Midpeninsula Regional
Open Space District

R-20-110
Meeting 20-27
November 18, 2020

**AGENDA ITEM 11**

**AGENDA ITEM**

Radio System Assessment Report and Recommendations

**GENERAL MANAGER'S RECOMMENDATION**

Direct the General Manager to implement the Radio System upgrade and improvement recommendations, as presented in the staff report, to improve coverage, reliability, functionality, and compatibility with local emergency response agencies, as well as address end-of-life concerns that affect the ongoing maintenance and use of the current system at a total implementation cost over the next two fiscal years estimated at $2.51M. These upgrades include improvements and/or replacements of repeaters/equipment on communications towers repeater sites, new repeater sites, new digital handheld devices, mobile vehicle radios, and base stations. Estimated equipment costs include savings through cooperative purchasing agreements and staff will continue to explore options to further reduce costs.

**SUMMARY**

The Midpeninsula Regional Open Space District's (District) radio system requires upgrades as some of the equipment is reaching end-of-life (EOL) and manufacturers are no longer fabricating replacement parts or providing support. In July 2019, the Board of Directors (Board) awarded a contract to Forrest Telecom Engineering (FTE) to prepare a radio system assessment report and master plan (R-19-92). As part of this work, the consultant evaluated radio coverage issues on District lands and within potential new acquisition areas. The General Manager recommends implementing the recommended radio system upgrades in this report over two fiscal years beginning in Fiscal Year 2021–22 (FY22). The total cost over the two-year implementation period is estimated at $2.51M. Estimated equipment costs include savings through cooperative purchasing agreements and staff will continue to explore options to further reduce costs.

**DISCUSSION**

**Current Radio System**
In June of 2011, the Board approved a contract with Santa Clara County Communications for the design and installation of the current radio system (R-11-57). The radio system came online in 2012 at a total cost of approximately $1,500,000.

The current radio system actually includes two systems: 1) a very high frequency (VHF) analog simulcast system (hereafter referred to as the Patrol Simulcast System), and 2) an analog multi-channel system (hereafter referred to as the Maintenance/Administrative System), both of which cover most core areas of the District.

The Patrol Simulcast System uses microwave infrastructure to link repeater towers, allowing a radio transmission made at one end of the District to simultaneously be transmitted over the entire system. This enables a person at any location within the District to communicate with others anywhere else in the District. This simulcast channel is the primary channel used by District Rangers for emergency and non-emergency communications.

The Maintenance/Administrative System utilizes the same repeater towers as the Patrol Simulcast System, but users must choose the channel based on their location. This system is used by District maintenance and administrative staff, as well as for logistical (non-urgent) communications by emergency response staff.

The District utilizes seven radio towers for both systems (see Attachment 1 for tower locations).

**2019 Radio System Assessment and Recommendations**

Although the current radio system has served the District well, given its age, the equipment is beginning to reach end-of-life (EOL) and manufacturers are no longer fabricating replacement parts or providing support to ensure that the system remains functional and reliable into the future. Given these issues, the Board awarded a contract to FTE in July 2019 to assess radio system needs and deficiencies/gaps and develop recommendations for system improvements.

***Radio System Needs Assessment and Alternative Plans Report (Attachment 2)***

As part of the radio system assessment, FTE completed the following deliverables:

- Conducted a complete assessment of the radio systems;
- Evaluated equipment based on EOL, parts, and support availability;
- Identified and addressed areas of poor radio coverage;
- Evaluated new and emerging technologies in the radio communications industry;
- Considered technology upgrades of other local agencies to ensure compatibility;
- Evaluated the ability to reuse existing District radio equipment; and
- Considered projected future land acquisitions to comprehensively assess, model, and incorporate new land holdings into the planned coverage areas.

Key findings include:

- Patrol Simulcast System repeaters and central simulcast are obsolete in terms of support;
- Maintenance/Administrative System repeaters are also obsolete in terms of support;
- Microwave infrastructure currently connecting towers can be retained and reused;
- Back-up batteries for the repeater and microwave links are old and need to be replaced;
- Microwave segment between Pise tower and Santa Clara County Communications hub needs to be replaced;
- Sierra Morena/Skeggs Point tower site has no back-up generator;
- Terrain blockage is responsible for most coverage issues;
- Coverage issues can be resolved by using vehicle repeaters, acquiring new towers, and/or replacing towers with ones located in better areas; and
- Minor site deficiencies can be mitigated while other work is happening at the towers.

Recommendations:

The Needs Assessment and Alternative Plans report (Attachment 2) was reviewed by the District's Chief Ranger, both Area Superintendents, the Land and Facilities Department Manager, the Skyline Area Manager, and the Management Analysts in both Visitor Services and Land and Facilities Departments. All concur that the recommendations in this report meet the

District's field emergency and maintenance operations needs now and into the future. The recommendations fall into two categories:

1) *Required Items* to maintain operational analog VHF radio systems.
2) *Recommended Items* to improve performance, reliability, and coverage.

***Required Items – Total Cost Estimate: $993,000***[^]

The following items are required to ensure the radio systems remain operational:

1) Replace the existing Patrol Simulcast System with new equipment (Attachment 2, Item 1[*]).
2) Replace the existing Maintenance/Administrative System with new equipment (Attachment 2, Item 2).
3) Install common site equipment in each tower and install a microwave backhaul link between the Pise tower and Santa Clara County Communications hub (Attachment 2, Item 3[*])

In addition, it is in the District's best interest to:

4) Replace the Skeggs Point tower with a repeater on the Allen Peak tower (Attachment 2, Item 9). This shift will avoid the need to purchase a back-up generator for the Skeggs Point tower (which costs the same as installing a repeater at the Allen Peak tower). This has the added benefit of improving coverage in the following Preserves and new acquisitions:
    - La Honda Creek
    - El Corte de Madera
    - Russian Ridge
    - Tunitas Creek
    - South Cowell Property (Purisima Creek Redwoods)
    - Irish Ridge Property (Purisima Creek Redwoods)

    See Attachment 3(a) for a map of coverage improvements. Implementation is contingent upon space availability at the Allen Peak tower at the time of project activation.

***Recommended Items – Total Cost Estimate: $1.408M***[^]

The following items are recommended to improve performance, reliability, and coverage.

**Performance and Reliability Improvements – Cumulative Cost: $901,000**

*1) Upgrade to P25 Digital (Attachment 2, Item 4) - Cost: $866,000*

The District is currently using analog-type VHF radio systems. Recommendations call for upgrading the Patrol Simulcast System from analog to digital for the following reasons:

- *Better Long-Term Support*: Manufacturer support of analog radios and the availability of radio technicians familiar with analog is slowly diminishing and will become more of a problem as the equipment approaches EOL as more systems go digital.

---

[^]All estimates in this report are in 2022 dollars (time of anticipated implementation); an approximate inflation rate of 3% has been added to FTE estimates to compensate for one year of deferral. Equipment costs have been estimated based on reduced pricing through cooperative government purchasing agreements.

[*]The assessment report identifies two items as at risk for short-term failure: 1) the central hub of the simulcast system (Baseline Item 1 in Attachment 2), and 2) the back-up batteries at all towers (Baseline Item 3 in Attachment 2). The costs for these items ($38,000) are included in the FY21 Budget and therefore not included in the FY22 estimates shown in this report.

- *Coverage Improvements*: Digital maintains, if not improves, radio coverage in most areas, particularly in light of technical improvements that have been made in the late 2000s that offset previous connectivity issues in mountainous areas.
- *Major Voice Clarity Improvement:* Digital significantly improves signal clarity as the effects of noise and fading are no longer present.[†] Field users and dispatchers prefer digital over analog from a clarity standpoint.
- *Caller-ID:*[‡] Each voice call can be clearly identified on all receiving radios and dispatch consoles with the radio identification number, caller name, or particular function.
- *Radio Emergency Button*: Digital radios are equipped with an orange button that sends an alarm to the dispatcher and/or others on the radio channel when a user needs help but cannot verbally communicate.
- *Other Features*: Digital allows radios to transmit their location when either the emergency button is pressed or on a regular basis for enhanced safety.[§] Voice encryption is also possible, providing strong message privacy.

Costs includes $166,000 to purchase digital-capable equipment (beyond the costs listed under *Required Items*) and $700,000 to replace handheld and vehicle radios.

*2) Upgrade Maintenance/Administrative System to Simulcast (Attachment 2, Item 5) - Cost: $35,000*
For a relatively low cost, this upgrade would add a simulcast function to the Maintenance/ Administrative System, allowing staff in any part of the District to communicate with anyone in another part of the District using a single channel, similar to the Patrol Simulcast System. This upgrade would simplify the user-interface by reducing the number of channels from five to one, reducing the amount of training required to use multiple channels and subsequent user confusion—something that is particularly helpful for administrative office staff who do not utilize the radio system on a regular basis. This upgrade would also avoid congesting the Patrol Simulcast channel with non-emergency traffic.

**Coverage Improvements – Cumulative Cost: $507,000**
The following recommendations would improve coverage across the District:

1) Upgrade the Redwood tower to allow for transmit of radio signals;
2) Replace the Tomita tower with a repeater at the McQueen Ridge tower; and
3) Install a new repeater at the Pigeon Point tower.

NOTE: These recommendations are contingent upon space availability at each of the towers at the time of project activation.

*1) Upgrade Redwood Tower to Allow for Transmit (Attachment 2, Item 7) - Cost: $215,000*
The District currently has equipment to *receive* radio signals in the Redwood tower. The recommendation is to add equipment that allows users to *transmit* via the tower. The area covered by this tower is in a high-fire severity zone. Its addition will therefore greatly improve

[†] Voice quality (as opposed to clarity) can vary significantly among radio models and manufacturers; optimization of specific internal radio settings in the beginning is critical.
[‡] This feature along with the emergency button, encryption, and GPS were available on some analog radios in the past but were often proprietary and compromised radio performance.
[§] Requires GPS-equipped radios and map display system at dispatch center.

response and communication during wildland fires in this area. Additionally, this will greatly improve coverage in some of the busiest Preserves, as well as two new planned trails:

- Bear Creek Redwoods
- St. Joseph's Hill
- Priest Rock
- Limekiln
- Beatty Trail (MAA22-004)
- Ridge Trail Connection (MAA20-02)

See Attachment 3(b) for a map of coverage improvements associated with adding this tower.

*2) Install Repeater at McQueen Ridge; Replace Tomita Tower (Attachment 2, Item 9) - Cost: $80,000*
The area covered by this tower has seen multiple moderate-sized wildland fires over the last 15 years. Replacing the Tomita tower with the McQueen Ridge tower will therefore greatly improve response and communication during wildland fires in this area. Additionally, replacing the Tomita tower with the McQueen Ridge tower will provide improved coverage in the following areas of Sierra Azul Open Space Preserve:

- Twin Creeks
- Loma Prieta Ranch
- Loma Prieta/Loma Chiquita
- South side of Mt. Umunhum

See Attachment 3(c) for a map of coverage improvements associated with adding this tower.

*3) Install New Repeater at Pigeon Point (Attachment 2, Item 13) - Cost: $212,000*
Installing a new repeater at Pigeon Point tower will significantly improve coverage in potential and existing growth areas:

- Cloverdale/Pescadero area
- The greater San Mateo County coast

See Attachment 3(d) for a map of coverage improvements associated with adding this tower.

**FISCAL IMPACT**

Original total project costs were projected at $1,219,000 over three fiscal years before more accurate cost projections were developed as part of the Needs Assessment and Alternative Plans report (Attachment 2). Refined cost estimates to implement the proposed recommendations now total approximately $2,512,000 and are shown in detail below. Estimated equipment costs include savings through cooperative purchasing agreements and staff will continue to explore options to further reduce costs.

| Item | Cost |
|---|---|
| *Existing Contract: Consultant Engineering Services* | *$111,000* |
| Replace Existing Patrol Simulcast System | $385,000 |
| Replace Existing Maintenance/Administrative System | $182,000 |
| Common Site Equipment | $346,000 |
| Install Repeater at Allen Peak; Replace Skeggs Tower | $80,000 |
| **SUBTOTAL for Required Items and Existing Contract** | **$1,104,000** |
| Upgrade Patrol Simulcast System to Digital | |
| Upgrade to P25 Digital | $166,000 |
| Replace All District Radios | $700,000 |
| Upgrade Administrative System to Simulcast | $35,000 |
| SUBTOTAL for Performance and Reliability Improvements | $901,000 |
| Upgrade Redwood Tower to Transmit | $215,000 |
| Install Repeater at McQueen Ridge; Replace Tomita Tower | $80,000 |
| Install New Repeater at Pigeon Point | $212,000 |
| SUBTOTAL for Coverage Improvements | $507,000 |
| **SUBTOTAL for all Recommended Items** | **$1,408,000** |
| **TOTAL** | **$2,512,000** |

The following table outlines the costs-to-date and projected future expenditures if all the recommended items are approved by the Board. Funds would be programmed into future fiscal year budgets as a part of the annual Budget and Action Plan process. By the end of FY21, $5.5 million are projected in the committed for capital maintenance fund balance, which can be used to cover future expenditures for this project if there are insufficient revenues in the general fund.

| Radio System Assessment and Upgrade (#65407) | FY20 Actuals | FY22 Projected | FY23 Projected | TOTAL |
|---|---|---|---|---|
| Consultant Engineering Services Contract: | $54,788 | $20,000 | $36,212 | **$111,000** |
| Communications/Network Infrastructure & Equipment: | $0 | $706,000 | $908,000 | **$1,614,000** |
| Installation Design & Engineering Consultant: | $0 | $335,000 | $452,000 | **$787,000** |
| **Estimated Total** | **$54,788** | **$1,061,000** | **$1,396,212** | **$2,512,000** |

## BOARD COMMITTEE REVIEW

There was no prior Committee review for this agenda item. The full Board approved the contract for the radio system assessment.

## PUBLIC NOTICE

Public notice was provided as required by the Brown Act. No additional notice is required.

## CEQA COMPLIANCE

This item is not a project subject to the California Environmental Quality Act.

## NEXT STEPS

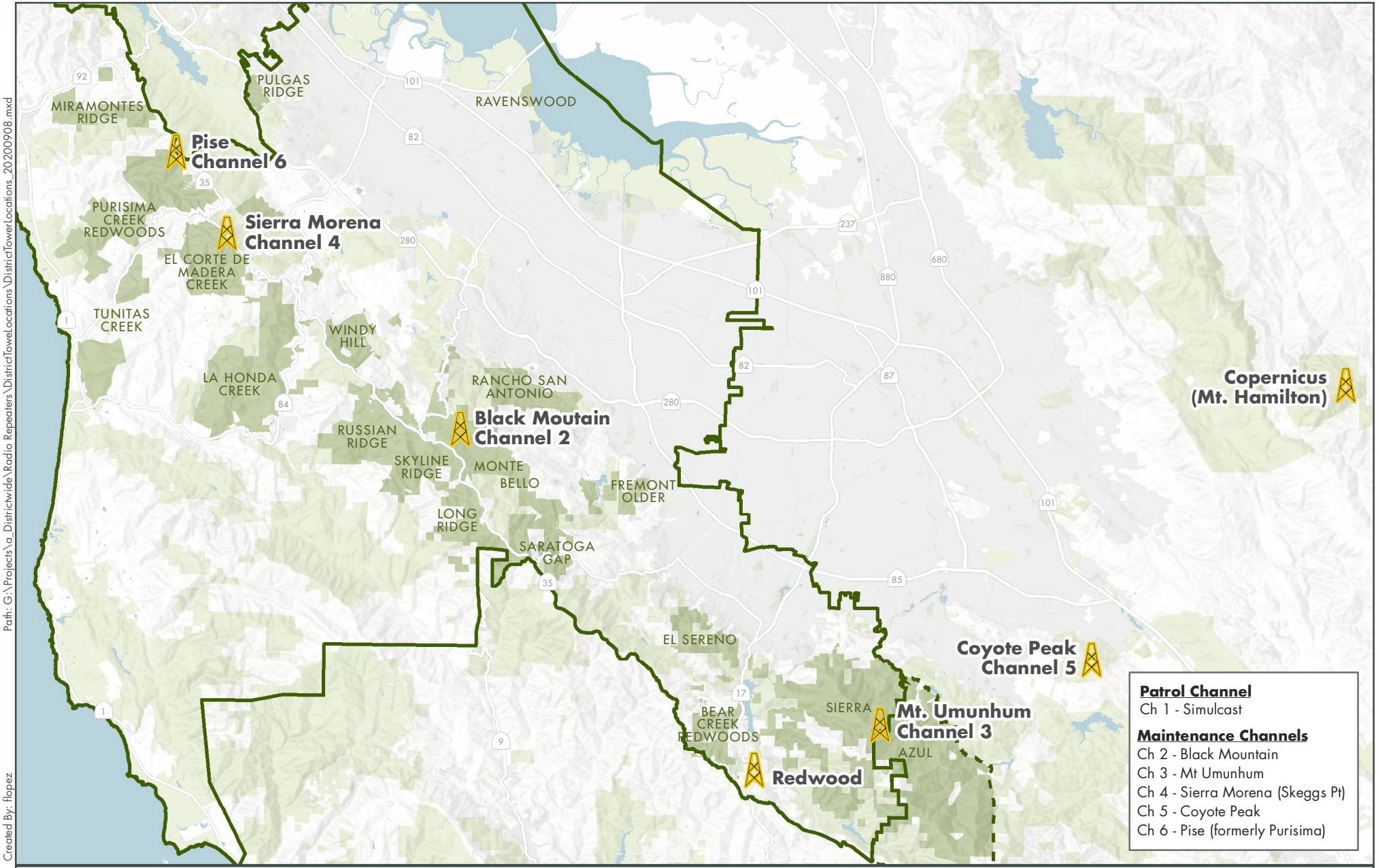
Pending Board approval of the recommendation, a Request for Proposals would be released in FY22 for implementation of the recommendations and new equipment.

Attachments

1. Map of District Radio Tower Locations
2. Needs Assessment and Alternative Plans
3. Coverage Improvement Maps

Responsible Department Head:
Matt Anderson, Chief Ranger, Visitor Services Department

Prepared by/Contact Person:
Deborah Bazar, Management Analyst II, Visitor Services Department




Path: G:\Projects\a_Districtwide\Radio Repeaters\DistrictTowerLocations\DistrictTowerLocations_20200908.mxd

Created By: flopez

## Map of District Radio Tower Locations

MROSD Preserves
Other Protected Lands
Private Property
MROSD Boundary
Sphere of Influence
District Radio Repeater

Midpeninsula Regional
Open Space District
*(Midpen)*
9/8/2020

Miles
0 5 10

While the District strives to use the best available digital data, these data do not represent a legal survey and are merely a graphic illustration of geographic features.

# *Midpeninsula Regional Open Space District*
# *Voice Radio Communication Systems Assessment*

*NEEDS ASSESSMENT AND ALTERNATIVE PLANS*

*May 21, 2020*

Forrest Telecom Engineering, Inc.

Author

Greg Forrest, P.E., Principal
Forrest Telecom Engineering, Inc. (FTE)
Pleasanton, CA 94566
Tel: 925-251-1212
Email: gforrest@fortele.com

Version History

| | | Draft | | Final | |
|---|---|---|---|---|---|
| Description | Version | Draft Date | Author | Approval Date | Approver |
| Initial Draft | 0.0 | 4/20/2020 | Greg Forrest | | |
| First Revision (includes cost rev.) | 1.0 | 5/21/2020 | Greg Forrest | | |
| | | | | | |
| | | | | | |

# Table of Contents

# List of Tables



# List of Figures



File: MROSD Radio Assessment Report R2 5-21-20.docx

# 1 General

The District operates two voice radio systems that support over 200 handheld, vehicular and base station radios used by rangers, maintenance personal and administrative staff. Both systems have reached End of Life (EoL) from a manufacturer support perspective, and some critical parts may no longer be available. The District has contracted with Forrest Telecom Engineering Inc. (FTE) to develop a Master Plan for replacement and possible improvement.

This first report includes a comprehensive needs assessment, evaluates the current system's strengths and deficiencies, and develops several conceptual design options based upon cost, construction feasibility, licensing, and other criteria.

Appendix A provides a glossary of various technical terms used in this report.

### *Background*

District radio systems include a wide-area system for rangers (referred to as the Patrol Channel), and a second more localized one to support maintenance and administration (Admin Channel). While some cellular phones are in use as well, service coverage in many of the preserves is poor to non-existent, and most are unable to support group voice messaging ("one-to-many" or party-line type calls) which is important for staff safety.

The Patrol channel consists of five high-elevation repeater sites configured for simulcast operation, as well as three auxiliary receive sites.[1] Each connects to centralized control equipment installed at Santa Clara County's primary communications facility in San Jose.[2] A combination of District- and County-owned microwave radio links and leased digital circuits provide these connections. The District contract's with the Mountain View Police Department for 24-hour dispatch services for the Patrol channel. The City's dispatch workstations (consoles) connect to the central control equipment through County-owned microwave radio.

Admin Channel repeaters are co-located with Patrol repeaters at the same five tower sites. These are configured in a multisite or stand-alone arrangement, where messages are only retransmitted through one repeater at a time. Thus, they can improve coverage within the area immediately surrounding each repeater, but not between widely separated areas or preserves. Field users must manually select the best repeater given their location and that of the message recipient(s).

#### *Key Interview Findings*

FTE interviewed rangers, maintenance and administration staff and found overall satisfaction with the systems as well as their maintenance and administration. The most widely-reported system deficiency was poor handheld radio coverage in specific areas. The Foothills Field Office (indoors), DHF and Wildcat Canyon first to be mentioned. Later, large-scale maps were provided in various offices for users to mark additional areas. Each problem area was categorized as handheld, vehicle, or both.

Approximately twenty additional locations were identified, with all but one being handheld radio limitations. See Section 5.2 for a complete list. It was also noted that the highest use of radio occurs in the Rancho San Antonio and Sierra Azul areas.

FTE also discussed a few common radio system enhancement or applications that are becoming more common. It was believed that the Chief Ranger has expressed some interest in GPS-based location

[1] Simulcast-type systems simultaneously broadcast every radio message through each repeater to allow reception anywhere within the covered area.
[2] Located on Carol Drive in San Jose.

reporting from handheld radios the past. It was decided that more internal discussions would be necessary on this topic.

### *FTE Findings*

Our analysis also established the following:

- The Patrol repeaters and associated central simulcast control system have become obsolete from a support perspective. The Admin repeaters are also obsolete and overdue for replacement.
- This District's microwave backhaul equipment is only half way through its useful life and can be retained and reused with any future radio system project.
- Backup batteries supporting the repeater and microwave links are aging and will need replacement.
- A segment of the backhaul link between the Pise Tower site and Carol Drive (leased from San Mateo County) is incompatible with newer simulcast technologies that will be required for the Patrol channel. This microwave segment will need replacement.[3]
- The Sierra Morena site (leased) is not equipped with a backup generator and has limited battery backup. FTE recommends that a generator be installed here if possible.
- FTE verified most all user reports of poor handheld coverage, and we established the degree of vehicle coverage in these same areas. Terrain blockage is causing the vast majority of coverage problems. Such coverage challenges can only be solved by relocating or adding repeater sites at specific locations.
- There are various other minor site deficiencies that can be corrected when other work is planned for the tower sites (see Section 3.9).

### *Recommendations and Budgetary Costs*

We have categorized our recommendations as baseline (or "like-kind" replacements), enhancements or as coverage mitigation items.

- Baseline Item 1: Replace Existing Patrol Radio System ($378,000)
- Baseline Item 2: Replace Existing Admin Multicast System ($177,000)
- Baseline Item 3: Common Site Equipment for Patrol & Admin Channels[4] ($370,000)
- Enhancement Item 4: Add - Upgrade Patrol Channel to P25 Digital ($161,000)
- Enhancement Item 5: Add - Upgrade Admin Channel to Simulcast ($34,000)
- Enhancement Item 6: Backup Generator at Sierra Morena/Skeggs Tower Site ($78,000)

Mitigation items below all relate to improving handheld or vehicular coverage by relocating or adding repeaters at existing government or privately-owned tower sites. Cost ranges shown in Items 9 and 10 represent relocation of an existing repeater site (lower cost) or installation of an additional repeater (higher cost) at the tower site specified.

[3] The County cannot provide a compatible IP-based segment here until 2022 or later when its microwave system is scheduled for replacement.
[4] Must be implemented if either Items 1 or 2 are implemented.

- Mitigation Item 7: Upgrade Redwood Site for Patrol Repeater Operation ($334,000)
- Mitigation Item 8: Install New Patrol Repeater at Cal Water Site ($374,000)
- Mitigation Item 9: Install New Patrol Repeater at Allen Peak ($78,000 - $416,000)
- Mitigation Item 10: Install New Patrol Repeater at McQueen Ridge ($78,000 - $366,000)

All costs include supply and installation by Santa Clara County, spare equipment, sales tax, freight, testing and integration costs. Costs do not include handheld, vehicular or base radios. Engineering costs are included if shown.

### *Possible Project Risks*

FTE sees limited risk with any of the recommendations or cost items. However, it will be important for Rangers to review changes in radio coverage if the Sierra Morena or Tomita tower sites are relocated. While relocating a repeater to a new tower site can improve coverage in some area, it can also create coverage holes where they may not have existed before.

### *Next Steps*

FTE recommends the following next steps:

1. Select and prioritize any desired coverage improvement package(s) from Items 7, 8, 9 and/or 10.
2. If existing repeaters at Sierra Morena or Tomita will be relocated to Allen Peak and/or McQueen Ridge (Items 9 or 10), have FTE meet with Patrol and Admin channel field users to review the coverage changes in detail.
3. Have FTE work with San Mateo and Santa Clara counties to establish if a new microwave path can be installed at Pise to replace the existing legacy link from San Mateo Co.

# 2 Scope of Project

This project encompasses all areas within the District boundaries, including future coastal lands proposed for acquisition. The following communications systems and equipment are also under consideration:

- An eight-site, VHF conventional simulcast radio system (Patrol Channel)
- A five-site VHF, conventional multisite radio system (Admin Channel)
- Single dispatch console/workstations at Mountain View Police
- Four 6 and 11 GHz microwave radio backhaul paths
- Associated supporting facilities, such as shelters, tower and immediate backup power

FTE's scope of work consists of the following major tasks:

- Task 1 – Needs Assessment
- Task 2 – Develop Architecture Alternatives & Plan
- Task 3 – Technical Specifications
- Task 4 – Proposal Review
- Task 5 – Oversee Implementation

Deliverables include the following:

- Deliverable #1: Needs Assessment and Alternative Plans (DRAFT & FINAL)
- Deliverable #2: Needs Assessment and Alternative Plans Presentation
- Deliverable #3: FCC Applications, Showings, Engineering, etc.
- Deliverable #4: Technical Specifications (DRAFT & FINAL)
- Deliverable #5: Evaluation Comments
- Deliverable #6: Design Review Comments
- Deliverable #7: Punchlist, Survey Notes, Photos
- Deliverable #8: Punchlist, Letter Indicating Successful Tests and Acceptance

This is Deliverable #1 and consolidates the findings from Task 1 & 2.

# 3 Existing System Assessment

This Section describes the existing systems and provides our assessment of the condition, age and potential reuse of some key assets.

## 3.1 Key Interview Findings

FTE interviewed several Rangers and Maintenance staff that use the voice radios on a regular basis. The most critical findings are summarized below.

1. When asked about their one most critical issue surrounding the radio system's reliability, operation, maintenance or performance, none cited any critical flaws or major dissatisfaction.
2. They recall one recent Patrol channel problem where the channel became "noisy" during a short period of time. FTE contacted the Santa Clara County, who provides maintenance service. They recall the problem and believe it was due to a cable failure between two critical simulcast devices at Carol Drive. This was repaired and the channel is working again.
3. The most widely reported system deficiency was poor radio coverage in specific areas. The following locations were noted during this meeting, but a more comprehensive study was conducted later (see Section 5.2).
    - Foothills Field Office – Indoors and outdoors, handheld radios, both channels
    - DHF - Indoors and outdoors, handheld radios, both channels
    - Wildcat Canyon - Outdoors, handheld radios, both channels
4. FTE asked where indoor handheld radio coverage would be helpful now or in the immediate future. Users note that most locations are already equipped with a base station that provides adequate capability. Due to the size of the Distel offices, indoor handheld coverage here was desired as it would be impractical to install a large number of base stations.
5. The Distel office may be moving to 505 El Camino in the next few years; indoor coverage here would be helpful.
6. As anticipated, the greatest amount of radio messages occur in the busiest areas of the District, which includes Rancho San Antonio and Sierra Azul. (FTE notes that this should have some influence on where coverage improvements are considered).
7. FTE discussed a few common radio system enhancements or applications that are becoming available. It was believed that the Chief Ranger has expressed some interest in GPS-equipped handheld radios to help locate Rangers when their locations are not known. None of the existing vehicular or handheld radios are equipped with GPS today. It was decided that more internal discussions would be necessary on this topic.[5].

[5] Application requires a control and display system. A digital-type radio system would likely be required to properly support this application. Location reporting should be limited to each voice transmission, or only on emergency button activations, instead of full-time to avoid interrupting voice messages on the same channel.

8. None of the existing handheld or vehicle radios are equipped with a "lone worker" alarm feature.[6] Such features are sometimes used by public safety and utilities, particularly if the office or dispatch is not 24/7, or when operating alone.

## 3.2 Radio System Operations

The following Section describes how key radios channels are being used today. This information was obtained during interviews.

### *Patrol Channel*

The Patrol channel is used exclusively by the Rangers for most all communications. This includes communications and coordination between field units, field offices and the Mountain View Police Dept. dispatch center. All maintenance radios also have access to this channel for access for additional assistance when needed.

District staff noted that one CALFIRE member can operate here occasionally, and they were aware that San Mateo County Fire and San Jose Fire may also have access (refer to 3.4.6 for a complete list of Sharing Agreements).

### *Patrol Talkaround Channel*

The Patrol Talkaround channel is meant for communications directly between radio users, unassisted by the repeater system. Its range it limited to several miles. It provides a method to communicate using one half of the primary channel should the repeater system fail, or for messages that need not be conveyed over the entire service area. Mountain View dispatch has no capability to listen to messages on this channel using their consoles.

### *Administrative Channel*

The Admin channel is used for maintenance and administrative communications, and for some seasonal staff. Mountain View dispatch does not have access to this channel, and it is not routinely monitored at most of the District offices.

### *MROSD Tactical*

As noted above, this channel is specifically for car-to-car or direct mode operation by rangers or maintenance. Its range is the same as the Patrol Talkaround Channel. It will be retained.

## 3.3 Radio System Design

Four conventional radio channels are in use today on a routine basis. Two of the channels are equipped with repeaters, receivers and antennas at various tower sites. Two other Direct Mode, or "car-to-car" channels also exist for localized communications.

The District also hold licenses on five other channels used for interoperability, or communications with other outside agencies. These channel are only used during fire, rescue or medical events when working with outside agencies such as Santa Clara Co. of San Mateo County Fire and/or Calfire.

[6] This is typically activated by the field user when they enter a potentially high-risk environment. It requires the user to affirmatively press a radio button, or physically move the radio, to reset a "watchdog" alarm timer every 5 to 60 minutes; failure to silence the alarm will cause radio to automatically report its ID (and location if GPS-equipped) to dispatch.

The distribution of District repeater and receiver is shown below. "TX/RX" devices are repeaters (a repeater consists of a transmitter and receiver), and "RX" refers to a stand-alone receiver.

| | | *Site Name:* | Black Mtn. | Coyote Peak | Pise | Sierra Morena (Skeggs Pt.) | Tomita (Umunhum) | Black Mtn. (FAA) | Copernicus (Mt. Hamilton) | Redwood | Mobile Only |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Elev. (ft.)* | 2805 | 1125 | 1994 | 2342 | 3325 | 2806 | 3325 | 1500 | |
| *Channel Function* | *Base TX (MHz)* | *Base RX (MHz)* | *Station Type and Location* | | | | | | | | |
| PATROL | 152.0900 | 158.5500 | TX/RX | TX/RX | TX/RX | TX/RX | TX/RX | RX | RX | RX | |
| ADMIN | 151.2350 | 159.2550 | TX/RX | TX/RX | TX/RX | TX/RX | TX/RX | | | | |
| TACTICAL | 150.7750 | 150.7750 | | | | | | | | | M |
| MOBILE RPTR | 173.2500 | 173.2500 | | | | | | | | | M |
| *Interoperability Channels* | | | | | | | | | | | |
| EBRPD | 45.0000 | 45.0000 | | | | | | | | | M |
| FIRE V | 153.8450 | 153.8450 | | | | | | | | | M |
| VFIRE22 | 154.2650 | 154.2650 | | | | | | | | | M |
| VFIRE21 | 154.2800 | 154.2800 | | | | | | | | | M |
| VFIRE23 | 154.2950 | 154.2950 | | | | | | | | | M |

TX/RX - Repeater RX - Receiver M - Direct Mode/Car-to-Car

**Table 1 – Radio Channels and Tower Sites**

The two repeater channels support a number of field office base stations, handheld, and vehicular radios, as well as dispatch console positions/workstations. These are described later in this Section.

### 3.3.1 Patrol Channel

This channel is equipped with five repeater sites ("TX/RX") and three receiver ("RX") sites as shown in Table 1 above. The repeater stations transmit with equal or greater power than the vehicular radios, so they generally provide reliable two-way (or symmetrical) uplink and downlink coverage for vehicles.[7] Since handheld radios transmit much less power than the vehicle radios, signals from these radios are often much weaker, limiting their coverage. However, the District's three receive-only sites (Black Mtn. FAA, Copernicus & Redwood) partially offset this limitation by improving uplink coverage in surrounding areas.

The five repeater transmitters are configured for simulcast operation. This means that all messages to and from the field users are broadcast from all five site simultaneously, and on the same radio frequency. Special equipment at each repeater and the system's core site (County Communications, Carol Drive, San Jose) ensure that message transmissions are synchronized closely with one another to minimize distortion in the field.

Simulcast enhances coverage reliability and safety overall by providing multiple signal paths for each message. It also simplifies field operations by eliminating the need for users to switch channels when operating in different areas.

All eight receivers (five associated with the repeaters, and three stand-alones) connect to a voter/comparator located at Carol Drive. The voter/comparator selects the best incoming signal for retransmission by the five transmitter sites.

[7] In a two-war radio system, uplink refers to signals transmitted from the field user to the repeater; downlink is the opposite signal direction. See Appendix A - Acronyms, Abbreviations and Definitions.

As shown in Table 1 above, two receivers exist at Black Mountain. The primary receiver, located on the top of Black Mountain, provides broad coverage. The second receiver is located due east of the primary one, in a position having slightly better visibility into Wildcat Canyon and Deer Hollow Farm (DHF).

Seven of the eight tower sites connect to Carol Drive through a combination of District, County and shared microwave radio links, and a leased T1 line. See Section 3.4 below for details.

### 3.3.2 Admin Channel

Like the Patrol channel, this channel is equipped with five repeater sites, but has no additional receiver sites. Thus, it provides slightly less coverage for handheld radios in certain areas. However, the most significant difference is its operation.

This channel is configured for multicast, not simulcast. This means that messages are only transmitted through one site at a time as each site is stand-alone. Users must be familiar with what tower site to use in different areas, and then use their channel selector switch to choose it. Thus, five channel positions exist on radios that have access to this system, each associated with one of the repeater sites.

Users will often select Black Mountain first as it has the widest and most central coverage (unless they know of a better site). However, if two users needing to communicate are separated by a great distance, which requires them to use different tower sites, it is possible that they may not hear each other since they are on different repeaters. There must be some degree of overlapping coverage to allow such users to communicate.

Since messages are only transmitted through one site at a time, overall coverage reliability will be much less than the Patrol channel.[8]

FTE also found that each repeater was equipped with a Community Tone Panel. This device permits a limited level of shared use by assigning different departments or outside agencies (but not at the same time) different access codes. This only prevents different agencies from hearing each other; it does not provide any additional capacity, and message collisions would be common if there was significant shared use. It was believed that the State Department of Water Resources (DWR) may be one of the other users. A detailed review of sharing agreements might uncover what these are present.

The District could reuse or replace these panels (about $2500 each X 5 sites) and just continue to provide the capability if not operational changes are planned for the Admin channel. They would not compatible with some types of system enhancements.

### 3.3.3 Repeater System Equipment

The following table shows two-way radio station equipment and related hardware (except microwave radio equipment) located at the remote radio and control sites. The table lists District-owned equipment only. The District shares antennas and backup power systems with other County users at some sites.

[8] Patrol previously used this multicast channel, but transitioned to a new simulcast-type system in the mid-2000s to simplify operation and improve overall coverage reliability.

| Qty. | Station Equipment | Est. Age (Years) | Useful Life* (Years) | Comment(s) |
|---|---|---|---|---|
| 5 | VHF Quantar Repeater | 9 | 10-15 | Patrol Channel |
| 5 | VHF MTR2000 Repeater | 9-20 | 10-15 | Admin. Channel |
| 3 | VHF AstrocTAC (Quantar) Receiver | 9 | 10-15 | Patrol Channel |
| 12 | Telewave ANT150 Antenna | 9-20 | 10-15 | Two & four-bay models |
| 10 | Duplexer filters | 9-20 | 10-15 | |
| 4 | Community Tone Panel (Zetron 38) | 20 | 10-15 | Admin. channel |
| 1 | Community Tone Panel (CSI TP3200) | 20 | 10-15 | Admin. Channel, Sierra Morena |
| 6 | GPS Frequency Standard | 9 | 10-15 | Each rptr. site & Carol Drive |

* Based on equipment relaibility; obsolesence or support may be less.

**Table 2 – Fixed Two-Way Radio Equipment Inventory**

As shown, the Patrol repeaters and central simulcast control system are 8-9 years old. These typically have a useful life of 10-15 years from a reliability standpoint. However, these and the central control system were purchased late in their production life and have become obsolete from a support perspective.

## 3.4 Backhaul Networks

The District owns and operates microwave radios for four backhaul paths, and uses bandwidth on other microwave systems and leased T1 lines to connect to its central radio core at the Santa Clara County's Carol Drive communications site. Figure 1 below shows the various paths and their termination points.

The other microwave systems are owned and operated by San Mateo and Santa Clara counties, as well as an E-COMM path from Coyote to Carol Drive.[9]

The T1 connections are leased from AT&T by Santa Clara County. Each supports radio circuits from other agencies as well. Due to leased distance charges, each connects to County microwave radio that eventually routes to Carol Drive.

[9] The E-COMM system is a region-wide digital microwave network that links all 14 of the 9-1-1 Call Centers in Santa Clara County.

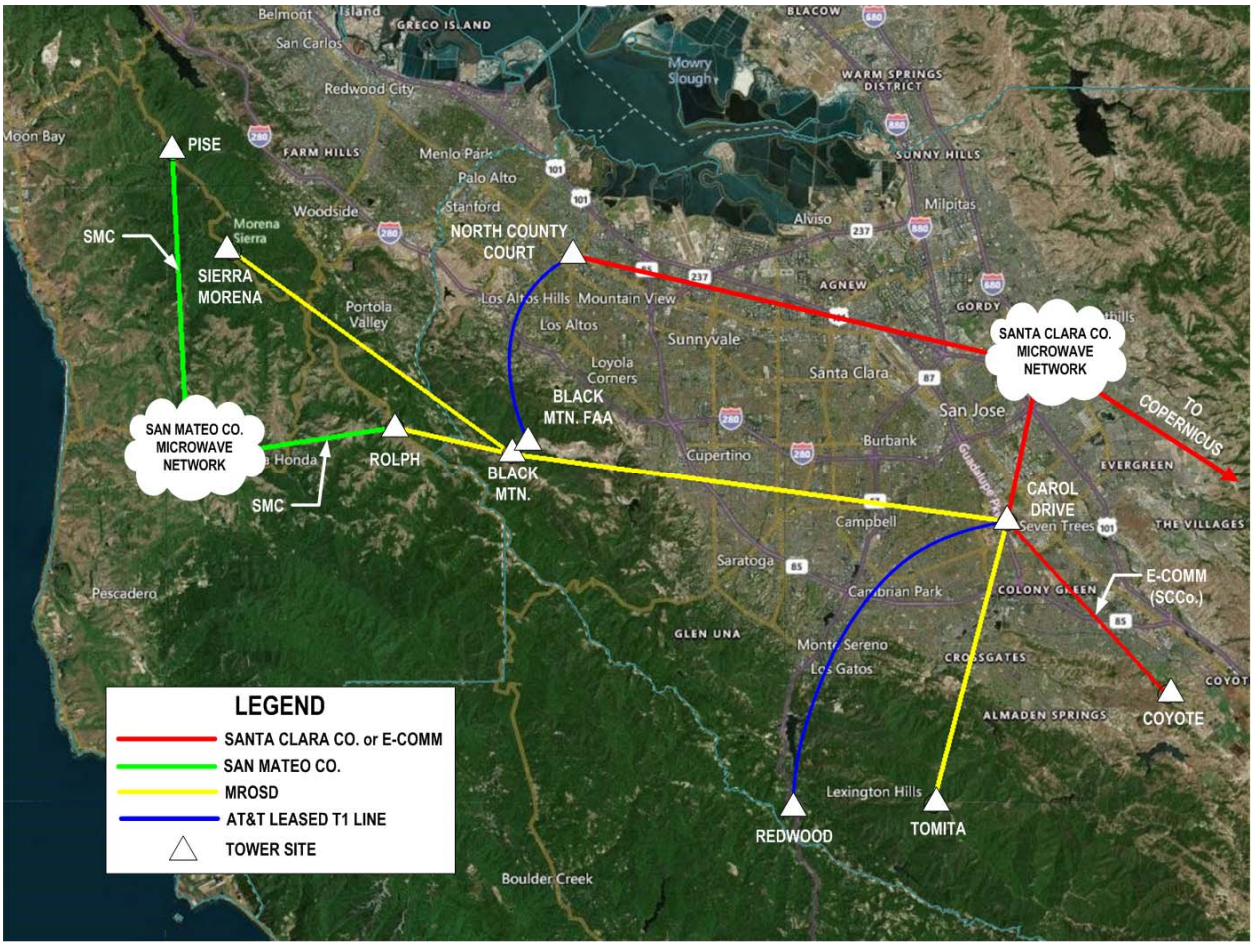



**Figure 1 – Existing Microwave Backhaul Network**

### 3.4.1 District Microwave Equipment

All of the District-owned paths use licensed, indoor radios manufactured by Aviat (IRU-600 series). Such models are also in use by other agencies in Santa Clara and other surrounding counties. Each path is equipped with redundant, or "hot-standby" transceivers that will maintain the link should a failure be detected.

We also note that the District has purchased spare equipment for both the 6 GHz and 11 GHz paths.

### 3.4.2 Backhaul Equipment

The following table lists all District-owned microwave radio equipment at the remote radio and control sites. The table lists District-owned equipment only. Dish antennas are not shown. Related backup power systems are shown in Table 2 above.

| Qty. | Common Site Equipment | Est. Age (Years) | Useful Life* (Years) | Comment(s) |
|---|---|---|---|---|
| 2 | Aviat IRU600 V2 HSB terminal, 6 GHz | 9 | 15-20 | Black Mtn. to Carol Drive |
| 6 | Aviat IRU600 V2 HSB terminal, 11 GHz | 9 | 15-20 | Sierra Morena, Rolph & Tomita |
| 4 | Aviat IRU600 V2 spares (6 & 11 GHz) | 9 | 15-20 | One each, low & high 6 & 11 GHz band |
| 1 | Aviat ProVision® monitoring package | 9 | 15-20 | |
| 7 | Multiplexer, Motorola TENSR | 9 | 15-20 | No longer supported/no parts available. |
| 7 | DC Backup Power System | 9 | 15-20 | Batteries 10 yrs.; charger 20 yrs. |

* Based on equipment relaibility; obsolesence or support may be less.

**Table 3 – Microwave Equipment Inventory**

The District's microwave equipment is only 50% through its useful life from a reliability standpoint and can likely be reused with any new replacement radio technology through its IP interface. This model radio will likely be supported for another five to seven years. However, some critical modules my need replacement after this.

The equipment warranty expired in 2015/16. The manufacturer estimates that a new annual warranty for advanced replacement and factory repair would be approximately $5k/year (total) for all four paths.[10]

The microwave radio equipment is equipped with forced-air cooling fans. These fans are the most common failure of this equipment. FTE has recommended that these be replaced as a preventative measure as part of this project.[11]

The District had also purchased Aviat's ProVision® software package for monitoring the paths remotely (presumably the County has installed this package and monitors the District's paths). This warranty has also expired but is relatively expensive to maintain (~$7K annually). However, the current software is expected to operate throughout the lifetime of the equipment without this.

All of the backup batteries are aging and will need replacement.

### 3.4.3 Existing Backhaul Interfaces & Capabilities

The District-owned microwave links are capable of both Time Division Multiplex (TDM) and IP technology.[12] Only the TDM interfaces are being used as the current baseband equipment (e.g., multiplexers, etc.) used with the current two-way radio systems are TDM technology. This includes the leased T1 lines. In particular, the current simulcast transmitter synchronization equipment is specifically designed to operate over TDM technologies.

Most new two-way radio equipment and simulcast hardware will be designed for IP-based backhaul. Table 4 below describes the current equipment capabilities.

[10] This still requires support from Santa Clara Co. to remove and replace any failed equipment on site.
[11] The County can order these as replacement parts and install them in the field. Fans in the spare equipment should be replaced if the spares were ever placed in operation.
[12] References to "T1" lines herein refer to TDM-type connections.

| Site | Technology | Current Connection Type (to Carol Drive) | Current Capability (to Carol Drive) | Owner/Lessee/Carrier |
|---|---|---|---|---|
| Black Mountain | Microwave | T1 | T1 and IP | MROSD |
| Coyote Peak | Microwave | T1 | T1 and IP | SC Co. E-COMM |
| Pise | Microwave | T1 | T1* | San Mateo Co. & MROSD |
| Sierra Morena (Skeggs Pt.) | Microwave | T1 | T1 and IP | MROSD |
| Tomita(Umunhum) | Microwave | T1 | T1 and IP | MROSD |
| Black Mountain(FAA) | Leased T1 | T1 | T1 | Santa Clara Co. / AT&T |
| Copernicus (Mt. Hamilton) | Microwave | T1 | T1 and IP | Santa Clara Co. |
| Redwood | Leased T1 | T1 | T1 | Santa Clara Co. / AT&T |

* IP capability in 2022

**Table 4 – Backhaul Interfaces and Capabilities**

As noted, District and Santa Clara County microwave radio can support IP, but San Mateo County cannot. Thus, the Pise connection to Rolph is currently limited to TDM operation.

San Mateo County has begun to replace their microwave with IP-capable models, it is not scheduled for completion until 2022 or later. FTE has included costs to install new IP-capable microwave at Pise to a yet-to-be-determined Santa Clara Co. tower site.[13]

As the leased T1 TDM lines currently only support VHF receivers (not transmitters), it is possible that these can remain TDM in the near term, in some cases. See next Section.

### 3.4.4 TDM/T1 versus AT&T Switched Ethernet Services

AT&T indicates that it may drop support for T1 lines this year (2020). AT&T's goal is to move all TDM technologies, such as T1 service, to fiber-based IP by 2020, using their AT&T Switched Ethernet (ASE) IP product. However, it is widely believed that T1 services could be available for another three to six years before a forced transition would occur.

If AT&T fiber does not already exist at a radio site (most sites), AT&T must install fiber at the Customer's expense. Costs could be in the tens of thousands, and sometimes over $100k, per site, if fiber was not already nearby.

The following sites below are affected by AT&T's support policy. Some options are noted here as a well.

***Black Mountain FAA:*** This is a receiver site for the District, primarily for the DHF area. If the new Cal Water site is built, a receiver here may no longer be needed. If it is needed, one option is to install a low-capacity microwave link ($15K) between this site and Black, which is close by.

***Redwood site:*** This is an important receiver site for the District, and FTE has also proposed an option to upgrade this site to a full repeater as an option. However, site access is based on an informal agreement between AT&T and Santa Clara Co., and further enhancements may not be possible. If it remains a receiver, TDM access may suffice. Repeater capability may require AT&T fiber, or a new microwave path. However, given its location, finding a line-of-sight microwave path through trees and surrounding terrain will require further analysis.

[13] This may require two microwave paths; in this case, the Black Mtn. to Rolph path equipment could be used as it would no longer be needed at Rolph.

### 3.4.5 Subscriber Equipment

The District's end-user inventory includes approximately 212 subscriber radios (e.g., handheld, vehicular and base stations) and four desktop "slave" desktop remotes. The remotes permit access to a single shared TK5720K control station radio at the same office. The following table lists this equipment.

| Radio Type | Kenwood Models | Manuf. Support? | Age (yrs.)* | Total | Administration | Maintenance | Patrol |
|---|---|---|---|---|---|---|---|
| Handheld | NX5200 | YES | 1-2 | 10 | 5 | 5 | |
| | TK2402 | YES | 3-5 | 29 | 19 | 8 | 2 |
| | TK2402V | YES | 3-5 | 2 | | | 2 |
| | TK290 | NO | 12+ | 83 | 21 | 30 | 32 |
| | **Total** | | | **124** | **45** | **43** | **36** |
| Vehicular | TK5710 w/KCH16 | YES | 4-8 | 3 | 1 | 2 | |
| | TK5710 | YES | 4-8 | 46 | 9 | 17 | 20 |
| | TK5720 | YES | 4-8 | 1 | | 1 | |
| | TK7180 | YES | 4-6 | 1 | 1 | | |
| | TK790 | NO | 12+ | 32 | 2 | 17 | 13 |
| | **Total** | | | **83** | **13** | **37** | **33** |
| Control Station | TK5720K | YES | 4-8 | 5 | 4 | | 1 |
| Remotes | TK5720K-REM | YES | 4-8 | 4 | | | 4 |
| | **Total** | | | **216** | **62** | **80** | **74** |

* FTE estimate; no age or date of purchase available.

**Table 5 – Subscriber Equipment Inventory**

All radio equipment is manufactured by Kenwood. Handheld radios have a useful life of eight years, while the vehicular radios and remotes can last 10 years. Base radios can last 10 to 15 years.

All of the subscriber radio equipment is locally supported by Metromobile Communication in Belmont. The District indicates significant satisfaction with Metromobile's response and support.

This inventory does not include Dispatch console equipment located at Mountain View Police Department. This is owned by the City.

### 3.4.6 Agreements with Outside Agencies

The District maintains agreements with certain outside agencies permit them to operate on District frequencies, and separately for the District to operate on other's frequencies. In general, Sharing Agreements are for occasional use and not for routine use by the invited agency. They are most often used for joint operations, emergencies, or to provide an outside agency with coverage and/or Dispatch access they may not have on their own radio system.

Table 6 below lists agreements that allows an outside agency to use specific District frequencies under certain conditions. Presumably this means the use of the District's repeater system.

| Agency | License/Description | Frequency (MHz) | Issue Date | Expiration Date |
|---|---|---|---|---|
| California Dept. Parks & Rec | Emergency Use Only | 151.235/159.225 | 9/15/1992 | open |
| California Dept. Water Resources | Shared use of Black Mt. repeater and frequencies* | 151.235/159.225 | 5/6/1991 | open |
| East Bay Regional Parks | Frequency Sharing | 159.255, 45.0 | 10/16/1990 | open |
| City of Palo Alto Fire Dept. | Emergency Use Only | 151.235/159.225 | 3/11/1995 | open |
| City of Palo Alto Parks Dept. | Emergency Use Only | 151.235/159.225 | 6/28/1998 | open |
| Town of Los Gatos | Emergency Use Only | 151.235/159.225 | 3/11/1995 | open |
| Santa Clara Valley Water District | Emergency Use Only | 152.090/158.550<br>151.235/159.255 | 3/18/2015 | open |

* The State of California also holds their own license for 151.235 MHz at Black Mtn. (WPAC797) with no mobiles.

**Table 6 – Frequency Sharing Agreements for Outside Agencies**

Most of the agreements above were consummated when Patrol was using 151.235/159.225 MHz as their main channel. This channel became the Admin Channel after a new channel was implemented for Patrol (152.090/158.550 MHz). Some agreements may need updating if the outside agency needs to communicate directly with the Rangers on their channel or require Dispatch support (the Admin channel is not supported by the Mtn. View Police Dispatch center).

Table 7 above lists agreements that allow the District to use the frequencies of other agencies under certain conditions.

| Agency | License/Description | Frequency (MHz) | Issue Date | Expiration Date |
|---|---|---|---|---|
| California Office of Emergency Services (OES) | CALCORD (KB82490) | 156.075 | 7/16/1993 | open |
| | CLEMARS (KA4993) | 159.920<br>154.935 | 9/26/1994 | open |
| CalFire (CDF) | Emergency Use Only | State & local Fire Frequencies | 5/1/1995 | open |
| San Mateo County Dept. of Parks & Rec | Frequency Sharing | 151.475 | 9/22/1977 | open |
| Santa Clara County Dept. of Parks & Rec | Frequency Sharing | 151.145<br>159.120<br>151.490 | 3/19/1996 | open |
| San Jose Fire | Frequency Sharing | 155.025<br>155.925<br>153.980<br>154.115<br>154.430<br>154.310<br>151.040 | 9/14/2017 | open |

**Table 7 – Frequency Sharing Agreements for District Use**

### 3.4.7 Dispatch Operations

The District contracts with Mountain View Police Department for 24-hour dispatch services. This contract provides for Ranger support on the Patrol channel using the City's new Motorola MCC7500 dispatch workstations. These are connected to the District's equipment at Carol drive through County-owned microwave radio. All communications are recorded for archival purposes.

## 3.5 Radio Coverage

Radio coverage prediction maps for the current radio systems are shown in Appendix B – Existing Admin Channel Coverage, and in Appendix C – Existing Patrol Channel Coverage. As the Admin and Patrol channels use a different number of towers, separate maps are provided.

The tower site locations are shown with yellow labels, with a cross indicating the tower position.

Handheld and vehicular coverage will be different and has been shown separately. Locations with reliable handheld radio coverage are always shown in green, while reliable vehicle coverage is shown in blue.

Finally, "two-way" radio coverage consist of a "downlink" and an "uplink" signal path. The area covered in each direction will vary by radio channel design and by the type of field equipment in use. We have provided separate maps for each direction.

In general, radio coverage is only as good as the weakest direction. Uplink coverage maps will show the worse-case for the Admin channel. However, this is not true of the Patrol channel in all areas due to the use of receive-only sites. Consult both uplink and downlink maps to obtain a complete picture of Patrol Channel coverage.

## 3.6 Shelter and Tower Facilities

Brief descriptions of the communications shelters and are shown below. Shelter and tower owner names are based on information provided by Santa Clara Co., FTE's site survey and others. FTE was unable to confirm if the site generators were supporting the specific circuits in use by the District. However, this is usually the case.

**Black Mtn.**

Elevation: 2,805 ft. AMSL
Coordinates: 37.318727 / -122.147247
Shelter Owner: Communications & Control
Tower Owner: Communications & Control
Generator: Yes

**Black Mtn FAA**

Elevation: 2,799 ft. AMSL
Coordinates: 37.318883 / -122.146369
Shelter Owner: Santa Clara CO.
Tower Owner: Santa Clara CO.
Generator: No

**Copernicus**

Elevation: 4,284 ft. AMSL
Coordinates: 37.346561 / -121.630797
Shelter Owner: Santa Clara CO.
Tower Owner: Santa Clara CO.
Generator: Yes

**Coyote Peak**

Elevation: 1,125 ft. AMSL
Coordinates: 37.208933 / -121.77529
Shelter Owner: American Tower
Tower Owner: American Tower
Generator: Yes
(American may not be servicing this generator)

**Pise**

Elevation: 1,994 ft. AMSL
Coordinates: 37.455859 / -122.34097
Shelter Owner: San Mateo Co.
Tower Owner: San Mateo Co.
Generator: Yes

**Redwood**

Elevation: 1,487 ft. AMSL
Coordinates: 37.157579 / -121.983945
Shelter Owner: AT&T
Tower Owner: AT&T
Generator: Yes

(FTE was unable to access shelter and tower)

**Rolph**

Elevation: 2.377 ft. AMSL
Coordinates: 37.33065979 / -122.2139966
Shelter Owner: San Mateo Co.
Tower Owner: San Mateo Co.
Generator: Yes

**Sierra Morena**

Elevation: 2,342 ft. AMSL
Coordinates: 37.410657 / -122.306894
Shelter Owner: Crown Castle
Tower Owner: Crown Castle
Generator: No

**Tomita Hill**

Elevation: 3,325 ft. AMSL
Coordinates: 37.160016 / -121.908065
Shelter Owner: Communications & Control
Tower Owner: Communications & Control
Generator: Unknown

## 3.7 FCC Licenses

A list of all District FCC licenses and their associated radio frequencies is in Appendix E - District FCC Radio Licenses & Locations.

### 3.7.1 Patrol Channel - WQML377

The Patrol channel consists of a pair of geographically-licensed frequencies that were obtained through an FCC waiver process and purchased from a private entity. Rules governing this channel are contained in 47CFR22, Public Mobile Services. This geographic area is shown in Figure 2 below.

Geographically-licensed frequencies can be deployed anywhere within the area described on the FCC license, without having to notify the FCC. However, licensees must not interfere with others operating on the same channel in surrounding areas. This 10-year license expires on 6/21/2022 and must be renewed before this date.

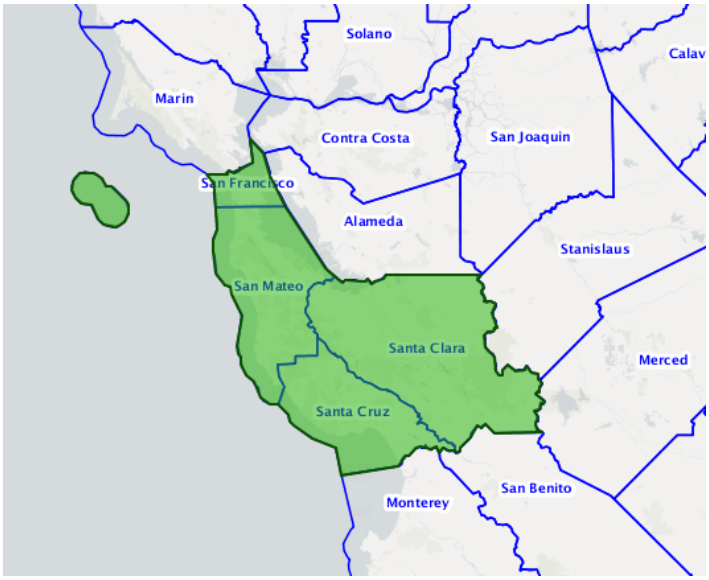



**Figure 2 – FCC-Authorized Geographic Area**

### 3.7.2 Admin Channel - WNVC239

The Admin channel consists of a pair of site-licensed frequencies that fall under 47CFR90, Private Land Mobile Radio Services. Site-licensed frequencies must only be used at the specific site coordinates or locations described on the license. Relocation or changes to the technical operation must be first approved by a registered frequency coordinator and the FCC. This 10-year license expires on 1/15/2023 and must be renewed before this date.

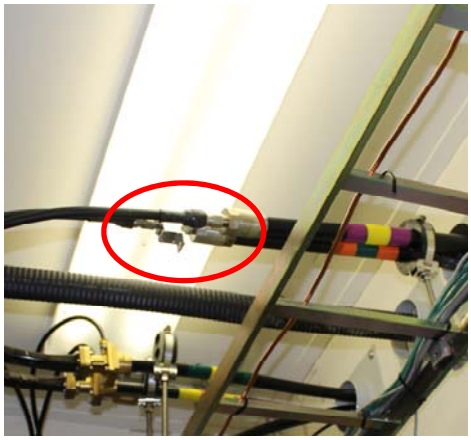
## 3.8 System and Subscriber Maintenance

The District contracts with Santa Clara County for maintenance of the fixed-end equipment, such as repeaters, microwave and antenna systems. Handheld, vehicle and base radios are maintained on a break-fix approach through Metromobile Communications Inc. of Belmont. The District has been satisfied with services from both.

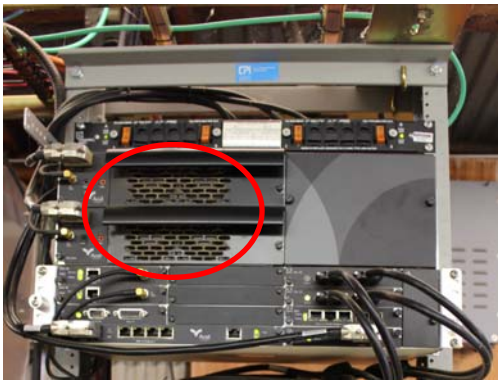
## 3.9 Summary of Existing System Deficiencies

| No. | Description |
|---|---|
| 1 | **Poor Handheld Radio Coverage in Numerous Areas**<br>Existing outdoor handheld radio coverage was reported and verified in approximately twenty areas. These are detailed in Section 5.2.<br>***Recommendation:*** Many of these areas were in canyons, which is common. Handheld coverage problems in such terrain cannot always be resolved without excessive expenditures. The District is already using vehicular repeaters, which is one of the most cost-effective methods.[14] See Section 5.2.1 for suggested improvements. |
| 2 | **Limited Vehicular Radio Coverage in Some Areas**<br>Limited vehicular radio coverage was reported in one area, and we discovered additional locations in areas having poor portable coverage. These are detailed in Section 5.2.<br>***Recommendation:*** Same as above. Radio coverage in the District is almost entirely terrain-limited, requiring existing sites to be relocated or new sites implemented. If vehicular coverage can be improved, Rangers will be able to use their vehicular repeater in many cases. See Section 5.2.1 for suggestions for improvement. |
| 3 | **Technical Deficiencies Common to Most Tower Sites**<br>The following deficiencies were identified at most sites:<br>• Backup batteries approaching end of life (MAJOR)<br>• Admin channel antennas and lines should be replaced (MAJOR)<br>• Insufficient equipment grounding (MINOR)<br>Backup batteries for repeater and microwave radios were dated 2012; these have a useful life of eight to ten years, depending on use.<br>The Admin channel antennas and lines appear may be original (beyond 12 years of age). If so, these should be replaced.<br>Devices mounted in the District's equipment racks, including repeaters, multiplexers, microwave radios, power supplies were not consistently bonded to a common rack or site ground system. This helps reduce possible equipment damage during lightning strikes and voltage surges by ensuring that all devices at the same voltage potential (voltage differences among devices can result in excessive current flow, arcing, heat and damage).<br>In general, the District's leased commercial sites had poorly maintained site grounding systems. However, having the site equipment bonded together by the installer can still reduce problems.<br>***Recommendation:*** Replace all batteries and Admin Channels antennas when other equipment is replaced at the sites. Lightning storms are infrequent in California (compared with other states); improve grounding when other work is completed at the sites. |

[14] These can improve coverage within a range of ½ to 1 mile around a vehicle, but there are some operational limitations.

| | |
|---|---|
| **4** | **Technical Deficiencies Common to Microwave Terminals (MAJOR)**<br><br>Forced-air cooling fans in the microwave radio power amplifiers have a limited equipment life and are critical to proper operation. While fan failures should send an alarm to Santa Clara County, its best to replace these before they fail to reduce potential amplifier damage. These fans are shown in the top-left photo in Item 8 below.<br><br>***Recommendation:*** Replace all power amplifier fans during performance of other planned site work. This can be accomplished by Santa Clara Co. without special tools. However, the microwave equipment may have to be deactivated for a short period of time (less than one hour), disabling the site. |
| **5** | **Technical Deficiencies at the Black Mountain Tower Site**<br><br>The following deficiencies were identified at this site:<br><br>• Antenna element is misaligned on the tower (MINOR)<br>• No lighting/surge protection on one of two antenna lines (MINOR)<br>• Lighting protection device is not grounded (MINOR)<br><br>Wind has likely caused one of four antenna elements to become misaligned; this will have a very slight impact on radio coverage. Of the two District antennas (Patrol & Admin channel), the Admin Channel antenna line is not equipped with a Transient Voltage Surge Suppression (TVSS) device. The Patrol channel line is equipped with a TVSS, but it has not been connected to the site ground system.<br><br>***Recommendation:*** County reports difficulties keeping this antenna model from becoming misadjusted. Replace this model antenna with a different one when it is finally replaced. No other action needed at this time. Resolve lightning protection when other major work is completed at site.<br><br>   |
| **6** | **Technical Deficiencies at the Pise Tower Site**<br><br>The following deficiencies were identified at this site:<br><br>• Lighting protection devices (2) are not bonded to ground (MINOR)<br><br>While both antenna lines are equipped with Transient Voltage Surge Suppression (TVSS) devices, neither device has been directly bonded to the building ground system on the copper bus below them.<br><br>***Recommendation:*** Bond these devices to the site ground when other major work is completed at site. |

| | |
|---|---|
| **7** | **Technical Deficiencies at Sierra Morena (Skeggs Site)**<br><br>The following deficiencies were identified at this site:<br><br>• Equipment is not equipped with a backup generator (MAJOR)<br><br>This site is not equipped with a generator for long-term operation during utility power outages. It appears that one may have existed as a concrete foundation exists for one. While the District's microwave and radio equipment is equipped with backup batteries, these will only support this site for a limited time. County reports that they must respond with a portable generator for extended outages (such as the PG&E PSPS events) with a run time of about eight hours. Thus, the generator must be refueled daily; FTE estimates this to be a two-hour round-trip. While they consider this in their scope, a permanent generator on this important site would be a better alternative.<br><br>As this is a simulcast site for the Patrol channel, and outage here can have wide coverage impacts, beyond the coverage footprint of this site.<br><br>***Recommendation:*** Site is owned by Crown Castle; attempt to work with them to accommodate some type of long-term backup (possibly three to five days). Reuse of existing concrete pad and conduit may reduce installation complexity and cost. A solar deployment would be challenging due to tree cover and space requirements at this leased site. |

| | |
|---|---|
| **8** | **Technical Deficiencies at the Tomita Site**<br><br>The following deficiencies were identified at this site:<br><br>• Admin channel antenna line is not equipped with a TVSS device (MINOR)<br>• Site is extremely dusty (MINOR)<br>• Seismic bracing improvement needed (at wall) (MINOR)<br><br>No lightning suppression device has been installed in the Admin Channel antenna line. Site is not equipped with air conditioning but is equipped with fans. However, air filtering is insufficient and dust will eventually clog equipment fans and restrict cooling (see dirty fan intakes on microwave radios below). Site temperature may also be high during warm days.<br><br>Small J-hooks are used to secure the ladder rack to the wall (see below). These may pull out during a severe earthquake. Racks are secured to foundation but it's not clear how strong these bolts are.<br><br>***Recommendation:*** Purchase and install a TVSS device if other equipment is replaced at site. Site grounding system here is poor, so a ground rod (or connection to an existing one) and other work may also be necessary.<br><br>Site is leased so little can be done about the dusty conditions. However, equipment could be placed in sealed cabinets as long as they are equipped with fine particulate filters that are serviced often, and forced-air cooling. This can be considered for the new equipment.<br><br>Better secure the horizontal brace connection at wall when other work is completed at site.<br><br>   <br><br>  |

| | |
|---|---|
| **9** | **Technical Deficiency at the Coyote Site**<br><br>The following deficiencies were identified at this site:<br><br>• Admin channel repeater not connected to site batteries (MINOR)<br>• No lighting/surge protection on Admin antenna line (MINOR)<br><br>The Admin channel repeater is connected to the site's utility power directly, but not to short-term battery backup like the Patrol repeater. Space is limited and this may be due to limited battery capacity here. However, American Tower (site owner or manager) has a poor reputation for maintaining generators.<br><br>No lightning suppression device has been installed in the antenna line to the Admin channel antenna.<br><br>***Recommendation:*** Place this station on battery backup when battery systems are replaced. Purchase and install a TVSS device if other equipment is replaced at site. Site grounding system here is poor, so a ground rod (or connection to an existing one) and other work may also be necessary. |

# 4 System Replacement Considerations

Based on interview results and our findings, FTE recommends that any replacement systems focus on the following areas, in order of importance (highest first):

- Coverage Improvement
- Reliability
- Ease of Use

Poor handheld radio coverage was reported at approximately twenty locations within the District. In general, vehicular coverage was not reported to be as problematic. However, we did find significant vehicular coverage issues. Due to the District's terrain, solving all handheld coverage problems is not economically feasible in all cases. The District is already using vehicular-based repeater systems that act as a relay between handheld radios and the repeater system for Patrol. This will likely remain the most practical method to maintain handheld coverage, as long as vehicular coverage is provided.

As the main goal of the radio system is to provide communications for safety and for emergency events, system reliability is of critical importance, as well as District control over its restoration should it become disabled. While reliable utility and backup power is likely the single most important factor, network simplicity/reduced complexity can also contribute to more reliable operation and reduce restoration time following a failure. We note that most of the solutions presented here are not expected will increase complexity.

Ease of use of the equipment and network will also facilitate greater usage and provide greater value during emergencies. Users did not express the need for a vast array of radio system features; they simply needed it to reliably perform its main purpose.

## 4.1 Other Modern Radio Features

The following describes additional features available that may be helpful to the District. Some would be available at additional cost unless noted, while others are simply programming changes (these costs are not included in our cost estimates later in this report).

***Radio Channel Integration on Smartphones –*** A smartphone application and backroom equipment that allows users to listen or communicate over a particular District radio channel when they don't have a radio or are out of range of the District's system. These operate over the cellular data network and Wi-Fi.

***Outdoor Location (GPS)*** – Some handheld and vehicular radio models have GPS capability to report their location either (a) automatically, (b) button-press by the radio user, (c) only when transmitting a voice message, or (d) only when the Emergency / Panic button is pressed.[15]

***"Lone Worker" Alarm*** – A safety alarm timer, enabled by a handheld radio user, when working alone in a hazardous or risk-prone environment. It requires the user to press a button, or physically move the radio to prevent it from automatically transmitting an alarm (and possibly its GPS location) back to a dispatch center or office when the alarm timer expires. Works best when used with a digital-type radio system (Project 25, etc.).

***Person-down Alarm*** – Similar to the Lone Worker Alarm feature, radio will transmit an alarm (and possibly its GPS location) to a dispatch center or office if the handheld radio is positioned horizontally too long (person unconscious), and/or the person has not moved within a predefined period of time. Works best when used with a digital-type radio system (Project 25, etc.).

## 4.2 Future Radio System Attributes

The following key attributes should be considered and established during this current planning phase:

- Air Interface (analog or digital)
- Radio Frequency Band
- Broadcast Design (simulcast, multicast, multisite, etc.)
- Technology (Trunking, Conventional)
- Coverage & Repeater sites

These attributes are discussed below.

***Air Interface:*** This describes how field radios interface with the repeater sites, over-the-air. Both analog and digital interfaces are available. The District uses analog today, and it could continue using analog for the foreseeable future. However, one disadvantage will be diminishing manufacturer and maintenance vendor support over the long term for analog equipment. Digital would have greater support going forward.

FTE has found that most users prefer digital over analog, due to lack of noise and improved clarity. However, voice quality can vary among different digital products, and among users and environments.[16] Some trial-and-error adjustments are often needed.

***Frequency Band:*** The District operates in the 150-174 MHz VHF radio band today. Table 8 below summarizes key attributes of various radio bands.

[15] Regular automatic reporting may require an additional radio channel and network.

[16] The use of digital radios in noisy environments requires special attention (high quality, noise-cancelling microphones may be required along with advance digital processing). Some Fire agencies have had challenges with digital radios and use analog channels in noisy environments.

| Radio Frequency Band (MHz) | Channel Availability | Outdoor Coverage | Indoor Coverage | Interference Protection | District Interoperability w/Outside Agencies | Digital Available | Analog Available |
|---|---|---|---|---|---|---|---|
| **30-50** | Poor | Excellent | Poor | Poor | CHP, EBRPD | No | Yes |
| **150-174** | Poor | Good | Average | Poor | CalFire/SMCo. Fire/Most Fire | Yes | Yes |
| **450-470** | Poor | Average | Better | Poor | None | Yes | Yes |
| **470-512** | N/A | Average | Better | Good | None | Yes | Yes |
| **700** | Limited | Line-of-Sight | Best | Excellent | SMCo. S.O./SCCo. Fire, Parks | Yes | No |
| **800** | Limited | Line-of-Sight | Best | Excellent | SMCo. S.O./SCCo. Fire, Parks | Yes | Yes |
| **900** | Limited | Line-of-Sight | Best | Excellent | None | Yes | Yes |

SMCo. - San Mateo County SCCo. - Santa Clara County S.O. - Sheriff's Office

**Table 8 – Characteristics of Various Radio Bands**

In general, lower bands provide greater outdoor coverage, but require relatively larger antennas. The lower bands are currently suffering from an increase in man-made interference in metropolitan areas, but the District's repeaters and radios are less affected given their rural usage.

***Broadcast Design:*** The broadcast design establishes whether each adjacent repeater site uses the same or different set of radio frequencies to broadcast messages, and how users interact with the network. The Patrol channel uses simulcast, while the Admin channel is a multisite design. Simulcast is considered vastly superior from a coverage, usability and compatibility standpoint.

***Technology:*** The District uses conventional technology today. Conventional systems are a relatively simple technology where each department is assigned to a given channel and set of repeaters (e.g., Rangers and Admin/Maintenance). Trunking technology exists to allow a large number of departments to share a limited number of channels and repeaters. A centralized computer server temporarily assigns each department or group of users to a channel only when required by a call. Today, the District has enough channels to give each major user group its own, so trunking does not provide much added value.

Participating in a shared, regional trunked system can be practical. While the District has a close relationship with Santa Clara County, the majority of its service area is in San Mateo County. They operate a Countywide 700 MHz trunked system for Sheriff and EMS, but it may have coverage limitations similar to the District's own system, and it would have to be expanded further south to support area in Santa Clara County. Expansion and purchase of all new trunked subscriber radio may exceed the cost of replacing the District's own system. Actual costs have not been established.

***Coverage & Repeater Site Selection:*** Two main factors establish radio coverage: voice quality and signal reliability. Voice quality has to do with how well the messages can be understood in the presence of signal fading, radio noise and some types of interference. The wireless industry uses the term Delivered Audio Quality (DAQ) to define seven levels of voice quality performance:

| DAQ Delivered Audio Quality | Subjective Performance Description |
|---|---|
| 1 | Unusable, Speech present but unreadable |
| 2 | Understandable with considerable effort. Frequent repetition due to Noise/Distortion |
| 3 | Speech understandable with slight effort. Occasional repetition required due to Noise/Distortion |
| 3.4 | Speech understandable with repetition only rarely required. Some Noise/Distortion |
| 4 | Speech easily understood. Occasional Noise/Distortion |
| 4.5 | Speech easily understood. Infrequent Noise/Distortion |
| 5 | Speech easily understood. |

**Table 9 – Radio Voice Quality**

Choosing a high DAQ level will provide higher voice quality over a greater number of locations than a lower DAQ. Digital air interfaces will provide more consistent voice quality than analog. While analog radio systems typically have the best audio quality under strong signal conditions, digital can perform better than analog when radio signals become weaker or experience interference.

Signal Reliability is primarily a function of signal strength. It is statistical in nature; it is defined as the likelihood of achieving an acceptable signal with a specified DAQ. We achieve high signal reliability by introducing a signal margin into our calculations and design. Public safety systems are designed with a margin that provides 95% reliability or better, where commercial and utility systems are designed to a 90% reliability.

Coverage prediction maps provided in this reports show 90% or 95% likelihood of achieving the specified DAQ value for the Admin and Patrol Channel, respectively.

# 5 Radio System Recommendations

Based on our consideration of the District's current and future requirements, we recommend the following approach when the systems are replaced:

- Consider an analog or digital P25 Phase I Air Interface
- Maintain 150 MHz VHF operation
- Maintain simulcast operation on the Patrol Channel; consider simulcast for the Admin channel
- Maintain conventional operation

Either Air Interface will meet the District's internal needs. For the Patrol channel, compatibility with outside agencies that communicate or monitor the Patrol channel should be a consideration. The same may apply to the Admin channel as most of the District's outside agreements are based on this channel (whether intentional or not).

If digital is selected, Project 25 Phase I is recommended as Santa Clara County is most familiar with it, it better promotes long-term regional interoperability and compatibility, and can be deployed in a simulcast arrangement. Note that all District subscriber equipment that has access to a digital channel must be equipped for P25, updated, or replaced to have this capability.

We also note that a "dual-mode" (analog & digital) network design option also exists, which allows for either operation. Use this feature to provide schedule flexibility when transitioning from an analog to a digital network only. Only operate on one mode or the other going forward.[17]

150 MHz VHF is likely the most appropriate radio band for outdoor coverage and regional interoperability. FTE feels that simulcast operation on the Patrol Channel has led to improved user satisfaction and provides improved coverage performance over other methods. Admin and maintenance users did not report any issues using their multicast system. However, the relatively small incremental cost of expanding simulcast to the Admin channel suggests this might be a good investment, given the improvement in coverage and ease of use.[18]

## 5.1 Coverage and Repeater Site Selection

All of the coverage deficiencies were related to the Patrol channel. We have listed these areas in **Section 5.2 below**, and address how each might be improved in later Sections and Appendices.

## 5.2 Areas Targeted for Improvement

Rangers reported poor coverage in areas and locations shown in Table 10 below. Locations near each other were grouped together as a single area. Appendix D – Proposed Coverage Solutions shows these locations geographically.

Maintenance did not report and coverage deficiencies on their radio channel.

The user reports represented poor to no coverage for handheld radios, with the exception of A12 (Sears Ranch Parking Lot). Here, users reported poor coverage for both handheld and vehicular radios.

While trees and canopy coverage can attenuate VHF signals to a small degree, the primary cause of poor coverage in the District's jurisdiction is terrain blockage. As a result, changes in antenna patterns, higher gain, or increases in transmit power and/or receiver sensitivity did not make any significant improvement.

The use of handheld radios, while critical for Rangers, also negatively impact coverage due to inherently poor antenna performance and reduced transmitter power as described in Section 3.3.1.

In all cases an additional repeater site, or conversion of a receive-only site to full repeater operation would be required to resolve the coverage issue. In other cases users must rely on their existing vehicular repeaters for handheld coverage.

[17] Additional costs could be in the low tens of thousands for each dual-mode channel, on top of the cost of a digital conversion.

[18] The low incremental cost is because the Patrol Channel simulcast hardware can expanded to support the Admin Channel.

| AREA NO. | DESCRIPTION | POOR COVERAGE | | POSSIBLE SOLUTIONS | |
|---|---|---|---|---|---|
| | | Handheld | Vehicle | Handheld | Vehicle |
| A1 | Alamitos Road/SA35/SA36 | Yes | Yes | (Note 2) | McQueen Ridge Repeater |
| A2 | Loma Prieta Road & Ranch/SA32/SA31 | Yes | Yes | | (Note 2) |
| A3 | Cathermole Road, Lake Elsman | Yes | Yes | Vehicular Repeater | Redwood Transmitter |
| A4 | Hicks Road/Guadalupe Res./SA02/Rincon/Twin Cr. | Yes | Yes | Vehicular Repeater | McQueen Ridge Repeater |
| A5 | Hendry's Creek/SA43 | Yes | Yes | Vehicular Repeater | Redwood Transmitter |
| A6 | Bear Creek Redwoods | Yes | No | Redwood Transmitter | |
| A7 | No. Lexington Res./Jones Tr./Bridge Rd./SA22/SA40 | Yes | Yes | Vehicular Repeater | Redwood Transmitter |
| A8 | (not Assigned) | | | | |
| A9 | Peters Creek | Yes | Yes | | (Note 2) |
| A10 | FFO, Upper High Meadow/Wildcat Cyn./DHF | Yes | No | Cal Water Repeater | |
| A11 | Coastal Area Outpost (CAO) | Yes | Yes | (Note 2) | Allen Pk. Repeater (Note 1) |
| A12 | Sears Ranch parking lot | Yes | Yes | Vehicular Repeater | Allen Pk. Repeater (Note 1) |
| A13 | Mindego, east of RR03 lot | Yes | Yes | (Note 2) | Allen Pk. Repeater |
| A14 | Old La Honda, Thornwood, Dennis Martin Creek | Yes | Yes | Vehicular Repeater | Allen Pk. Repeater |
| A15 | Purisima Creek Trail; PC05 to Craig Britton Trail | Yes | Yes | | (Note 2) |
| A16 | Lower Woodrat / Polly Geraci Trail | Yes | No | Vehicular Repeater | |
| A17 | Harrington Creek Bridge | Yes | Yes | Vehicular Repeater | Allen Pk. Repeater (Note 1) |
| A18 | Pond, upper Rogue Valley | Yes | No | Cal Water Repeater | |
| A19 | Pichetti Ranch (south) | Yes | No | | (Note 2) |
| A20 | Foothills/Los Trancos | Yes | No | | (Note 2) |

Yes: FTE's coverage modeling verified or identified a significant coverage deficiency for this type of user equipment.
No: FTE did not find a coverage problem; coverage appeared to be 90% of the area/location or better.

Note 1: San Mateo's County's Rolph Pk. site is a distant secondary solution here if Allen Pk. is not feasible.
Note 2: No existing tower site was identified that could provide a significant improvement. A new greenfield tower and shelter may be required.

**Table 10 – Radio Coverage Deficiencies and Solutions**

The Poor Coverage column indicates where FTE was able to verify the particular user report, as well as discover vehicle coverage problems if they existed.

The Possible Solutions columns indicate what equipment might be deployed to solve the particular coverage problem.

### 5.2.1 Approach to Solutions

Using the current FCC license database, we identified the location of over 300 repeaters or microwave radio links licensed by the State of California, or by San Mateo, Santa Clara or Santa Cruz counties. This equipment is usually housed in state or county-owned tower site facilities, which are ideal for any new District repeaters.

We also assembled a databases of over 2,000 privately-owned and operated “commercial” tower sites that contained utility, business, government and some cellular telephone radio systems. These included the following companies:

- American Tower
- Crown Castle
- Comsites West
- Communications & Control
- Pacific Gas & Electric
- SBA

We first considered existing government or utility-owned sites, followed by commercial ones when looking for new tower sites. In general, government and utility sites will have lower lease costs, be better maintained and provide more reliable utility or backup power and security.

When a coverage problem was noted by a Ranger or found by us, we first tried to identify the most optimal tower site to support handheld radios. If none could provide this, we then modeled coverage

to vehicular radios from the same site(s). If the site(s) provided at least 90% vehicle coverage, use of the existing vehicular repeaters will be the most practical and cost-effective solution.

If no site could support vehicle radios, we noted that a completely new "greenfield" tower site would have to be constructed to improve coverage.

### 5.2.2 Recommended Sites

The following sites were found to provide varying degree of coverage improvement to one or more areas. Pictures may also show nearby tower sites already in use by the District. Each Patrol channel site must be equipped with a backhaul link to Carol Drive.

Appendix D – Proposed Coverage Solutions shows how each new site improves coverage for areas in Table 10 above.

Cost estimates are provided in Section 6.

**Allen Peak (Lookout)**
Elevation: 2,315 ft.
Coordinates: 37.386833 / -122.294722
Apparent Owner: State of California / CalFire

Site Notes: Communications tower is located near a Fire Lookout here. Availability needs to be confirmed.

Site might replace Sierra Morena.[19]

Backhaul Connectivity: Possible connectivity to Black Mtn. (preferred), Coyote or Copernicus. Must be confirmed.


**Cal Water**
Elevation: 612 ft.
Coordinates: 37.336229 / -122.099189
Apparent Owner: California Water Service

Site Notes: An existing shelter and tower exists that appears to be a cellular carrier (e.g., AT&T, Verizon, T-Mobile, etc.). Site also enhances DHF and the Field Office (only if antenna height is maximized), and would eliminate the need for the fixed mobile repeater that provides limited coverage of the farm. Site availability needs to be officially established.

Backhaul Connectivity: Possible path to Mtn. View Police Department (preferred), Tomita Coyote or Copernicus.


[19] Moving or eliminating a site must be done carefully as coverage will change, impacting field operations.

**McQueen Ridge**
Elevation: 3.431 ft.
Coordinates: 37.154569/ -121.897814
Apparent Owner: Communications & Control

Site Notes: This site may have the same owner as the District's existing Tomita Hill site. Site availability needs to be officially established.

Site might replace Tomita Hill.[20]

Backhaul Connectivity: Various sites.


**Redwood (existing District Site)**
Elevation: 1,487 ft.
Coordinates: 37.157579 / -121.983945
Apparent Owner: AT&T

Site Notes: Santa Clara County originally arranged for a Patrol Channel receiver here a number of years ago. Sharing here is under an extremely limited relationship with AT&T. No transmitter exists (e.g., this is not a full repeater). County reports that there is limited space and may not be enough to support a District repeater or other equipment. Further review is necessary. No other existing site was found to fully replace Redwood's coverage performance.

Backhaul Connectivity: Currently leased T1 line that is unreliable. Microwave path unknown, but Tomita is close by.


### 5.2.3 Indoor Coverage Areas

Users noted that having reliable indoor coverage at the Distel offices would be helpful as it would be impractical to install enough base stations there. Preliminary coverage modeling shows that indoor coverage here is likely poor to non-existent. This can be solved through use a Distributed Antenna System (DAS). A DAS receives an outdoor (downlink) signal, amplifies it, and sends it to ceiling-mounted indoor antennas (and visa-versa for the uplink path). Ceiling antennas would be installed in rooms or corridors needing Patrol and/or Admin channel coverage. Costs could be $20k to $100k per building. One DAS could support both the Patrol and Admin channels.

Such systems can be installed at any time but may require more building modifications than if done during new construction or early in a remodel.[21]

[20] Moving or eliminating a site must be done carefully as coverage will change, impacting field operations.
[21] They can be installed at any time but requires more building modifications.

## 5.3 Backhaul Recommendations

As the District's existing microwave hardware is only halfway through its useful life, FTE recommends that these links be maintained and reused.

Each proposed repeater site will require Internet Protocol (IP) connectivity back to Carol Drive.

With the exception of San Mateo County's paths, all existing microwave is already IP-capable. For sites equipped with a leased T1 line, a leased commercial broadband service on copper or fiber, microwave radio, or a combination of these would also work.[22]

In rural areas, the reliability of commercial broadband service can be poor, and fiber availability is unlikely.[23] FTE recommends that any new site use microwave when possible. When properly engineered, microwave radio can be more reliable than leased broadband or fiber by several orders of magnitude.

If county, state of local government microwave already exists at the site, it may be possible to share part of this bandwidth for a connection to another existing site, to eventually route to Carol Drive. Otherwise microwave path engineering would be needed for a new path. Microwave requires slightly greater than line-of-sight between microwave antennas to establish a reliable connection. This is sometimes challenging in such terrain or in heavily wooded areas.

Licensed microwave backhaul is always preferred and has been assumed for this application. Unlicensed, or "shared-channel" microwave can also be used, particularly when both ends of a path are not in or near a population center, as long as high-gain, high-quality antennas are used, and the paths are properly engineered (line-of-sight, no reflection points, correct antenna alignment and proper margins). However, interference can occur without notice, and in most cases the District must accept it or reprogram its equipment to a different channel to avoid it. When an outage occurs, a tower site or sites may become disconnected from the rest and become islands, reducing wide-area coverage.

## 5.4 Impacts of Other District Projects

The District is constantly acquiring new property and areas within its sphere of influence. Each area must be separately assessed to verify whether handheld or vehicular coverage is provided by existing tower sites, or whether a new site might be required.

Coverage issues associated with any new acquisition are presented in Appendix F – Coverage Solutions for Acquisitions.

[22] The use of cellular data (4G LTE, etc.) has not been found to be reliable for simulcast applications.

[23] Santa Clara County reports that the Redwood site has very unreliable service; both Santa Clara and San Mateo counties rely on microwave radio for backhaul in the vast majority of cases.

# 6 Budgetary Costs of Solutions

This Section presents costs for three categories of solutions. These include baseline or replacement with "like-kind" items, enhancements and coverage mitigation items. "Add" items are incremental costs that are added to an earlier item. Baseline items include:

- Item 1: Replace Existing Patrol Radio System
- Item 2: Replace Existing Admin Multicast System
- Item 3: Common Site Equipment for Patrol & Admin Channels

Item 3 must be implemented if either Items 1 or 2 are implemented.

System enhancements include the following:

- Item 4: Add - Upgrade Patrol Channel to P25 Digital
- Item 5: Add - Upgrade Admin Channel to Simulcast
- Item 6: Backup Generator at Sierra Morena/Skeggs Tower Site

The remaining items attempt to improve coverage deficiencies reported by users of the Patrol Channel:

- Item 7: Upgrade Redwood Site for Patrol Repeater Operation
- Item 8: Install New Patrol Repeater at Cal Water Site
- Item 9: Install New Patrol Repeater at Allen Peak
- Item 10: Install New Patrol Repeater at McQueen Ridge

All costs include supply and installation by Santa Clara County, spare equipment, sales tax, freight, testing and integration costs, and usually include a one-year manufacturer warranty. Additional engineering costs (when known) are shown separately.

Costs do not include replacement of existing microwave links, handheld, vehicular or base radios, land purchases, or significant dispatch console modifications (none are anticipated). Maintenance costs are included when we anticipate a significant increase.

## 6.1 Cost Details

| ***Item 1: Replace Existing Patrol Radio System - Analog*** | ***Cost Estimate*** |
|---|---|
| **Radio System - Replace with Like-Kind (Analog)**<br>Replaces existing analog repeaters at five sites, receivers at three sites, and associated antenna systems. Modernizes simulcast system with IP-capable backhaul interface and associated comparator control equipment No coverage improvements.<br><br>Requires Item 3 to be implemented at the same time. | $378,000 |
| ***Total:*** | ***$378,000*** |

| *Item 2: Replace Existing Admin Multicast System* | *Cost Estimate* |
|---|---|
| **Radio System - Replace with Like-Kind**<br>Replaces existing analog repeaters at five sites, associated antenna systems and the shared Community Tone Panels. System will remain a multicast design (not simulcast).<br><br>Requires Item 3 to be implemented at the same time. | $177,000 |
| ***Total:*** | ***$177,000*** |

| *Item 3: Common Site Equipment for Patrol & Admin Channels* | *Cost Estimate* |
|---|---|
| **Site Backhaul** | |
| ***New IP-Capable Pise Link*** : New simulcast equipment (Patrol Channel) requires IP backhaul from all transmit sites; Pise is not currently IP. This installs a District-owned microwave path to replace that provide by San Mateo Co. Includes microwave eqmt. for new protected (redundant) IP path between Pise and a to-be-determined Santa Clara or San Mateo County tower having IP connectivity with Carol Drive; also relocates Black Mtn. <> Rolph microwave path eqmt. to support path as needed. Tower structural and microwave engineering costs cannot be determined and are not included. | $196,000 |
| **Professional Engineering Services:** Work w/Santa Clara Co. to identify possible microwave sites; microwave path engineering; MW licensing and planning. | $13,000 |
| **Site Support Equipment** | |
| Common/shared eqmt. for 5 repeater & 3 receiver sites; incl. backup battery systems, racks, microwave line dehydrator and networking equipment. | $153,000 |
| **Site Improvements** | |
| ***All Microwave Sites:*** *Replace forced-air cooling fans in microwave equipment (8 HSB microwave terminals)* | $8,000 |
| ***Total:*** | ***$370,000*** |

| *Item 4: ADD - Upgrade Patrol channel to P25 Digital* | *Cost Estimate* |
|---|---|
| **Radio System**<br>Incremental cost to construct a Project 25 Phase I digital Patrol simulcast repeater system versus an analog type (add this cost to Item 1). Assumes Patrol channel is installed as digital initially (e.g., costs not representative of later conversion from analog to digital).<br><br>Converts analog repeaters to digital capability (adds P25 software license), adds Linear Simulcast Modulation (LSM) to reduce impact of multipath signal interference, includes a digital voter/comparator, backhaul and dispatch console interface. No coverage improvements included.<br>Does not include costs to upgrade or replace analog-only vehicle, handheld or base stations radios with digital capable models. | $156,000 |
| **Professional Engineering Services:** Digital simulcast feasibility study to verify adequate coverage and voice quality over the District's service area. | $5,000 |
| **Prerequisites**<br>****** All vehicle, handheld and base radios must be P25 digital capable ******<br><br>****** Outside agencies accessing system must capable of P25 digital ******<br><br>****** May impact model of vehicular repeaters in future****** | |
| ***Total:*** | ***$161,000*** |

| *Item 5: ADD - Upgrade Admin Channel to Simulcast* | *Cost Estimate* |
|---|---|
| **Radio System**<br>Incremental cost to upgrade the Admin Channel radio system from multisite to simulcast operation (add this cost to Item 2).<br><br>Includes repeater upgrade options, backhaul components, etc. Shares much of the common simulcast components associated with the Patrol Channel.<br><br>Improves Admin channel radio coverage overall, simplifies use (e.g., eliminates need for users to manually select the best radio site for use; removes four of five Admin channel selections on vehicle, handheld and base radios). Does not add tower site to expand coverage.<br><br>****** Item is not compatible with Community Tone Panels if needed for outside agencies ****** | $34,000 |
| ***Total:*** | ***$34,000*** |

| ***Item 6: Provide Backup Generator at Sierra Morena/Skeggs Tower Site*** | ***Cost Estimate*** |
|---|---|
| **Site Improvements** | |
| ***Sierra Morena/Skeggs:*** Install backup power generator on existing concrete pad; fuel storage, electrical work, transfer panel. Propane (preferred). | $40,000 |
| **Changes in Recurring Costs (**Present Worth, 4% money, 3% annual escalation, 10-year term) | |
| ***Generator Maintenance & Fuel:*** *Sierra Morena generator maintenance contract and fuel estimate (annual contract, 10 years).* | $35,000 |
| **Professional Engineering Services:** Assist District with sizing and technical issues. | $3,000 |
| ***Total:*** | ***$78,000*** |

| *Item 7: Upgrade Redwood Site for Patrol Repeater Operation* | *Cost Estimate* |
|---|---|
| **Radio System**<br>Replaces patrol channel receiver with a full simulcast repeater (transmit and receive) to improve downlink coverage in key areas.<br><br>Improves Downlink Coverage in Problem Areas A3, A5-A7: Cathermole Road, Lake Elsman, Hicks Road/Guadalupe Res./SA02/Rincon/Twin Cr., Hendry's Creek/SA43, Bear Creek Redwoods, & No. Lexington Res./Jones Tr./Bridge Rd./SA22/SA40.<br><br>Note: Equipment space in existing shelter, lease issues and limited line-of-sight microwave paths to/from this site may be difficult and prevent realization of this item. | $20,000 |
| **Site Backhaul**<br>***New IP-Capable Microwave Link*** : Microwave eqmt. for new protected (redundant) IP path between Redwood and a to-be-determined District or Santa Clara tower having IP connectivity with Carol Drive. Path may not be possible; may require leased fiber services to be installed instead (further analysis needed). | $138,000 |
| **Site Improvements**<br>***Outdoor Equipment Cabinet:*** *Provides air-conditioned cabinet on concrete pedestal for repeater and backup batteries; electrical service; and tower structural engineering to add Patrol and microwave antenna on existing tower. Does not include land purchase costs.* | $35,000 |
| **Changes in Recurring Costs** (Present Worth, 4% money, 3% escalation, 10-year term)<br>***Site Lease Costs:*** *For outdoor cabinet/pedestal on private land (annual contract)* | $125,000 |
| **Professional Engineering Services:** Site planning, radio and microwave engineering, oversee and test final system w/County. | $16,000 |
| ***Total:*** | ***$334,000*** |

| ***Item 8: Install New Patrol Repeater at Cal Water Site*** | ***Cost Estimate*** |
|---|---|
| **Radio System**<br>Provides a new simulcast repeater, antenna and backup battery power using the existing cellular shelter and tower at the Cal Water tank property above DHF. Eliminates need for the mobile repeater that was installed at the farm in 2019.<br><br>Improves Coverage Problem Area A10 & A18: DHF/Wildcat/Upper High Meadow & Pond, upper Rogue Valley. Note that Wildcat handheld coverage will remain significantly incomplete (complete vehicular coverage, however). Antenna height must be maximized to provide indoor coverage at the field office here.<br><br>Note: Equipment space, lease issues and limited line-of-sight microwave paths to/from this site need confirmation. | $59,000 |
| **Site Backhaul**<br>***New IP-Capable Microwave Link*** : Microwave eqmt. for new protected (redundant) IP path between this site and a to-be-determined District or Santa Clara tower having IP connectivity with Carol Drive (may be Mtn. View PD tower). Further analysis needed. | $138,000 |
| **Changes in Recurring Costs** (Present Worth, 4% money, 3% escalation, 10-year term)<br>***Site Lease Costs:*** *For indoor equipment rack in existing shelter; utility power.* | $163,000 |
| **Professional Engineering Services:** Site planning, radio and microwave engineering, oversee and test final system w/County. | $14,000 |
| ***Total:*** | ***$374,000*** |

| *Item 9: Install New Patrol Repeater at Allen Peak* | *Cost Estimate* |
|---|---|
| **Radio System**<br>Provides a new simulcast repeater, antenna and backup battery power using the existing shelter and tower at this site.<br><br>Improves Coverage Problem Areas A11-A14, A17: Areas west and northwest of Skyline/Black Mtn.<br>Note: Equipment space, lease issues and limited line-of-sight microwave paths to/from this site need confirmation. | $65,000 |
| **Site Backhaul**<br>***New IP-Capable Microwave Link*** : Microwave eqmt. for new protected (redundant) IP path between this site and a to-be-determined District, San Mateo or Santa Clara tower having IP connectivity with Carol Drive. Further analysis needed. | $138,000 |
| **Changes in Recurring Costs** (Present Worth, 4% money, 3% escalation, 10-year term)<br>***Site Lease Costs:*** *For indoor equipment rack in existing shelter; utility power.* | $200,000 |
| **Professional Engineering Services:** Site planning, radio and microwave engineering, oversee and test final system w/County. | $13,000 |
| ***Total:*** | ***$416,000*** |

| | |
|---|---|
| **Alternative: Allen Peak Replaces Sierra Morena**<br>Costs above could be reduced to that shown here if Allen Peak could cover most all of the area now supported by Sierra Morena, and improve coverage in the target problem areas. Cost includes installation of new, and relocation of reused equipment for both Patrol and Admin channels from Sierra Morena to Allen Peak, engineering, FCC license modifications. | $78,000 |

| *Item 10: Install New Patrol Repeater at McQueen Ridge* | *Cost Estimate* |
|---|---|
| **Radio System**<br>Provides a new simulcast repeater, antenna and backup battery power using the existing shelter and tower at this site.<br><br>Improves Coverage Problem Area A1 & A4: Alamitos Road/SA35/SA36 & Hicks Road/Guadalupe Res./SA02/Rincon/Twin Cr.<br><br>Note: Equipment space, lease issues and limited line-of-sight microwave paths to/from this site need confirmation. | $65,000 |
| **Site Backhaul**<br>***New IP-Capable Microwave Link*** : Microwave eqmt. for new protected (redundant) IP path between this site and a to-be-determined District, San Mateo or Santa Clara tower having IP connectivity with Carol Drive. Further analysis needed. | $138,000 |
| **Changes in Recurring Costs** (Present Worth, 4% money, 3% escalation, 10-year term)<br>***Site Lease Costs:*** *For indoor equipment rack in existing shelter; utility power.* | $150,000 |
| **Professional Engineering Services:** Site planning, radio and microwave engineering, oversee and test final system w/County. | $13,000 |
| ***Total:*** | ***$366,000*** |

| | |
|---|---|
| **Alternative: McQueen Ridge Replaces Tomita Hill**<br>Costs above could be reduced to that shown here if McQueen could cover most all of the area now supported by Tomita, and improve coverage in the target problem areas. Cost includes installation of new, and relocation of reused equipment for both Patrol and Admin channels from Tomita to McQueen, engineering, FCC license modifications. | $78,000 |

# 7 Next Steps

FTE recommends the following. Long lead time issues are listed first:

1. Select and prioritize any desired coverage improvement package from Items 7, 8, 9 and/or 10. Have FTE investigate backhaul and space requirements; District should investigate lease contact costs.
2. If Sierra Morena and/or Tomita are to be relocated (See Alternative costs in Items 9 or 10), have FTE meet with Patrol and Admin channel field users to review the coverage changes using larger, more detailed maps than those in this report.
3. If Item 1 (Patrol System Replacement) will be implemented, a new microwave path will be needed from Pise as described in Item 3. Have FTE work with San Mateo and Santa Clara counties to establish how a new microwave antenna can be added to Pise, and where it might connect with.

END OF DOCUMENT

# Appendices

# Appendix A - Acronyms, Abbreviations and Definitions

| | |
|---|---|
| Air-Interface | Describes the wireless or "over-the-air" technique used to link field radios together, and to a radio network. This includes traditional analog Frequency Modulation (FM) and newer digital C4FM and Frequency Shift Keying (FSK) digital techniques used in Project 25, Digital Mobile Radio (DMR) and others. |
| Backhaul | A two-way communication path back to a central point or other communications site for the purposes of integrating or networking a communications system. Typically accomplished through point-to-point microwave radio links, fiber, leased digital communications lines. |
| Conventional Radio System | A type of radio system where each group of users operates on a pre-assigned radio channel and repeater(s). Multiple groups or departments often share a particular channel in a party-line arrangement. |
| Coverage | The ability of a radio system to provide adequate radio signal strength and quality to allow users to communicate. |
| FCC | Federal Communications Commission |
| LMR | Land Mobile Radio |
| MHz | Megahertz |
| Mobile Repeaters | A vehicle-mounted device that enables a nearby handheld radio user (+/- 1/2 mile away) to access the fixed radio network or repeaters through the high-powered vehicular radio. Extends the range of a handheld radio equal to that of the vehicular radio. Requires users to switch to an off-network or special channel. |
| Multicast | A radio system configuration in which repeaters or base stations at different repeater sites are configured to simultaneously broadcast the same message on different radio frequencies, in the downlink direction. However, a common uplink channel is often used with a comparator device. Requires manual user intervention (channel switching), or subscriber radios capable of automatic roaming, to switch the subscriber radios to the appropriate repeater site. Normally deployed using analog conventional systems. |
| Multisite | A radio system configuration in which repeaters or base stations operate on different frequencies at each repeater site. Each site may or may not broadcast the same message. Used in wide-area trunked systems or Advanced Conventional Systems. Requires manual user intervention (channel switching), or subscriber radios capable of automatic roaming to switch the subscriber radios to an appropriate repeater site. |

| | |
|---|---|
| Project 25 (P25) | A suite of standards for digital radio for use by federal and state/province and local public safety agencies in North America. Includes the TIA 102 standards documents. Available types include Phase I (FDMA) in conventional and trunked, and Phase II (TDMA) trunked only. Also known as "APCO 25". |
| Repeater | A radio station that simultaneously rebroadcasts messages received on one radio frequency, onto another radio frequency. Normally located at high elevation, repeaters are able to rebroadcast (or relay) signals between widely separated field units or to and from a dispatch center and a field unit. |
| RF | Radio Frequency; refers to a portion of spectrum real estate, or to the electromagnetic range of frequencies used for communications. |
| Simulcast | A radio system design in which repeaters or base stations at different sites are configured to **simul**taneously broad**cast** the same message on the same radio frequency. Requires no user intervention or site "hand-offs" when roaming to different areas as it provides seamless wide-area coverage. It is primarily used to evenly distribute capacity over a given area. Can be used with analog and some digital radio systems, and with conventional or trunked technology. |
| Talk-in | The wireless path between a field subscriber unit, typically a mobile or handheld radio, and a base station or repeater. May also be referred to as Uplink or Talk-back. |
| Talk-out | The wireless path between a field subscriber unit, typically a mobile or handheld radio, and a base station or repeater. May also be referred to as Downlink. |
| Trunking<br>(Trunked Radio System) | A type of radio system where a central computer automatically assigns groups of users (talkgroups) to an available (clear) channel dynamically. Allows a large group of users to share a limited number of radio frequencies and repeaters. |
| UHF | Ultra High Frequency (typically considered 380-512 MHz in public safety radio applications) |
| VHF | Very High Frequency (typically considered 150-174 MHz in public safety radio applications) |
| Wide-area Communications | The ability of a radio network to allow two or more field users in different geographic areas to communicate, when they are not in range of the same communications repeater site. Wide area communications can be provided by multi-site or simulcast type radio systems. |

# Appendix B – Existing Admin Channel Coverage

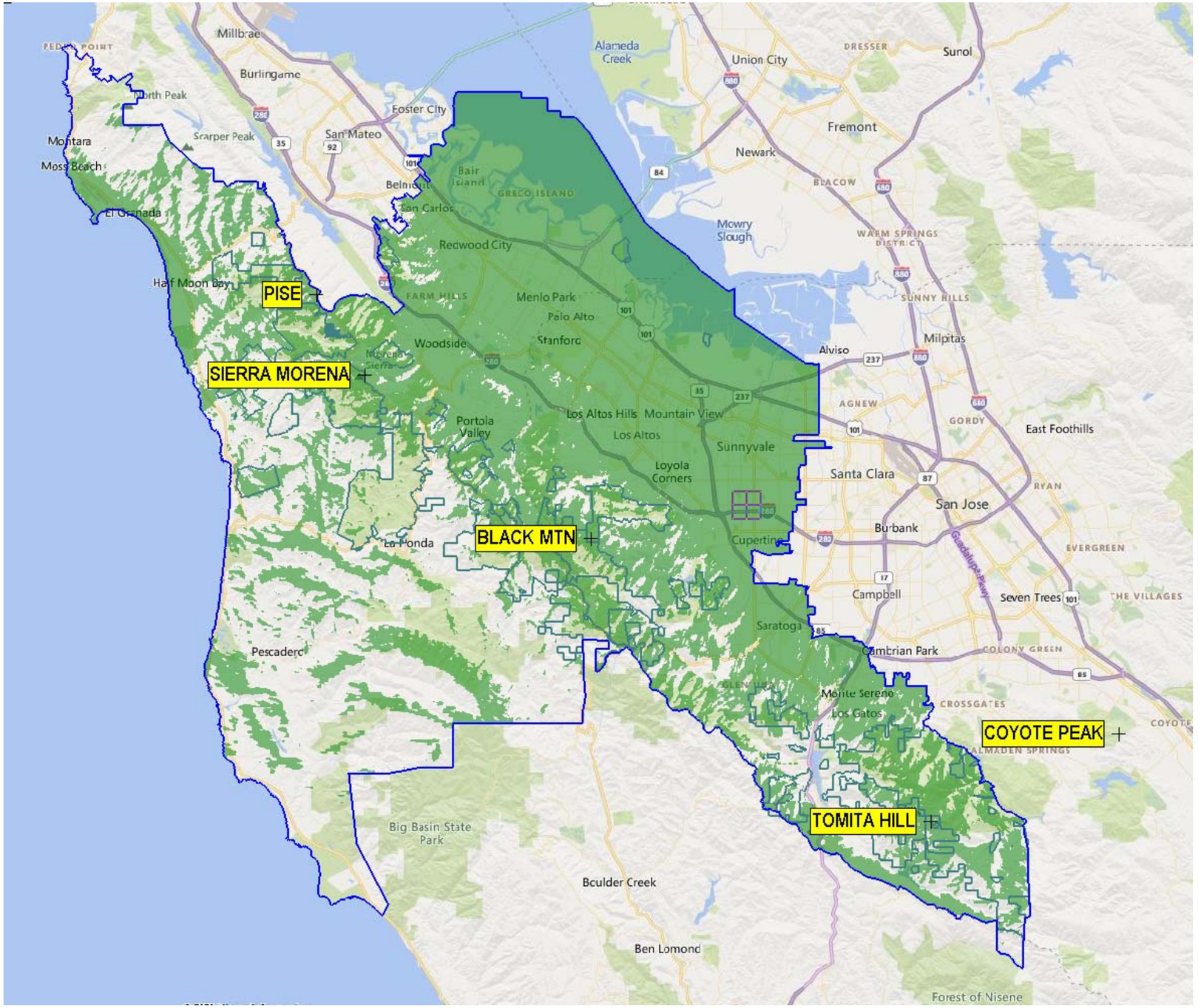



**Figure 3 – Appendix D: Admin Handheld Downlink**

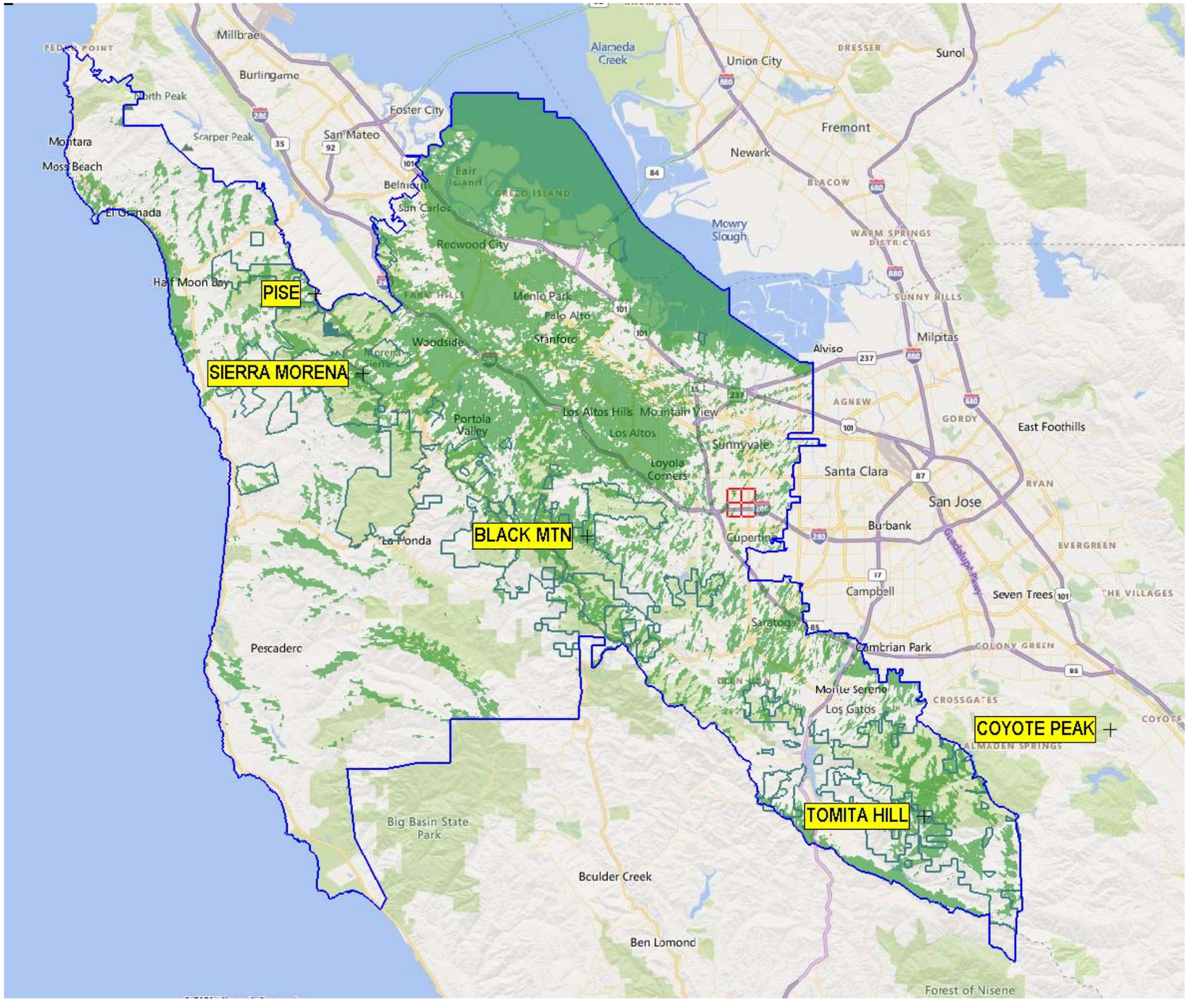



**Figure 4 – Appendix D: Admin Handheld Uplink**

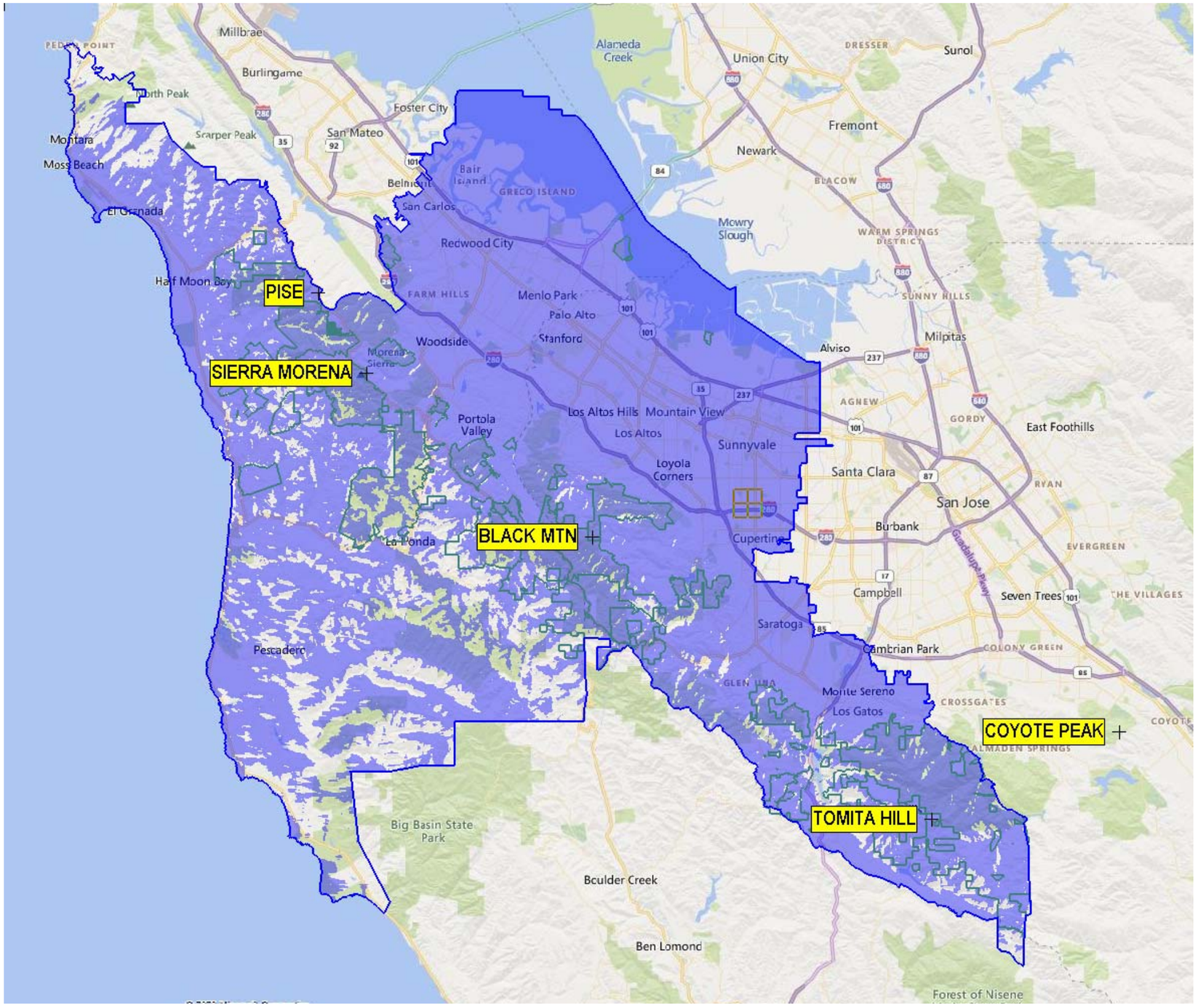



**Figure 5 – Appendix D: Admin Vehicle Downlink**

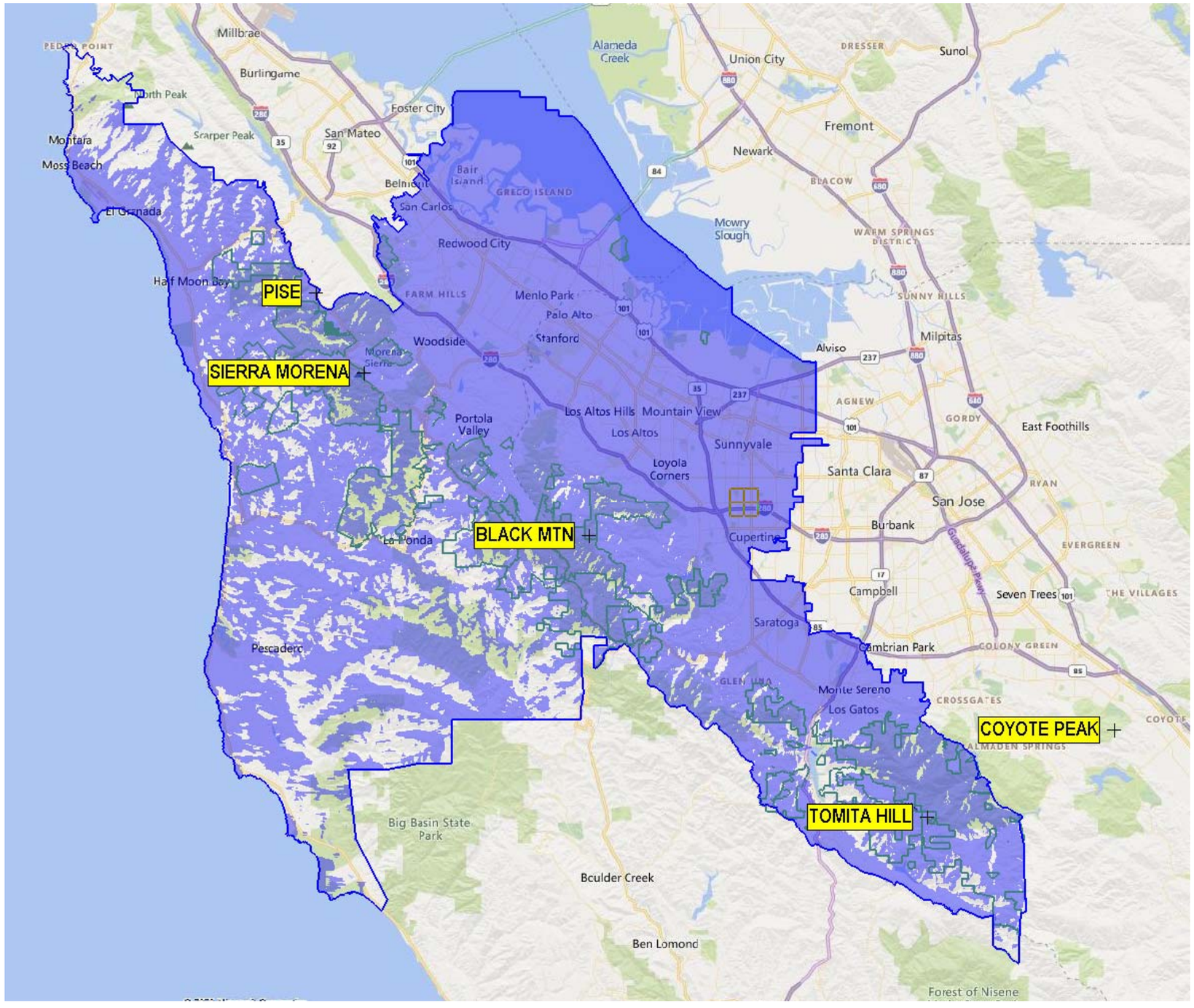



**Figure 6 – Appendix D: Admin Vehicle Uplink**

# Appendix C – Existing Patrol Channel Coverage

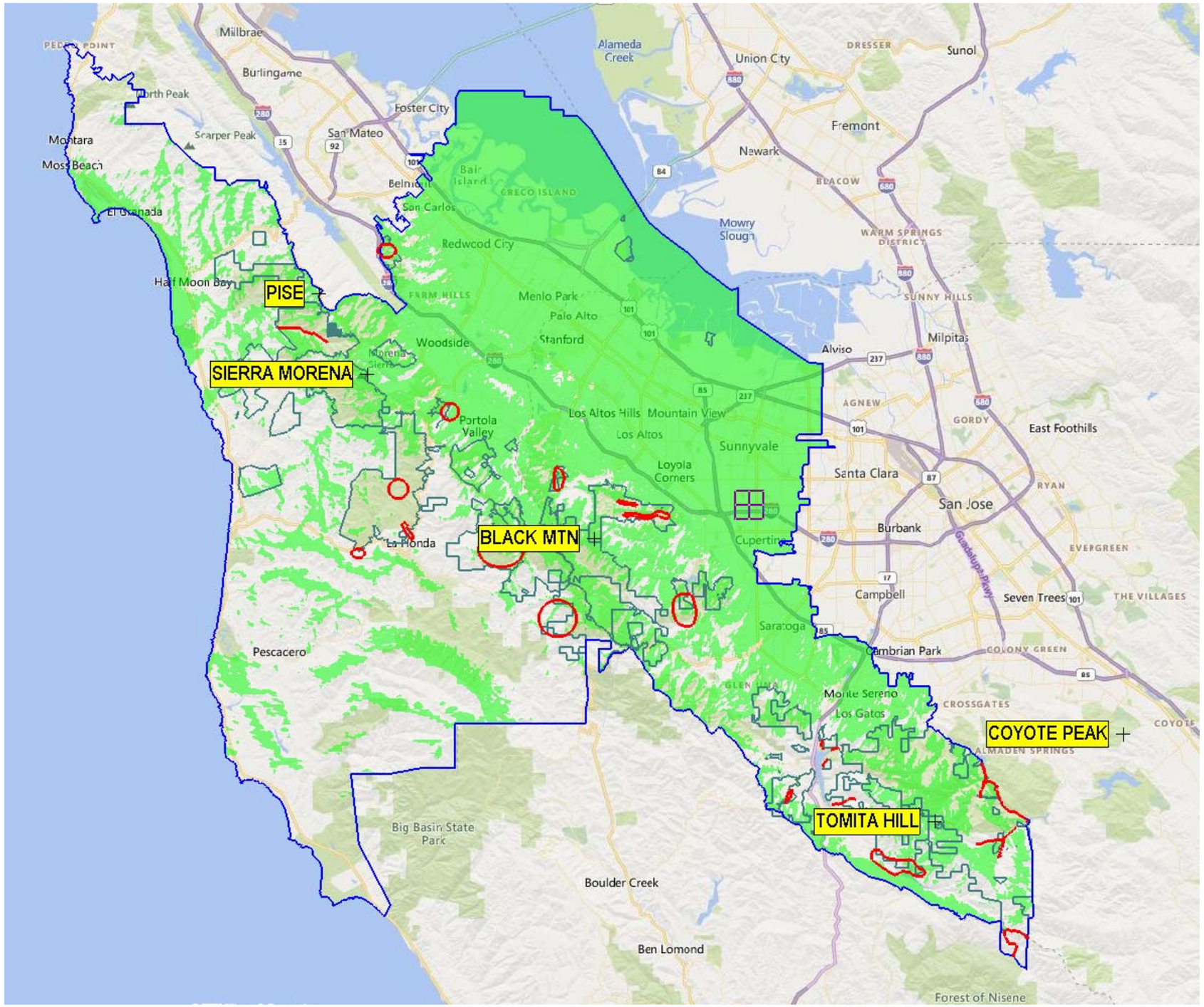



**Figure 7 – Appendix C: Patrol Handheld Downlink**

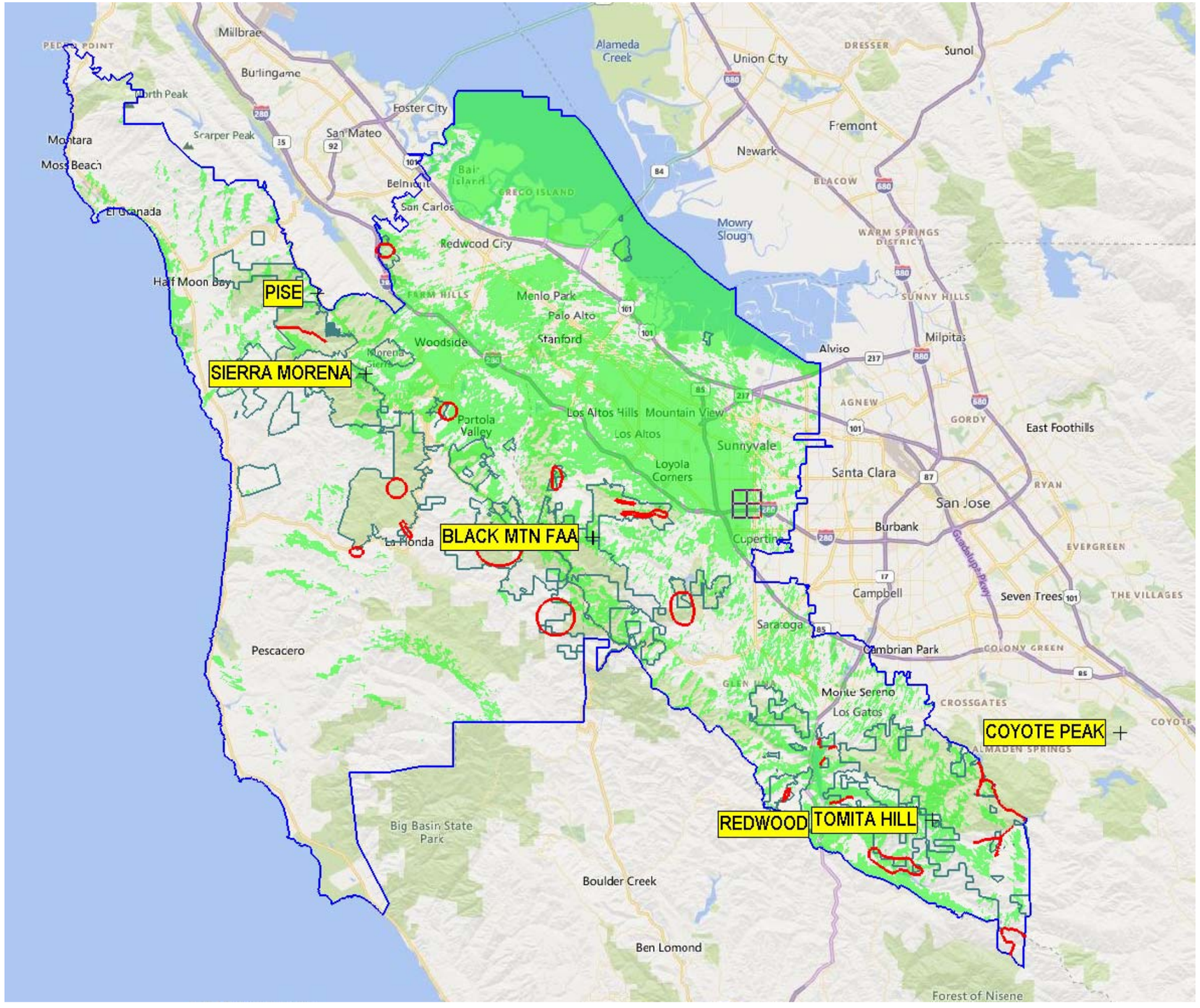



**Figure 8 – Appendix C: Patrol Handheld Uplink**

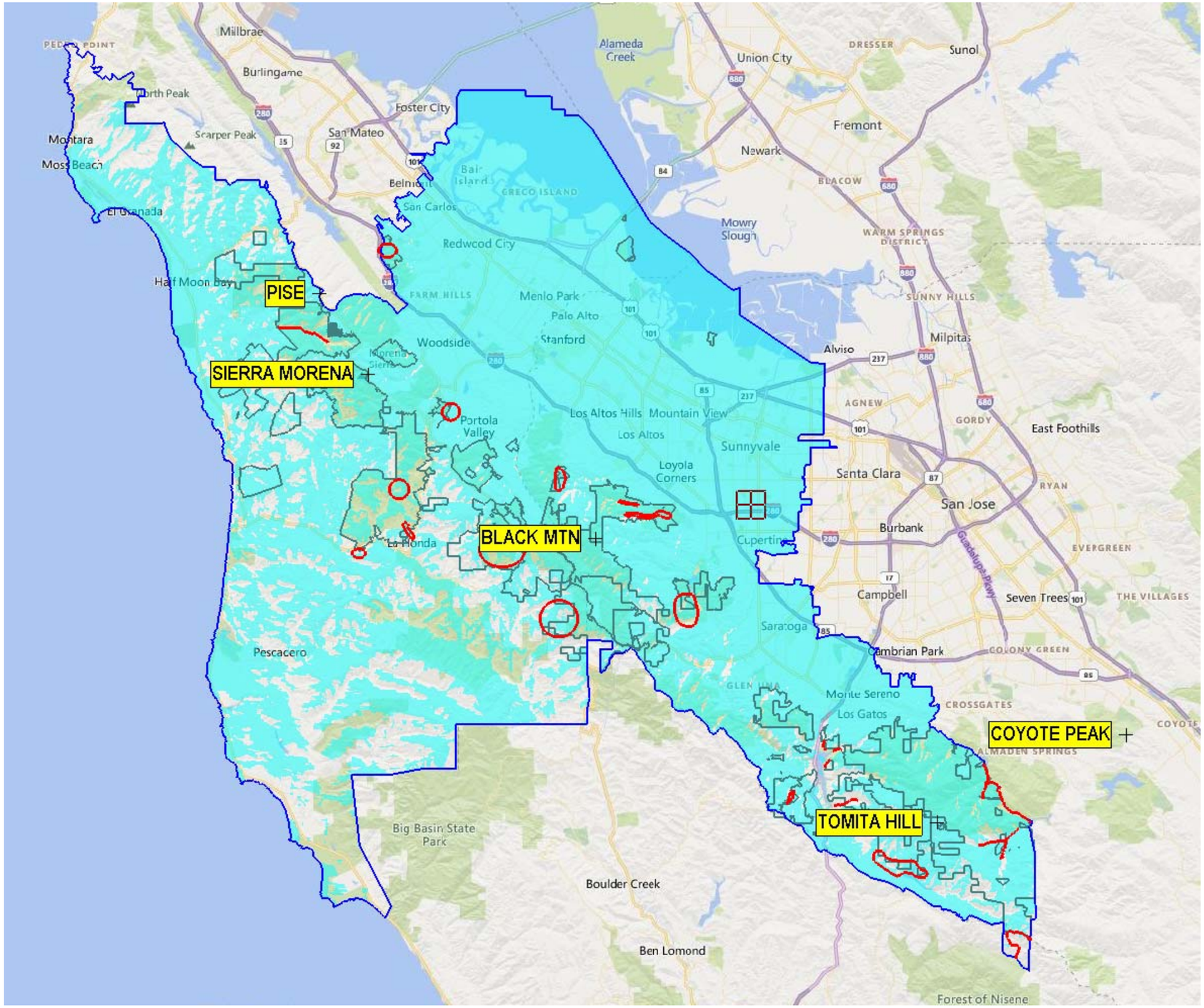



**Figure 9 – Appendix C: Patrol Vehicle Downlink**

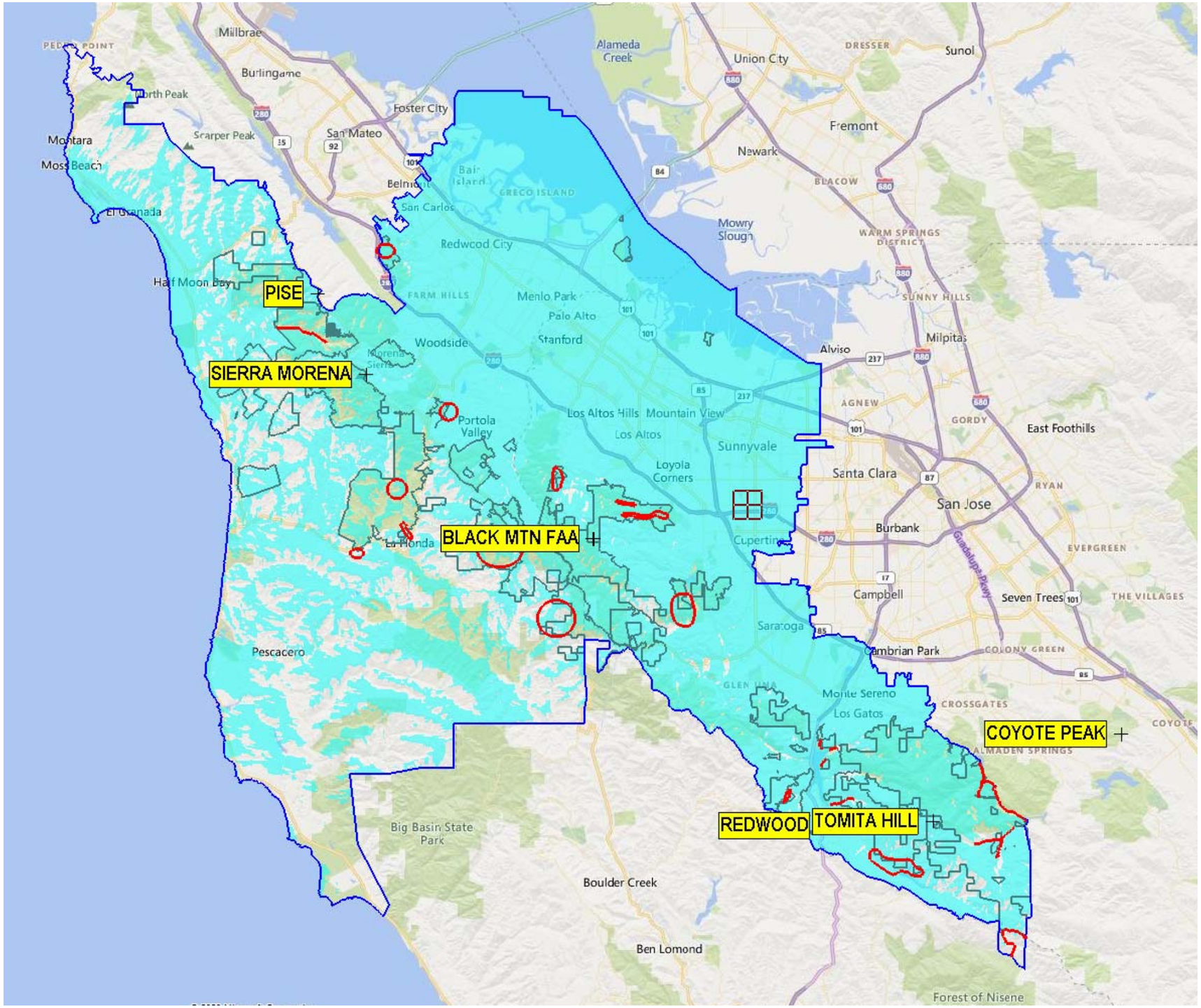



**Figure 10 – Appendix C: Patrol Vehicle Uplink**

# Appendix D – Proposed Coverage Solutions

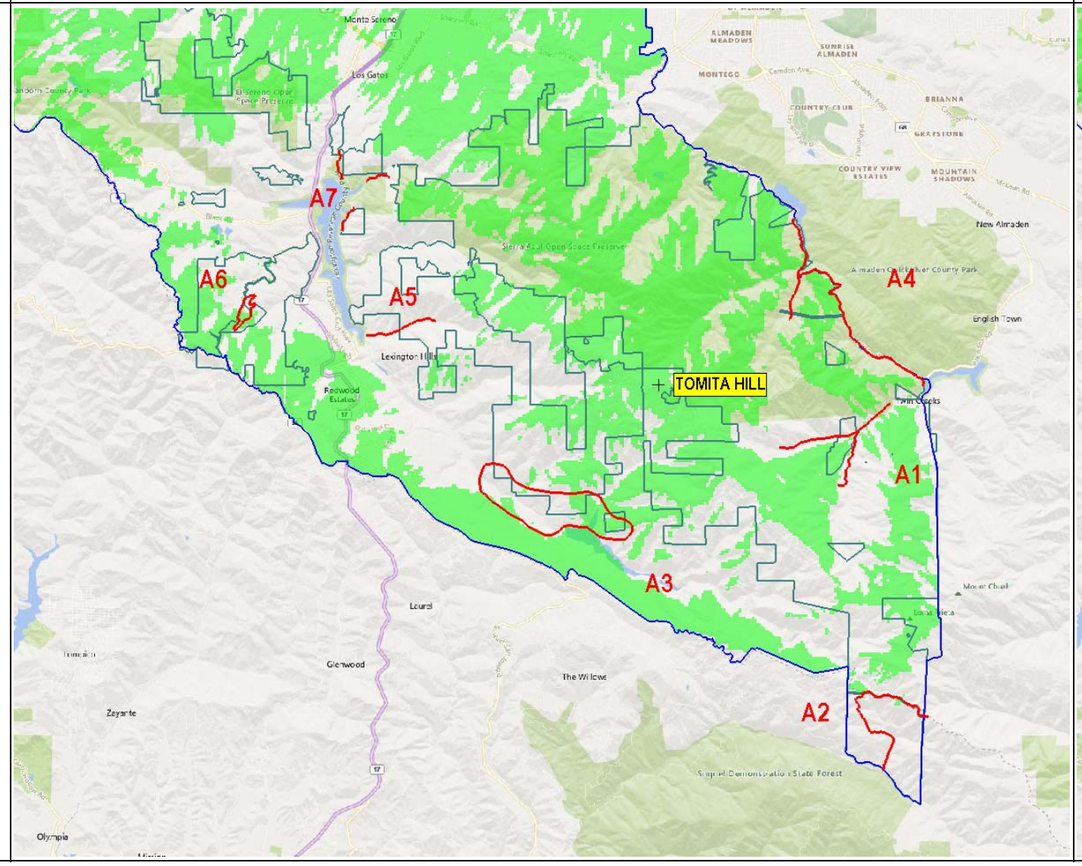
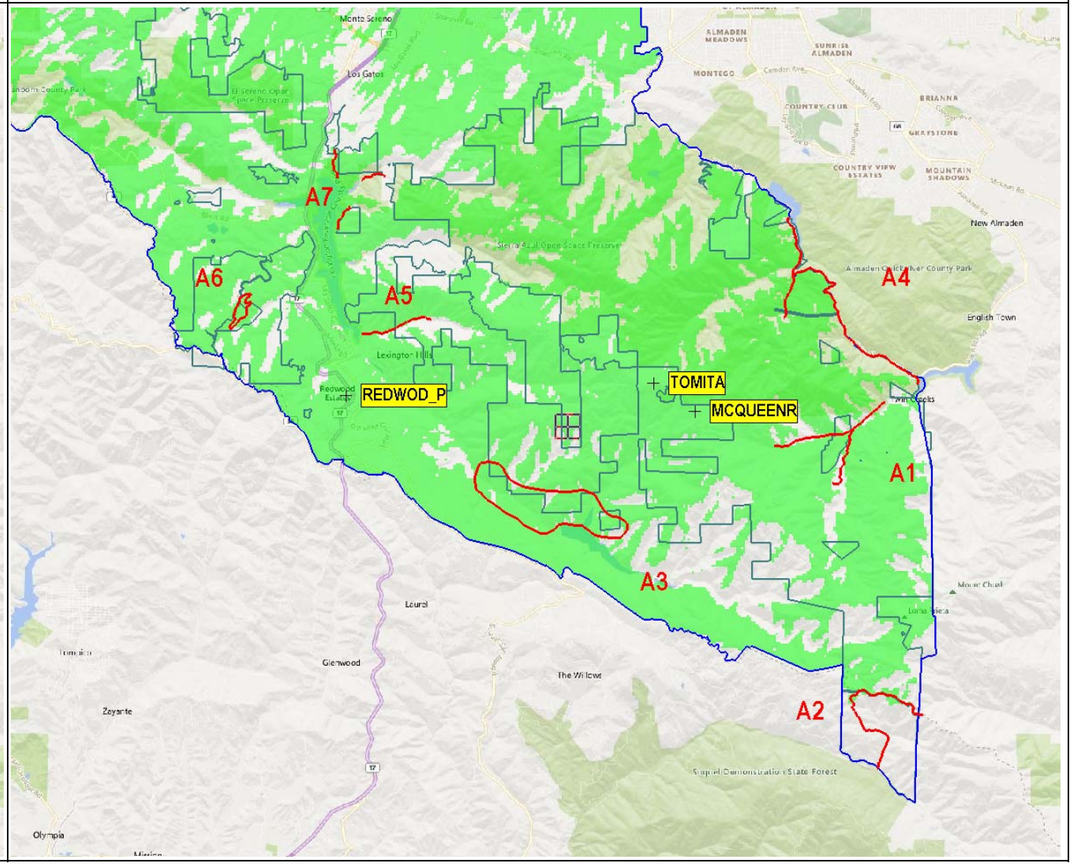
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Downlink<br><br>**Proposed New Sites:**<br>McQueen Ridge<br>Transmitter at Redwood |  |  |

**Figure 11 – Appendix D: H-DL McQueen Ridge & Redwood**

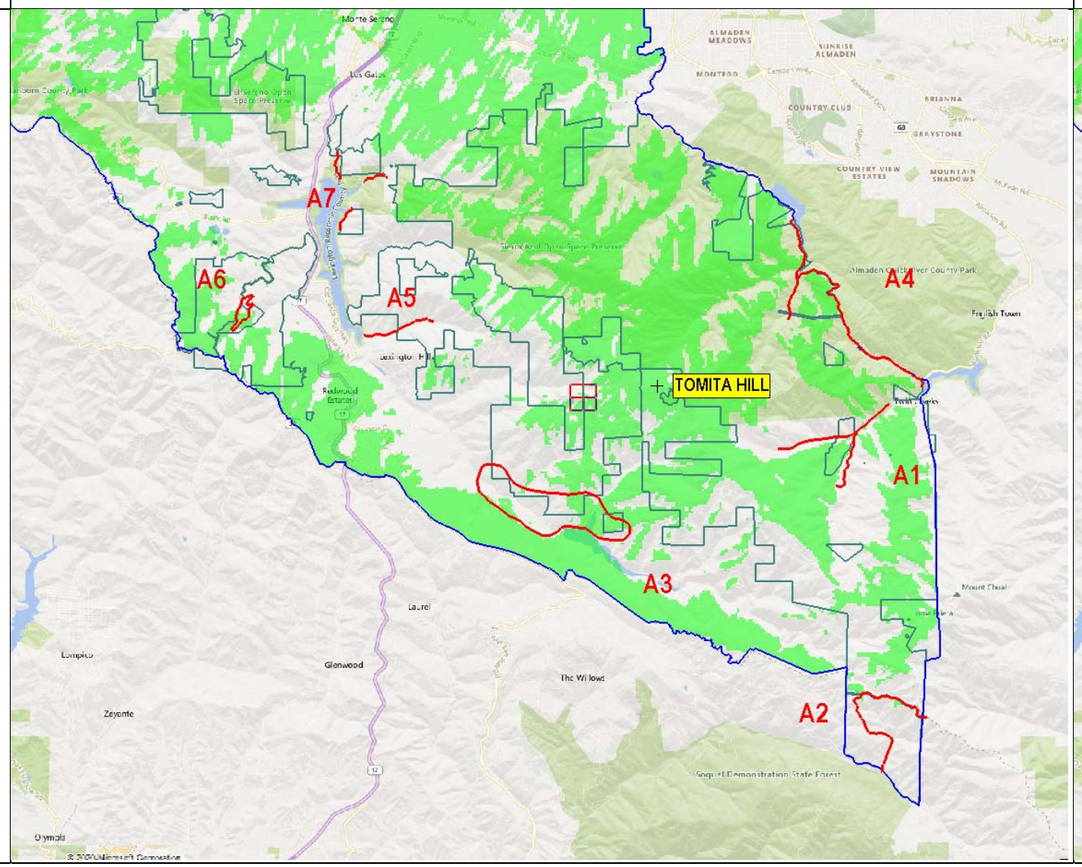
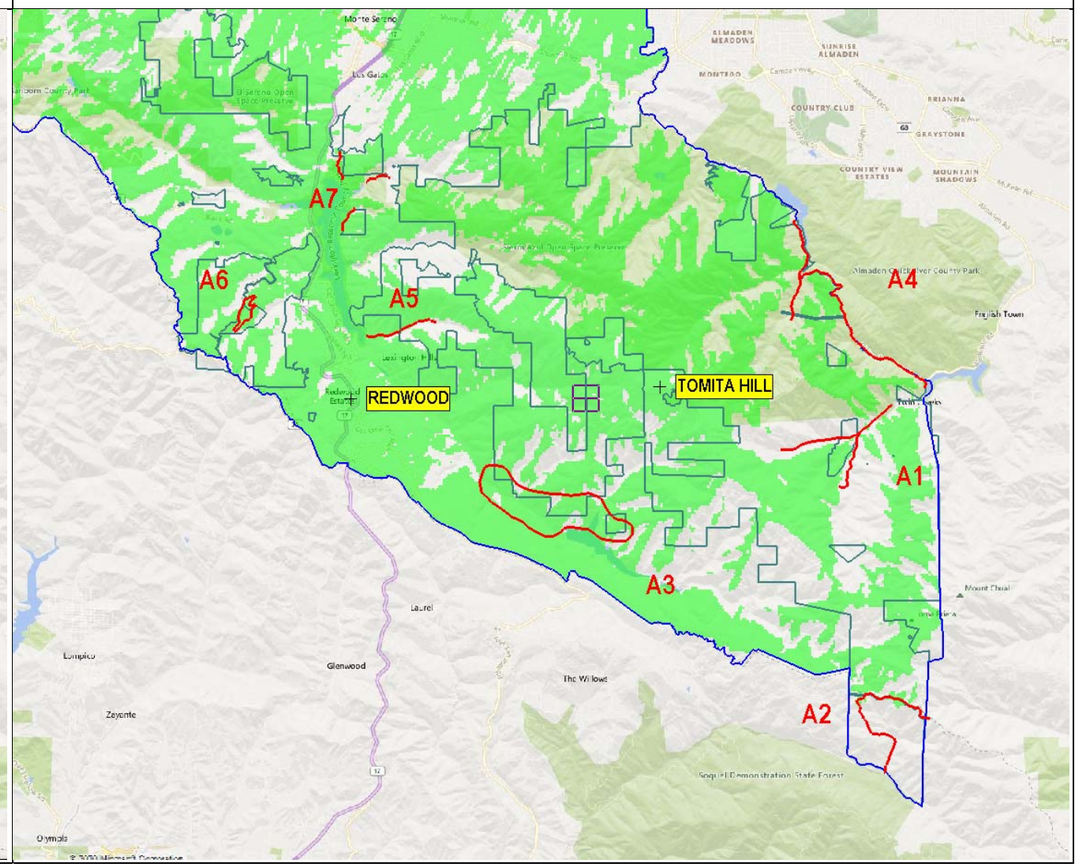
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Downlink<br><br>**Proposed New Sites:**<br>Transmitter at Redwood |  |  |

**Figure 12 – Appendix D: H-DL Redwood**

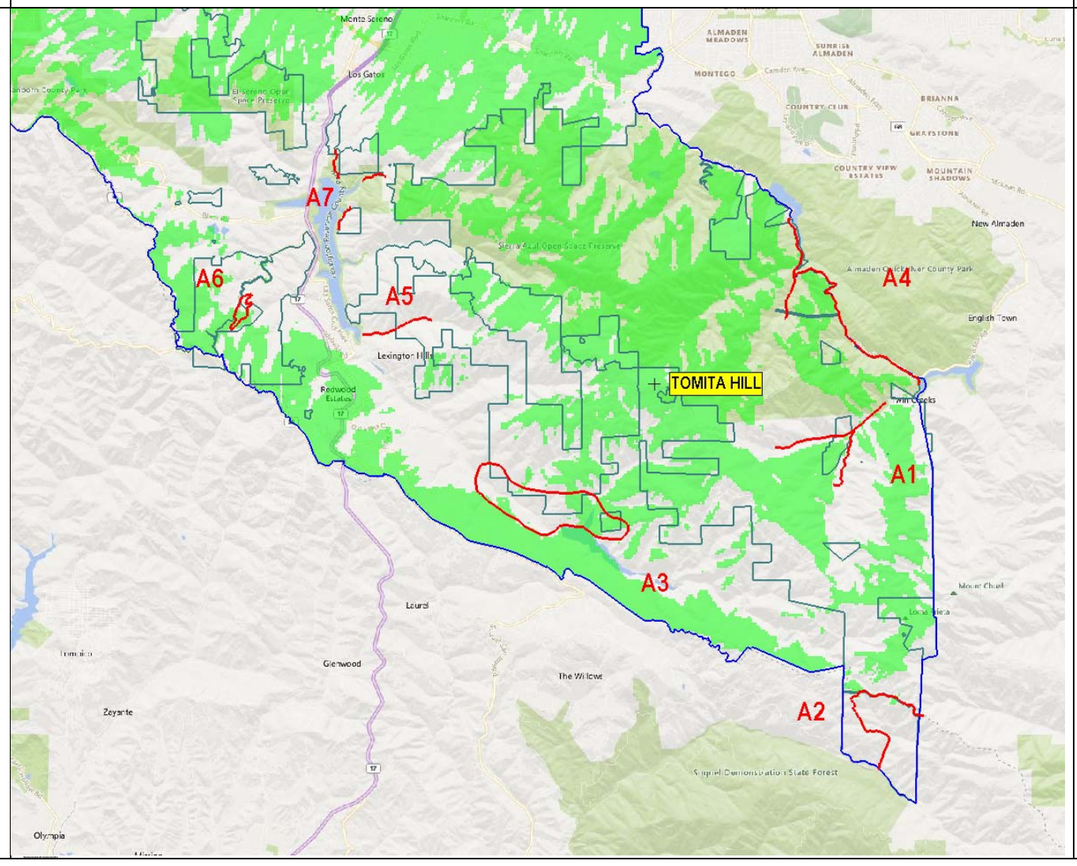
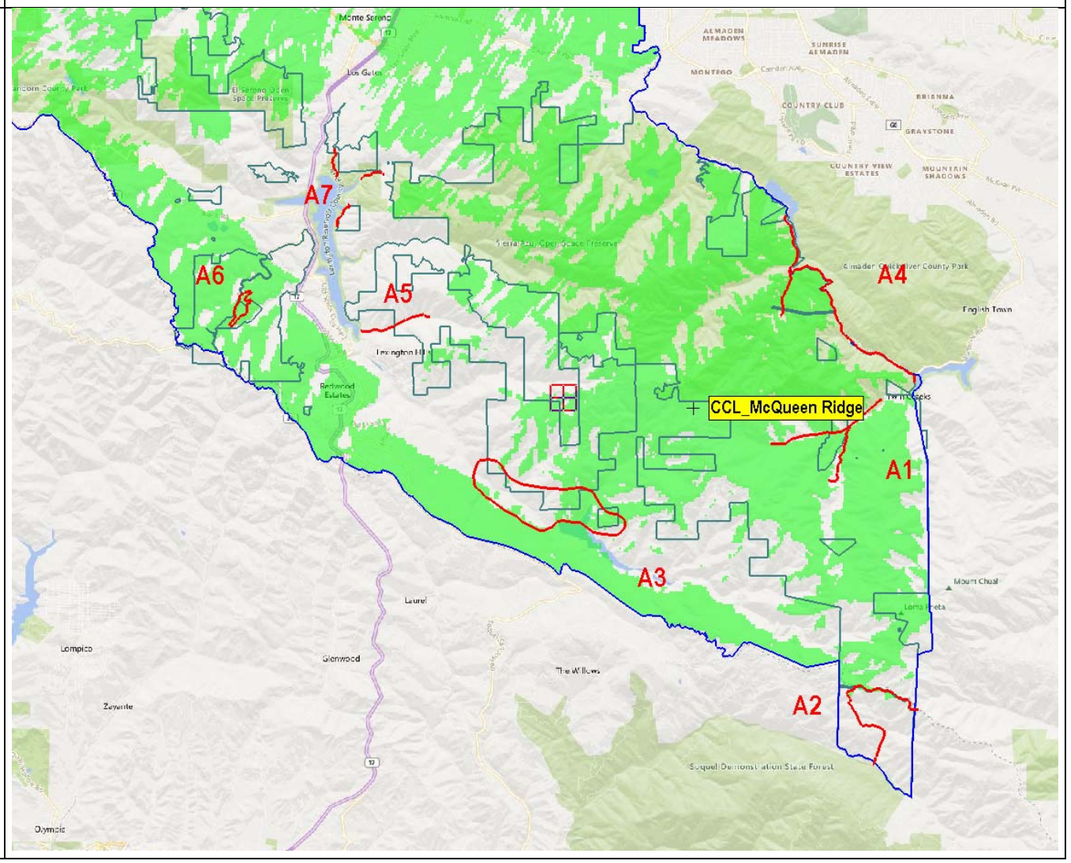
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Downlink<br><br>**Proposed New Sites:**<br>McQueen Ridge<br>(Tomita Replacement) |  |  |

**Figure 13 – Appendix D: H-DL Tomita vs. McQueen Ridge**

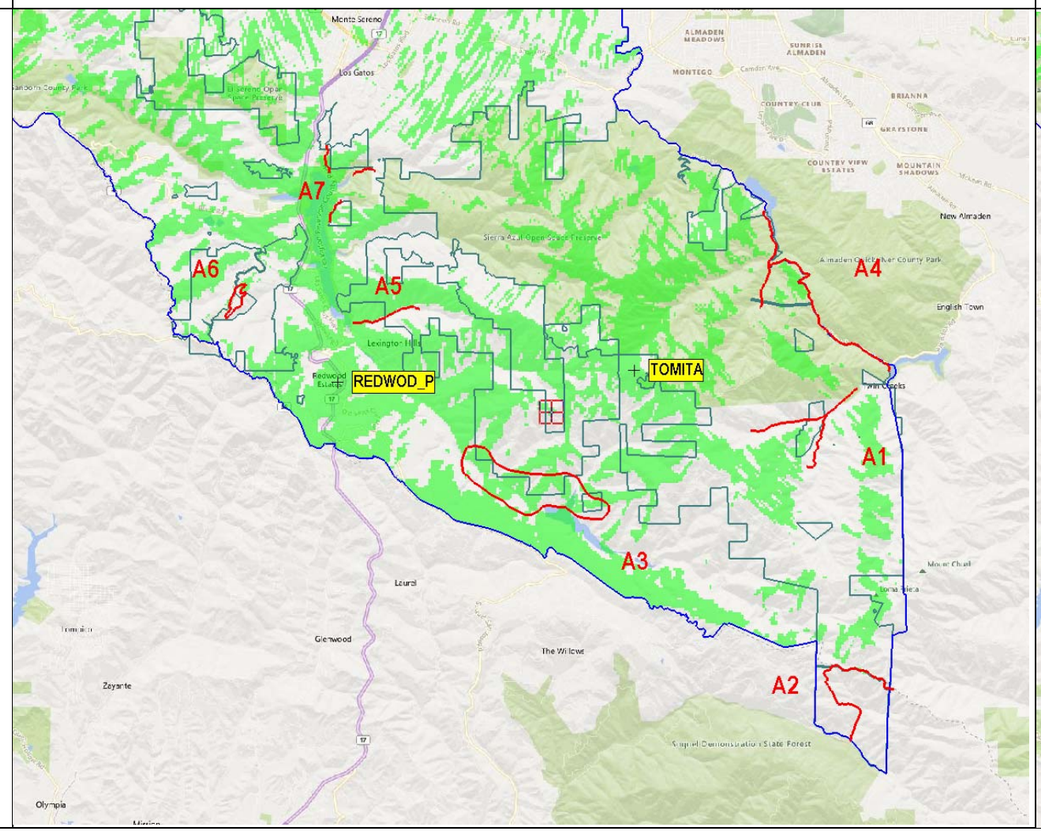
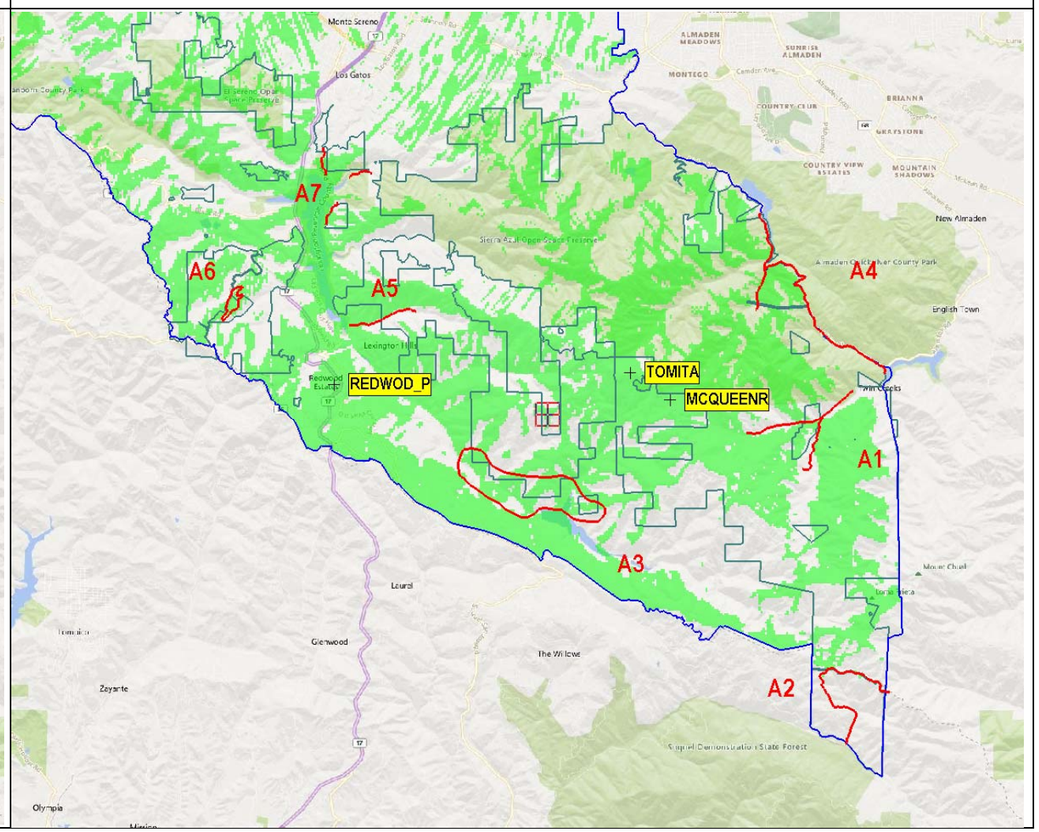
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Uplink<br><br>**Proposed New Sites:**<br>McQueen Ridge |  |  |

**Figure 14 – Appendix D: H-UL McQueen Ridge**

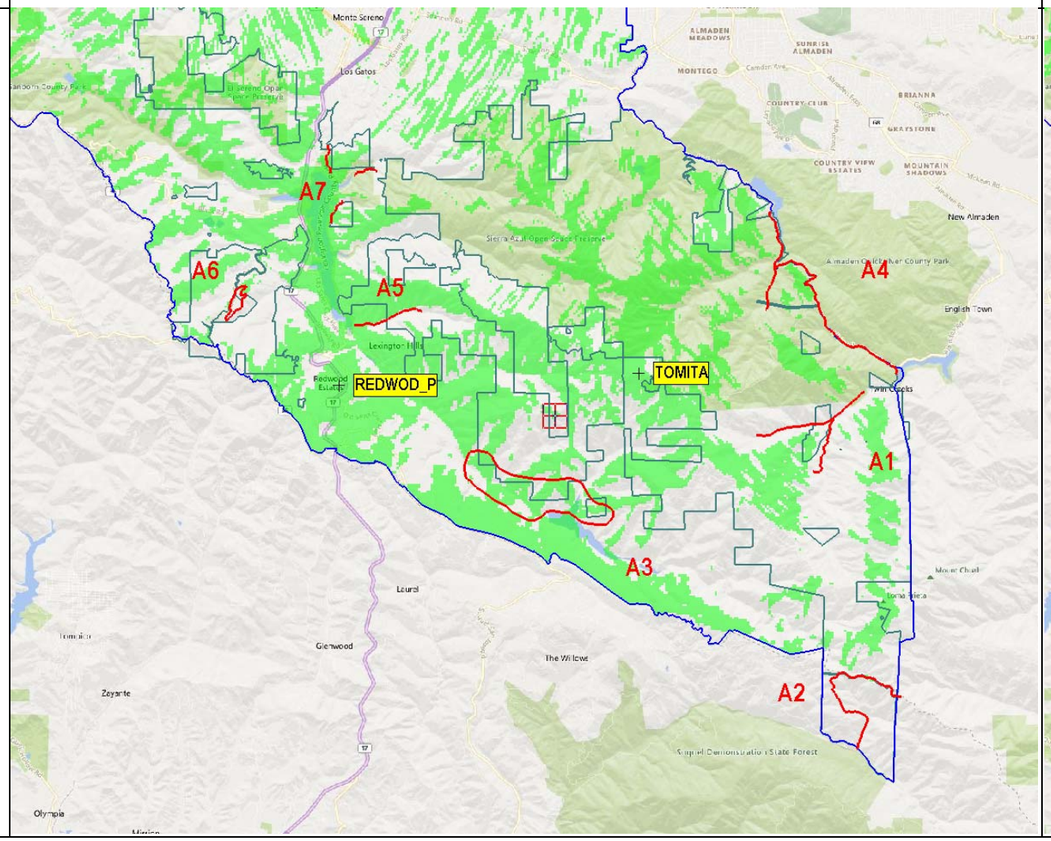
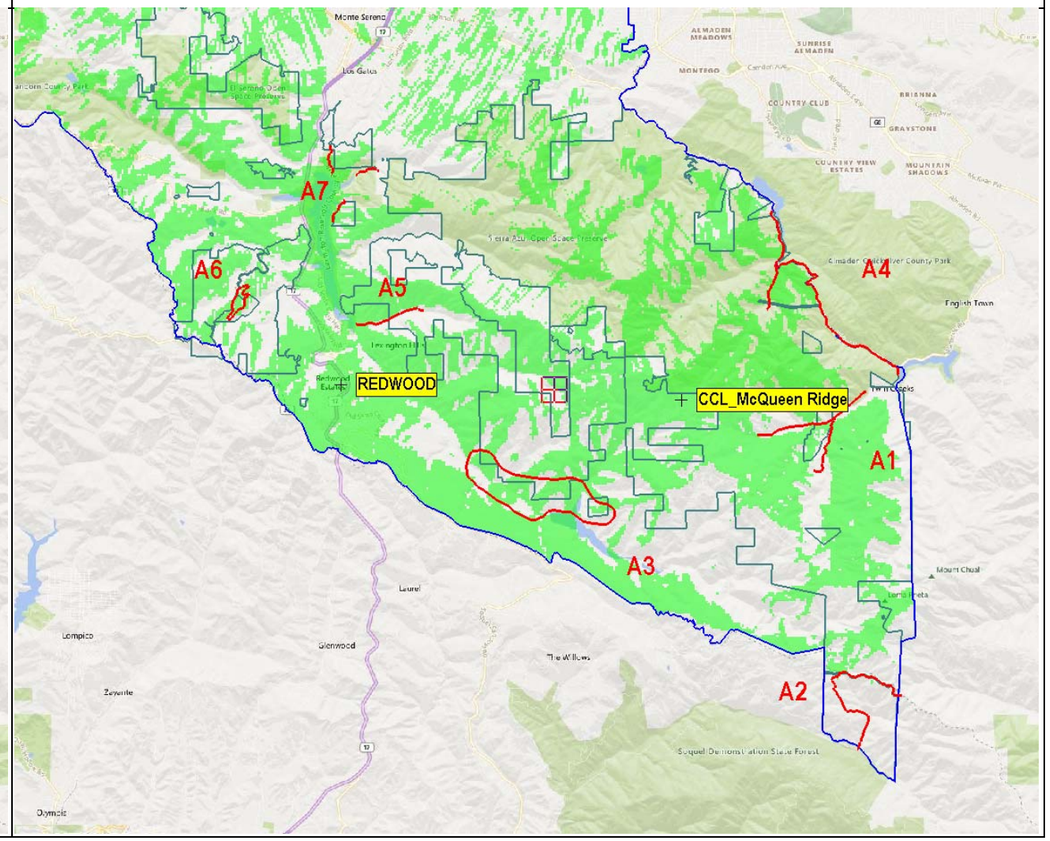
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Uplink<br><br>**Proposed New Sites:**<br>McQueen Ridge<br>(Tomita Replacement) |  |  |

**Figure 15 – Appendix D: H-UL Tomita vs. McQueen Ridge**

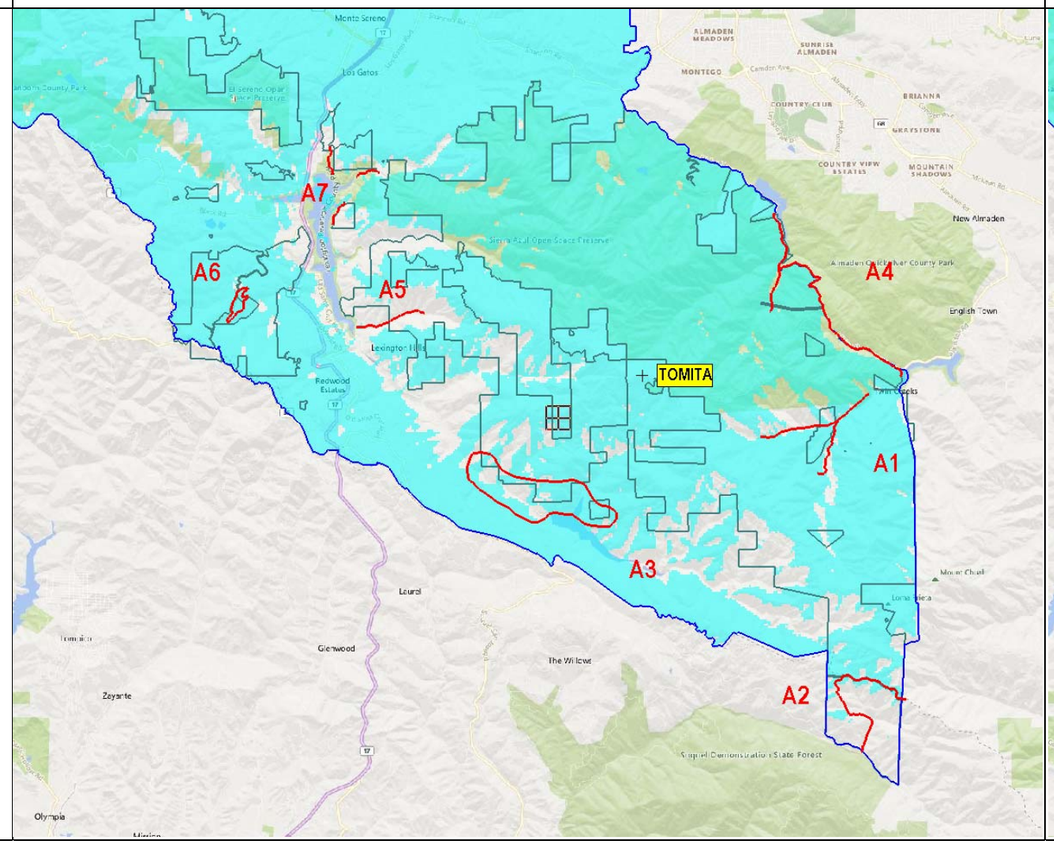
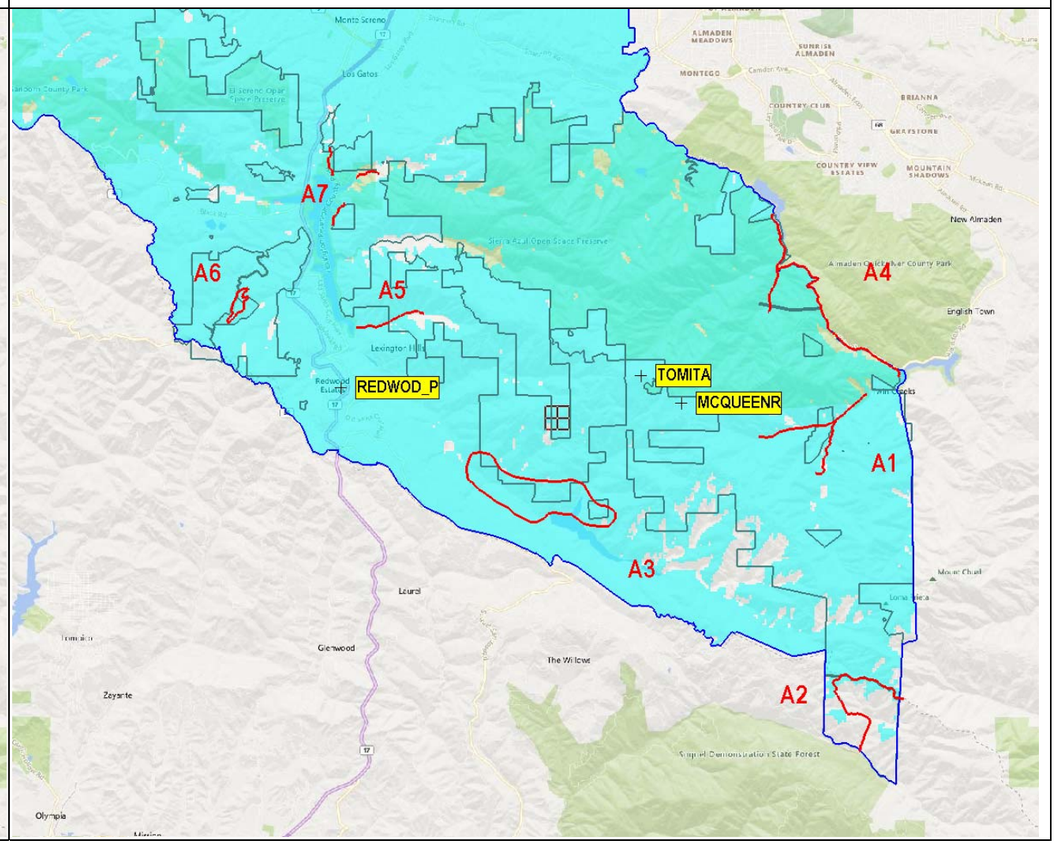
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Downlink<br><br>**Proposed New Sites:**<br>McQueen Ridge<br>Redwood Transmitter |  |  |

**Figure 16 – Appendix D: V-DL McQueen Ridge & Redwood**

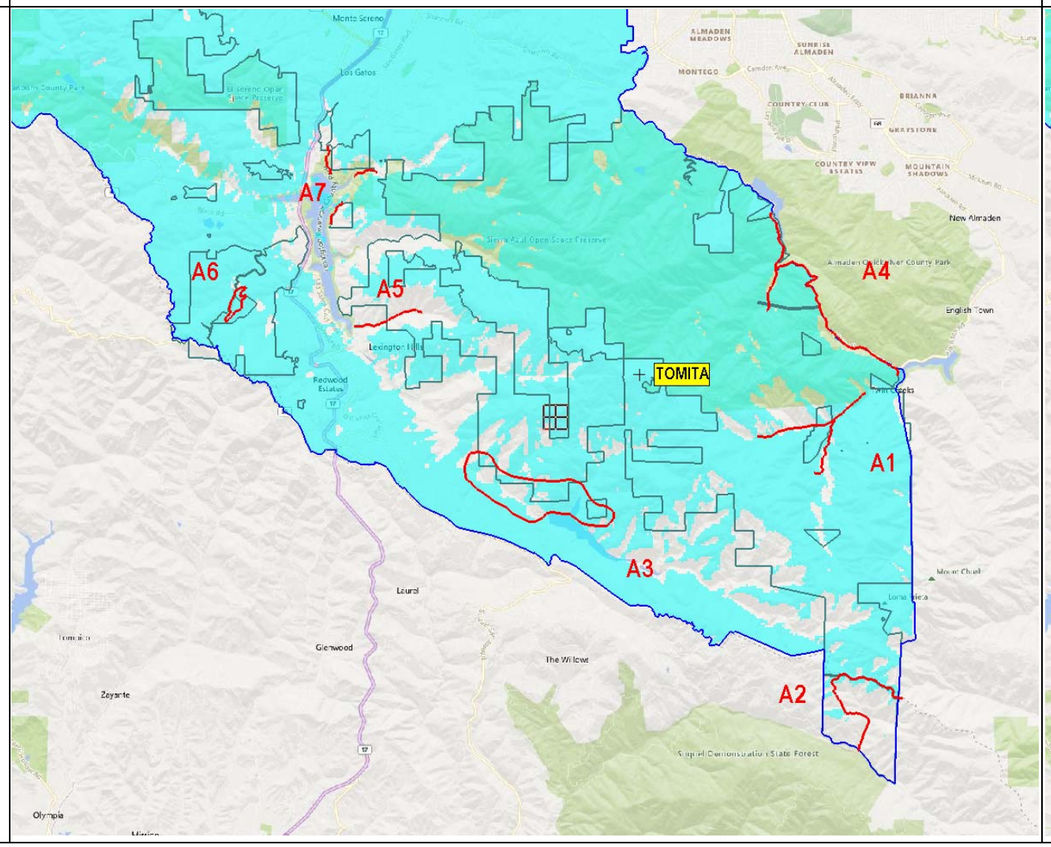
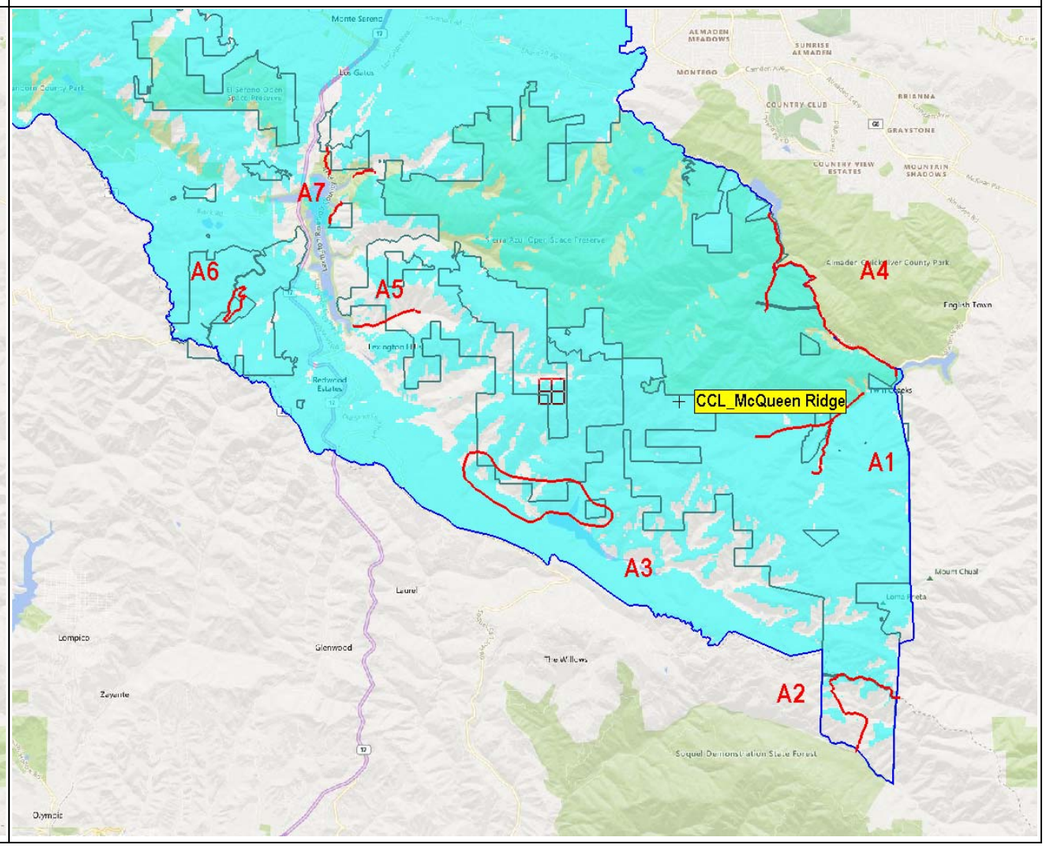
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Downlink<br><br>**Proposed New Sites:**<br>McQueen Ridge<br>(Tomita Replacement) |  |  |

**Figure 17 – Appendix D: V-DL Tomita vs. McQueen Ridge**

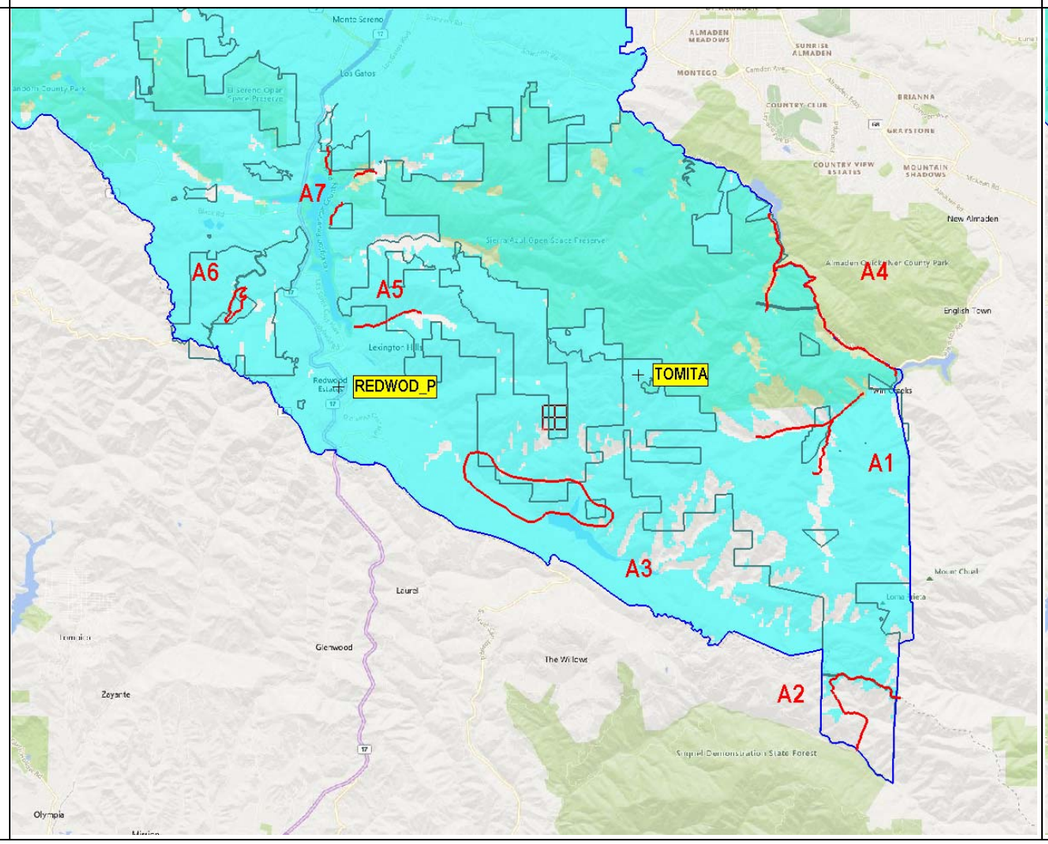
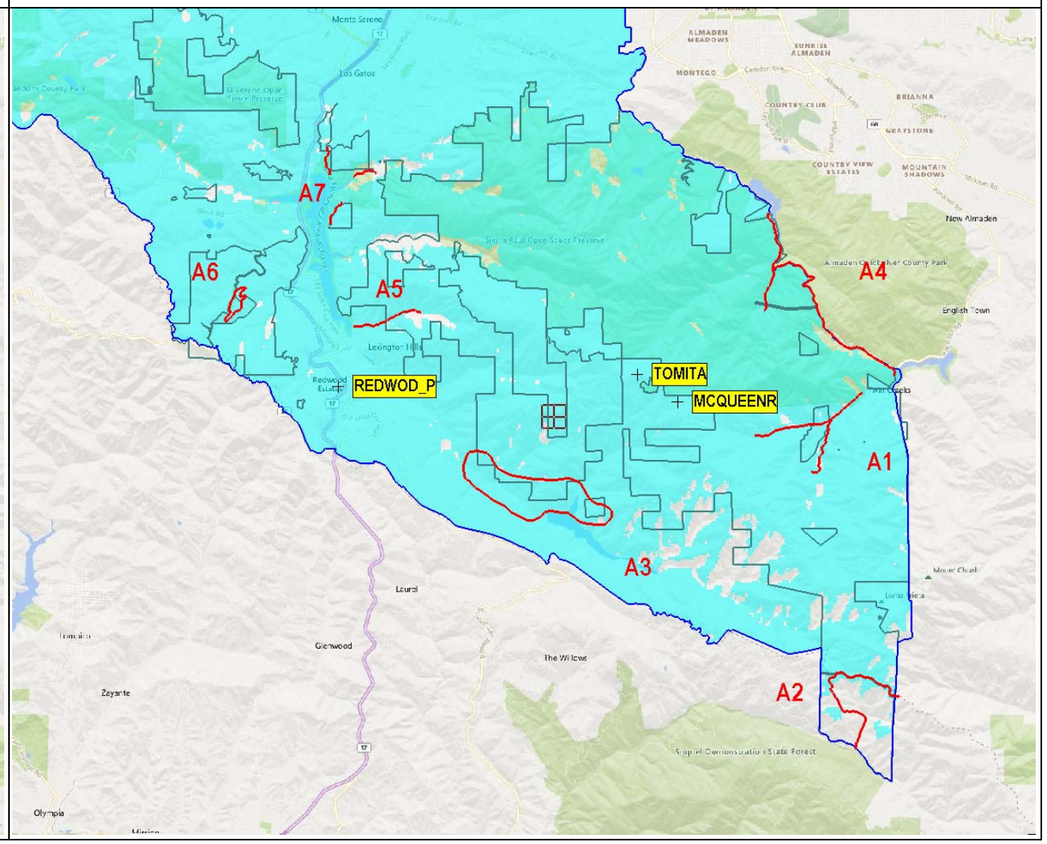
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Uplink<br><br>**Proposed New Sites:**<br>McQueen Ridge |  |  |

**Figure 18 – Appendix D: V-UL McQueen Ridge**

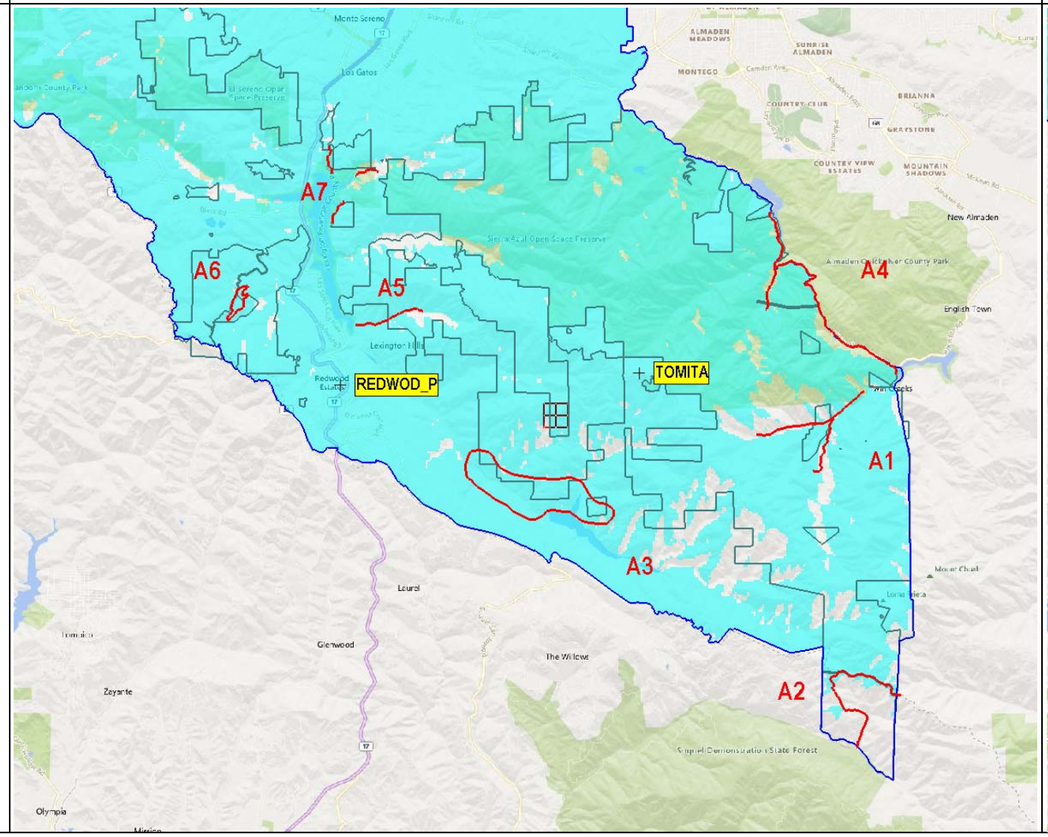
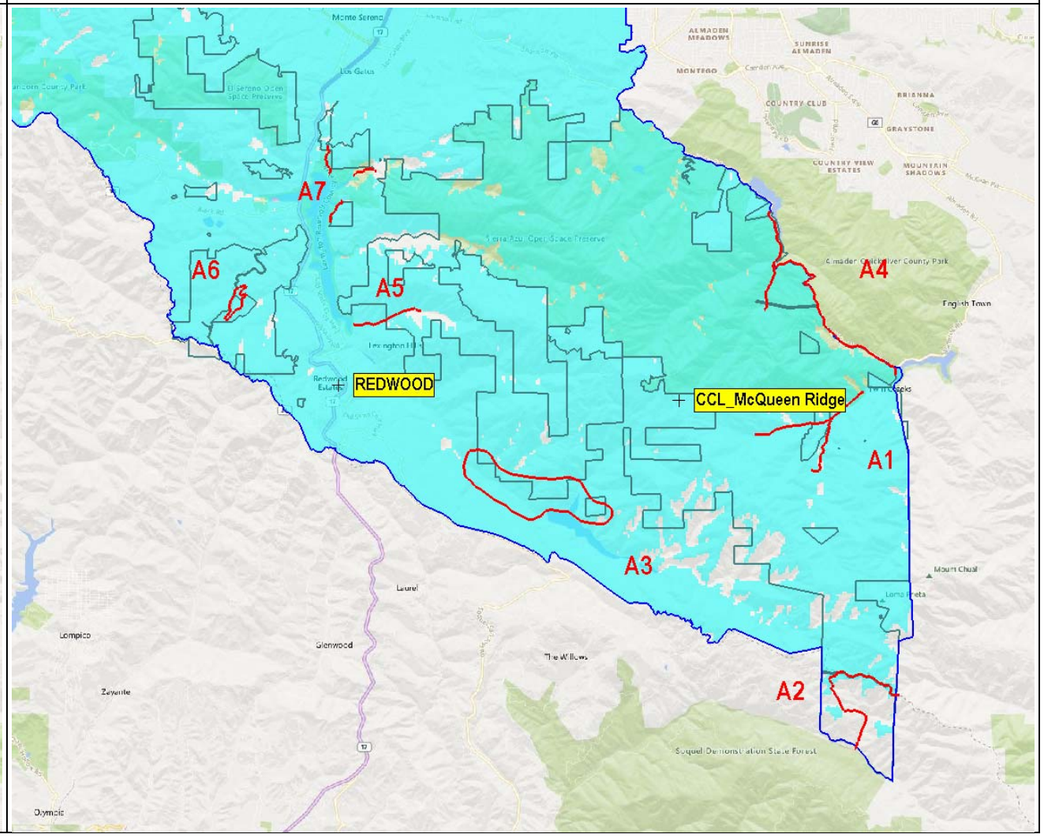
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Uplink<br><br>**Proposed New Sites:**<br>McQueen Ridge<br>(Tomita Replacement) |  |  |

**Figure 19 – Appendix D: V-UL Tomita vs. McQueen Ridge**

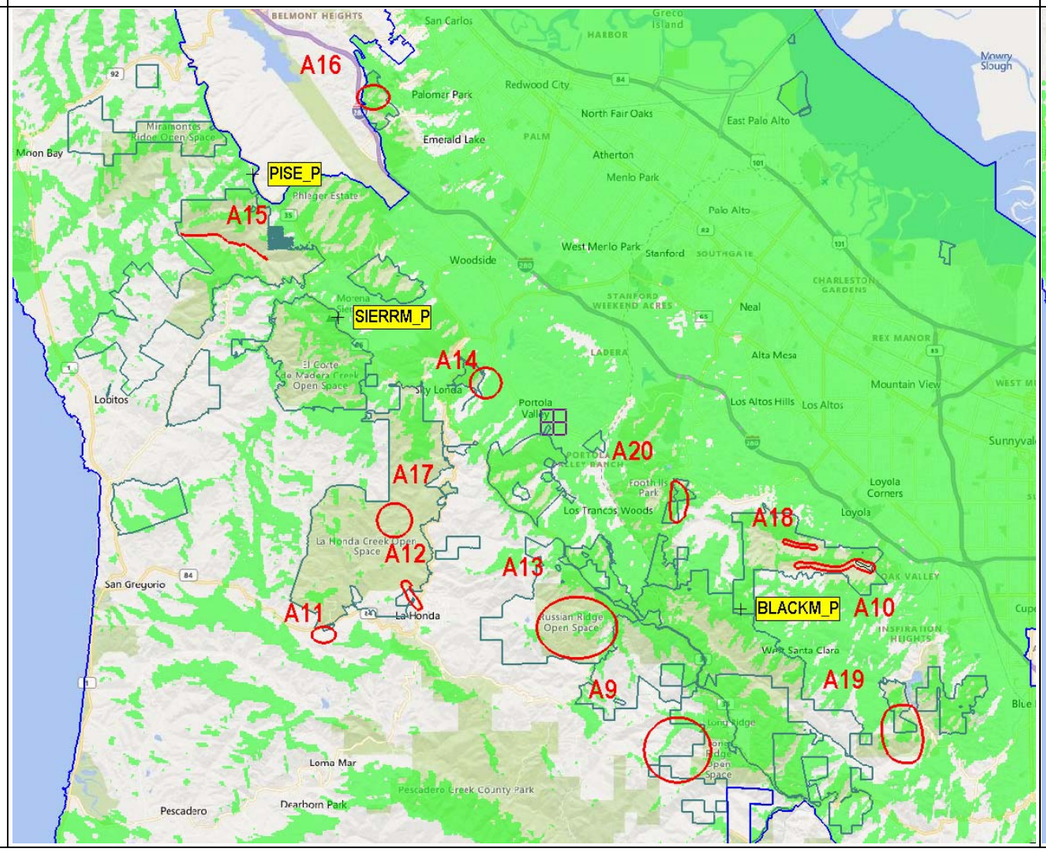
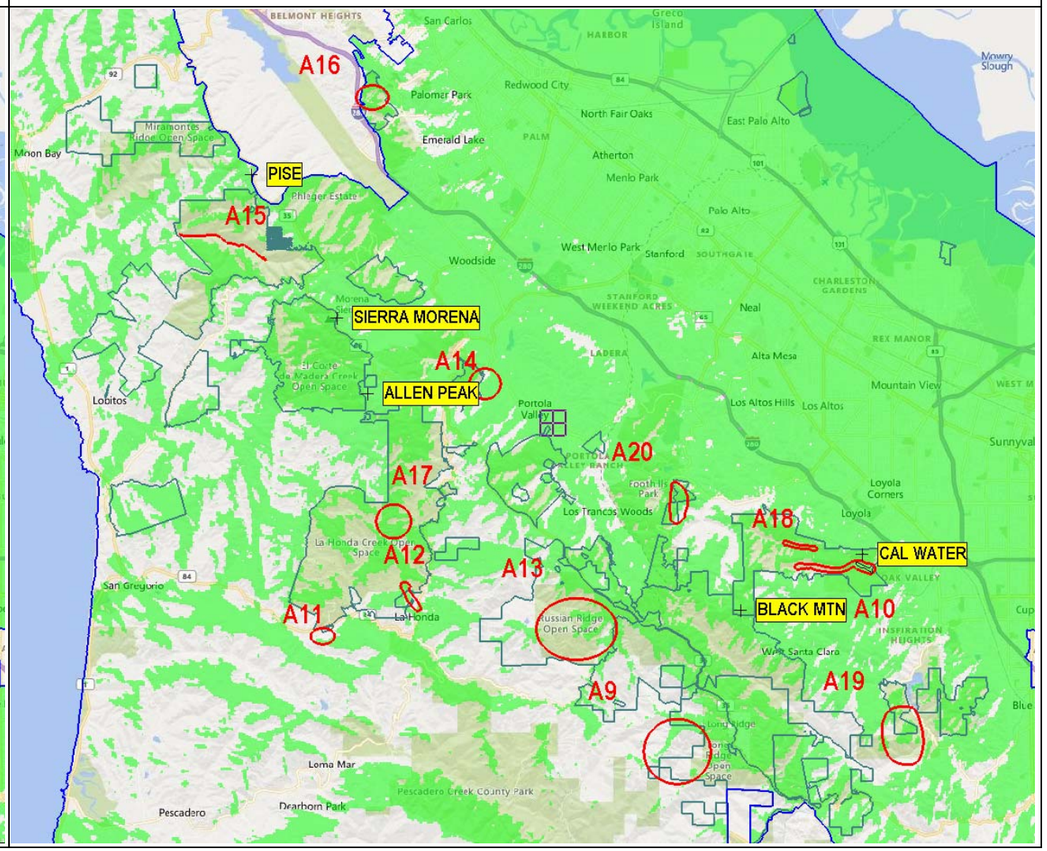
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Downlink<br><br>**Proposed New Sites:**<br>Allen Peak<br>Cal Water |  |  |

**Figure 20 – Appendix D: H-DL Allen Peak & Cal Water**

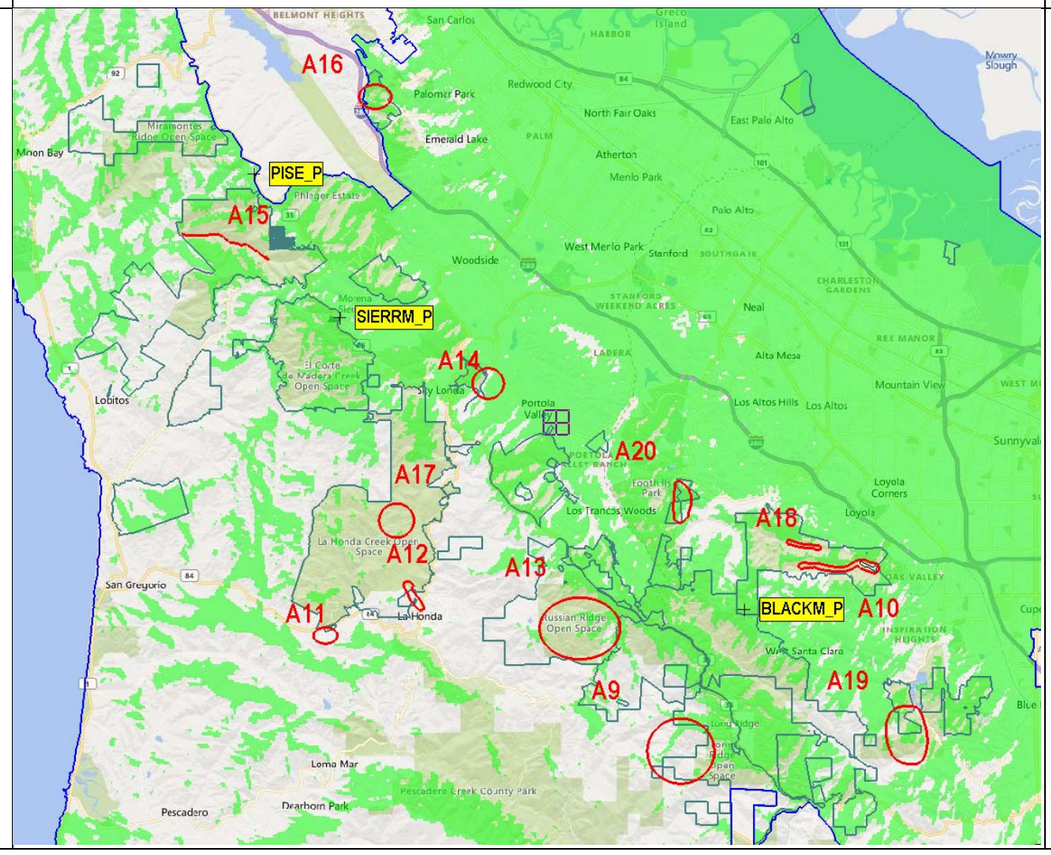
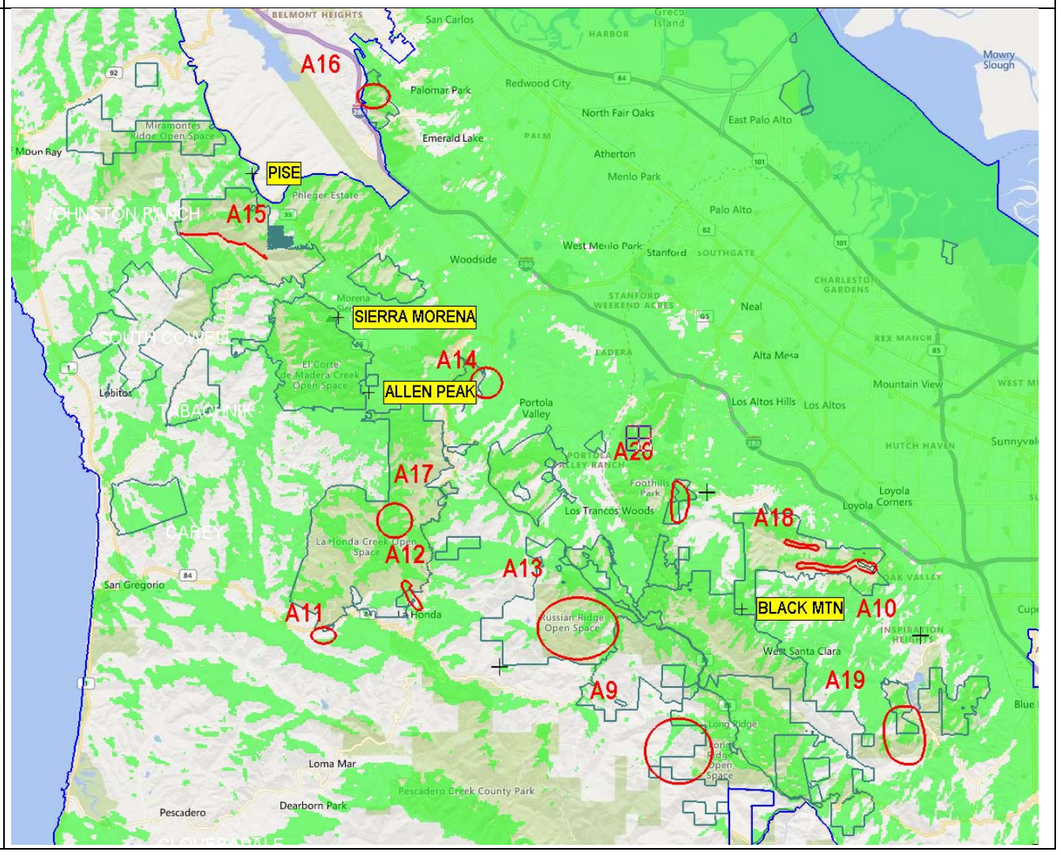
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Downlink<br><br>**Proposed New Sites:**<br>Allen Peak |  |  |

**Figure 21 – Appendix D: H-DL Allen Peak**

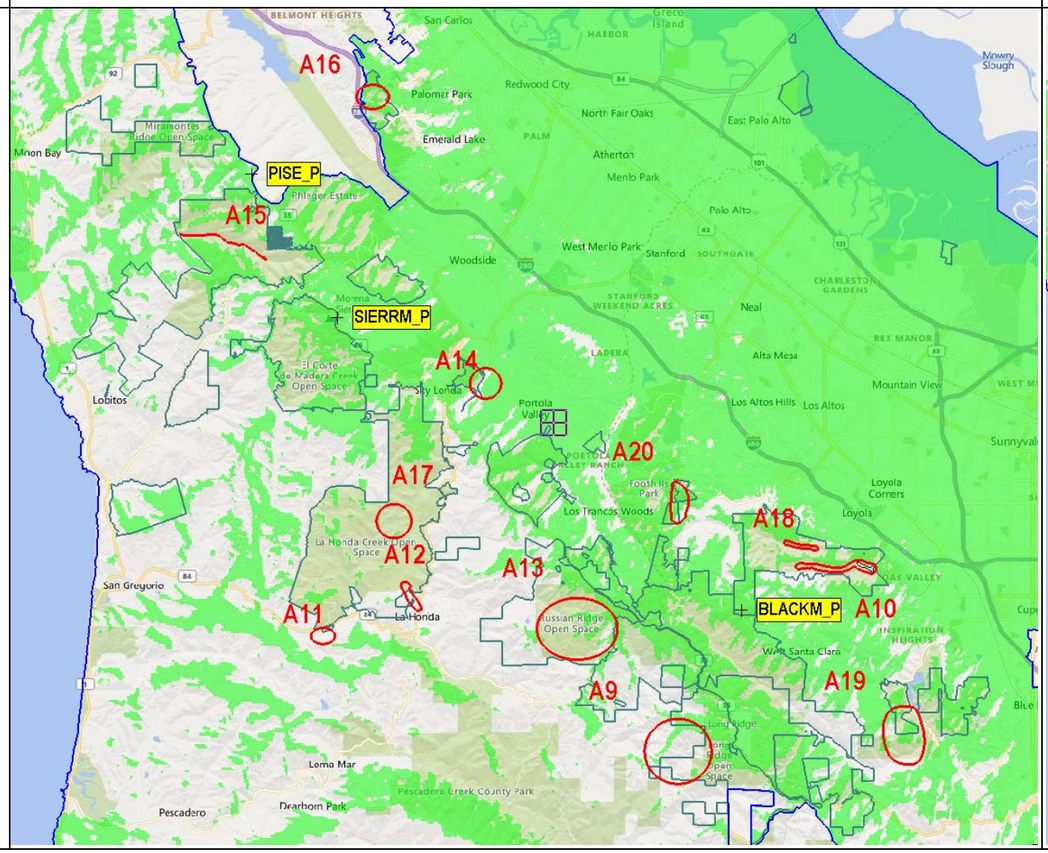
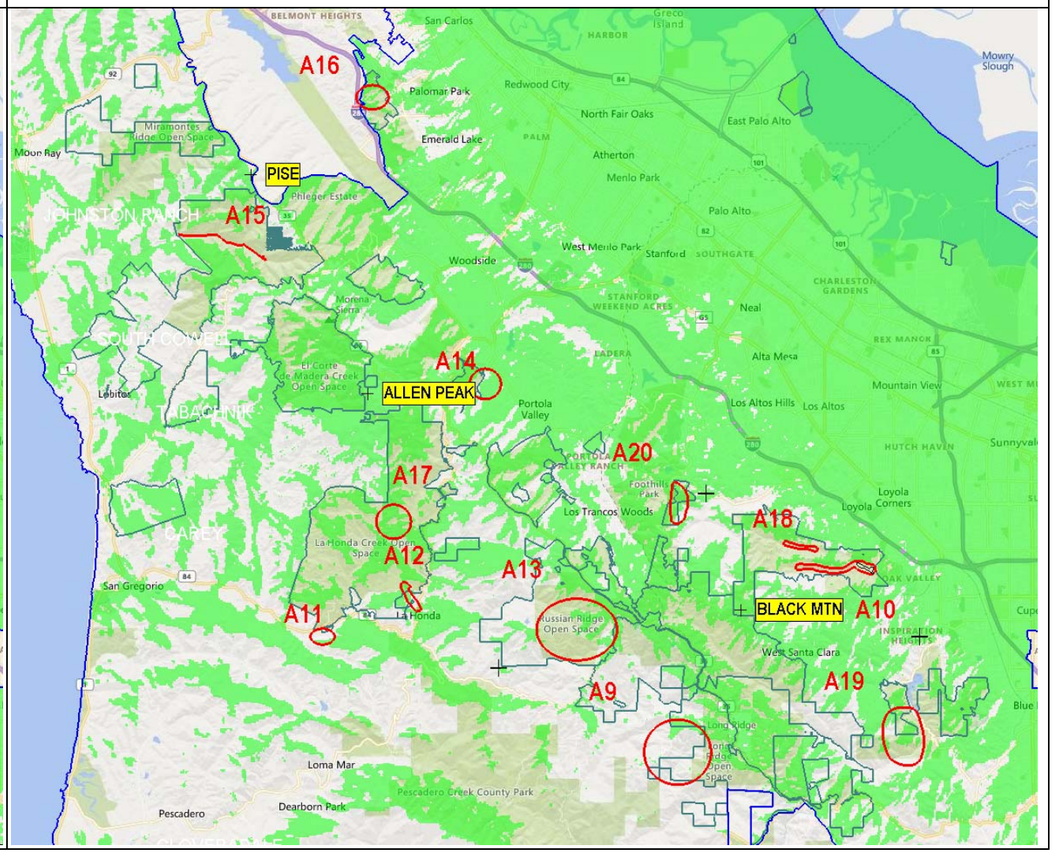
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Downlink<br><br>**Proposed New Sites:**<br>Allen Peak<br>Cal Water |  |  |

**Figure 22 – Appendix D: H-DL Sierra Morena vs. Allen Peak**

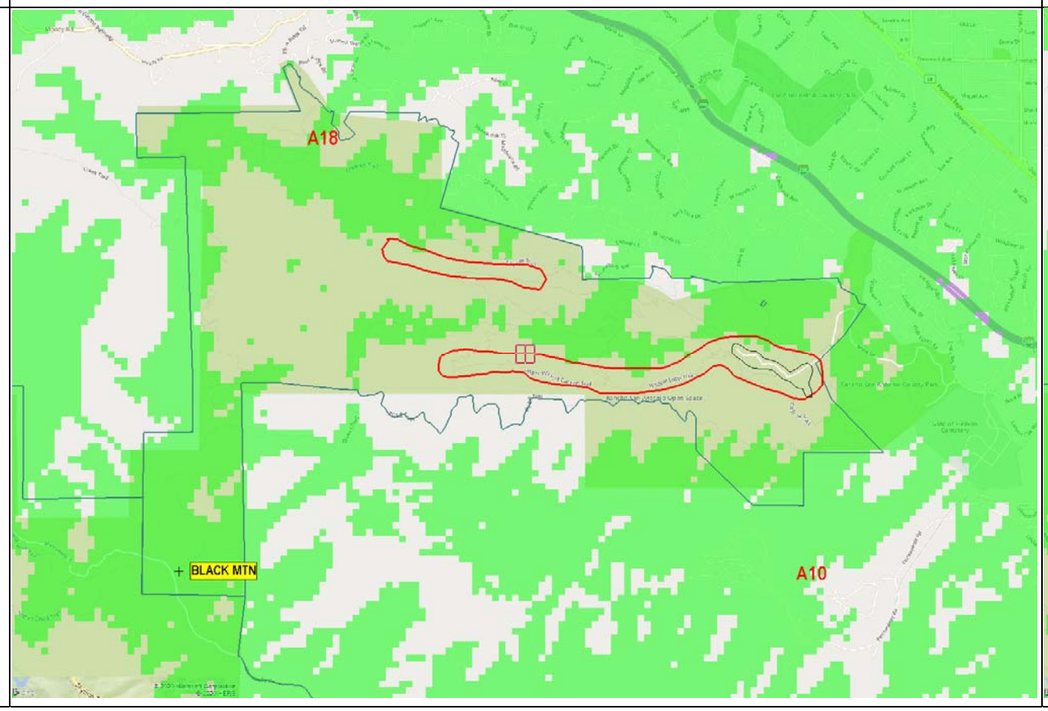
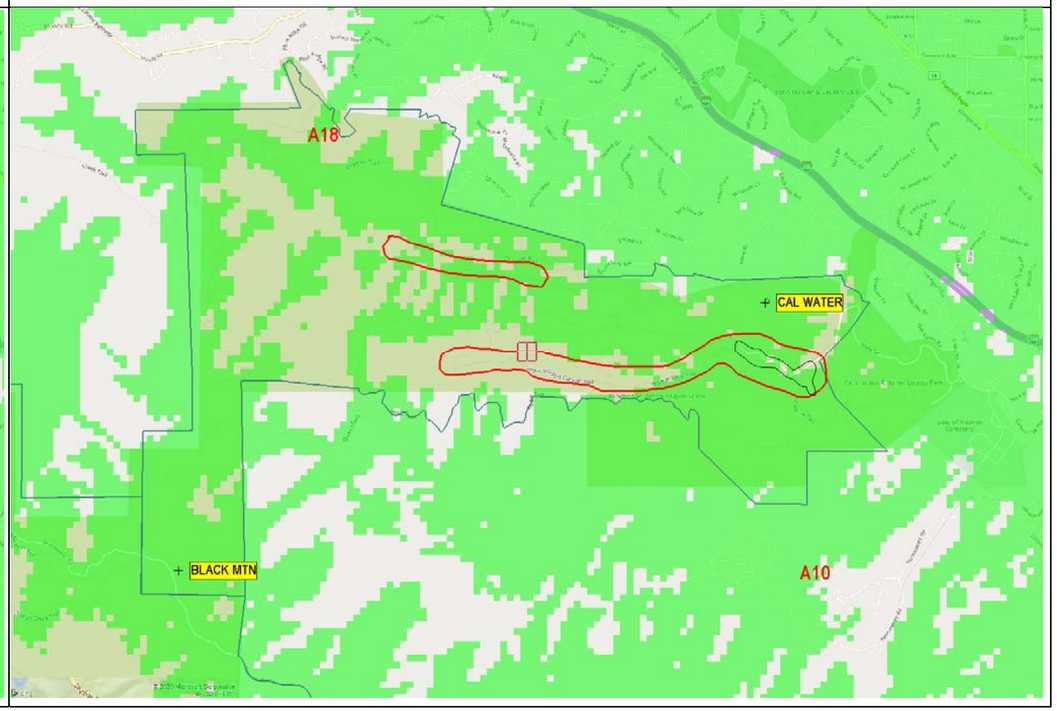
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Downlink<br><br>**Proposed New Sites:**<br>Cal Water |  |  |

**Figure 23 – Appendix D: H-DL Cal Water**

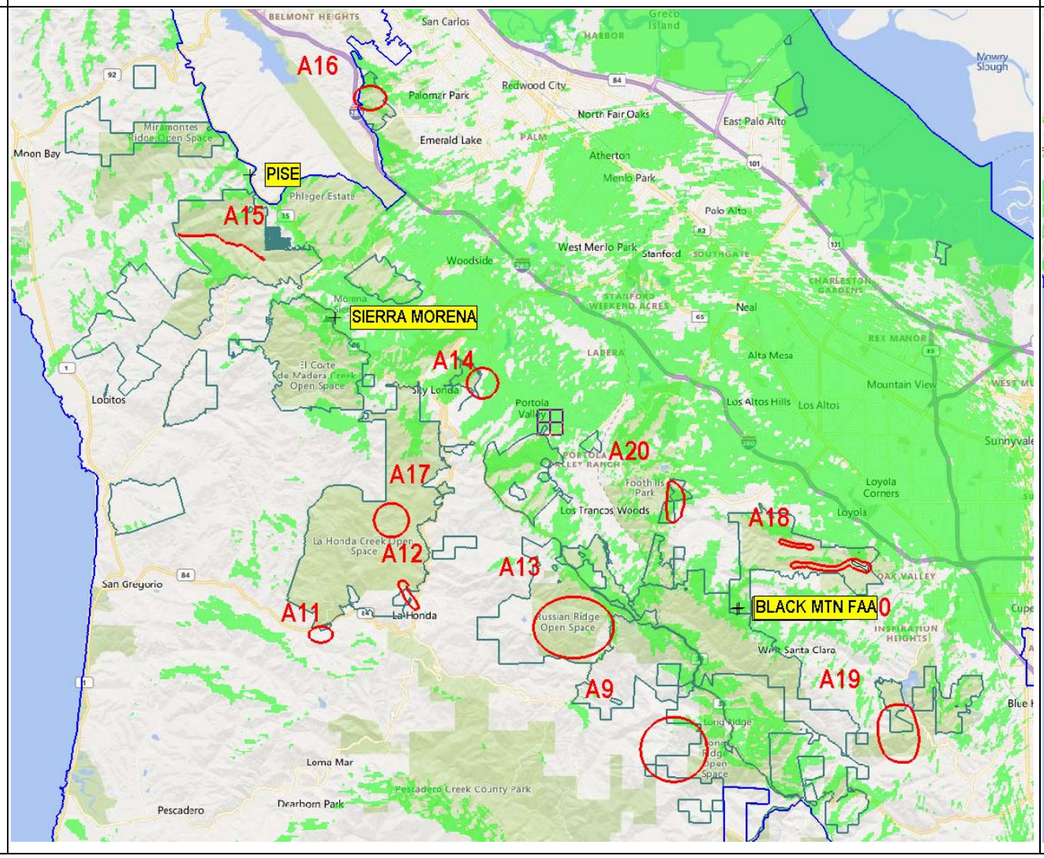
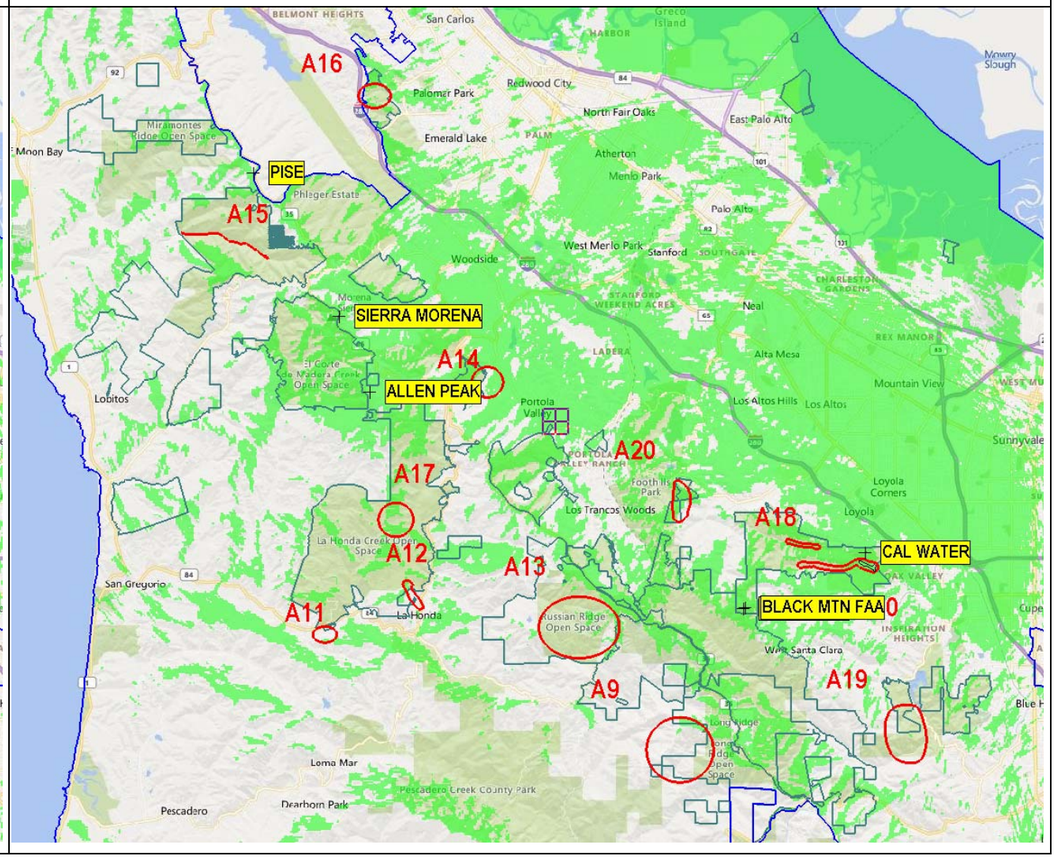
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Uplink<br><br>**Proposed New Sites:**<br>Allen Peak<br>Cal Water |  |  |

**Figure 24 – Appendix D: H-UL Allen Peak & Cal Water**

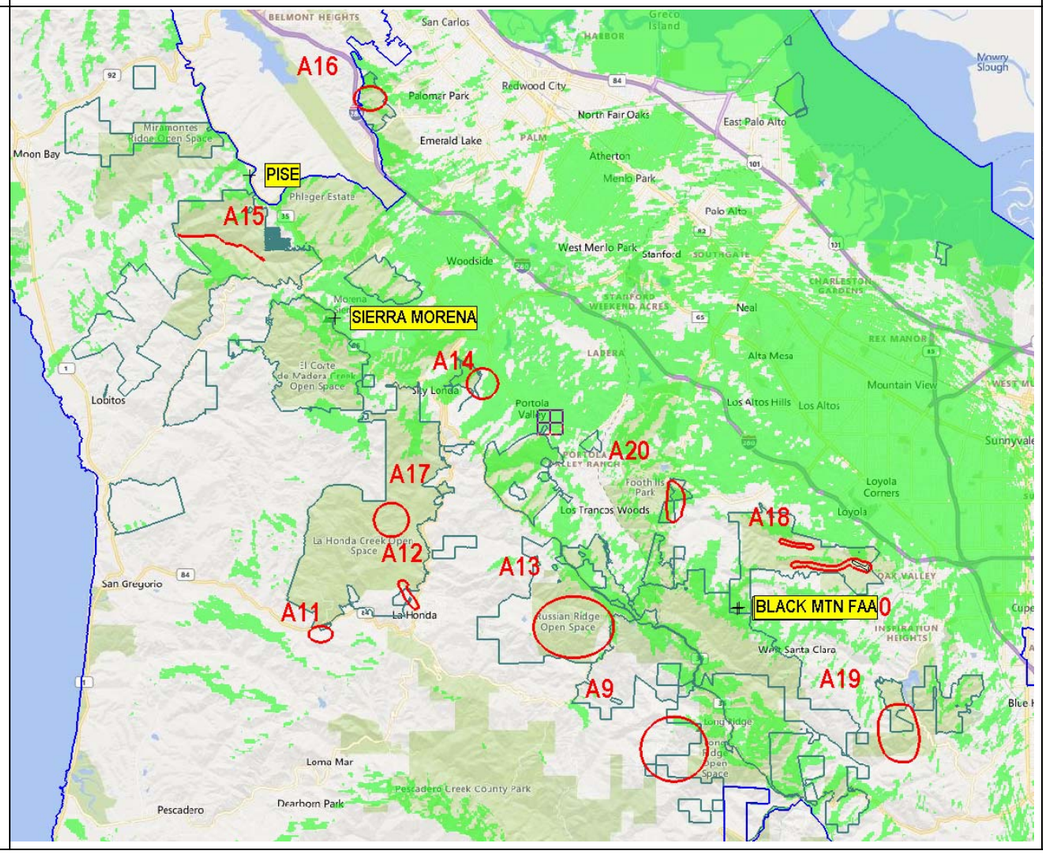
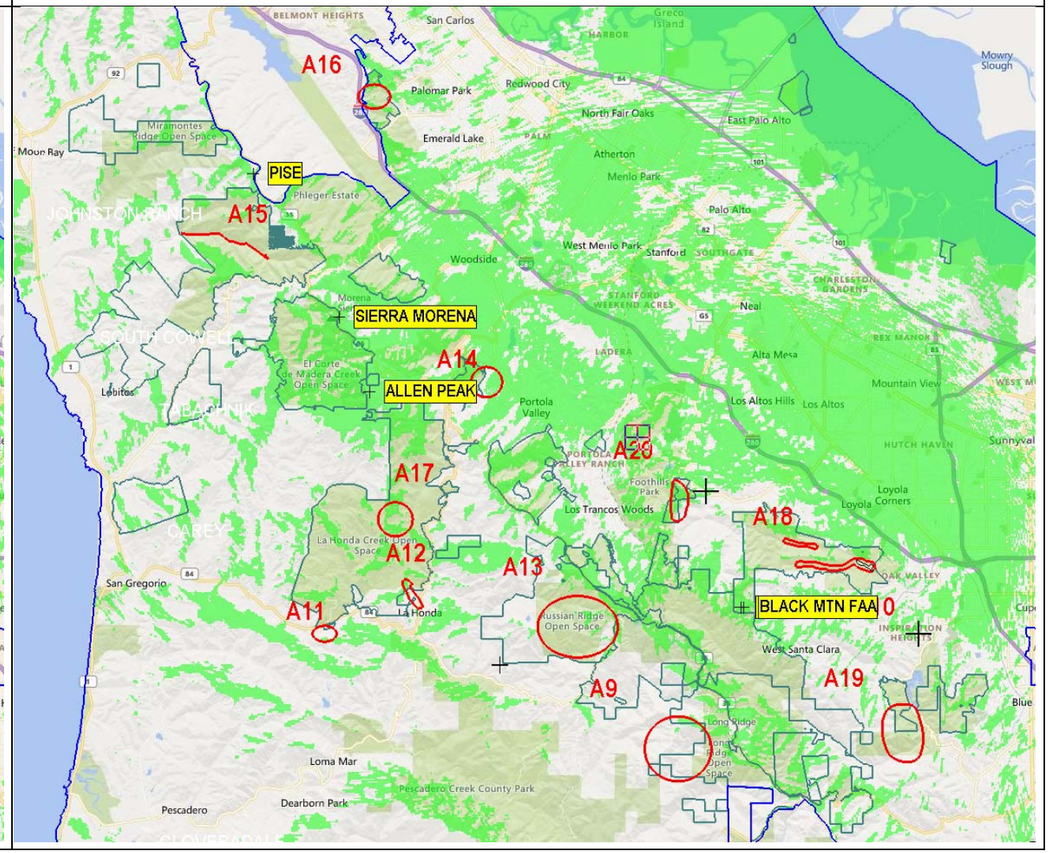
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Uplink<br><br>**Proposed New Sites:**<br>Allen Peak |  |  |

**Figure 25 – Appendix D: H-UL Allen Peak**

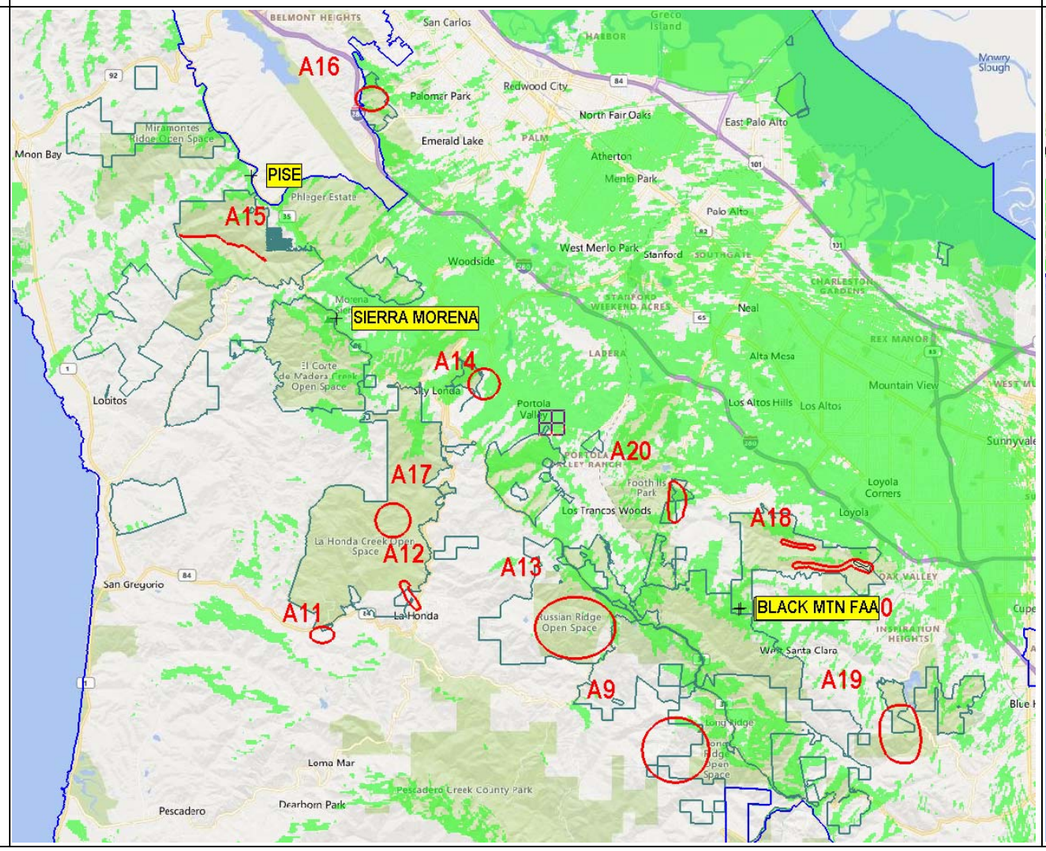
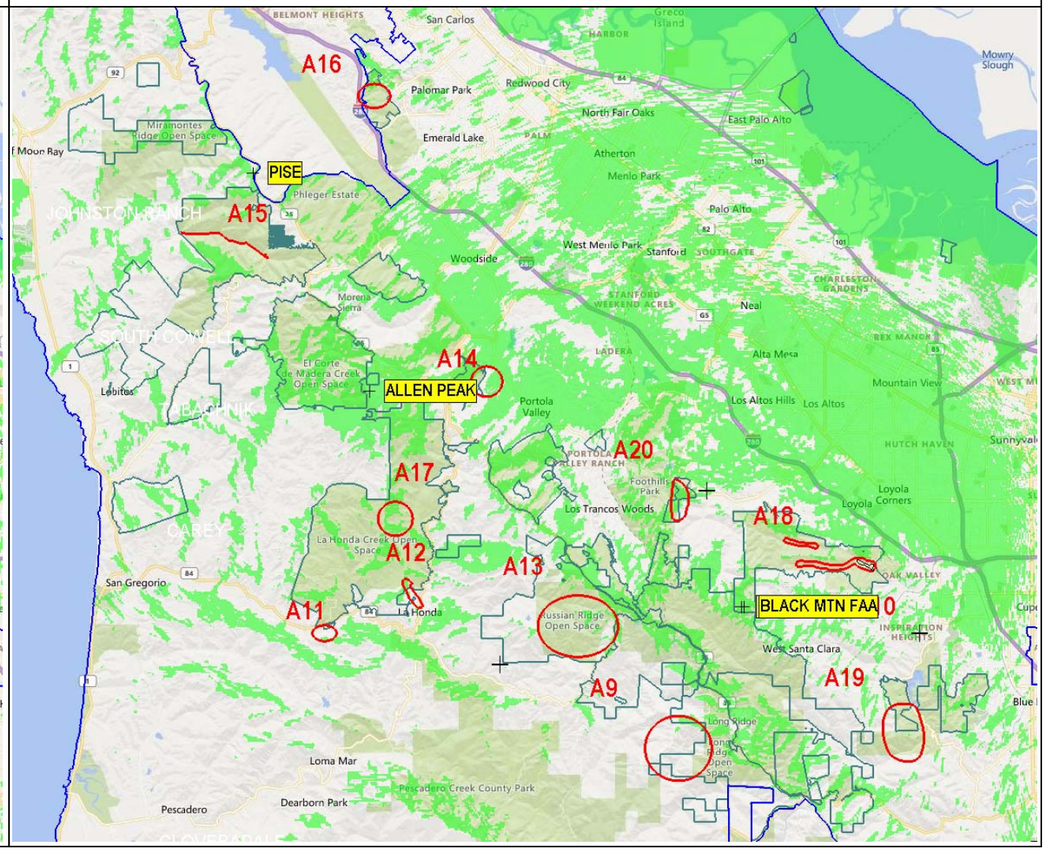
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Uplink<br><br>**Proposed New Sites:**<br>Allen Peak<br>(Sierra Morena Replacement) |  |  |

**Figure 26 – Appendix D: H-UL Sierra Morena vs. Allen Peak**

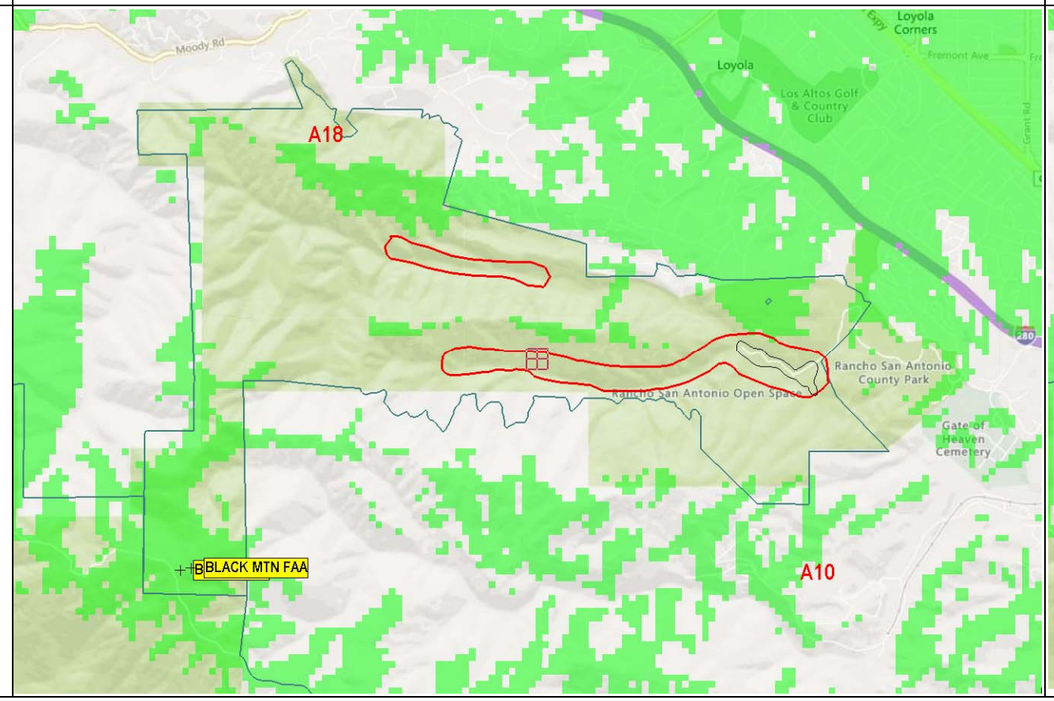
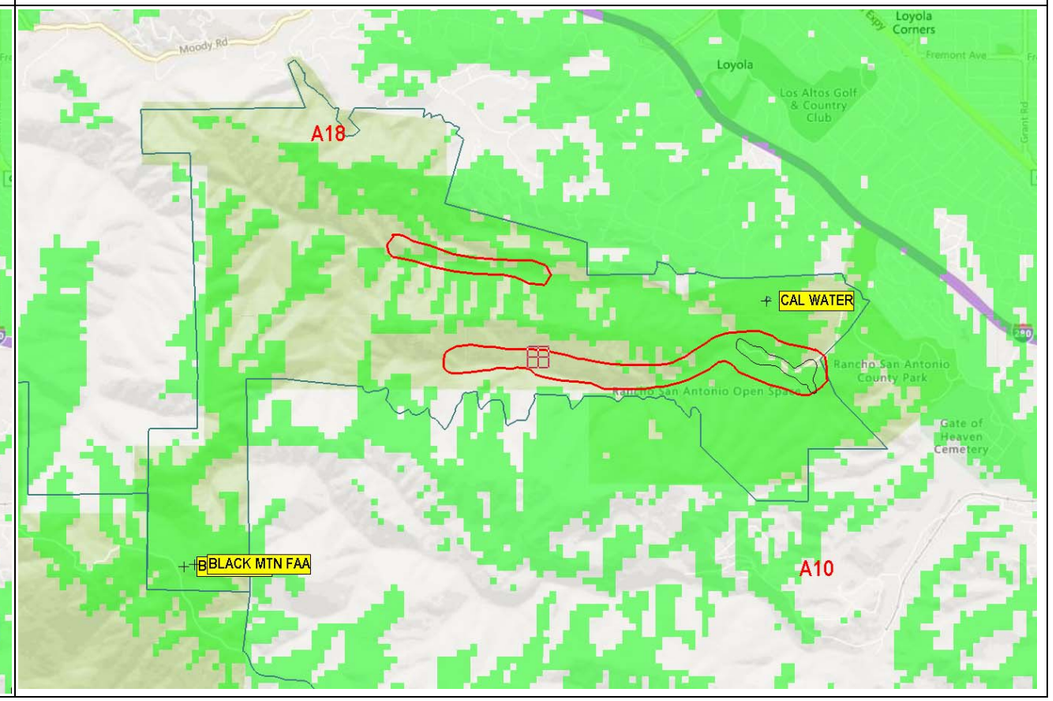
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Uplink<br><br>**Proposed New Sites:**<br>Cal Water |  |  |

**Figure 27 – Appendix D: H-UL Cal Water**

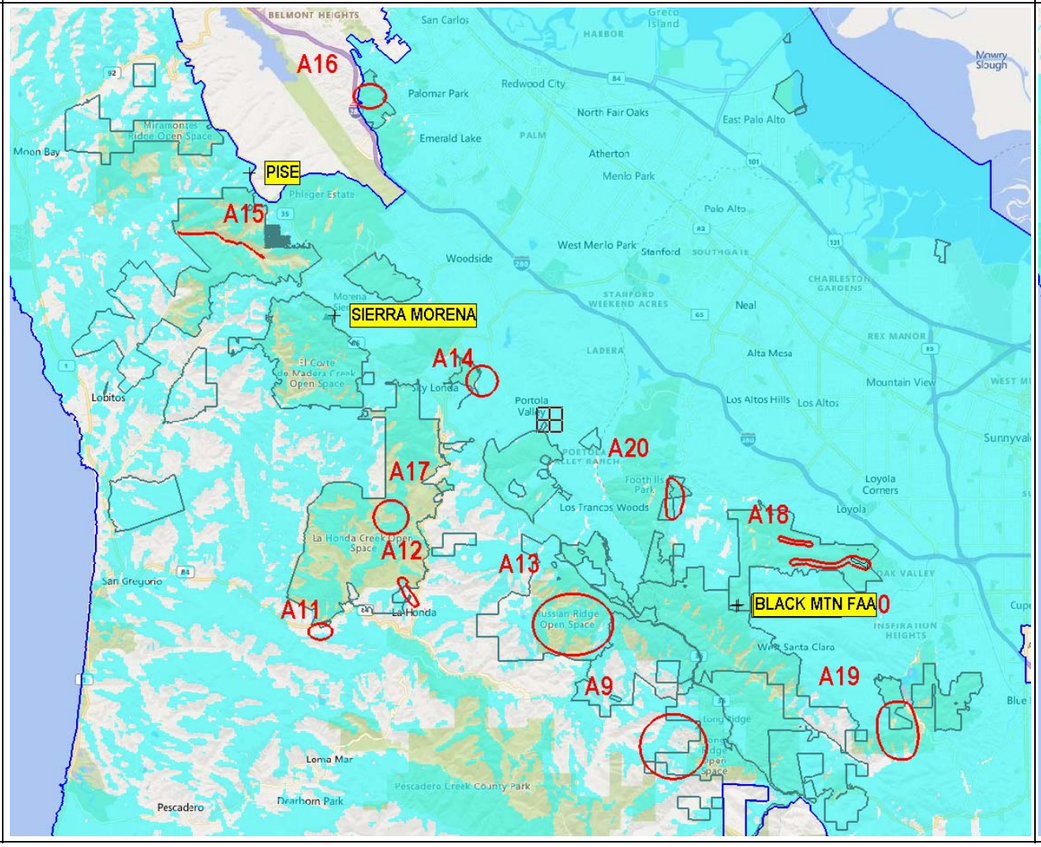
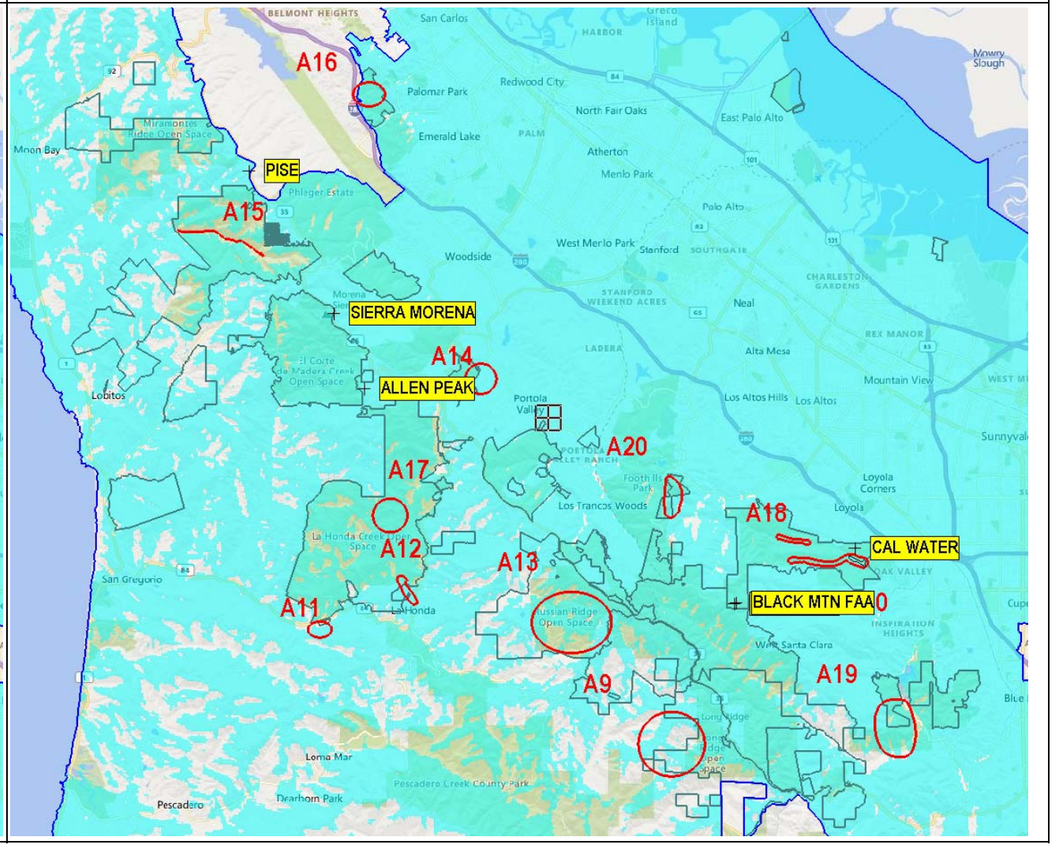
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Uplink<br><br>**Proposed New Sites:**<br>Allen Peak<br>Cal Water |  |  |

**Figure 28 – Appendix D: V-UL Allen Peak & Cal Water**

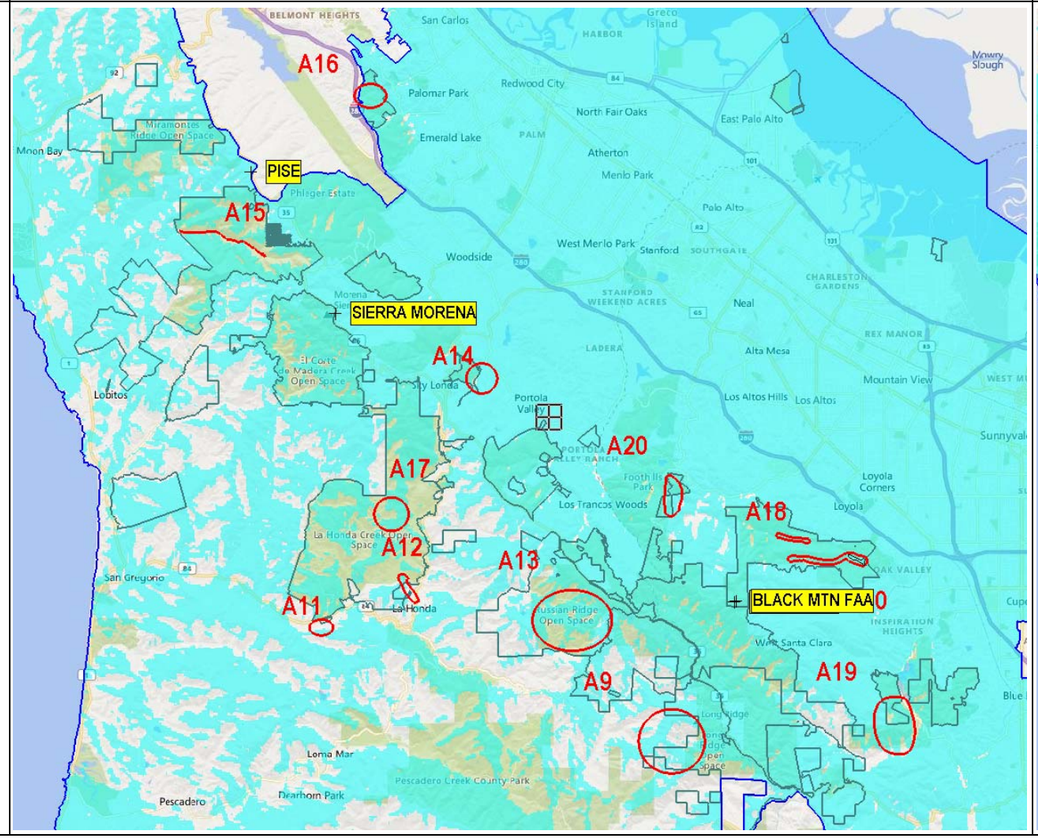
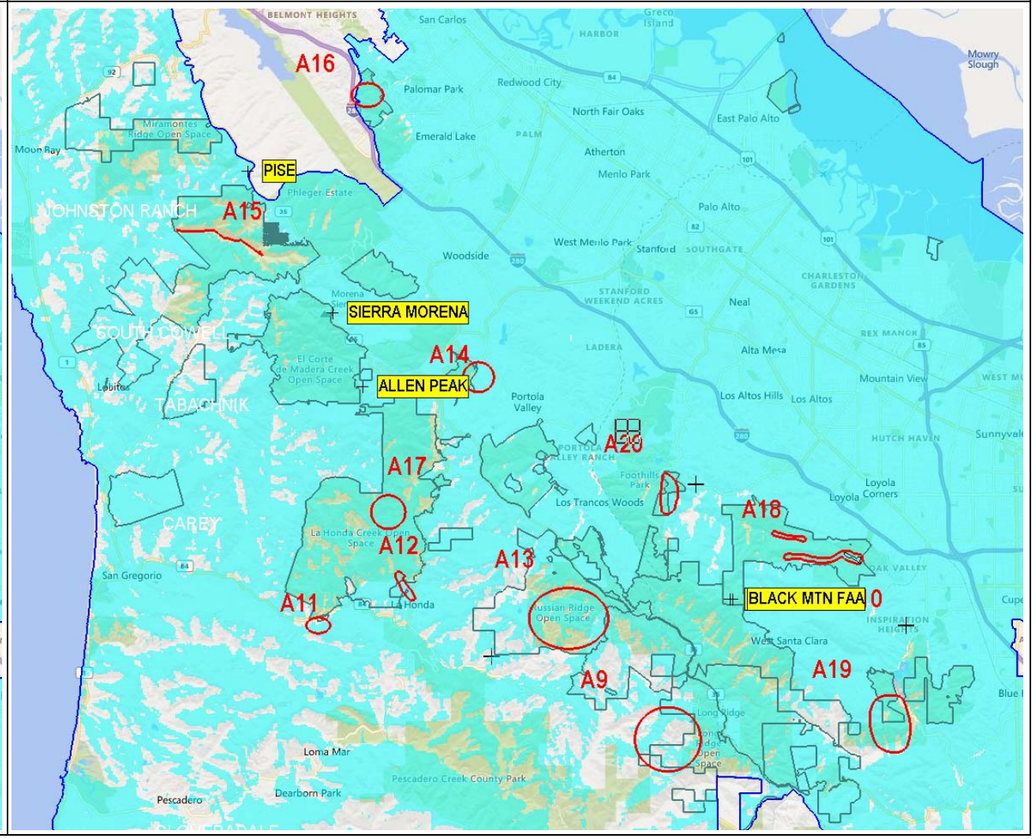
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Uplink<br><br>**Proposed New Sites:**<br>Allen Peak |  |  |

**Figure 29 – Appendix D: V-UL Allen Peak**

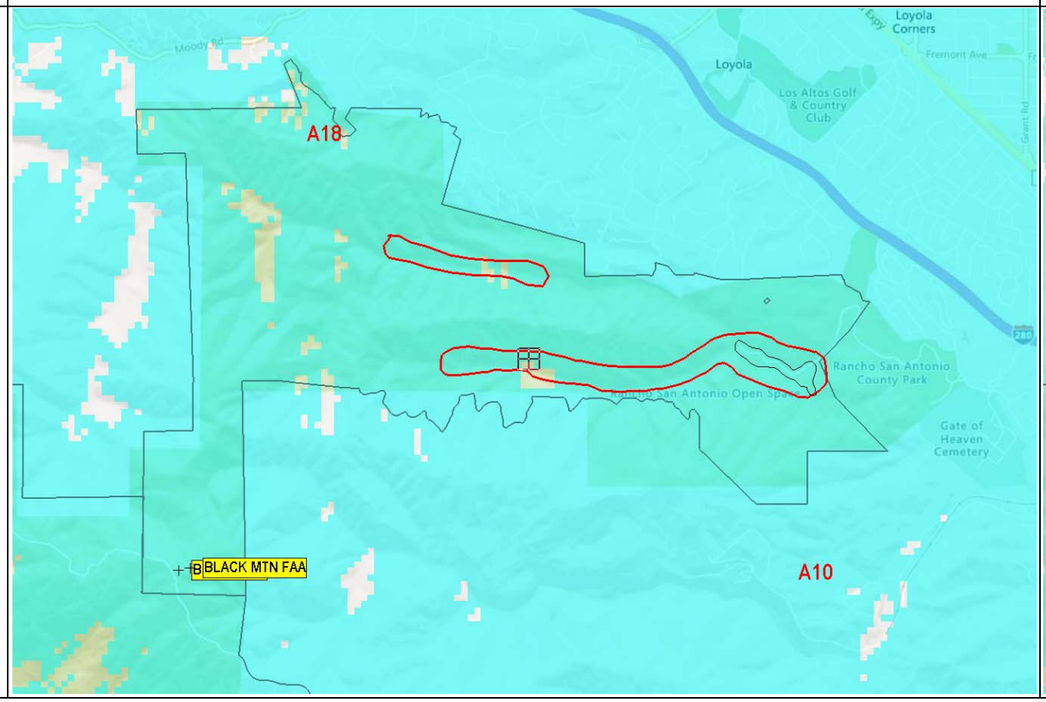
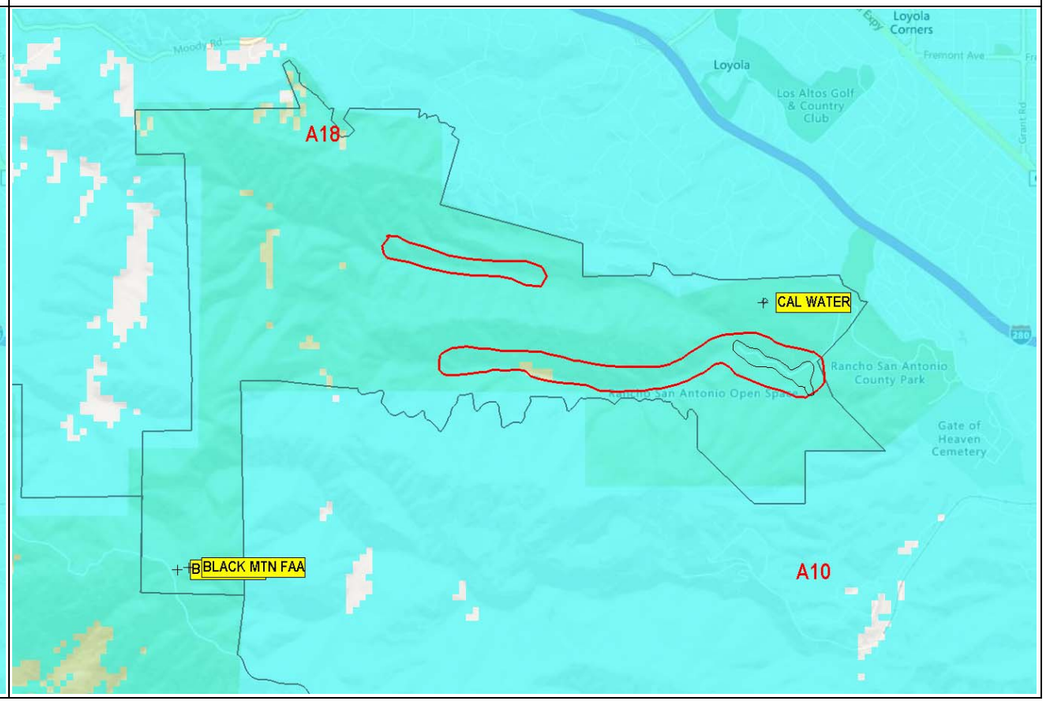
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Uplink<br><br>**Proposed New Sites:**<br>Cal Water |  |  |

**Figure 30 – Appendix D: V-UL Cal Water**

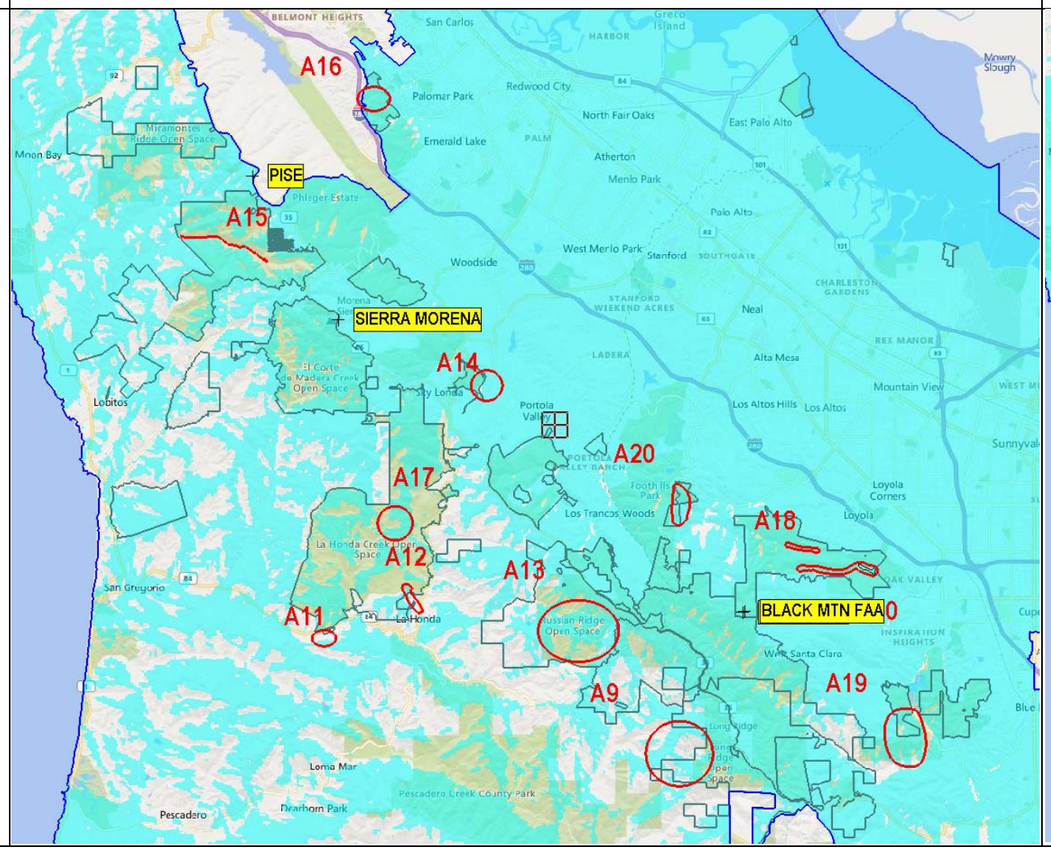
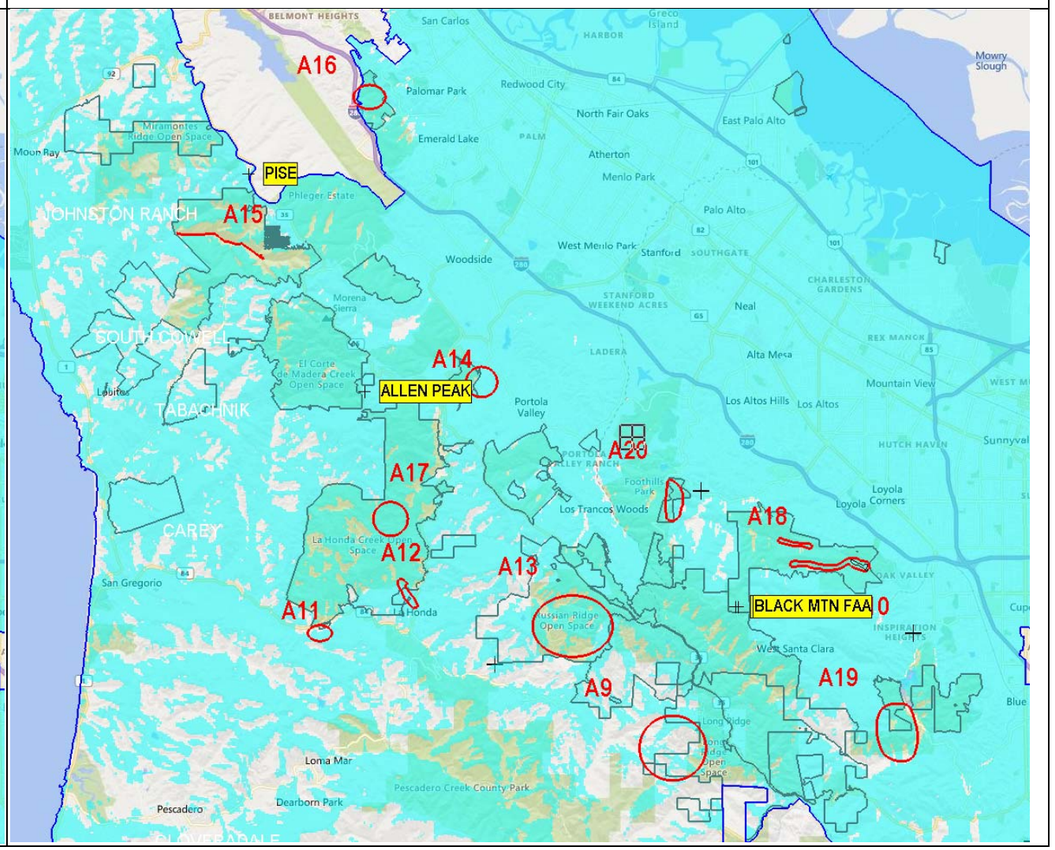
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Uplink<br><br>**Proposed New Sites:**<br>Allen Peak<br>(Sierra Morena Replacement) |  |  |

**Figure 31 – Appendix D: V-UL Sierra Morena vs. Allen Peak**

# Appendix E - District FCC Radio Licenses & Locations

## District FCC Radio Licenses & Locations

| FCC FRN: 0005751540 | | | | | *Site Name:* | Black Mountain | Coyote Peak | Pise | Sierra Morena (Skeggs Pt.) | Tomita (Umunhum) | Black Mountain (FAA) | Copernicus (Mt. Hamilton) | Redwood | Mobile |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | *Latitude:* | 37.318727 | 37.208933 | 37.455859 | 37.410657 | 37.160016 | 37.318883 | 37.346561 | 37.157579 | |
| | | | | | *Longitude:* | -122.147247 | -121.77529 | -122.34097 | -122.306894 | -121.908065 | -122.146369 | -121.630797 | -121.983945 | |
| | | | | | *Elev. AMSL (ft.)* | 2805 | 1125 | 1994 | 2342 | 3325 | 2806 | 3325 | 1486 | |
| **Primary Patrol Channels** | | | | | | | | | | | | | | |
| | | | | | *Ant. Ht. AGL (ft.):* | 70 | 105 | 30 | 78 | 41 | 40 | 40 | 80 | |
| *Channel Function* | *Channel Desig.* | *Base TX (MHz)* | *Base RX (MHz)* | *FCC Callsign* | *DL/UL Code* | *Repeaters / Receivers / Comparators* | | | | | | | | |
| PATROL | 1SCAST | 152.090 | 158.550 | WQML377 | 146.2 / 146.2 | TX/RX | TX/RX | TX/RX | TX/RX | TX/RX | RX | RX | RX | M |
| **Primary Maintenance Channels** | | | | | | | | | | | | | | |
| | | | | | *Ant. Ht. AGL (ft.):* | 42 | 105* | 45 | 96 | 47 | | | | |
| *Channel Function* | *Channel Desig.* | *Base TX (MHz)* | *Base RX (MHz)* | *FCC Callsign* | *DL/UL Code* | *Repeaters / Receivers / Comparators* | | | | | | | | |
| ADMIN | 2BM | 151.235 | 159.255 | WNVC239 | 123.0 / 123.0 | TX/RX | | | | | | | | |
| | 3MU | | | | 123.0 / 110.9 | | | | | TX/RX | | | | |
| | 4SM | | | | 123.0 / 131.8 | | | | TX/RX | | | | | |
| | 5COY | | | | 123.0 / 179.9 | | TX/RX | | | | | | | |
| | 6PIS | | | | 123.0 / 218.1 | | | TX/RX | | | | | | |
| | N/A | | | | Note 1 | TX/RX | TX/RX | TX/RX | TX/RX | TX/RX | | | | |
| **Tactical & Special Use Channels** | | | | | | | | | | | | | | |
| TACTICAL | 7MITAC | 150.775 | 150.775 | WPKE752 | 203.5 / 203.5 | | | | | | | | | M |
| MOBILE RPTR | VRPT | 173.250 | 173.250 | WQLR438 | 203.5 / 225.7 | | | | | | | | | M |
| **Interoperability / Mutual Aid Channels** | | | | | | | | | | | | | | |
| EBRPD | N/A | 45.000 | 45.000 | WNUP247 | Unknown | | | | | | | | | M |
| VFIRE22 | 34VFR22 | 154.265 | 154.265 | WPDG644 | Unknown | | | | | | | | | M |
| VFIRE21 | 33VFR21 | 154.280 | 154.280 | WPDG644 | Unknown | | | | | | | | | M |
| VFIRE23 | 35VFR23 | 154.295 | 154.295 | WPDG644 | Unknown | | | | | | | | | M |
| SCCFD CMD30 | 20SCC20 | 153.845 | 158.835 | WPGN309 | CSQ | | | | | | | | | M |

| **Microwave Path Channels - Transmit Sites** | | | | | |
|---|---|---|---|---|---|
| MICROWAVE | N/A | 4940 | 4940 | WQYW917 | SKYLINE FIELD OFFICE |
| MICROWAVE | N/A | 4940 | 4940 | WQYW917 | BLACK MOUNTAIN |
| MICROWAVE | N/A | 6655 | 6655 | WQNP835 | 1720 MONTE BELLO RD |
| MICROWAVE | N/A | 6815 | 6815 | WQNP837 | 2700 CAROL DRIVE |
| MICROWAVE | N/A | 10715 | 10715 | WQNP835 | 1720 MONTE BELLO RD |
| MICROWAVE | N/A | 11215 | 11215 | WQNP843 | 15010 SKYLINE RD/SKEGGS |
| MICROWAVE | N/A | 10715 | 10715 | WQNP845 | MT UMUNHUM/TOMITA |
| MICROWAVE | N/A | 11215 | 11215 | WQNP837 | 2700 CAROL DRIVE |
| MICROWAVE | N/A | 10915 | 10915 | WQNP835 | 1720 MONTE BELLO RD |
| MICROWAVE | N/A | 11405 | 11405 | WQNP841 | ROLPH HILL |

TX/RX - Repeater RX - Receiver M - Mobile (Vehicle or Handheld) CSQ - Carrier Squelch (no code)
Table shows actual equipment locations. Coordinates have been corrected to reflect actual antenna support location if different from FCC records.
Note 1: Community tone panels are interfaced with repeaters at each site. The enabled codes in these devices are not known.

# Appendix F – Coverage Solutions for Acquisitions

# (CONFIDENTIAL)

## Radio Coverage of Potential Acquisitions

The District is considering acquisition of four properties west of Skyline and just east of Highway 1, between Half Moon Bay and Pigeon Point. This Appendix shows existing Patrol Channel coverage in these areas and suggests some new sites for improved coverage.

## Coverage and Repeater Site Selection

There are few existing commercial tower sites serving these areas. However, as numerous San Mateo County agencies provide services here, a number of County-owned tower sites already exist. While each is equipped with microwave backhaul (which indirectly connects with existing District microwave at Rolph Peak), it will not be IP-capable until 2020 or later. As noted in Section 3.4.3, this limits the ability to simulcast these sites with the rest of the Patrol Channel network should it be replaced.

However, other options exist that could improve coverage temporarily without simulcast. FTE can review these when appropriate.

FTE assessed existing coverage and has identified some potential sites below. Due to coastal terrain challenges in all areas, these sites primarily improve vehicular coverage.[24]

| | | POOR COVERAGE | | POSSIBLE SOLUTIONS | |
|---|---|---|---|---|---|
| Area | DESCRIPTION | Handheld | Vehicle | Handheld | Vehicle |
| ACQ1 | JOHNSTON RANCH | Yes | Yes | Vehicular Repeater | Half Moon Bay PD Repeater |
| ACQ2 | SOUTH COWELL | Yes | Yes | (Note 1) | Allen Peak Repeater (Note 2) |
| ACQ3 | TABACHNIK | Yes | Yes | Vehicular Repeater | Allen Peak Repeater |
| ACQ4 | CAREY | Yes | Yes | (Note 1) | Stage Road |
| ACQ5 | CLOVERDALE | Yes | Yes | Vehicular Repeater | Pigeon Point Repeater |

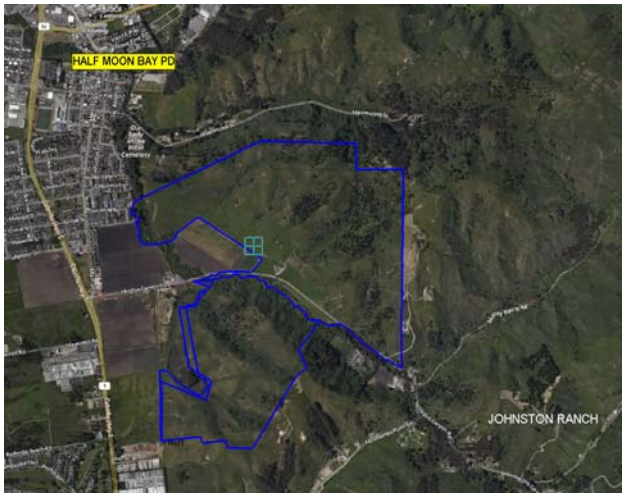
Note 1: No existing tower site could provide a significant improvement. A new greenfield tower and shelter may be required.
Note 2: Improvement here was marginal; a new greenfield tower and shelter will be required

**Table 11 – Radio Coverage Deficiencies and Solutions**

## Recommended Sites

The following sites were found to provide varying degrees of coverage improvement to one or more areas. Pictures may also show nearby tower sites used by the District.

[24] New Greenfield tower sites must be developed to provide reliable handheld coverage.

| | |
|---|---|
| **Half Moon Bay PD**<br>Elevation: 58 ft.<br>Coordinates: 37.465750/ -122.431889<br>Apparent Owner: Half Moon Bay or San Mateo Co.<br><br>Site Notes: Space and availability needs to be confirmed.<br><br>Backhaul Connectivity: San Mateo Co. microwave. |  |
| **Allen Peak (Lookout)**<br>Elevation: 2,315 ft.<br>Coordinates: 37.386833 / -122.294722<br>Apparent Owner: State of California / CalFire<br><br>Site Notes: Communications tower is located near a Fire Lookout here. Availability needs to be confirmed.<br><br>Site might replace Sierra Morena.[25]<br><br>Backhaul Connectivity: Possible connectivity to Black Mtn. (preferred), Coyote or Copernicus. Must be confirmed. |  |

[25] Moving or eliminating a site must be done carefully as coverage will change, impacting field operations.

| | |
|---|---|
| **Stage Road (Planned Future Co. Site)**<br>Elevation: 787 ft.<br>Coordinates: 37.309556/ -122.379278<br>Apparent Owner: San Mateo Co.<br><br>Site Notes: County considered developing this site in the past. There may be an opportunity for joint development here.<br><br>Backhaul Connectivity: To be determined. |  |
| **Pigeon Point**<br>Elevation: 498 ft.<br>Coordinates: 37.193056/ -122.368333<br>Apparent Owner: San Mateo Co.<br><br>Site Notes: A County shelter and a short tower exists here. County indicates that little to no space exists in the shelter, but they might be interested in working with the District to install a larger one.<br><br>Backhaul Connectivity: Existing County microwave. |  |

## Proposed Coverage Solutions

Radio coverage prediction maps for current and proposed Patrol Channel coverage follow.

Locations with reliable handheld radio coverage is always shown as green, while reliable vehicle coverage is shown in blue. Two-way radio coverage consists of a “downlink” and an “uplink” signal path. These maps represent the uplink signal path as this was found to be the worse-case direction.

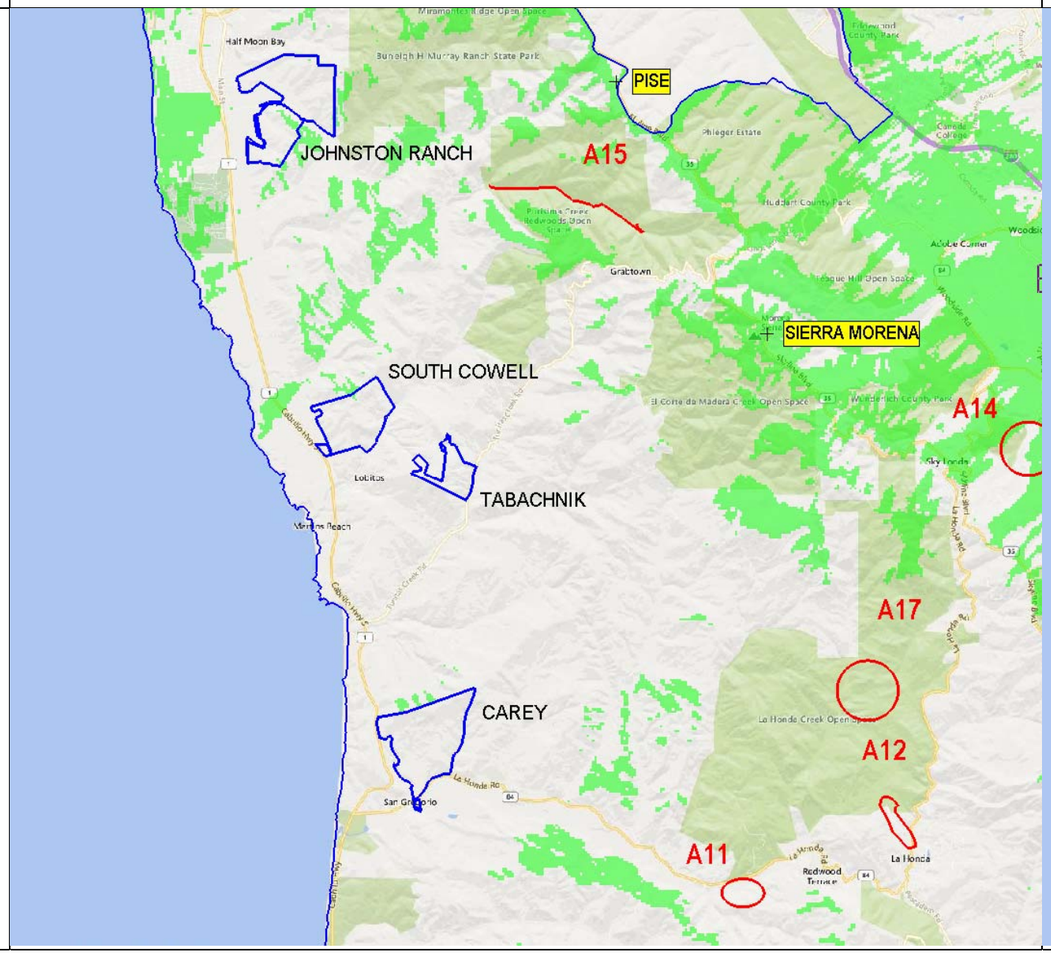
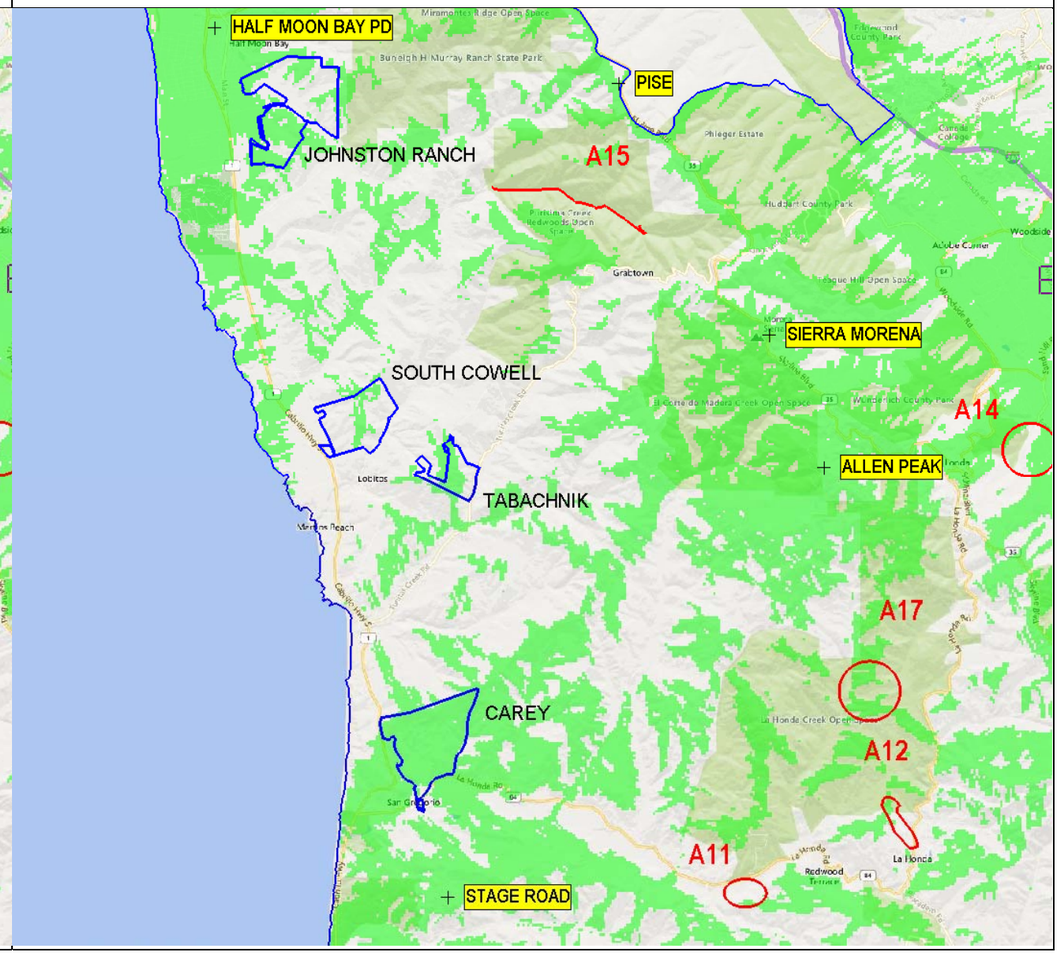
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Uplink<br><br>**Proposed New Sites:**<br>Half Moon Bay PD<br>Allen Peak<br>Stage Road<br><br>**Note:**<br>Johnstone Ranch is served by HMB PD site<br>Tabachnik is served by Allen Peak site<br>Carey site is served by Stage Road site |  |  |

**Figure 18 – Appendix D: H-DL Half Moon Bay PD, Allen Peak & Stage Road**

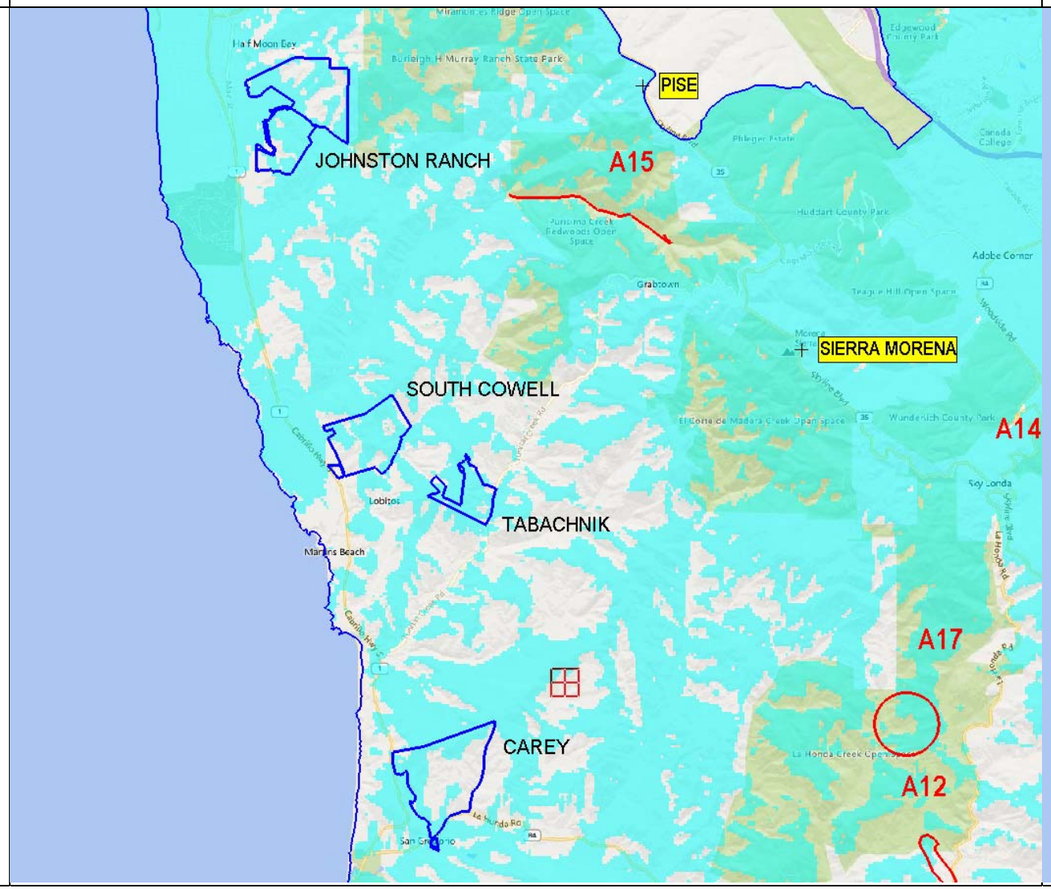
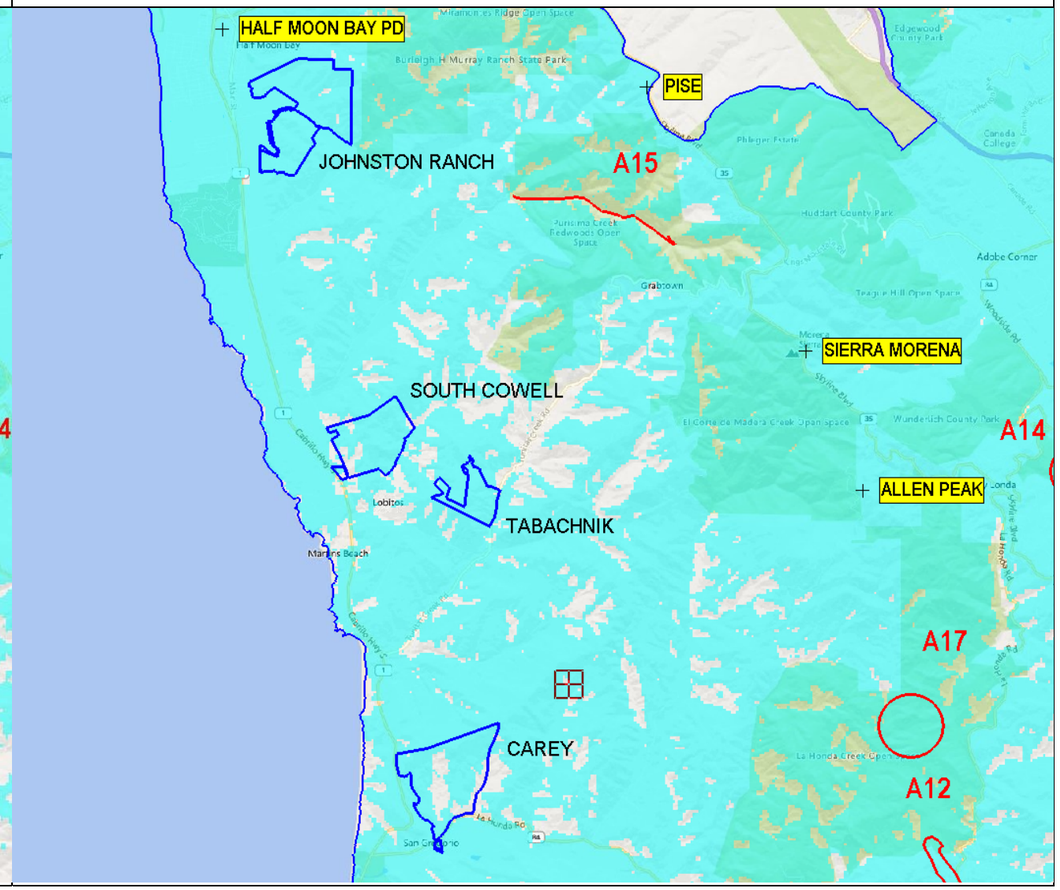
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Uplink<br><br>**Proposed New Sites:**<br>Half Moon Bay PD<br>Allen Peak<br><br>**Note:**<br>Johnstone Ranch is served by Pise and HMB PD site<br>South Cowell is served by Pise and Allen Peak<br>Tabachnik is served by Pise, Black and Allen Peak site<br>Carey site is served by Black, Sierra Morena and the Allen Peak site<br>Stage Road site would cover the entire Carey property if present. |  |  |

**Figure 19 – Appendix D: V-UL Half Moon Bay PD & Allen Peak**

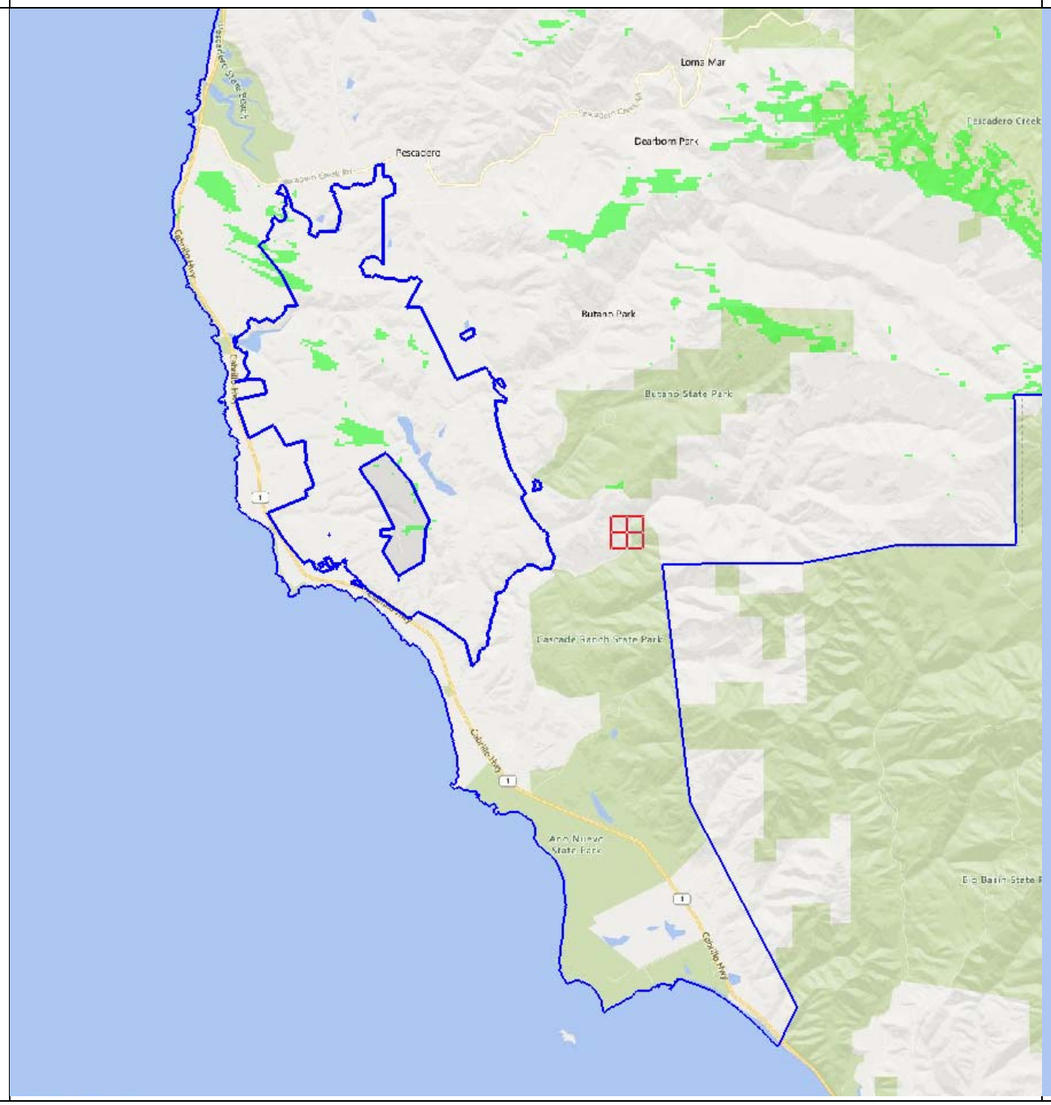
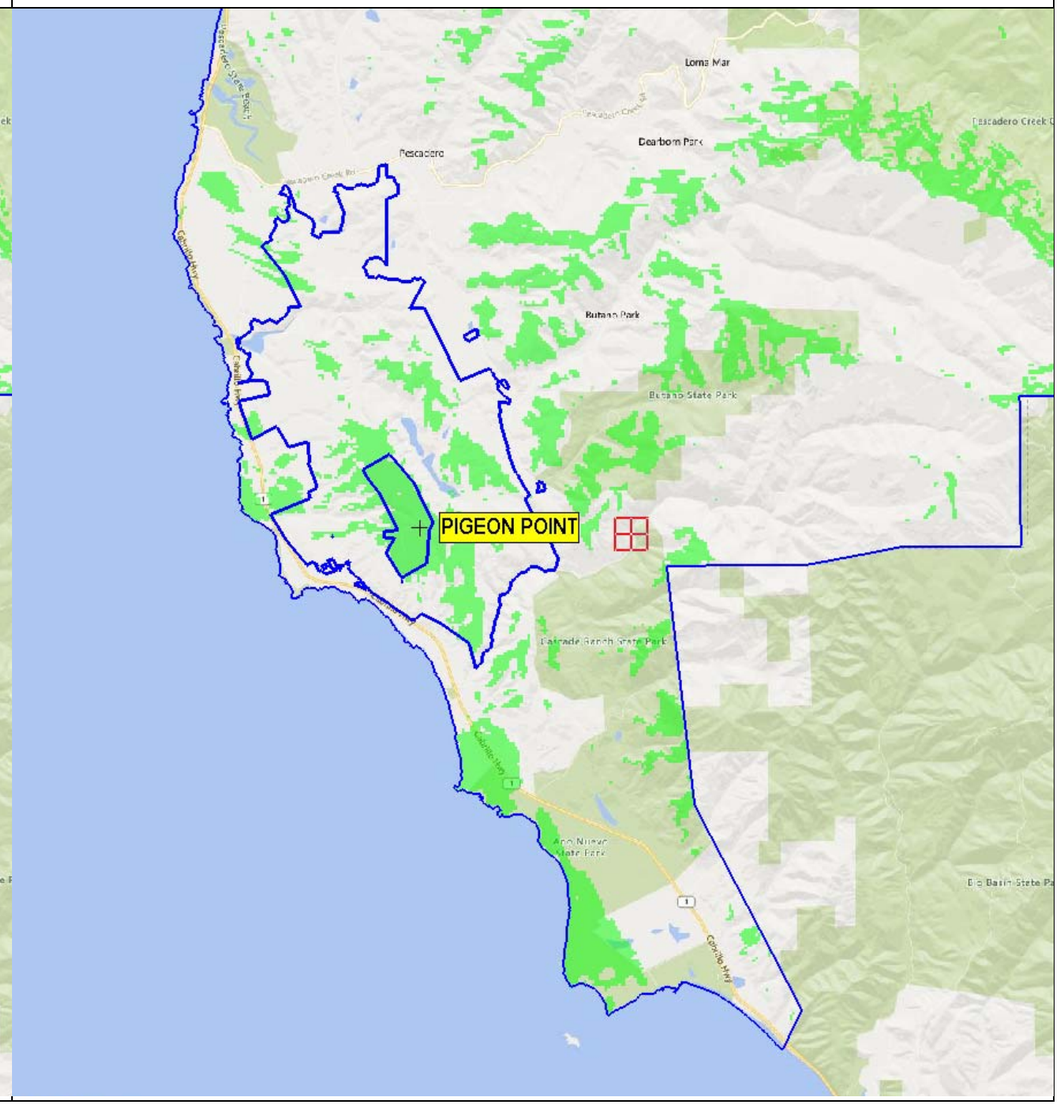
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Handheld Uplink<br><br>**Proposed New Sites:**<br>Pigeon Point |  |  |

**Figure 20 – Appendix D: H-UL Pigeon Point**

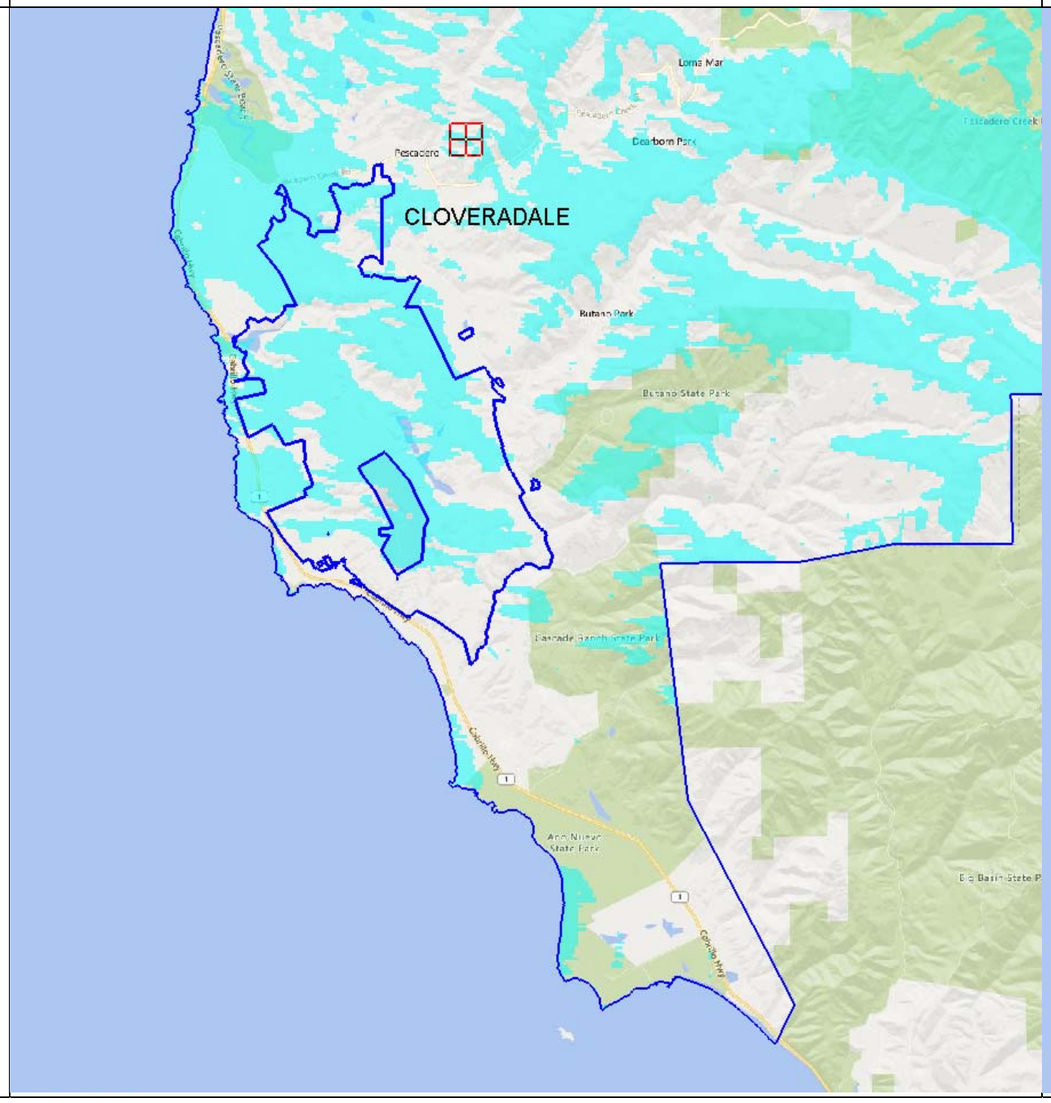
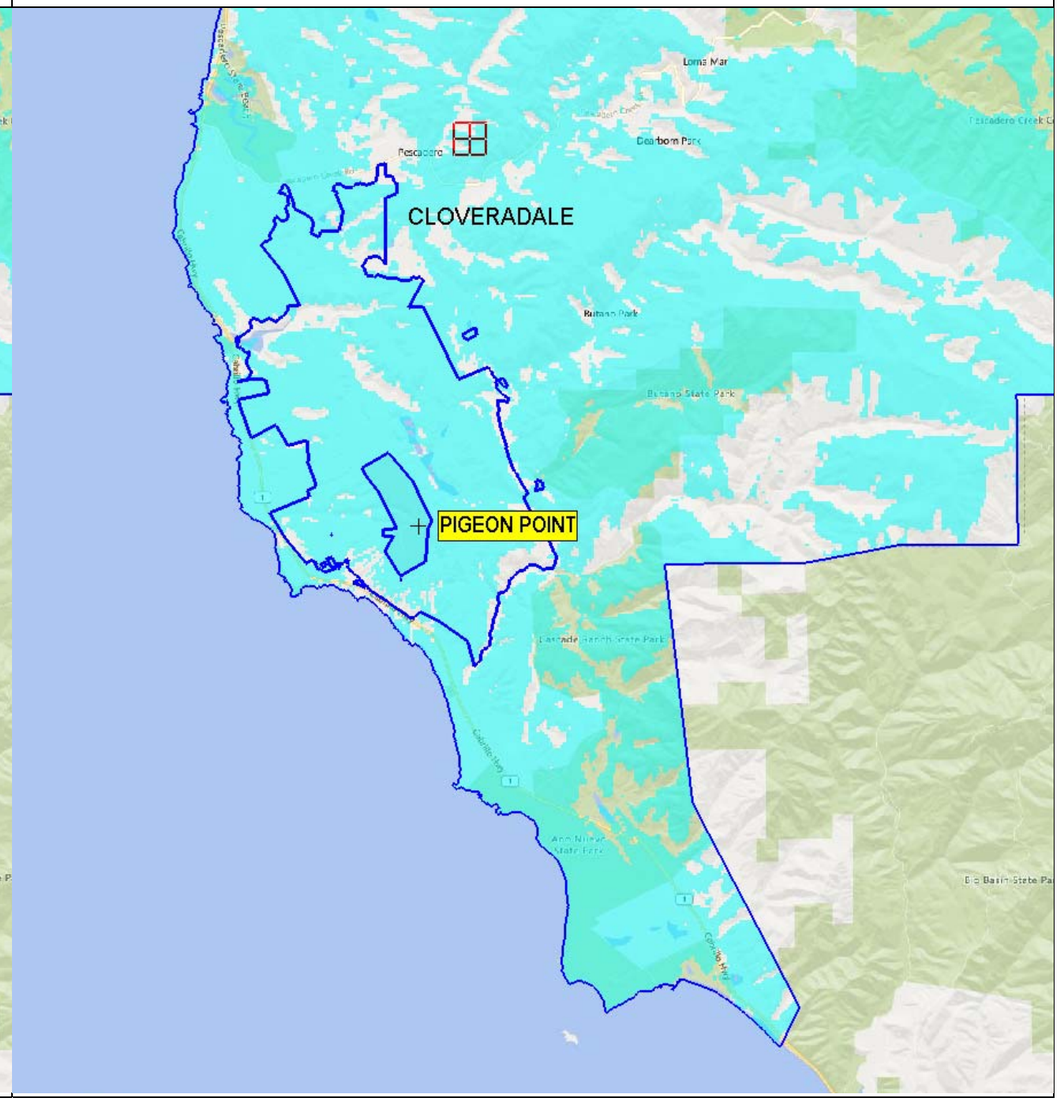
| DESCRIPTION | EXISTING COVERAGE | PROPOSED COVERAGE |
|---|---|---|
| **Map Type:**<br>Vehicle Uplink<br><br>**Proposed New Sites:**<br>Pigeon Point<br><br>**Note:**<br>Existing coverage in the Cloverdale area is provided by Sierra Morena and Pise. |  |  |

**Figure 21 – Appendix D: V-UL Pigeon Point**

## Cost Details

Costs applied to each acquisition are associated as shown below:

- Cost Item 11: Johnston Ranch (ACQ1)
- Cost Item 9 (restated here): South Cowell & Tabachnik (ACQ2 & ACQ3)
- Cost Item 12: Carey (ACQ4)
- Cost Item 13: Cloverdale (ACQ5)

| ***Item 11: Install New Patrol Repeater at Half Moon Bay PD (Johnston Ranch)*** | ***Cost Estimate*** |
|---|---|
| **Radio System**<br>Provides a new simulcast repeater, antenna and backup battery power using the existing shelter and tower at this site.<br><br>Improves coverage in the **Johnston Ranch** area.<br><br>Note: Equipment space and lease issues need confirmation. | $59,000 |
| **Site Backhaul**<br>***San Mateo County Microwave*** **:** Includes costs to interface with existing San Mateo Co. microwave equipment. Note that it will not be IP-capable until 2022 or after (this is a requirement for new simulcast repeaters). Some temporary options exists however. | $17,000 |
| **Changes in Recurring Costs** (Present Worth, 4% money, 3% escalation, 10-year term)<br>***Site Lease Costs:*** *For indoor equipment rack in existing shelter; utility power.* | $200,000 |
| **Professional Engineering Services:** Site planning, radio and microwave engineering, oversee and test final system w/County. | $13,000 |
| ***Total:*** | ***$289,000*** |

| ***Item 9: Install New Patrol Repeater at Allen Peak (South Cowell & Tabachnik)*** | ***Cost Estimate*** |
|---|---|
| **(This cost item was previously shown earlier in report; it is restated here for completeness).**<br>Improves Coverage in the South Cowell and Tabachnik areas. | |
| ***Total:*** | ***$416,000*** |

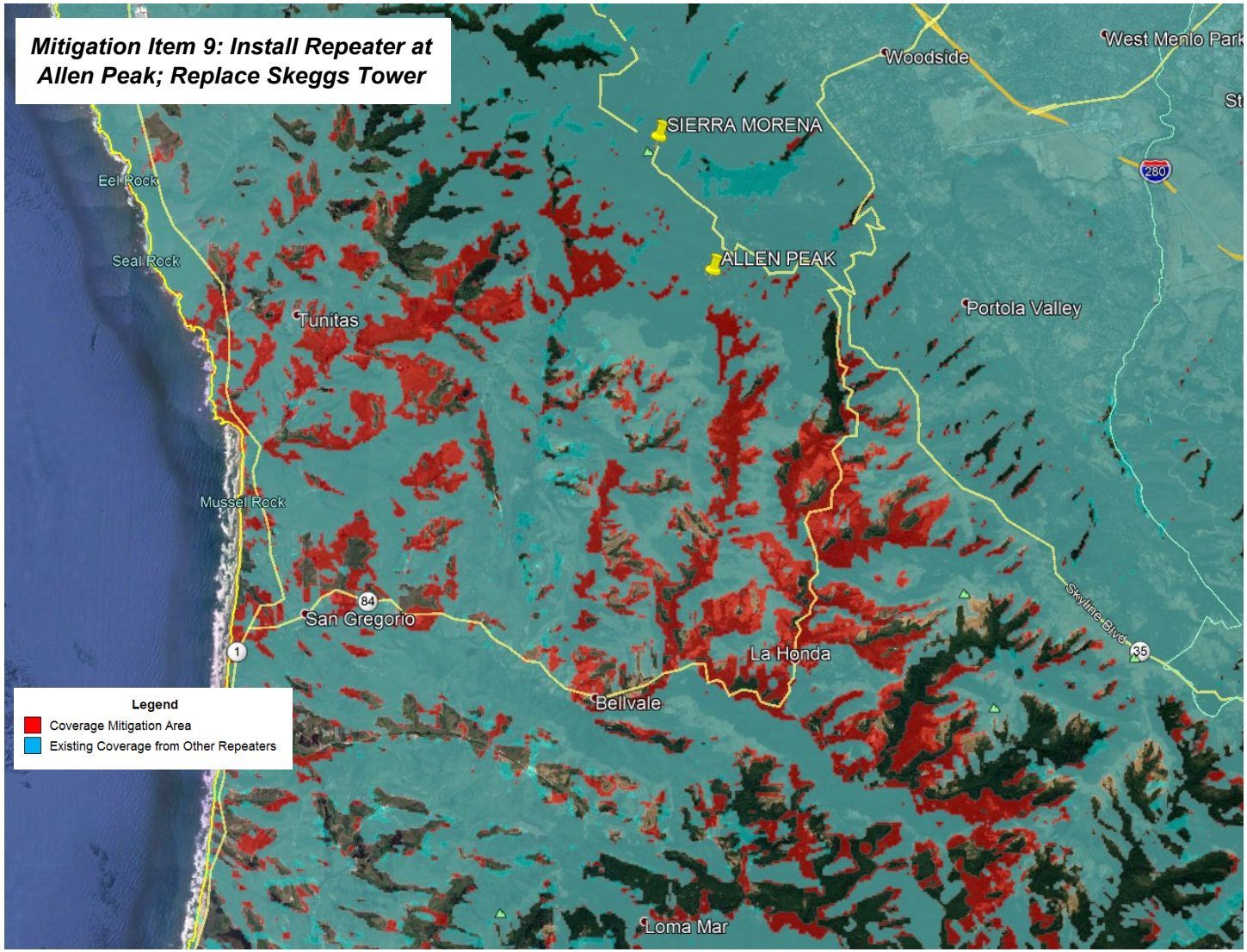
| ***Item 12: Install New Patrol Repeater on Stage Road (Carey)*** | ***Cost Estimate*** |
|---|---|
| **Radio System**<br>Provides a new simulcast repeater, antenna and backup battery power in a new shelter.<br><br>Improves coverage in the **Carey** area. | $59,000 |
| **Site Backhaul** | |
| ***New IP-Capable Microwave Link*** : Microwave eqmt. for new protected (redundant) IP path between this site and an existing San Mateo Co. microwave site. Path may not be possible; may require leased fiber services to be installed instead (further analysis needed). Note that the county's microwave system will not be IP-capable until 2022 or after (this is a requirement for new simulcast repeaters). Some temporary options exists however. | $138,000 |
| **Site Improvements** | |
| ***Equipment Shelter, Tower & Generator:*** *Provides for a new air-conditioned aggregate shelter on concrete foundation; new 30 ft. tower; generator and electrical service. Size & location to be determined. Space & location to be determined. County might consider sharing development costs (not considered here).* *Does not include land purchase costs.* | $360,000 |
| **Changes in Recurring Costs** (Present Worth, 4% money, 3% escalation, 10-year term) | |
| ***Land Lease Costs:*** *For new shelter, tower and easement for access road (estimate)* | $499,000 |
| **Professional Engineering Services:** Site planning, radio and microwave engineering, oversee and test final system w/County. | $30,000 |
| ***Total:*** | ***$1,086,000*** |

| ***Item 13: Install New Patrol Repeater at Pigeon Point (Cloverdale)*** | ***Cost Estimate*** |
|---|---|
| **Radio System**<br>Provides a new simulcast repeater, antenna and backup battery power using the existing shelter and tower at this site.<br><br>Improves coverage in the **Cloverdale** area.<br><br>Note: Equipment space and lease issues need confirmation. | $59,000 |
| **Site Backhaul**<br>***San Mateo County Microwave*** **:** Includes costs to interface existing San Mateo Co. microwave equipment. Note that it will not be IP-capable until 2022 or after (this is a requirement for new simulcast repeaters). Some temporary options exists however. | $17,000 |
| **Site Improvements**<br>***New (Larger) Equipment Shelter:*** *The existing San Mateo Co. equipment shelter has no space for new equipment; Co. interested in a new shelter as well. Provides for a new air-conditioned aggregate shelter on concrete foundation to house county's relocated equipment and new District repeater and backup batteries; electrical service; includes use of existing County tower; demolition/removal of existing shelter. Size & location to be* | $110,000 |
| **Changes in Recurring Costs** (Present Worth, 4% money, 3% escalation, 10-year term)<br>***Site Lease Costs:*** *For indoor equipment rack in existing shelter; utility power.* | $200,000 |
| **Professional Engineering Services:** Site planning, radio and microwave engineering, oversee and test final system w/County. | $20,000 |
| ***Total:*** | ***$406,000*** |

END

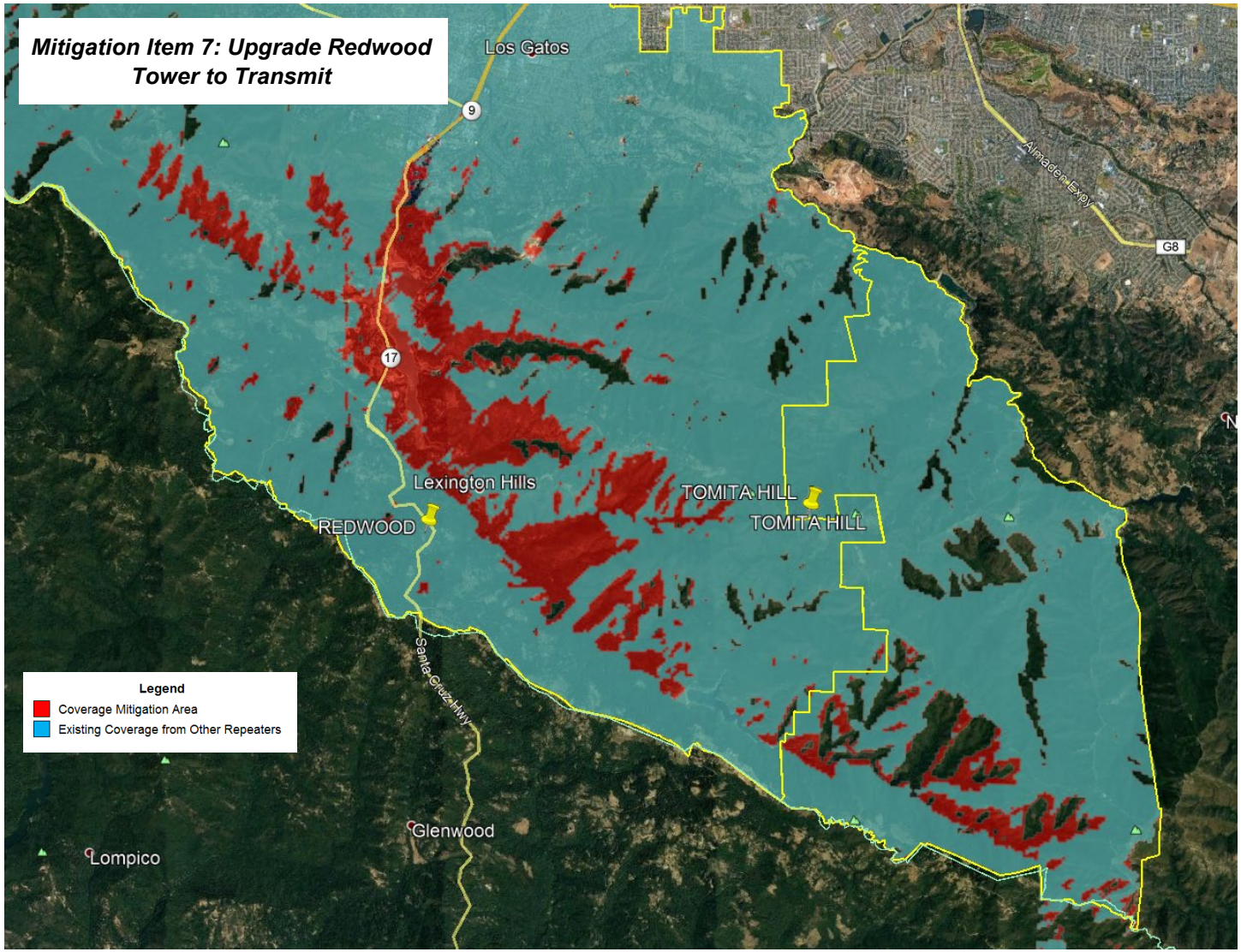
**Attachment 3(a): Allen Peak Tower Coverage Improvement Map**

Areas of improvement are shown in red. Blue is the current District coverage.



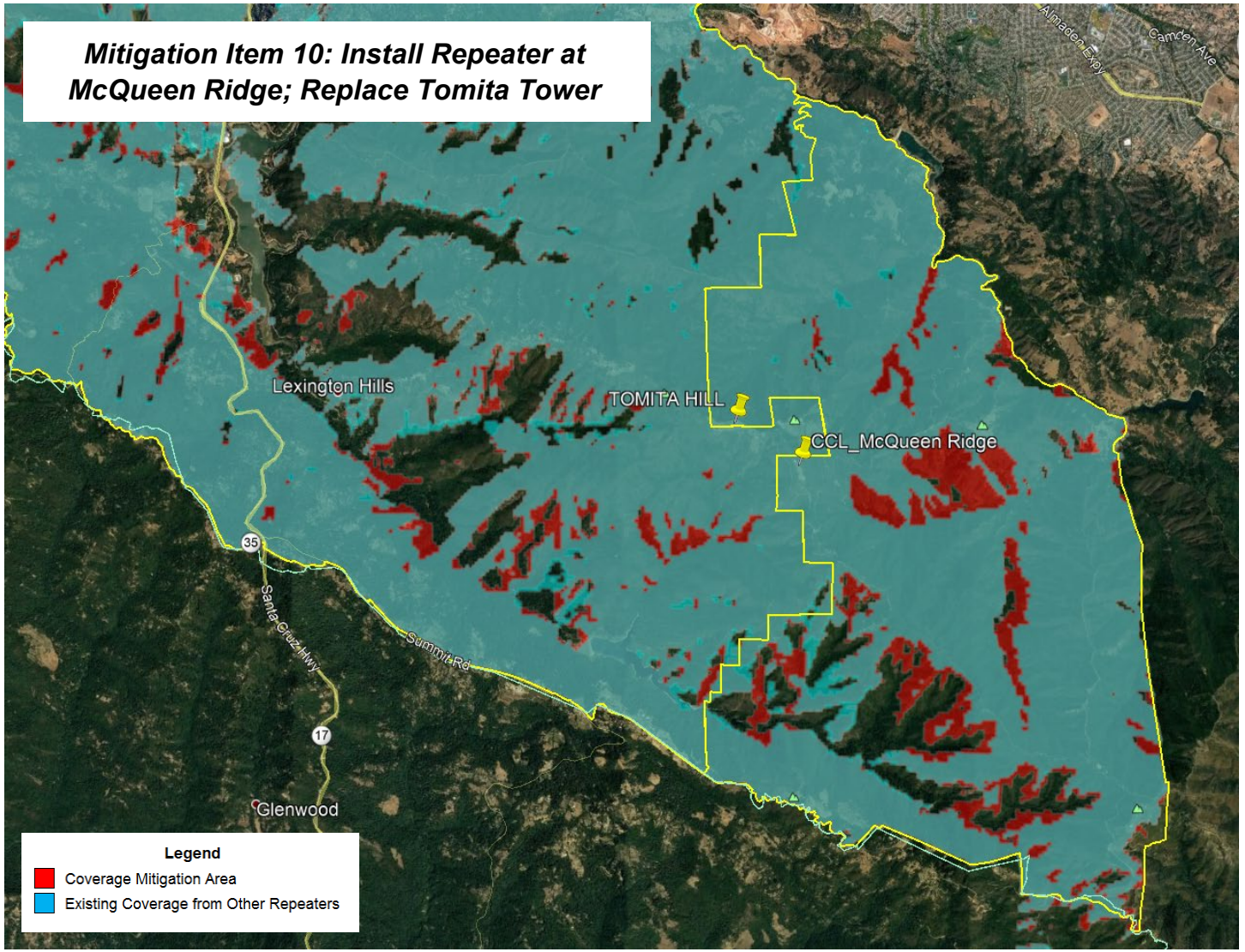
**Attachment 3(b): Redwood Tower Coverage Improvement Map**

Areas of improvement are shown in red. Blue is the current District coverage.



**Attachment 3(c): McQueen Ridge Tower Coverage Improvement Map**

Areas of improvement are shown in red. Blue is the current District coverage.



**Attachment 3(d): Pigeon Point Tower Coverage Improvement Map**

Areas of improvement are shown in red. Blue is the current District coverage.