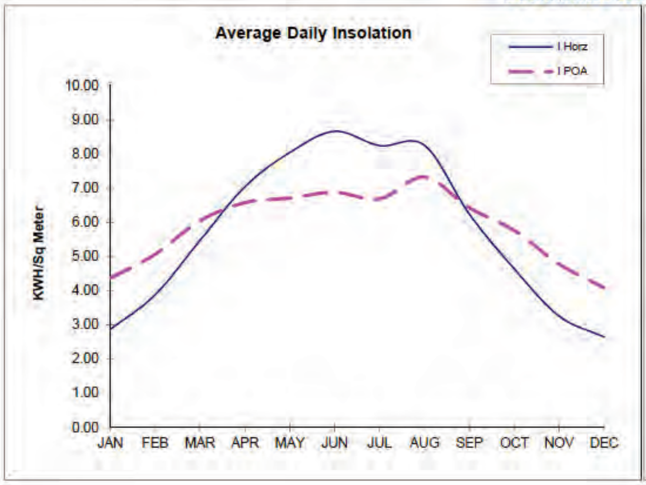
Nexgen Energy, Inc PVCALC rev 9.5 Photovoltaic/Hybrid Performance Program

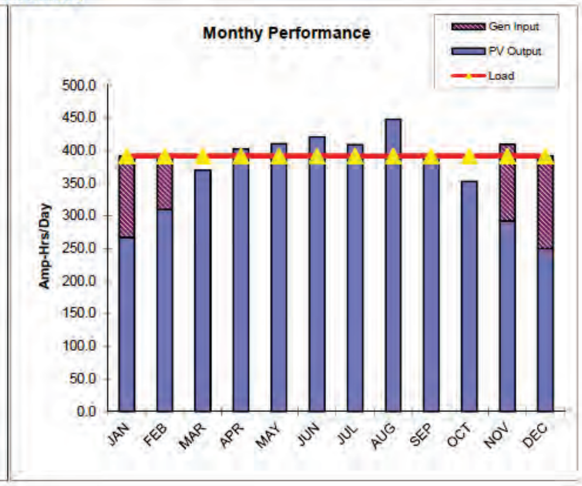
Calculated System Perfomance for SCE

Design By: Mike M **Date:** 11/4/2013

Site	**Client**	Ken McCrimmon	**Climate File**	INYOKERN
	Company	SCE	**Latitude**	35.7
	Project Name	Rogers Peak	**Longitude**	117.7
Load	**Average Load**	388.64 Amp-Hrs/day	**Peak Current**	38.6
	Average Load	9.33 KWhrs/day	**Peak Wattage**	927.27
Array	**Array Wpeak**	2520	**Selected Module**	MSX 120
	Array Amps	61.26	**Total Qty**	21
Battery	**Battery Ahrs**	3370.25	**Selected Battery**	1-100G87
	Battery Kwhrs	80.886	**Total Qty**	12
	Autonomy	6.9 Days to 80% Discharge	**Nominal Voltage**	24
Generator	**Generator KW**	35.0	**Charging Current**	150
	Estimated Run	94 Hrs/year	**Rectifier KW**	4
Results	**Total Load**	143485.31 Ahrs/yr		
	PV Output	132120 Ahrs/yr	**Load Provided by PV**	90%
	Gen. Input	14148 Ahrs/yr	**Load Provided by Genset**	10%

Calculated Performance





Appendix B. Caltrans Building Equipment Layout

Exhibit B1 - Equipment Inventory and Rack Assignment Summary - Caltrans Shelter

Inventory as of September 12, 2013. Rack Agency Assignments based on SCE site documentation dated 6/29/2006.

Assignments		Space			Current Rack Usage			
Rack/Cabinet Position No. (see Exhibit C1)	Agency Assignment	Unused Space in Rack	Open Floor Space	Empty Rack	Land Mobile Radio	Microwave Radio	Cellular/ Wireless Svs.	DC Power
1	State of California DOT (Caltrans)	30%			•			
2	State of California DOT (Caltrans)	30%			•			
3	Southern California Edison	70%				•		
4	Southern California Edison	20%				•		•
5	Southern California Edison	20%						•
6	(Unknown)		Partial					
7	Southern California Edison	5%			•			•
8	Southern California Edison	40%			•			
(space)	(Unknown)		Partial					
9	(Unknown)	100%		•				
10	FBI	40%			•			
11	(Unknown)	100%	•					
12	(Unknown)	100%	•					
13	State of California	0%						•
14	State of California GEN SVS	10%				•		
15	State of California GEN SVS	50%				•		
16	State of California CHP	10%			•			
17	(Unknown)	100%	•					
18	NPS	40%						•
19	Inyo Co./CA. Fish & Wildlife	0%			•			
20	CA. Fish & Wildlife	70%			•			
21	Western Wireless	0%					•	
22	Inyo Co. Roads/EMS	70%			•			
23	Inyo Co. Sheriff	20%			•			
24	Inyo Co. Sheriff	20%			•			
25	Southern California Edison	30%						•
26	Southern California Edison	0%						•
+24V Battery Bank A	Southern California Edison	0%						•
-24V Battery Bank B	Southern California Edison	0%						•
	Totals:	27%	4 Racks	1 Rack				

• Indicates equipment or space exists.
Note 1: Rack repositioning would allow Position 6 (15") to be combined with space between Position 8 and 9 (16") to form one+ rack position.
Position 6: Limited to 16" width, too small for rack.
Positions 11, 12: Was previous shown as "BLM".
Position 17: Was previous shown as "NPS".
Position 21: Not energized or in use.

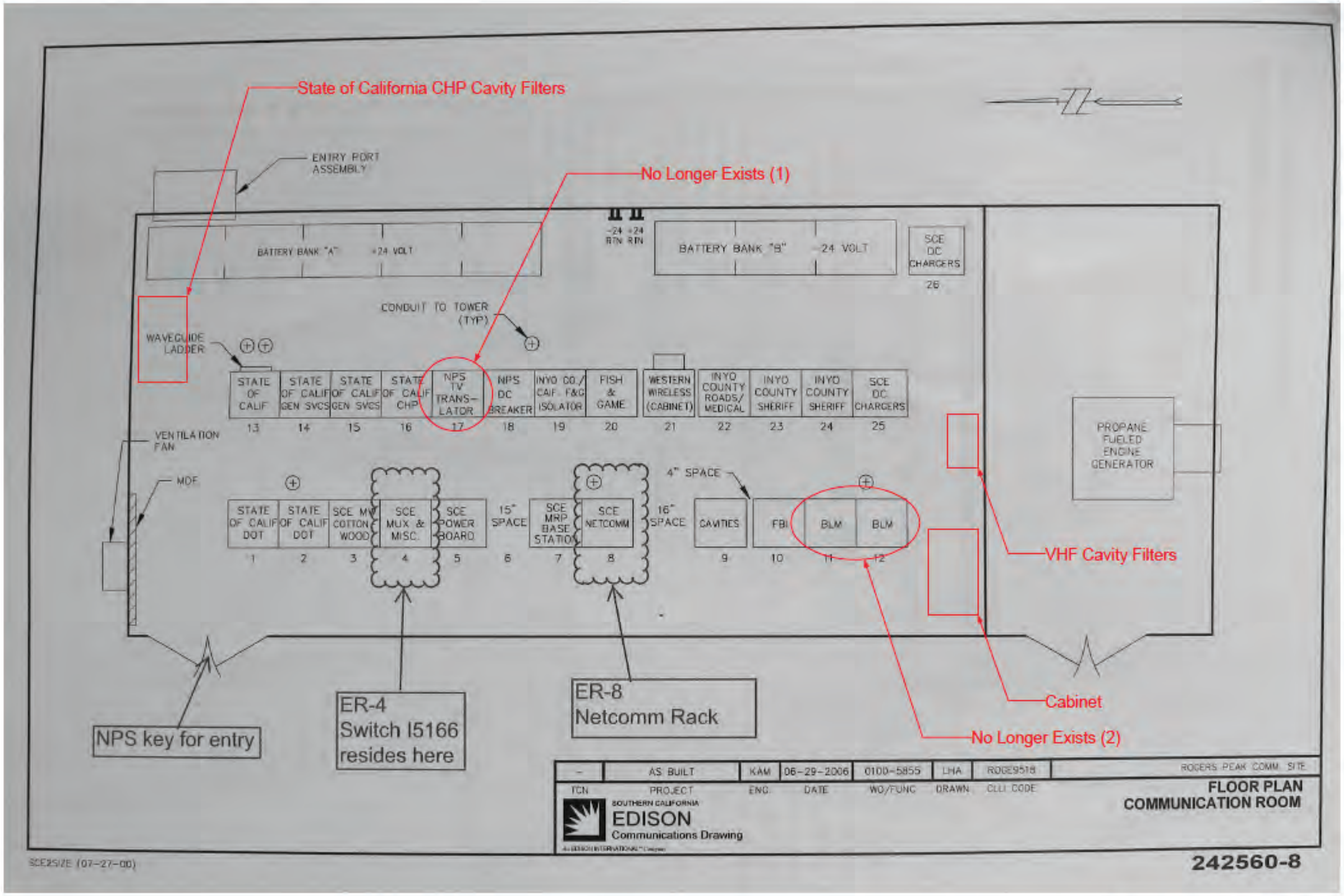


Exhibit B2 – Caltrans Shelter Racks Assignments and Positions Annotated with Changes Per Site Survey

FTE	Caltrans Shelter Rack Assignment & Positions
	Rogers Peak Communications Infrastructure
Date: January 15, 2014	B · 1 · A
G. Forrest	None · 1 OF 1

Appendix C. AT&T Proposed Cellular Facilities for Rogers Peak Site

BLUEWAVE DEPLOYMENT

Kathy Billings
Superintendent
United States Department of the Interior
National Park Service
Death Valley National Park
P.O. Box 579
Death Valley, California 92328

RE: AT&T Telecommunications Site – Rogers Peak

October 22, 2013

Dear Ms. Billings,

Thank you for your letter dated September 24, 2013, regarding AT&T's proposed revisions to the Rogers Peak telecommunications site. A SF-299 form was submitted for the site on October 26, 2012. The responses to the questions noted in your letter are noted below:

1) AT&T is seeking to remove old, unused shelter and concrete pad and place a new shelter and propane tanks in the previously disturbed area. The requested lease area is 20' x 60' including the 11'6" x 24' shelter and a 1,000 gallon propane tanks (shown in attached drawings, which were also submitted as part of the October 26, 2012 SF-299). AT&T is also seeking to construct a new, 60', self-support tower to hold the proposed antennae and provide location for future users in the Rogers Peak area.
2) The new shelter is 11'6" x 24' with a 4' x 4' stoop.
3) AT&T is seeking to place new solar panels at the site. AT&T is proposing to place the panels atop the proposed shelter, so no additional ground space will be required for power generation. The site will also have generator backup. The propane generator will be housed inside the proposed shelter and will be fueled by the proposed propane tanks, which are located inside the requested lease area.
4) AT&T is seeking to place six 8' panel antennae at the 55' RAD center and a 10' microwave dish at the 50' level on the tower. The bottom of the microwave dish will be at 45' above ground level (AGL). The azimuths of the proposed panels are 35°, 140° and 280°. The azimuth of the microwave dish is 298.55 degrees. The proposed service area is approximately 2,000 Square Miles inside and outside of Death Valley National Park, covering Highway 178/Badwater Road, Highway 190 from Furnace Creek to the East and West to Panamint Valley and South.
5) AT&T is proposing six panel antennae at the 55' RAD center and one microwave antenna at the 50' RAD. The azimuths of the proposed panels are 35°, 140° and 280°. The azimuth of the microwave dish is 298.55 degrees.

111 West Main Street, Suite 202
Garner, North Carolina 27529

6) AT&T is proposing a below-grade co/ax run between the proposed shelter and tower. The location of the below-grade run is shown on page C-1 of the attached drawings.
7) The proposed microwave will support AT&T, but the site will have space for others to add backhaul equipment.
8) The proposed frequencies are 850 MHz and 700 MHz. The proposed technologies are UMTS and LTE, respectively.
9) The maximum power consumption for the proposed equipment is 200 AMPs. The service will be generated by AT&T's onsite equipment.
10) AT&T proposes to access the site by the existing access road. All ground equipment will be housed within the locked, prefabricated shelter. No special access or security requirements are needed for the proposed site.
11) No other critical or relevant requirements are need for the site beyond those detailed in the above numbered items.

Please contact me should you have any questions or require additional information; my full contact information is noted below the signature. I look forward to finalizing this project with you and your team. Thank you for your time and consideration.

Sincerely,

Leslie Gorey
Project Manager
6658 Summer Darby Lane
Charlotte, North Carolina 28270
(704) 619-2634
leslie@bluewavedeployment.com

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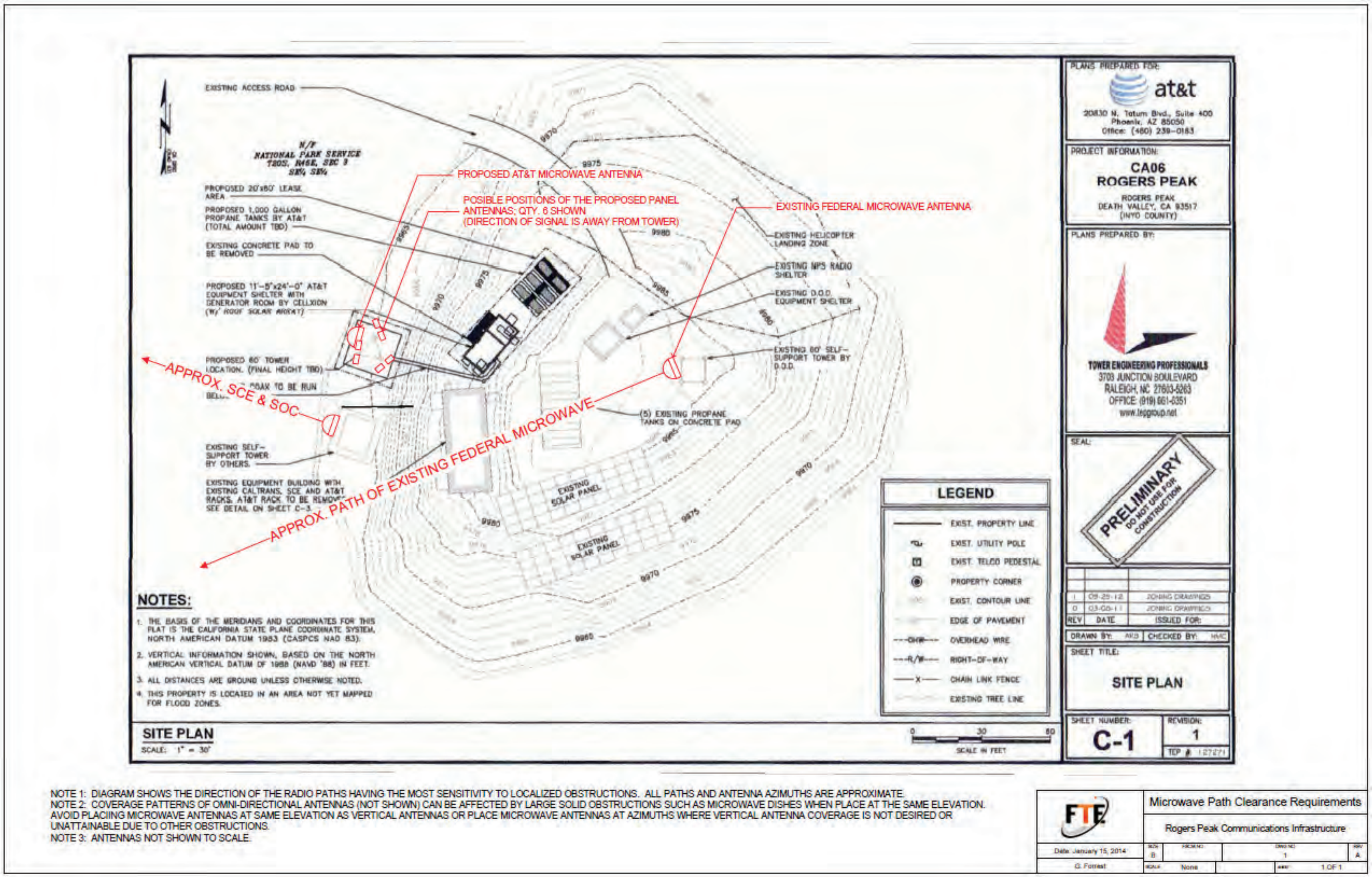
Garner, North Carolina 27529

Appendix D. Existing Microwave Radio Paths



Appendix E. Licensed Transmitters at Rogers Peak

Licensed Transmitters at Rogers Peak (as of January 2014)

Between 30 MHz and 26 GHz. Does not include geographic licensees or Federal Government authorizations.

Frequency (MHz)	FCC Callsign	Licensee Name	Purpose	Antenna Height (m)	Station Class	Radiated Power (w)	Expiration Date	Telephone	FRN No.	Latitude (NAD83)	Longitude (NAD83)	Emissions
42.12	KMD887	CALIFORNIA, STATE OF	CALIFORNIA HIGHWAY PATROL DISPATCH	20.0	FB	120	20141025	9166579999	0001724541	36.2177222	-117.0858889	20K0F3E
42.34	KUI764	CALIFORNIA, STATE OF	CALIFORNIA HIGHWAY PATROL DISPATCH	20.0	FB	120	20141025	9166579999	0001724541	36.2177222	-117.0858889	20K0F3E
44.7	KMD887	CALIFORNIA, STATE OF	CALIFORNIA HIGHWAY PATROL DISPATCH	20.0	FB	120	20141025	9166579999	0001724541	36.2177222	-117.0858889	20K0F3E
44.94	KMD887	CALIFORNIA, STATE OF	CALIFORNIA HIGHWAY PATROL DISPATCH	20.0	FB	120	20141025	9166579999	0001724541	36.2177222	-117.0858889	20K0F3E
88.7	K204BW	DEATH VALLEY NATURAL HISTORY ASSOCIATION	FM RADIO BROADCAST STATION		D	100	20211201			36.2183333	-117.085000	
151.43	KAN796	CALIFORNIA, STATE OF	CALIFORNIA DEPT. OF FISH AND WILDLIFE	12.0	FB2		20210903	9166579999	0001724541	36.2166111	-117.0856111	20K0F3E 11K2F3E 20K0F3E 11K2F3E
153.8	WPAN849	INYO COUNTY OF PUBLIC WORKS DEPARTMENT	PUBLIC WORKS DISPATCH	12.0	FB2	100	20220914	7608780201	0001525336	36.2186944	-117.0876389	11K2F3E
154.725	KNDA381	INYO, COUNTY OF	INYOU COUNTY SHEREIFF DISPATCH	12.0	FB2	90	20220714	7608780235	0001525336	36.2166111	-117.0856111	20K0F3E 11K2F3E 20K0F3E 11K2F3E
156.06	WPYQ969	INYO, COUNTY OF	INYO COUNTY HIGHWAY	17.0	FX1	3	20231002	7608780235	0001525336	36.2172222	-117.0863889	11K2F3E 20K0F3E
453.25	WPYQ969	INYO, COUNTY OF	INYO COUNTY PUBLIC SAFETY	15.5	FX2	17	20231002	7608780235	0001525336	36.2172222	-117.0863889	11K2F3E
453.8125	WPYQ969	INYO, COUNTY OF	INYO COUNTY PUBLIC SAFETY	15.5	FX2	17	20231002	7608780235	0001525336	36.2172222	-117.0863889	11K2F3E
460.375	WPTF305	CALIFORNIA, STATE OF	CALIFORNIA HIGHWAY PATROL DISPATCH	15.2	FB2	3	20210918	9166579999	0001724541	36.2177222	-117.0858889	20K0F3E 11K2F3E 20K0F3E 11K2F3E
460.45	WPTF305	CALIFORNIA, STATE OF	CALIFORNIA HIGHWAY PATROL DISPATCH	15.2	FB2	3	20210918	9166579999	0001724541	36.2177222	-117.0858889	20K0F3E 11K2F3E 20K0F3E 11K2F3E
824.04-834.99	KNKN209	NEW CINGULAR WIRELESS PCS, LLC	CELLULAR/MOBILE SERVICES (NOTE 1)	0.0		141	20191001		0003291192	36.2179722	-117.0859444	
845.01-846.48	KNKN209	NEW CINGULAR WIRELESS PCS, LLC	CELLULAR/MOBILE SERVICES (NOTE 1)	0.0		141	20191001		0003291192	36.2179722	-117.0859444	
869.04-879.99	KNKN209	NEW CINGULAR WIRELESS PCS, LLC	CELLULAR/MOBILE SERVICES (NOTE 1)	0.0		141	20191001		0003291192	36.2179722	-117.0859444	
890.01-891.48	KNKN209	NEW CINGULAR WIRELESS PCS, LLC	CELLULAR/MOBILE SERVICES (NOTE 1)	0.0		141	20191001		0003291192	36.2179722	-117.0859444	
857.1625	KNFD839	CALIFORNIA, STATE OF	CALIFORNIA DEPT. OF TRANSP. (CALTRANS)	21.0	FB2	13	20211008	9166579999	0001724541	36.2177222	-117.0858889	20K0F3E 20K0F3E
859.7375	KNFD839	CALIFORNIA, STATE OF	CALIFORNIA DEPT. OF TRANSP. (CALTRANS)	21.0	FB2	13	20211008	9166579999	0001724541	36.2177222	-117.0858889	20K0F3E 20K0F3E
860.9875	KNFD839	CALIFORNIA, STATE OF	CALIFORNIA DEPT. OF TRANSP. (CALTRANS)	21.0	FB2	13	20211008	9166579999	0001724541	36.2177222	-117.0858889	20K0F3E 20K0F3E
935.4625	WNVW901	SOUTHERN CALIFORNIA EDISON COMPANY	POWER UTILITY DISPATCH	3.0	FB2C	65	20221008	6263086900	0001535608	36.2180000	-117.0853333	13K6F2D
937.225	WNVW901	SOUTHERN CALIFORNIA EDISON COMPANY	POWER UTILITY DISPATCH	3.0	FB2C	65	20221008	6263086900	0001535608	36.2180000	-117.0853333	13K6F2D
938.9	WNVW901	SOUTHERN CALIFORNIA EDISON COMPANY	POWER UTILITY DISPATCH	3.0	FB2C	65	20221008	6263086900	0001535608	36.2180000	-117.0853333	13K6F2D
6635	WNTT702	CALIFORNIA, STATE OF	GOVERNMENT MICROWAVE RADIO LINK	13.7	FXO	8511.3803	20181206		0001724541	36.2177222	-117.0858889	10M0F9W
6695	WNTX507	SOUTHERN CALIFORNIA EDISON COMPANY	UTILITY MICROWAVE RADIO LINK	13.7	FXO	26302.679	20200118		0001535608	36.2180000	-117.0853333	5M00D7W

NOTE 1: STATION IS LICENSED BUT MAY NOT BE IN OPERATION.