Santa Cruz County, California

Radio System Assessment and Communications Roadmap Report

FINAL

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Executive Summary

Santa Cruz County, CA (County) operates a very high frequency (VHF) public safety analog conventional radio system providing communications for first responders in the county. The system is aging, and many components have reached or are near end of their expected lifecycle, with limited or no support or parts from the manufacturers. Also there are several areas within the county with gaps in coverage for the radio system users.

To address these issues, the County contracted ~~the~~ Z Consulting Group, with support from Federal Engineering, Inc. (***FE***) to assess the existing LMR system, identify current and future stakeholder needs, identify, and analyze replacement system alternatives and recommend the best alternative for the County and its regional partners to pursue.

FE performed the following tasks to assess the County's existing LMR system, develop stakeholder needs and identify replacement system alternatives:

- Reviewed existing system documentation
- Conducted stakeholder interviews to gain insight into current system issues and future radio system needs
- Evaluated existing system based on user-provided information
- Performed computer-based radio coverage analyses to provide a visual representation of the current system radio coverage, locate and asses the coverage gaps, and to identify candidate sites to fill these gaps
- Developed and analyzed system alternatives

Existing System Assessment

Based on data collected from our documentation review, user interviews, coverage workshop, and subsequent discussions, Z Consulting Group and ***FE*** identified the following issues related to the VHF analog conventional radio system:

- System infrastructure components are at or near the end of their lifecycle with limited or no support from the manufacturer
- System coverage gaps identified during the coverage workshop highlight a need for coverage improvements to address several problem areas

- The backhaul network includes telco circuits between radio sites, which the County wants replaced with microwave links to increase reliability

- While site visits were not included in the scope, user feedback and system documentation identified a number of issues at various sites that require site improvements before the new system is installed

- Need for the radio users to interoperate with neighboring P25 system(s)

Following the assessment, and collecting input from the user interviews, Z Consulting Group and ***FE*** identified two system alternatives to address stakeholder needs in the future system. These were discussed with the County and accepted as suitable alternatives.

LMR System Alternatives

Z Consulting Group and ***FE*** developed and analyzed the following LMR system alternatives:

- **Alternative 1** – replacement of existing VHF analog conventional channels with P25 Phase 1 conventional channels, including additional sites for improved coverage, and replacement of end-of-life subscriber equipment

- **Alternative 2** – replacement of existing VHF analog conventional channels with P25 Phase 2 trunking channels, including additional sites for improved coverage, and replacement of end-of-life subscriber equipment

LMR System Alternatives Comparison

Table ES1 summarizes the common benefits of the two system alternatives, as well as the key differences between them.

Table ES1 – System Alternatives Comparison

System Alternatives Comparison		
Item	***Alternative 1 P25 Conventional***	***Alternative 2 P25 Trunking***
Ownership and control	County-owned, full control	
Configuration	8 Simulcast transmit sites, 23 voted receive sites Standards-based Project 25 (P25) radio system	
Technology	P25 Phase 1 Conventional Frequency Division Multiple Access (FDMA); one talkpath per RF channel	P25 Phase 2 Trunking Time Division Multiple Access (TDMA); two talkpaths per RF channel (more spectrally efficient)
Spectrum	Very High Frequency (VHF)	
Channels / Talkpaths	6 Channels / 6 Talkpaths	4 Channels / 6 Talkpaths
Mobile radio coverage	>99% talk-in; 4% increase over existing system	
Portable on-street coverage	88% talk-in; 35% increase over existing system	
Features	P25 standard features Advance Encryption Standard (AES)	
		Over the air rekeying (OTAR) Over the air programming (OTAP) Unit Location Services (GPS) Smartphone Integration
Interoperability	Backwards compatible with analog conventional	
		Interoperability with surrounding P25 system(s) Backwards compatible with P25 Phase 1 Direct connectivity with surrounding P25 system(s) via Inter-RF Subsystem Interface (ISSI)
Backhaul network	Leverage existing backhaul where possible; nine new licensed microwave hops	
Network management	New network management system (NMS), clients, and remote terminal units	
Dispatch consoles	Two new P25 logging recorders; 15 new consoles at primary Dispatch Center; six new consoles at Backup Dispatch Center #1	
Subscriber units	Leverage existing P25 capable radios Replace end-of-life and non-P25 radios	
	New radios include P25 FDMA conventional software / licenses	New radios include P25 TDMA trunking software / licenses
Capital Cost	**$25,450,000**	**$29,150,000**
Maintenance Support (10 years)	**$16,950,000**	**$19,950,000**
Total Cost Estimate	**$42,400,000**	**$49,100,000**

Alternative 1 is the lowest cost solution and provides coverage enhancements over the existing radio system. Alternative 2 provides trunking technology, spectral efficiency, additional features, and enhanced interoperability compared to Alternative 1. Table ES-2 provides a side-by-side comparison of the Alternatives 1 and 2 cost estimates, including the delta between the two alternatives.

Table ES2 – Alternatives Cost Comparison

Alternatives Cost Estimate Comparison			
Item	*Alternative 1 P25 Conventional*	*Alternative 2 P25 Trunking*	*Delta*
Radio System	$7,910,000	$11,110,000	$3,200,000
Backhaul System	$2,270,000	$2,270,000	$0
Network Management	$950,000	$950,000	$0
Site Improvements	$1,860,000	$1,860,000	$0
Dispatch System	$4,940,000	$4,940,000	$0
Subscriber Units	$7,520,000	$8,020,000	$500,000
Capital Cost	**$25,450,000**	**$29,150,000**	**$3,700,000**
Maintenance Support (10 years)	**$16,950,000**	**$19,950,000**	**$3,000,000**
Total (Rounded)	**$42,400,000**	**$49,100,000**	**$6,700,000**

FE's budgetary estimates are intentionally conservative. Typically, vendor proposal pricing is unlikely to exceed ***FE***'s estimate, based on a comparable design as outlined in our assumptions. Our cost estimates are based upon recent non-discounted pricing. Frequently, system vendors provide discounts for large system and subscriber unit purchases, however dynamics in the competitive systems market make it impractical to forecast the specific discounts vendors may offer at the time of proposal submission. Global supply and labor shortages have also introduced more uncertainty in costs and this situation is unlikely to improve in the near to mid-term. Accordingly, ***FE*** includes a 20% continency for all cost estimates.

Recommendation

Based on our analysis of the existing radio systems and understanding of the County's needs and objectives, Z Consulting Group and ***FE*** recommend the County strongly consider pursuing Alternative 2. This alternative best addresses the stakeholder needs and requirements for P25 operation, improved coverage, and provides additional features over Alternative 1 such as Over The Air Rekeying (OTAR), Over The Air Programming (OTAP), and enhanced interoperability with surrounding P25 system(s).

Next Steps

The County should consider the following steps for implementing the new radio and backhaul system:

1. Select the preferred solution and seek Stakeholder's approval to move ahead with the project
2. Obtain funding for new system, subscribers, and consulting services
3. Prepare a request for proposals (RFP) for purchasing the system
4. Advertise the RFP on the County website
5. Evaluate proposals which may include presentations, best and final offers, and related negotiations
6. Select the preferred vendor and obtain County Board of Supervisors approval
7. Negotiate a contract with the awarded vendor
8. Monitor and oversee the vendor in implementing the system
9. Perform acceptance and coverage testing
10. Execute cutover and migrate groups of users onto the new system
11. Decommission or re-purpose the old system

Z Consulting Group and ***FE*** appreciate the opportunity to develop this *Radio System Assessment and Communications Roadmap Report* for Santa Cruz County.

Table of Contents

1. Project Background

Z Consulting Group in conjunction with Federal Engineering, Inc. (***FE***) formally submits this *Radio System Assessment and Communications Roadmap Report* to Santa Cruz County, CA (the "County") that outlines the results of our focus group interviews, existing system assessment, coverage, capacity, and interoperability analysis. The report describes the advantages, disadvantages, and budgetary cost estimates of each alternative with site recommendations, coverage maps, and deployment strategies for each. The report provides a breakdown of which system components would be owned by the County and which components may potentially be leased or services subscribed to from others. This report is inclusive of the following areas, some of which have been shared with the County via the *Existing Infrastructure and System Analysis Memorandum*:

- Existing Infrastructure and System Analysis
- Results of Focus Group Interviews
- Existing Coverage Assessment
- Identification of Alternatives
- Land Mobile Radio (LMR) Coverage Workshop and Analysis of LMR Alternatives
- Additional LMR Analysis to Determine Users' Communications Goals
    - Capacity Analysis and Frequency Coordination Planning
    - Interoperability and Regional Response Analysis
- Backhaul Network Modeling (Network Baseline)
- Cost Analysis and Recommendations

A meeting to review the draft report with the County's Steering Committee and designated stakeholders is scheduled for May 19, 2022. Appendix A contains the names and contract details of the Steering Committee. Following the review meeting, we ask that County provide its feedback and comments within five days. We will revise the report based on County stakeholders' comments. Z Consulting Group will then issue the final *Radio System Assessment and Communications Roadmap Report* for approval.

Request for Information (RFI)

On September 24, 2021, Z Consulting Group and ***FE*** sent a Request for Information (RFI) to the County to initiate the process of gathering pertinent technical information about their existing systems.

The RFI categorized the requested information into the following areas:

- Contact list with phone numbers and email addresses of Regional Partner agencies, who have interest in the radio project
- Copies of any recent coverage studies
- Existing Sites information
    - Backhaul
    - Land Mobile Radio (LMR)
    - Dispatch
    - Coverage Improvements Information
- New Sites
- Subscribers
- As-built Drawings (In raw form as AutoCAD or PDF) for the existing sites
- Working groups contact information

Upon receiving the requested information, Z Consulting Group and ***FE*** cataloged and reviewed several documents including previous studies, subscriber inventories, and other relevant documents. We used this initial information to facilitate in-person discussions and to determine other information needed for the analysis.

Project Initiation Meeting

On November 18, 2021, Z Consulting Group and ***FE*** conducted a project initiation meeting with the County project team. The purpose of the meeting was to establish a common understanding of the project goals, objectives, and vision; items best understood through a close working relationship between the respective management teams and staffs. At the meeting, Z Consulting Group and ***FE*** introduced the team and discussed in detail the scope of work, project plan and schedule, focus group interviews, and next steps.

Focus Group Interviews

On December 16, 2021, Z Consulting Group and ***FE*** conducted focus group interviews in different sessions with different agencies as follows:

- Session 1 – NETCOM and Information Services Department
- Session 2 – Capitola Police, Scotts Valley PD, and Watsonville Police

- Session 3 – Sheriff's Office, District Attorney's Office, Probation, and CHP-Aptos (Mutual Aid)
- Session 4 – Felton Fire and Scotts Valley Fire

The purpose of the interviews was to gather additional information from users about the operational and technical needs for public safety communications. Data gathered through the interviews helped to identify the ability of the current systems to meet users' needs, to identify any unmet needs, and to gather ideas for meeting those unmet needs.

Existing System Assessment

Based on a thorough analysis of existing system documentation and follow up discussions with the County, Z Consulting Group and ***FE*** produced and delivered the *Existing Infrastructure and System Analysis Memorandum*. The memo details key findings from our review of the documentation provided. We relied on documentation and inventory records provided by the County's project team and technical staff, local agencies, and information available from the Federal Communications Commission (FCC). Z Consulting Group and ***FE*** reviewed the memo with the County and collected feedback on revisions needed. This report contains the revised information from the updated memo.

Identification of Alternatives

Based on the results from the system analysis and needs assessment and discussions with the County, Z Consulting Group and ***FE*** analyzed the following LMR system alternatives:

- **Alternative 1** – replacement of existing VHF analog conventional channels with P25 Phase 1 Conventional channels, including additional sites for improved coverage, and replacement of end-of-life subscriber equipment.

- **Alternative 2** – replacement of existing VHF analog conventional channels with P25 Phase 2 Trunking channels, including additional sites for improved coverage, and replacement of end-of-life subscriber equipment.

For each alternative, ***FE*** identifies functionality and ability to meet the County's needs and requirements, system features, operational characteristics, and cost estimates for equipment and implementation services.

Coverage Analysis

On February 23, 2022, ***FE*** conducted a computer-based radio coverage workshop to establish existing coverage and to identify the specific sites and equipment required to meet each of the agency's coverage requirements. Key steps involved prior to, during, and after the coverage workshop included:

- Reviewing existing system documentation, FCC licenses, and site data to establish current sites and parameters
- Developing baseline coverage maps and identifying potential sites in preparation for a coverage workshop
- Conducting a ~~remote~~ coverage workshop with the agencies with the following objectives:
    - Present existing system coverage, obtain feedback on current system performance, confirm identified coverage problem areas, and to identify other radio sites to cover specific areas
    - Present predicted coverage of a replacement system, utilizing existing and candidate sites, new radio site equipment, and P25 digital technology vs. current analog conventional
- Completing the coverage analysis, developing a final list of radio sites, and producing coverage maps based on input received at the coverage workshop, follow up stakeholder feedback, and subsequent discussions with the County

Backhaul Network Analysis

On March 17, 2022, ***FE*** conducted a computer-based backhaul network workshop to assess the connectivity of the existing microwave network to the proposed radio sites. Where the current microwave links were considered as not suitable, new microwave links will be proposed to provide connection between all radio sites proposed.

2. Existing System Assessment

2.1 County's Public Safety Radio Regional Partners

Regional partners who currently or in the future will use the public safety radio network, include:

1. AMR Santa Cruz
2. Ben Lomond Fire
3. Boulder Creek Fire
4. Capitola Police
5. Central Fire
6. CHP-Aptos (Mutual Aid)
7. Felton Fire
8. NETCOM (Regional Dispatch)
9. Santa Cruz County, Department of Public Works
10. Santa Cruz County, District Attorney's Office
11. Santa Cruz County, Emergency Services
12. Santa Cruz County, Information Services Department (HS, HSD, Parks, GSD)
13. Santa Cruz County, Probation
14. Santa Cruz County, Sheriff's Office
15. Santa Cruz Fire
16. Santa Cruz Police
17. Scotts Valley Fire
18. Scotts Valley PD
19. State Parks (Mutual Aid)
20. UCSC Police (Mutual Aid)
21. Watsonville Police
22. Watsonville Fire
23. OR3
24. Zayante

It is important to note that the above list includes more agencies than those listed in the subscriber equipment Section 2.5 in this memo. For accuracy on system loading and cost estimates, the County and stakeholders need to confirm the total subscriber counts are accurate.

2.2 Backhaul Network

The County provided updates on the existing backhaul consisting of microwave links and telco circuits. In addition to a microwave ring, the County confirms use of telco circuits between many of the radio (reciter) sites. The following drawing in Figure 1 shows the existing backhaul in ring topology, as updated following County review on February 2, 2022.

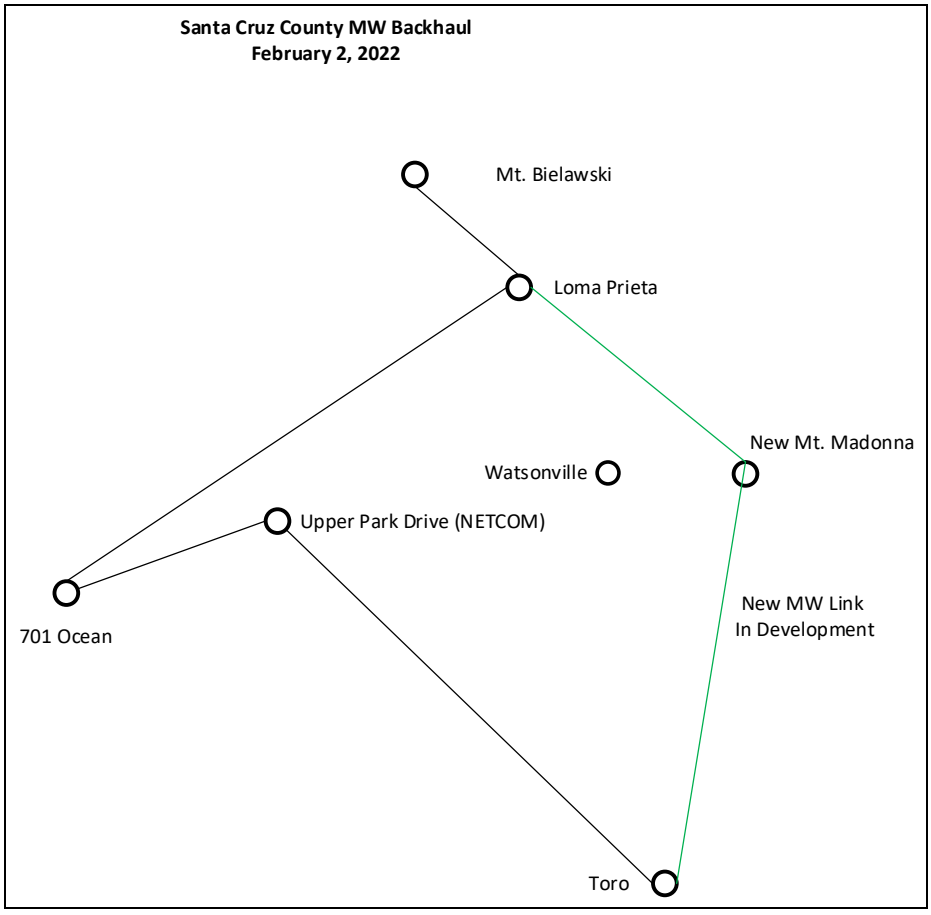


Figure 1 – Existing County Backhaul Network

One other file provided from the County indicates that previous Harris Constellation microwave equipment has been replaced for some of the 6GHz and 11GHz hops. It also appears that a previous 4.9GHz radio from Loma Prieta to Mt. Bielawski has been

replaced by 6GHz link. The County advises of new microwave links between Loma Prieta, New Mt. Madonna, and Toro, replacing the previous links between Loma Prieta, Watsonville, and Toro. Per County updates, the Salinas site will go away and no longer connect to the rest of the network. Therefore, Salinas is no longer shown on the microwave diagram.

2.3 Land Mobile Radio System

Upon receiving existing radio system information, ***FE*** cataloged and reviewed several documents including previous studies, subscriber inventories, and other relevant documents. We used this initial information to facilitate in-person discussions, assess existing assets, and to determine other information needed for the analysis.

2.3.1 System Channels

The existing radio system consists of the following VHF conventional analog channels for multiple County departments, including Fire and Sheriff, as follows:

- 1- Fire Yellow
- 2- Fire Red
- 3- Sheriff Red
- 4- Sheriff Blue
- 5- Public Works
- 6- LG
- Sheriff Silver – 2 Channels, which are on reserve, and currently not in-use

It is ***FE***'s understanding that UHF is mainly used for SCADA, and that 800 MHz is not used for primary voice communications for public safety. It is important to note that the County did provide a Google Earth file showing their locations on a map. The *Radio System Assessment and Communications Roadmap Report* will analyze in detail the radio coverage provided by each channel at these sites, and how they address coverage issues reported in the stakeholder interviews.

2.3.2 System Sites

The existing radio system consists of multiple transmit and receive sites strategically located throughout the County, as listed in Table 1 with latitude, longitude, and elevation:

Table 1 – Existing System Sites Information

Site Name	Site Type	Latitude	Longitude	Sheriff Red	Sheriff Blue	Fire Yellow	Fire Red	Public Works	LG
701 Ocean St.	TX/RX	36.97772	-122.02261	x	x	x	x	x	x
Bielawski	TX/RX	37.22278	-122.09375	x	x	x	x	x	x
Davenport (FG1523)	TX/RX	37.01877	-122.19682	x	x			x	x
Kite Hill	RX-Only	37.01217	-122.02694	x	x	x		x	x
Loma Prieta	RX-Only	37.11061	-121.84427	x	x	x	x	x	x
Cabrillo College	RX-Only	36.99120	-121.92257	x	x	x	x	x	x
Cadillac	RX-Only	37.05358	-122.01943	x	x		x	x	
Central Water Tank	RX-Only	36.96703	-121.86707	x	x	x	x	x	x
Mount Toro	RX-Only	36.53817	-121.62948	x	x	x	x	x	x
Big Creek Lumber	RX-Only	37.08453	-122.26004	x	x			x	
Capitola	RX-Only	36.97411	-121.95366			x	x		
CYA	RX-Only	37.13136	-122.16887	x	x			x	x
Davenport (Yagi)	TX-Only	37.01877	-122.19682	x	x			x	x
Delaware	RX-Only	36.95642	-122.05899			x	x		
Felton (Cal Fire)	RX-Only	37.04875	-122.07388	x	x	x	x	x	
Goat Farm	RX-Only	36.98608	-122.14537	x	x			x	
Holohan	RX-Only	36.94386	-121.75382	x	x		x	x	
Lodato	RX-Only	37.04894	-122.00559			x		x	
Mount Hermon	RX-Only	37.04605	-122.04873	x	x			x	
Netcom	RX-Only	36.99324	-121.99644	x	x	x	x	x	x
Nina Terrace	RX-Only	37.12076	-122.10387	x	x	x	x	x	x
Ormsby Properties	RX-Only	37.06709	-121.82745	x	x			x	
Soquel Central Fire S3	RX-Only	36.98870	-121.95678			x	x		
Soquel Water Tank	RX-Only	36.99999	-121.91350	x	x			x	
Summit	RX-Only	37.13394	-121.98114	x	x			x	
UCSC	RX-Only	37.00017	-122.06298	x	x	x	x		
Watsonville	TX/RX	36.93346	-121.78584	x	x	x	x	x	x

Please note Verizon Wireless has applied to construct a tower at the Seventh Day Adventist campground for cellular use, which could be added to the radio system with Verizon's consent. This site has a potential to fill a gap in the mid-County radio coverage (Fiber back to 701 Ocean). The County provided the coordinates information: 37.016149; -121.956191.

2.3.3 Site Equipment

The existing radio system consists of site equipment from multiple manufacturers at the different transmit and receive sites located throughout the County as listed in Table 2:

Table 2 – Existing Site Equipment Information

EXISTING SITE EQUIPMENT					
SITE	**CHANNEL**	**RADIO**	**SITE**	**CHANNEL**	**RADIO**
701 OCEAN	SO BLUE	TAIT TB8100	***KITE***	SO BLUE	TAIT RECITER
701 OCEAN	SO RED	TAIT TB8100	***KITE***	SO RED	TAIT RECITER
701 OCEAN	RED FIRE	TAIT TB8100	***KITE***	RED FIRE	TAIT RECITER
701 OCEAN	P.W.	TAIT TB8100	***KITE***	L.G.	TAIT RECITER
701 OCEAN	L.G.	TAIT TB8100	***KITE***	P.W.	TAIT RECITER
701 OCEAN	YELLOW FIRE	TAIT TB8100			
Big Creek Lumber	SO BLUE	TAIT RECITER	***LODATO***	RED FIRE	TAIT RECITER
Big Creek Lumber	SO RED	TAIT RECITER	***LODATO***	P.W.	TAIT RECITER
Big Creek Lumber	P.W.	TAIT RECITER	***LODATO***	RED FIRE	TAIT RECITER
BIELAWSKI	SO BLUE	TAIT TB8100	***LOMA***	SO BLUE	TAIT RECITER
BIELAWSKI	SO RED	TAIT TB8100	***LOMA***	SO RED	TAIT RECITER
BIELAWSKI	SO RED	TAIT TB8100	***LOMA***	RED FIRE	TAIT RECITER
BIELAWSKI	RED FIRE	TAIT TB8100	***LOMA***	P.W.	TAIT RECITER
BIELAWSKI	P.W.	TAIT TB8100	***LOMA***	L.G.	TAIT RECITER
BIELAWSKI	L.G.	TAIT TB8100	***LOMA***	YELLOW FIRE	TAIT RECITER
BIELAWSKI	YELLOW FIRE	TAIT TB8100			
CABRILLO	SO BLUE	TAIT RECITER	***MAD***	SO BLUE	TAIT RECITER
CABRILLO	SO RED	TAIT RECITER	***MAD***	SO RED	TAIT RECITER
CABRILLO	RED FIRE	TAIT RECITER	***MAD***	RED FIRE	TAIT RECITER
CABRILLO	P.W.	TAIT RECITER	***MAD***	P.W.	TAIT RECITER
CABRILLO	L.G.	TAIT RECITER	***MAD***	L.G.	TAIT RECITER
CABRILLO	YELLOW FIRE	TAIT RECITER	***MAD***	YELLOW FIRE	TAIT RECITER
CADILLAC	SO BLUE	TAIT RECITER	***NETCOM***	SO BLUE	TAIT RECITER
CADILLAC	SO RED	TAIT RECITER	***NETCOM***	SO RED	TAIT RECITER
CADILLAC	YELLOW FIRE	TAIT RECITER	***NETCOM***	RED FIRE	TAIT RECITER
CADILLAC	P.W.	TAIT RECITER	***NETCOM***	P.W.	TAIT RECITER
			NETCOM	L.G.	TAIT RECITER
			NETCOM	YELLOW FIRE	TAIT RECITER

EXISTING SITE EQUIPMENT					
SITE	**CHANNEL**	**RADIO**	**SITE**	**CHANNEL**	**RADIO**
CAPITOLA	RED FIRE	TAIT RECITER	***NINA***	SO BLUE	TAIT RECITER
CAPITOLA	YELLOW FIRE	TAIT RECITER	***NINA***	SO RED	TAIT RECITER
			NINA	RED FIRE	TAIT RECITER
			NINA	P.W.	TAIT RECITER
			NINA	L.G.	TAIT RECITER
			NINA	YELLOW FIRE	TAIT RECITER
CENTRAL WT	SO BLUE	TAIT RECITER	***ORMSBY***	SO BLUE	TAIT RECITER
CENTRAL WT	SO RED	TAIT RECITER	***ORMSBY***	SO RED	TAIT RECITER
CENTRAL WT	RED FIRE	TAIT RECITER	***ORMSBY***	P.W.	TAIT RECITER
CENTRAL WT	P.W.	TAIT RECITER			
CENTRAL WT	L.G.	TAIT RECITER			
CENTRAL WT	YELLOW FIRE	TAIT RECITER			
CYA	SO BLUE	TAIT RECITER	***SOQUEL***	RED FIRE	TAIT RECITER
CYA	SO RED	TAIT RECITER	***SOQUEL***	YELLOW FIRE	TAIT RECITER
CYA	L.G.	TAIT RECITER			
CYA	P.W.	TAIT RECITER			
DAVENPORT	SO BLUE	TAIT TB8100	***SUMMIT***	SO BLUE	TAIT RECITER
DAVENPORT	SO RED	TAIT TB8100	***SUMMIT***	SO RED	TAIT RECITER
DAVENPORT	P.W.	TAIT TB8100	***SUMMIT***	P.W.	TAIT RECITER
DAVENPORT	L.G.	TAIT TB8100			
DELAWARE	RED FIRE	TAIT RECITER	***SOQUEL WT***	SO BLUE	TAIT RECITER
DELAWARE	YELLOW FIRE	TAIT RECITER	***SOQUEL WT***	SO RED	TAIT RECITER
			SOQUEL WT	P.W.	TAIT RECITER
FELTON	SO BLUE	TAIT RECITER	***TORO***	SO BLUE	TAIT RECITER
FELTON	SO RED	TAIT RECITER	***TORO***	SO RED	TAIT RECITER
FELTON	RED FIRE	TAIT RECITER	***TORO***	RED FIRE	TAIT RECITER
FELTON	YELLOW FIRE	TAIT RECITER	***TORO***	P.W.	TAIT RECITER
FELTON	P.W.	TAIT RECITER	***TORO***	L.G.	TAIT RECITER
			TORO	YELLOW FIRE	TAIT RECITER
			TORO	BACKUP SYS	TAIT RECITER
GOAT	SO BLUE	TAIT RECITER	***UCSC***	SO BLUE	TAIT RECITER

EXISTING SITE EQUIPMENT					
SITE	**CHANNEL**	**RADIO**	**SITE**	**CHANNEL**	**RADIO**
GOAT	SO RED	TAIT RECITER	***UCSC***	SO RED	TAIT RECITER
GOAT	P.W.	TAIT RECITER	***UCSC***	RED FIRE	TAIT RECITER
			UCSC	YELLOW FIRE	TAIT RECITER
HERMON	SO BLUE	TAIT RECITER	***WATSON***	SO BLUE	TAIT TB8100
HERMON	SO RED	TAIT RECITER	***WATSON***	SO RED	TAIT TB8100
HERMON	P.W.	TAIT RECITER	***WATSON***	RED FIRE	TAIT TB8100
			WATSON	P.W.	TAIT TB8100
			WATSON	L.G.	TAIT TB8100
			WATSON	YELLOW FIRE	TAIT TB8100
			WATSON	MDC	TAIT TB8100
HOLOHAN	SO BLUE	TAIT RECITER			
HOLOHAN	SO RED	TAIT RECITER			
HOLOHAN	YELLOW FIRE	TAIT RECITER			
HOLOHAN	P.W.	TAIT RECITER			

It appears that major components in the existing radio system consist of TAIT TB8100 and MTR3000 for base stations and repeaters, Intraplex Multiplexers, Zetron paging stations, and Tait reciters. While the County replaced many Motorola Quantars with the TAIT TB8100s, there are many components that have reached or are near end of life, with limited or no support or parts from the manufacturers.

2.3.4 Site Assumptions

It is important to note that our assessment for this project did not include site surveys, tower structural analyses, or tower climbs. Therefore, our site assessments can only be based on information provided by the County rather than visual inspections. As part of our assessment and cost analysis, we typically develop a Site Improvements Matrix that outlines the following list of assumptions for all existing sites that may be feasible to include in the new conceptual design.

- Existing Tower or Rooftop with Available Space
- Tower Structural Analysis Needed
- Existing Tower Mods Needed
- New Tower Structure Needed
- A&E, Environmental Compliance

- Existing Shelter/Bldg. with Available Space
- Site Grounding Updates Needed
- Existing Shelter/Bldg. Mods Needed
- New Prefab Shelter Needed
- New Outdoor Cabinet Needed
- Commercial AC Power Available
- Solar/DC Site Upgrades Needed
- Backup Generator Available
- New Generator Needed
- New Rackmount UPS Needed

Following the coverage and backhaul workshops, ***FE*** worked with the County to identify existing and potential sites needed for the conceptual design and what the assumptions we should use for including in the cost estimates. Appendix D contains a complete matrix of site improvement assumptions on a per-site basis.

2.4 Regional Dispatch

Based on information gathered through the *Santa Cruz Public Safety Project Kick-off Meeting* conducted on November 18, 2021, ***FE*** gathered the following information on the Regional Dispatch system:

- 911/Dispatch is located at 495 Upper Park Road, Santa Cruz
- Dispatch center has 15 console positions
- It connects to 701 Ocean via MW link, plus there is a backup AT&T ASE circuit (20 MB)
- It has ModUcom system. ModUcom company was sold to 2 ex-employees, who now service the system
- Call logging: This is managed separately from the County radio system
- Backup Dispatch Center # 1 is located at Watsonville with 6 Raven consoles
- Backup Dispatch Center # 2 is located at Hollister site and is shared with San Benito County. NETCOM is considering installing Mindshare consoles
- Backup dispatch staff operates from splits between Backup Dispatch # 1 and 2 during the emergencies

As part of the communications roadmap, the budgetary estimates presented in this report include the procurement of 15 new consoles at Dispatch Center and six (6) new consoles the Backup Dispatch Center #1. Status of the consoles at the Backup Dispatch Center #2 is currently unknown, and therefore not included in the replacement costs.

2.5 Subscriber Equipment

FE received subscriber unit inventory information in separate files and different formats, including XLS sheets and PDF documents. These data sources were compiled, transcribed, and summarized into the list shown in Table 3.

Table 3 – Existing Subscriber Unit Inventory (Summarized)

Existing Subscriber Unit Count Summary					
Agency	*Handheld*	*Mobile*	*Base Station*	*Pagers*	***Total***
BOU (assume Boulder Creek Fire)	42	15	2	0	**59**
Central Fire District	205	50	8	40	**303**
County (multiple departments)	*Specific radio type breakdowns not provided				
District Attorney*					**41**
Emergency services	14				**14**
Health Services	1				**1**
Social Services (HSD)	4				**4**
Parks	1				**1**
Probation*					**54**
Sheriff-Coroner, Jail*					**614**
Public Works*					**333**
GSD	1	1			**2**
Scotts Valley PD	29	14	3	0	**46**
Ben Lomond Fire	36	18	0	0	**54**
Scotts Valley Fire	32	15	2	0	**49**
Santa Cruz PD	180	63	0	0	**243**
Felton Fire Protection District	36	13	0	0	**49**
Watsonville PD 2021	40	27	0	0	**67**
Watsonville Fire	40	4	0	0	**44**
Santa Cruz Fire	95	46	0	0	**141**
AMR (radio count not provided)					
Capitola Police	31	30	0	0	**61**
Zayante	35	16	0	0	**51**
Total					**2231**

It is important to note that a complete analysis is not possible until the following key findings and items are addressed:

- Multiple radio types were grouped per County department. For proper analysis of re-use and replacement, and a more accurate cost on a per-radio type, specific breakdown of radio types per County department are required.

- County advises that Sheriff, Coroner, and Jail departments have replaced their old XTS5000 radios with the newer APX series radios.

- With the exception of recent subscriber unit purchases (such as Motorola APX, EFJ VP, and Tait TM series radios), there are existing subscriber units that require replacement as they are at or near the end of their lifecycle, with limited or no support from the manufacturers.

- Depending on technology and spectrum of alternatives evaluated, the majority of existing subscriber units may require replacement as there are only a limited number of existing radios that are newer multi-band units with P25 Phase 1 and/or Phase 2 capabilities.

- Total subscriber count includes use of pagers by Central Fire District only. We need to confirm if only one agency or any other ones require paging capability in a replacement system, even if one of the potential alternatives is digital.

- Total subscriber count reflects quantity (3) of Dispatch Console 4018. Need to confirm if these are for paging purposes, and if they should be removed from this count and moved to the regional dispatch section.

FE provides Appendix B with a compiled list of existing subscriber unit inventory information. The County can verify counts and provide additional breakdowns where possible, as well as subscriber counts still missing for AMR.

3. Existing Coverage Assessment

FE evaluated the existing radio coverage of each agency's LMR radio system channels. This subsection presents the methodology employed by ***FE*** to perform the coverage analysis, and also presents coverage maps and geographic coverage percentages depicting the results of the analysis.

3.1 Radio Coverage Prediction Software

FE produced the radio coverage maps in this subsection using ***FEPerformancePro***™ and high-resolution elevation and land use/cover data from the United States Geological Survey (USGS). ***FEPerformancePro***™ uses ATDI's HTZ Communications network planning software which has been used extensively by the Federal Government and validated via field tests. ***FE*** calibrated this modeling tool and the coverage analysis methodology based on many years of experience and industry-accepted guidelines to deliver a very accurate view of radio coverage.

3.2 Radio Coverage Parameters

FE performed the radio coverage prediction studies using site information provided by the County such as transmit power levels, antenna make/model, geographic coordinates, and antenna mounting heights. In addition, ***FE*** used the technical parameters in Table 4 to model the coverage for the existing LMR systems.

Table 4 – Coverage Study Parameters

Parameter	Description
System Type	Conventional Analog
Frequency Band	VHF High Band
Channel Bandwidth	12.5 kHz (narrowband)
Reliability	95%
Audio Quality	Delivered Audio Quality (DAQ) – 3.4
Talk Paths	Mobile radio talk-out[1]

[1] Repeater to mobile and portable radio.

	Mobile radio talk-in[2] Portable radio talk-out, on-street Portable radio talk-in, on-street Portable radio talk-out, in light/residential buildings Portable radio talk-in, in light/residential buildings

The coverage displayed on each map indicates the areas predicted to have audio quality greater than or equal to Delivered Audio Quality (DAQ) 3.4. DAQ is a measure of audio quality over a transmission medium, with different levels as shown in Table 5. Industry best practice is to use DAQ 3.4 for public safety radio systems.

Table 5 – Delivered Audio Quality Definitions

DAQ Level	Definition
1.0	Unusable. Speech present but not understandable
2.0	Speech understandable with considerable effort. Requires frequent repetition due to noise or distortion
3.0	Speech understandable with slight effort. Requires occasional repetition due to noise or distortion
3.4	Speech understandable without repetition. Some noise or distortion present. DAQ 3.4 is the minimum Channel Performance Criterion (CPC) used for public safety agencies.
4.0	Speech easily understandable. Little noise or distortion
5.0	Perfect. No distortion or noise discernible

Reliability is a measure of confidence in the signals in areas shown as covered on the maps and is based on recommendations from the Telecommunications Industry Association (TIA) TSB-88[3] suite of documents. In the case of public safety radio systems, TSB-88 recommends 95% reliability, which means that users should be able to receive audio at DAQ 3.4 or better in any area deemed “covered” at least 95% of the time.

FE used the mobile and portable radio parameters in Table 6 to model radio coverage.

Table 6 – Mobile and Portable Radio Parameters

Parameter	Mobile	Portable
Transmit Power (watts)	50	5
Receive Sensitivity (dBm)	-119	-119
Antenna Location	Roof	Hip
Antenna Gain (dB)	0	0
Body Loss (dB)	N/A	22.8

[2] Mobile and portable radio to repeater.
[3] TIA TSB-88 Wireless Communications Systems - *Performance in Noise and Interference-Limited Situations*

3.1 Reported areas of coverage problems

Prior to the coverage workshop (conducted by ***FE*** on February 22, 2022), the County identified several areas where coverage problems existed based on user experience in the field. ***FE*** overlaid these regions on the existing system coverage maps presented in this subsection by outlining them in red. Later in this document, where the system alternatives are described, ***FE*** overlaid additional coverage problem areas on potential system coverage maps based on feedback provided by the County subsequent to the coverage workshop.

3.2 Radio Coverage Maps

The coverage maps presented in this subsection show the existing mobile, on-street portable, and in-building portable radio talk-out and talk-in coverage for each of the LMR radio system channels. The coverage maps use the following colors to model coverage:

- Green - areas where users should be able to communicate using their portable radios when inside light-density and/or residential buildings. For these coverage prediction studies, ***FE*** used 13 dB to represent signal loss inside these types of buildings
- Yellow - areas where users should be able to communicate using their portable radios on the street (on-street portable coverage should also exist in all green areas)
- Purple - areas where users should be able to communicate using their mobile radios (mobile coverage should also exist in all green and yellow areas)

Figures 2 and 3 show the talk-out and talk-in coverage, respectively, for the existing Fire Yellow channel.

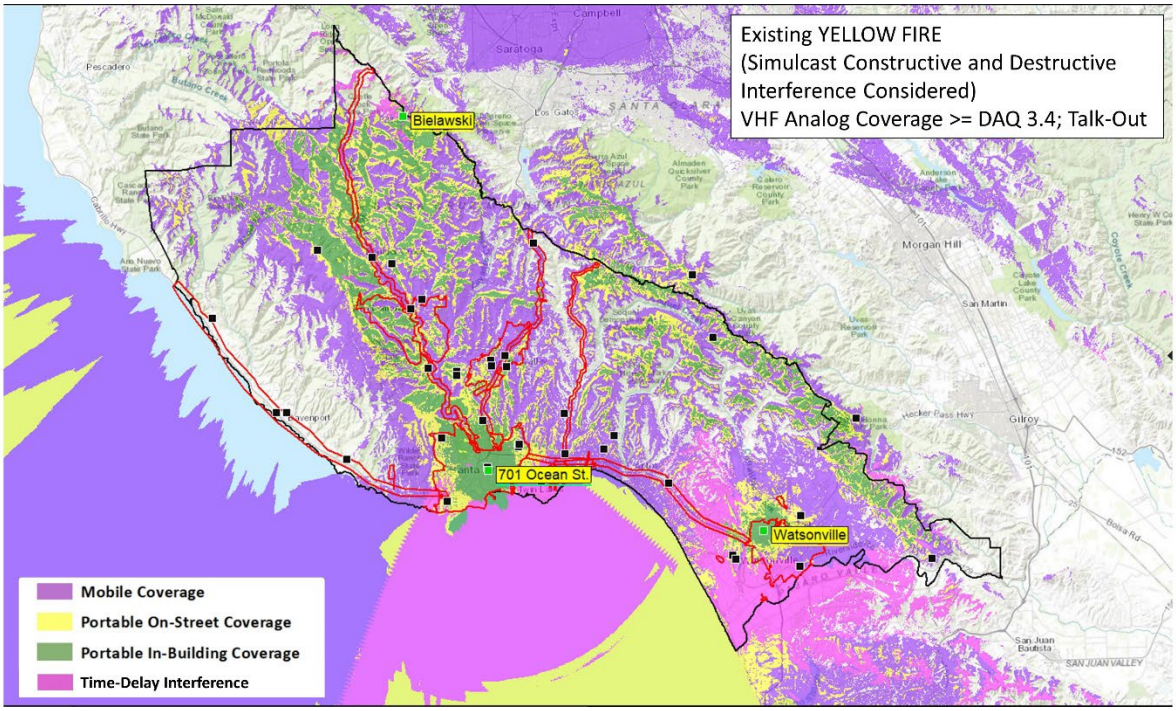


Figure 2 – Existing Fire Yellow Analog VHF Coverage >= DAQ 3.4; Talk-Out

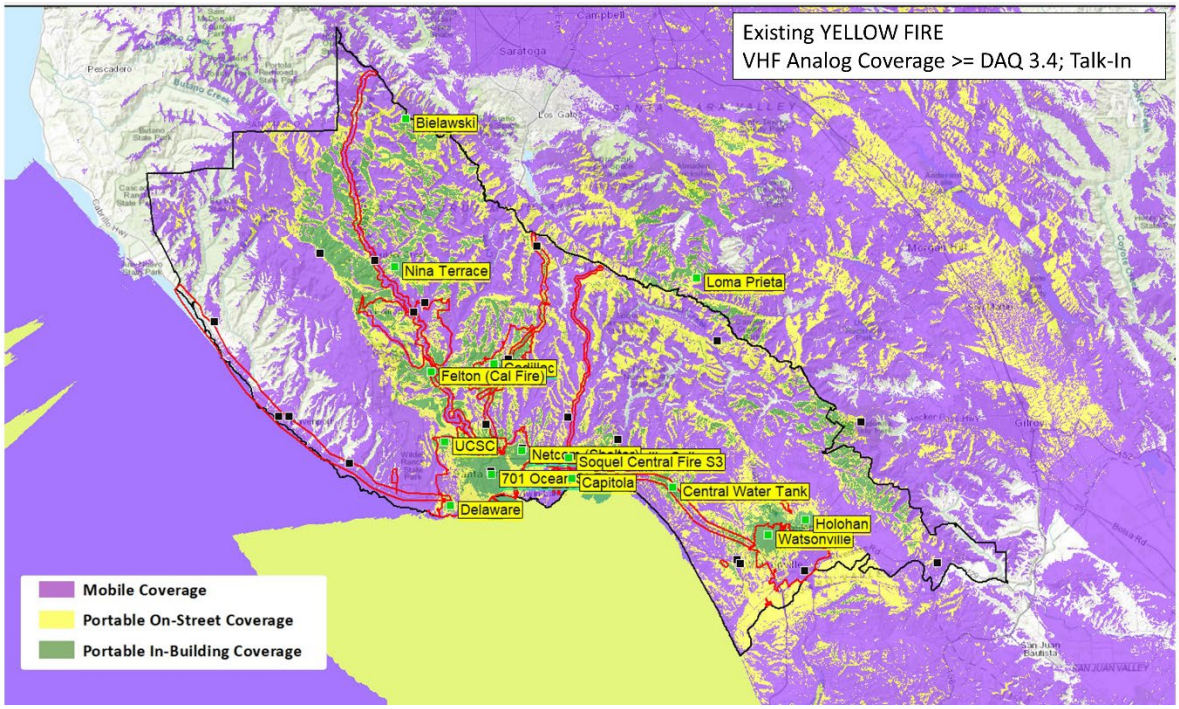


Figure 3 – Existing Fire Yellow Analog VHF Coverage >= DAQ 3.4; Talk-In

Figures 4 and 5 show the talk-out and talk-in coverage, respectively, for the existing Fire Red channel.

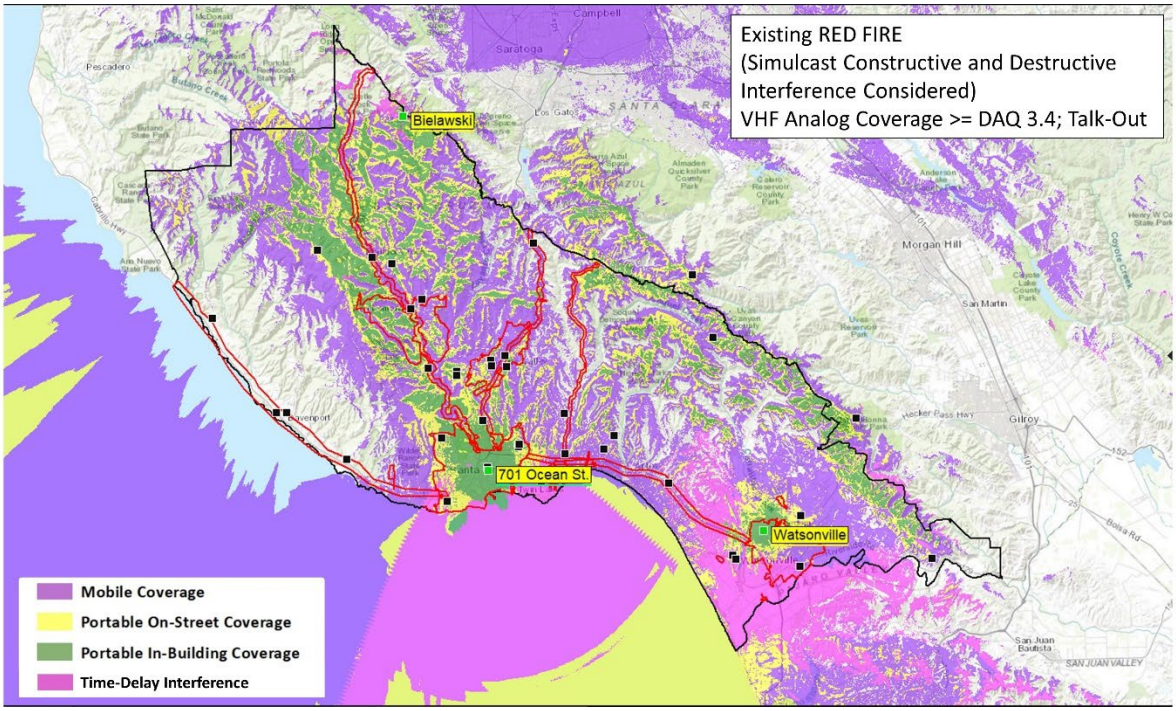


Figure 4 – Existing Fire Red Analog VHF Coverage >= DAQ 3.4; Talk-Out

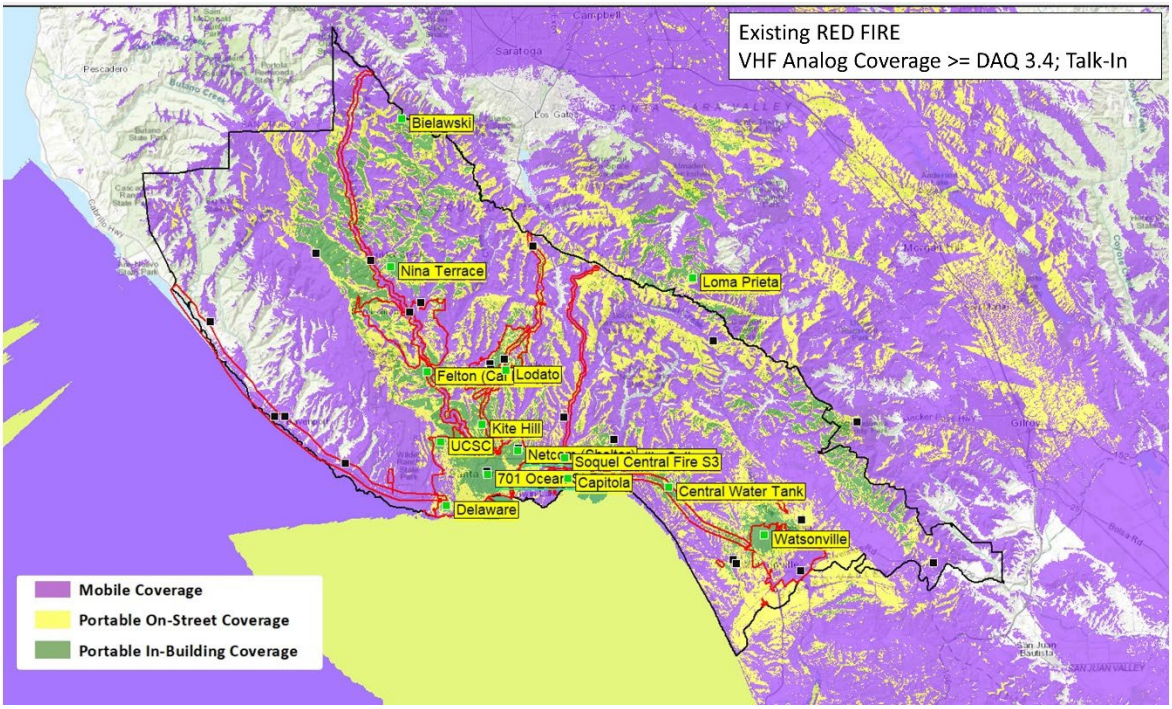


Figure 5 – Existing Fire Red Analog VHF Coverage >= DAQ 3.4; Talk-In

Figures 6 and 7 show the talk-out and talk-in coverage, respectively, for the existing Sheriff Red/Blue channels.

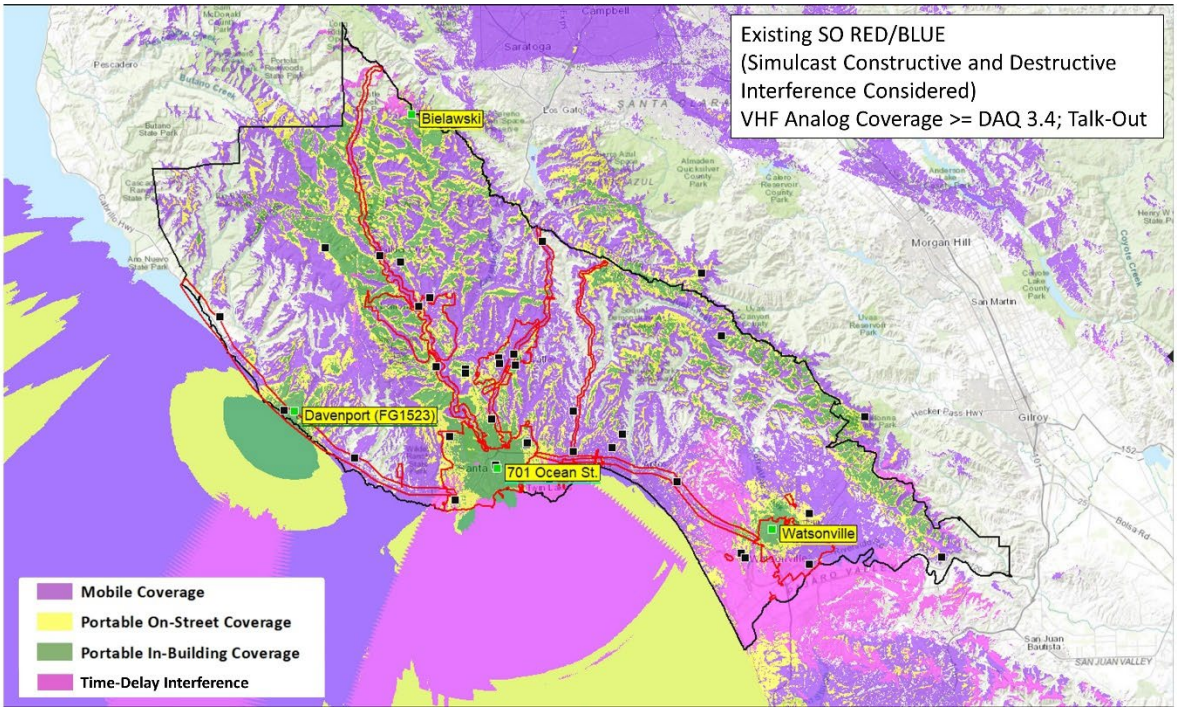


Figure 6 – Existing Sheriff Analog VHF Coverage >= DAQ 3.4; Talk-Out

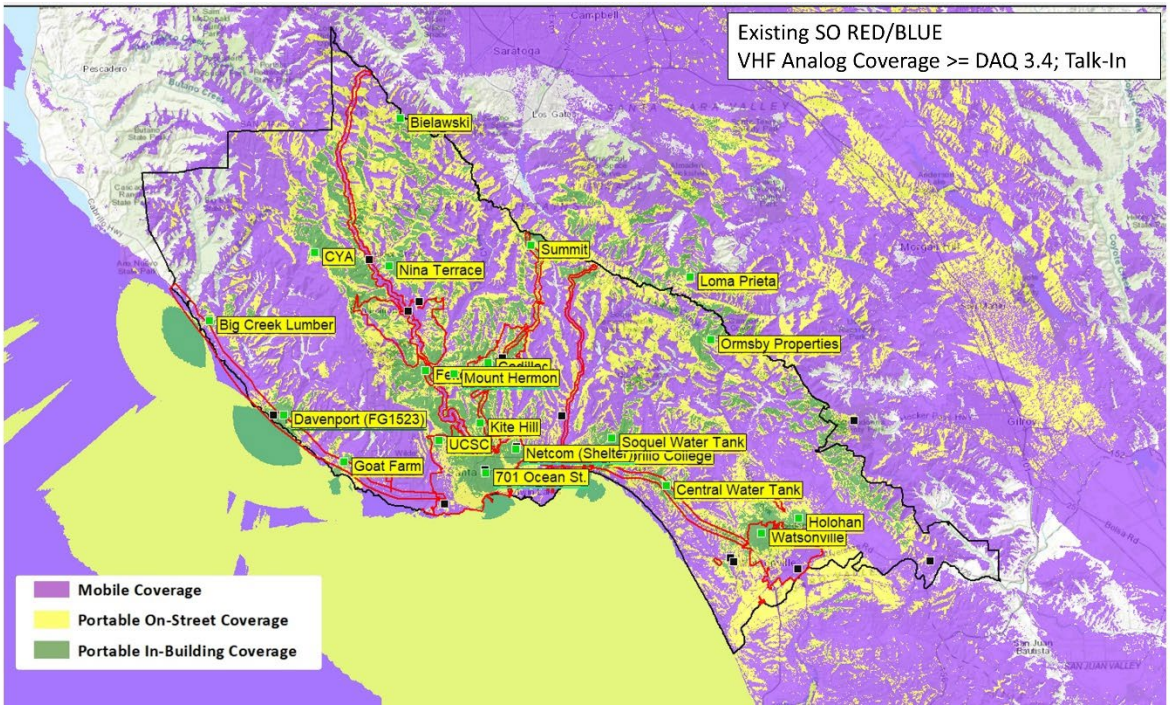


Figure 7 – Existing Sheriff Analog VHF Coverage >= DAQ 3.4; Talk-In

Figures 8 and 9 show the talk-out and talk-in coverage, respectively, for the existing Public Works channel.

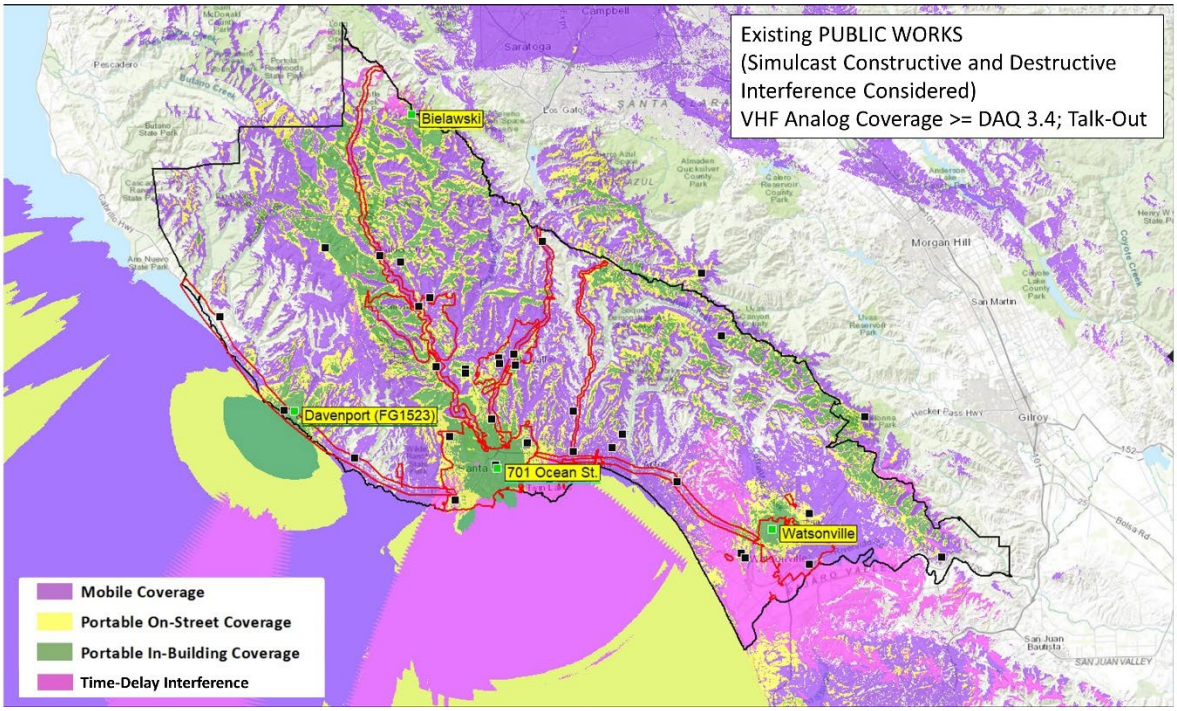


Figure 8 – Existing Public Works Analog VHF Coverage >= DAQ 3.4; Talk-Out

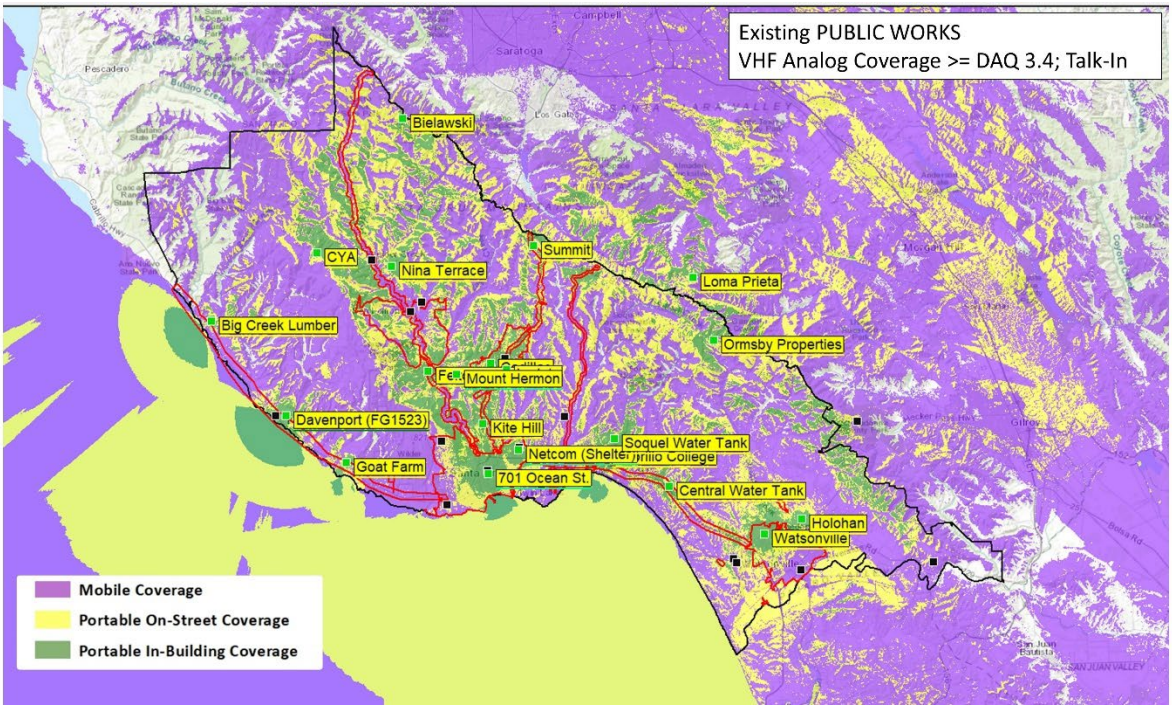


Figure 9 – Existing Public Works Analog VHF Coverage >= DAQ 3.4; Talk-In

Figures 10 and 11 show the talk-out and talk-in coverage, respectively, for the existing Public Works/LG channels.

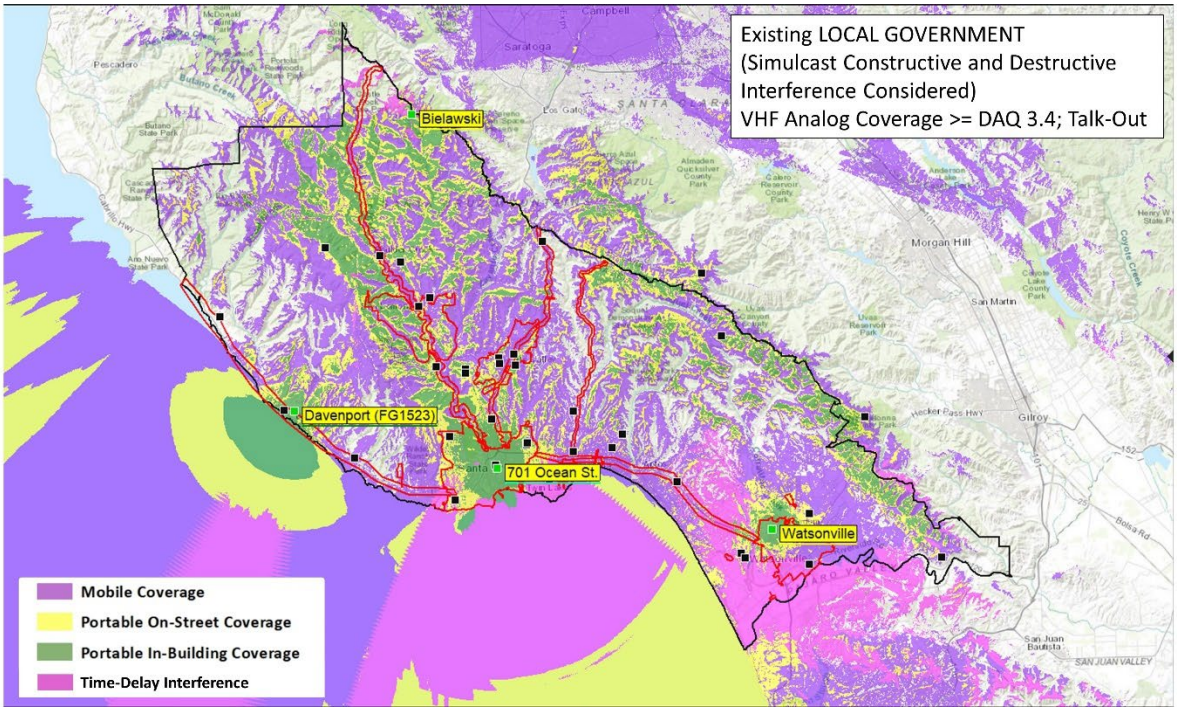


Figure 10 – Existing Local Government Analog VHF Coverage >= DAQ 3.4; Talk-Out

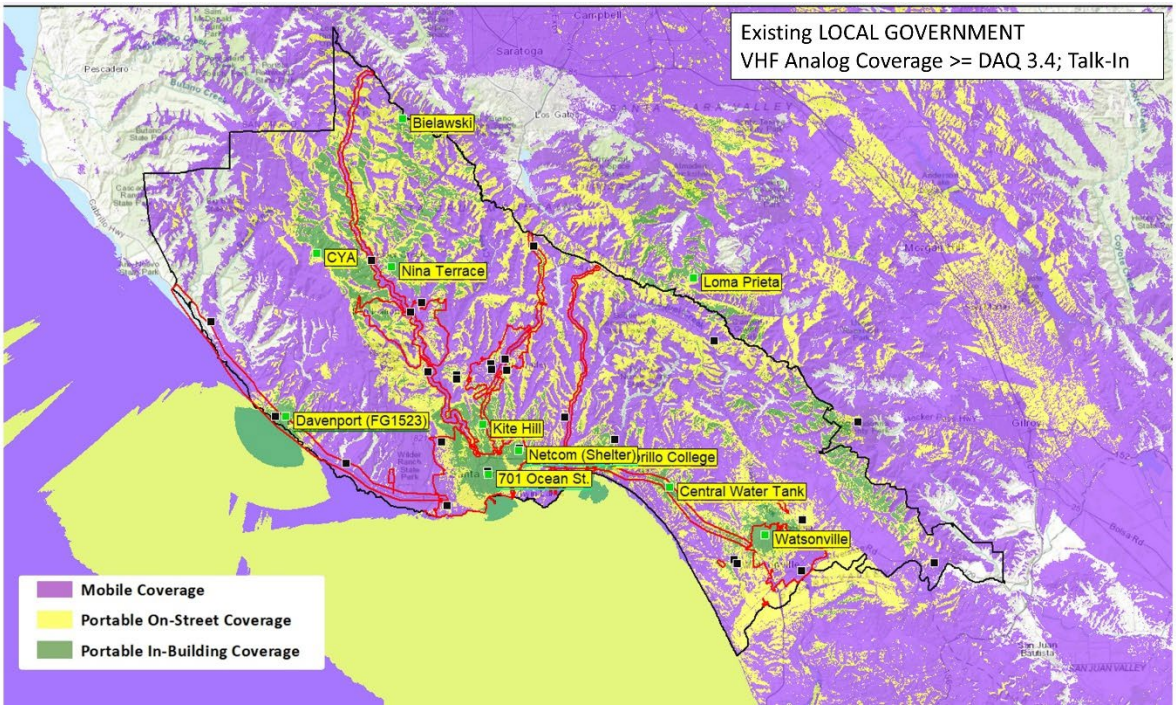


Figure 11 – Existing Local Government Analog VHF Coverage >= DAQ 3.4; Talk-In

3.2.1 Calls for Service Data

During an online coverage review with the County and ***FE***, the County ~~agreed to~~ provided ***FE*** with a year's worth of Calls for Service (CFS) data, which shows the geographic coordinates for every response on County radio channels during the year of 2021. As an added metric for evaluating existing coverage, ***FE*** imported the CFS data into coverage propagation software and analyzed the number of CFS within covered areas. For reference, Figure 12 shows all CFS locations for 2021 as provided by the County (a total of 112,587 individual calls) as purple dots.

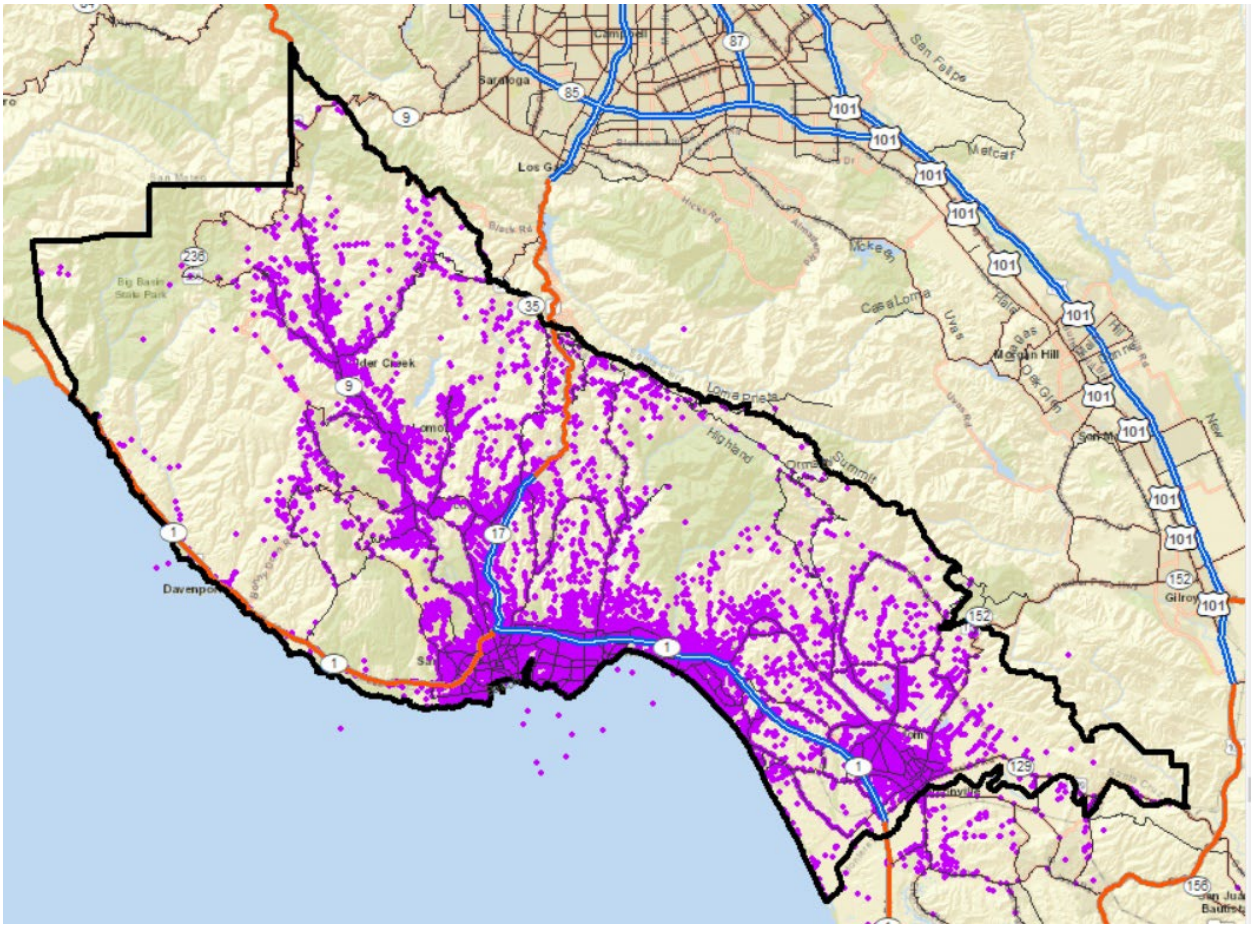


Figure 12 – 2021 Calls for Service on Santa Cruz County Radio Channels

3.2.2 Coverage Percentages

This subsection summarizes calculated coverage percentages for the Sheriff Red/Blue radio channels, which each share the same footprint, and represent the largest coverage footprints of the existing County radio channels. ***FE*** calculated the following coverage percentages:

- For mobile radio coverage, ***FE*** calculated the total amount of geographic coverage within the Santa Cruz County border.

- For portable on-street coverage, ***FE*** calculated the total amount of calls for service (CFS) which occurred within covered areas within the County border.

- For portable in-building coverage, ***FE*** calculated the population represented by United States census block centerpoints which fall within the covered areas within the County border. Each centerpoint within a census block (which is the smallest

geographic area of population data released by the US Census Bureau) represents a certain amount of population. If the centerpoint fell within an in-building coverage layer, ***FE*** considered that amount of population to be "covered," whereas the population represented by centerpoints outside of the covered areas were considered "uncovered."

Table 7 shows the calculated coverage footprints for the existing Sheriff Red/Blue channels.

Table 7 – Coverage Percentages for Existing Sheriff Red/Blue Channels

System Description	Number of Sites	Coverage Percentages					
		Mobile (County)		Portable On-Street (2021 Calls for Service)		Portable In-Building (US Census Block Population)	
		Talk-Out	Talk-In	Talk-Out	Talk-In	Talk-Out	Talk-In
Existing Sheriff Red/Blue Channels	4 TX / 22 RX	**73**	**95**	**46**	**53**	**26**	**29**

4. Alternative 1 Conceptual Design

4.1 Coverage Analysis

FE modeled the coverage that a VHF P25 Phase 1 Conventional LMR system can provide throughout the County. ***FE***, using a methodology similar to that used when modeling the existing LMR system's coverage (see Section 3 for reference), determined the optimal configuration of both existing radio sites and potential candidate sites to provide enhanced coverage. The primary goal of the enhanced coverage design was twofold:

- Provide improved coverage in areas where users reported coverage problems
- Increase the amount of portable on-street coverage over the 2021 calls for service (CFS) locations as provided by the County

Table 8 and Table 9 present the coverage study parameters and the subscriber unit parameters, respectively, ***FE*** used to perform the coverage analysis.

Table 8 – Coverage Study Parameters

Parameter	Description
System Type	P25 Phase 1 conventional (FDMA)
Frequency Band	VHF
Channel Bandwidth	12.5 kHz
Reliability	95%
Minimum Performance	Delivered Audio Quality (DAQ) – 3.4
Talk Paths	Mobile radio talk-out (from repeater to mobile) Mobile radio talk-in (from mobile to repeater) Portable radio talk-out, on-street (from repeater to a portable on the street) Portable radio talk-in, on-street (from portable on the street to repeater) Portable radio talk-out, in light/residential buildings (from repeater to portable inside buildings) Portable radio talk-in, in light/residential buildings (from portable inside buildings to repeater).

Table 9 – Subscriber Unit Parameters

Parameter	Mobile	Portable
Transmit Power (watts)	50	5
Receive Sensitivity (dBm)	-119	-119
Antenna Location	Roof	Hip
Antenna Gain (dB)	0	0
Body Loss (dB)	N/A	22.8

4.1.1 Additional Areas of Reported Coverage Problems

Subsequent to the coverage workshop conducted in February 2022, the County provided additional feedback to ***FE*** regarding areas where users reported problems with coverage, as well as areas where users desired general coverage improvements. The following is a summary of the additional feedback provided by various agencies. In the coverage maps presented later in this subsection, ***FE*** outlined these areas in purple.

Sheriff & PD Feedback

- Coverage along the Highway 9 corridor (Felton to Boulder Creek)
- The town of Brookdale
- Improved coverage in Zayante and Lompico
- Improved in-building coverage in Live Oak and Soquel
- Coverage through the Rio Del Mar/Seascape area
- Improved coverage in Dominican Hospital (specifically the ER)
- Aptos Village
- Rio Del Mar
- Beach areas of Live Oak (essentially SC Harbor east/south to Capitola – very busy in summer)
- SLV Service Center area and Felton Faire (Safeway and other shopping center)
- Bonny Doon
- North Coast beaches (north of Santa Cruz)
- Inside the Rodeway Inn

Fire Feedback

- Old San Jose Rd

- Branciforte Dr
- Vine Hill Rd
- Jarvis Rd
- N Rodeo Gulch
- Laurel Glen Rd
- Glenhaven Rd
- Porter Gulch Rd
- Glen Canyon Rd
- Glenwood Dr
- Lockhart Gulch
- Highway 9 between Felton and Santa Cruz
- Mt Hermon Conference Center
- Lompico Dr
- Hubbard Gulch
- Love Creek Rd
- Scenic Dr (Ben Lomond)

4.1.2 Candidate Sites

The County provided ***FE*** with a list of candidate site locations to consider for coverage improvements. Among the candidate sites were locations listed on two FCC licenses:

- FCC Callsign: WNXG382
    - 37.14744, -122.19497, EAGLE ROCK LOOKOUT 8 MI NW
    - 37.22244, -122.09219, 15715 SKYLINE BLVD
    - 37.16050, -122.28608, CHALK MOUNTAIN 8 MI NE
    - 37.02633, -122.04608, HENRY COWELL STATE PK 2 MI S
    - 37.22661, -122.29747, BUTANO AIRPORT RADIO SITE 5 MI SE
    - 37.56139, -122.47778, MONTARA RIDGE NORTH PEAK
- FCC Callsign: WNFB796

- 36.53442, -121.61994, MOUNT TORO 16 KM S
- 36.99994, -121.91356, NISENE MARKS STATE PARK TANK
- 36.50747, -121.90967, LOBOS RIDGE RADIO SITE 5 KM S
- 37.01619, -122.19881, 700 HIGHWAY 1

In addition to the candidate sites listed above, the County identified the following candidate radio sites in Table 10:

Table 10 – Additional Candidate Radio Sites

Site Name	Latitude	Longitude
Animal Services	37.05698	-122.00718
Ben Lomond Fire	37.08968	-122.08863
Ben Lomond Transfer	37.09593	-122.07852
Boulder Creek Fire	37.12577	-122.12193
Brommer Yard	36.96972	-121.97731
Buena Vista Land Fill	36.91726	-121.81262
CPD-Beach	36.97212	-121.95008
CPD-Gym	36.97792	-121.94708
CPD-Jade St. Park	36.96986	-121.96008
CPD-Mall	36.97574	-121.96870
CPD-Triple A Bldg	36.97358	-121.96085
Davenport Water Pump	37.01923	-122.20563
Main Jail	36.97986	-122.02384
Mount Madonna	37.00902	-121.70461
Netcom (Dispatch)	36.99508	-121.99596
Probation	37.04354	-122.04899
Rehabilitation	36.91403	-121.80984
Riverside Drive	36.91280	-121.64038
Scotts Valley PD	37.04967	-122.01913
SCPD-Auditorium	36.97375	-122.02978
SCPD-Dream Inn	36.96165	-122.02504
SCPD-SCPD	36.96784	-122.02740

Soquel (Adventist Camp)	37.01615	-121.95619
Watsonville PD	36.90882	-121.75458
WPD-Court House	36.90845	-121.75584
WPD-High School	36.91540	-121.79210
WPD-Independence Square	36.92927	-121.76442
WPD-Potty Plant	36.88658	-121.78321

4.1.3 Coverage Maps

Using the candidate sites identified by the County, ***FE*** determined the optimal site configuration to provide the desired coverage improvements. Figures 13 and 14 show the Alternative 1 talk-out and talk-in coverage, respectively.

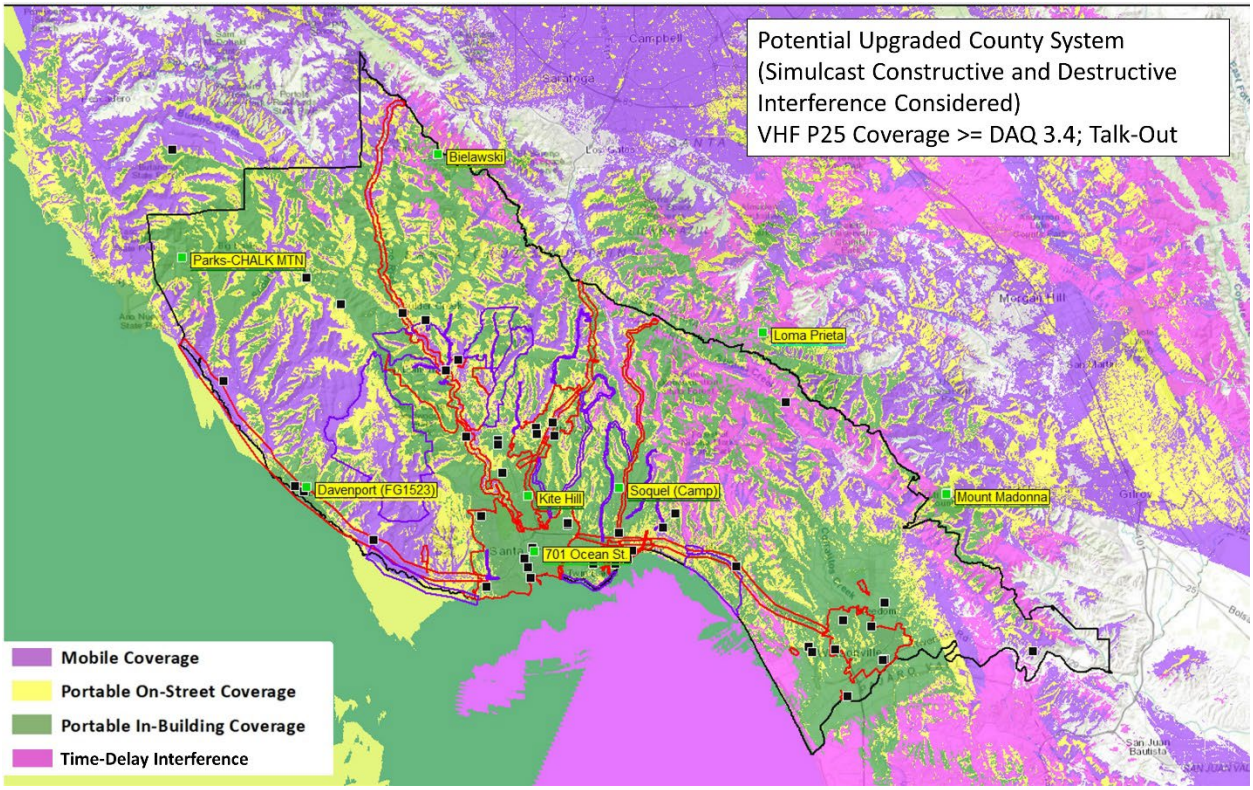


Figure 13 – Alternative 1 Coverage – Talk-Out

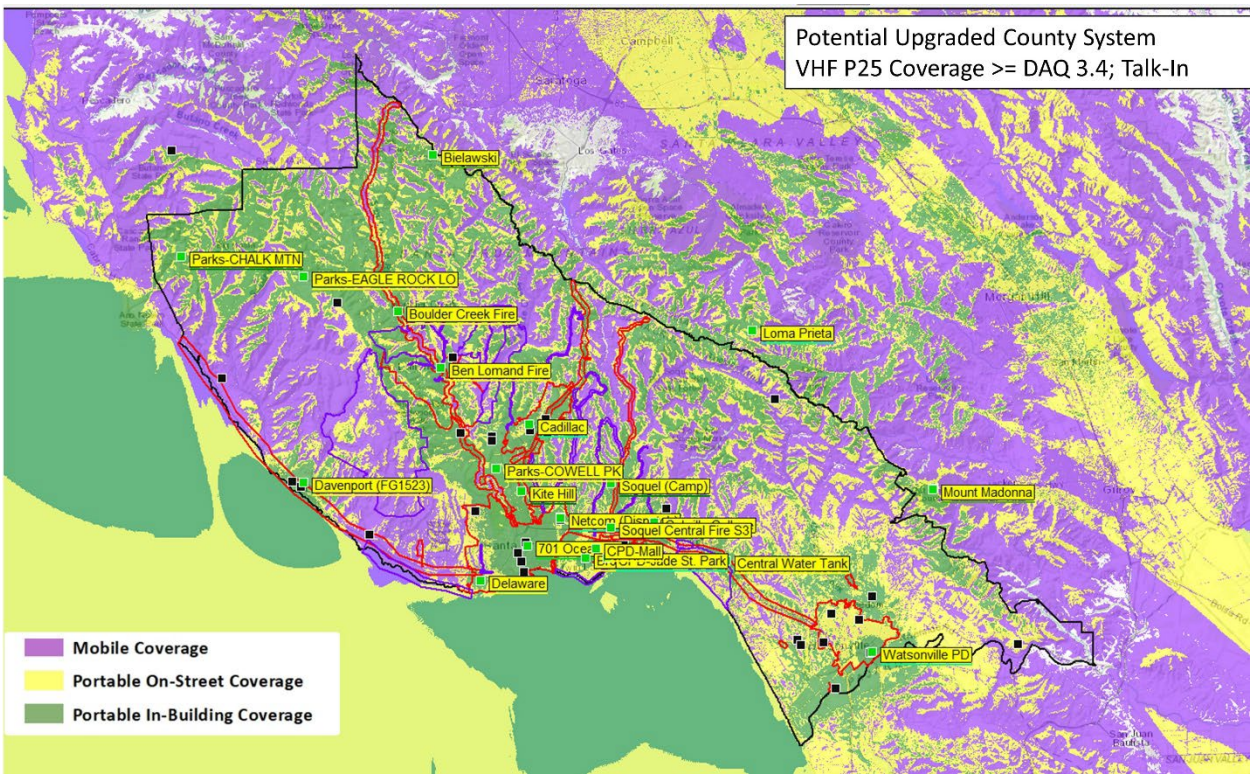


Figure 14 – Alternative 1 Coverage – Talk-In

4.1.4 Radio Coverage Percentages

FE calculated coverage percentages that Alternative 1 provides and compared that with the existing coverage provided by the Sheriff Red/Blue channels (i.e., the largest existing channel coverage footprint). Table 11 displays the coverage percentage comparison.

Table 11 – Coverage Percentages Alternative 1 compared with Existing Sheriff Red/Blue

System Description	System Technology	Number of Sites	Coverage Percentages					
			Mobile (County)		Portable On-Street (2021 Calls for Service)		Portable In-Building (US Census Block Population)	
			Talk-Out	Talk-In	Talk-Out	Talk-In	Talk-Out	Talk-In
Existing Sheriff Red/Blue Channels	VHF Analog	4 TX / 22 RX	**73**	**95**	**46**	**53**	**26**	**29**
Alternative 1	VHF P25	8 TX / 23 RX	**89**	**>99**	**88**	**88**	**72**	**50**

4.1.5 Site List

Table 12 presents a list the radio sites used in Alternative 1.

Table 12 – Alternative 1 Site List

Site Name	Existing Site Status	Site Type in Alternative	Latitude	Longitude	Structure Type	Structure Height (ft)
701 Ocean St.	TX/RX	TX/RX	36.97772	-122.02261	Building	90
Bielawski	TX/RX	TX/RX	37.22278	-122.09375	SST	80 (assumed)
Davenport (FG1523)	TX/RX	TX/RX	37.01877	-122.19682	Water Tank Support	60
Kite Hill	RX-Only	TX/RX	37.01217	-122.02694	SST	30 (assumed)
Loma Prieta	RX-Only	TX/RX	37.11061	-121.84427	SST	80 (assumed)
Mount Madonna	Candidate	TX/RX	37.00902	-121.70461	SST	100 (assumed)
Parks-CHALK MTN	CA Parks	TX/RX	37.16063	-122.29016	LO	59
Soquel (Camp)	Candidate	TX/RX	37.01615	-121.95619	Monopine	44
Ben Lomond Fire	MDC-Only	RX-Only	37.08968	-122.08863	Building	22
Boulder Creek Fire	MDC-Only	RX-Only	37.12577	-122.12193	Building	24
Cabrillo College	RX-Only	RX-Only	36.99120	-121.92257	Building	25
Cadillac	RX-Only	RX-Only	37.05358	-122.01943	Water Tank	35
Central Water Tank	RX-Only	RX-Only	36.96703	-121.86707	Water Tank	25 (assumed)
CPD-Jade St. Park	Capitola PD	RX-Only	36.96986	-121.96008	Building	23
Mount Toro	RX-Only	RX-Only	36.53817	-121.62948	SST	40 (assumed)
Parks-COWELL PK	CA Parks	RX-Only	37.02633	-122.04608	Building	20
Parks-EAGLE ROCK LO	CA Parks	RX-Only	37.14744	-122.19497	LO	49
Watsonville PD	Candidate	RX-Only	36.90882	-121.75458	Tower on Roof	30 (Twr), 30 (Roof)
Brommer Yard	Candidate	RX-Only	36.96972	-121.97731	Building	20 (assumed)
CPD-Mall	Capitola PD	RX-Only	36.97574	-121.96870	Building	30
Delaware	RX-Only	RX-Only	36.95642	-122.05899	Building	20 (assumed)
Netcom (Dispatch)	County Site	RX-Only	36.99324	-121.99644	SST	100 (assumed)
Soquel Central Fire S3	RX-Only	RX-Only	36.98870	-121.95678	Building	20 (assumed)

4.2 Capacity Analysis and Spectrum Availability

4.2.1 Channel Capacity

The County currently operates six conventional channels in the VHF frequency band, as described in the Existing System Assessment section of this report. Alternative 1 assumes that the same channel capacity (i.e., **six conventional channels**) shall be built out at all proposed sites.

4.2.2 Spectrum Availability

FE assessed the potential for the County to license additional channels to perform a migration from the existing analog VHF channels to new P25 VHF channels. Ideally, the County would be able to license additional VHF channels for the new P25 system, allowing for the existing analog channels to all remain operational.

Obtaining new licenses in VHF can be difficult: the signals propagate farther than those in higher frequency bands and can therefore cause interference to radios at great distances. In addition, the majority of radio systems in remote/rural regions continue to operate in the VHF band. As a result, available spectrum in this band is scarce.

After performing a preliminary availability study, it appears VHF spectrum in Santa Cruz County is very scarce, and there may not be available “free and clear” channels that the County can license for Countywide operation. While there may be available VHF channels within the County that are currently licensed but not operational, in the worst-case scenario where no additional spectrum is available, the County may need to deactivate one or more existing channels, and temporarily migrate users to another channel during the transition.

It is important to note ***FE*** typically advocates for agencies to require any potential system vendors to perform a detailed frequency plan and ability to license analysis prior to submitting a proposal for a new radio system. This can be done by adding a requirement in a Request for Proposal (RFP) for system vendors to perform these evaluations as part of their proposal.

5. Alternative 2 Conceptual Design

5.1 Coverage Analysis

FE modeled the coverage that a VHF P25 Phase 2 Trunking LMR system can provide throughout the County. ***FE***, using a methodology similar to that used when modeling the existing LMR system's coverage (see Section 3 for reference), determined the optimal configuration of both existing radio sites and potential candidate sites to provide enhanced coverage. Table 13 and Table 14 present the coverage study parameters and the subscriber unit parameters, respectively, ***FE*** used to perform the coverage analysis.

Table 13 – Alternative 2 Coverage Study Parameters

Parameter	Description
System Type	P25 Phase 2 trunking (TDMA)
Frequency Band	VHF
Channel Bandwidth	12.5 kHz
Reliability	95%
Minimum Performance	Delivered Audio Quality (DAQ) – 3.4
Talk Paths	Mobile radio talk-out (from repeater to mobile) Mobile radio talk-in (from mobile to repeater) Portable radio talk-out, on-street (from repeater to a portable on the street) Portable radio talk-in, on-street (from portable on the street to repeater) Portable radio talk-out, in light/residential buildings (from repeater to portable inside buildings) Portable radio talk-in, in light/residential buildings (from portable inside buildings to repeater).

Table 14 – Alternative 2 Subscriber Unit Parameters

Parameter	Mobile	Portable
Transmit Power (watts)	50	5
Receive Sensitivity (dBm)	-119	-119
Antenna Location	Roof	Hip
Antenna Gain (dB)	0	0
Body Loss (dB)	N/A	22.8

5.1.1 Coverage Considerations

When performing the coverage analysis for Alternative 2, ***FE*** considered the same coverage problem areas, potential candidate radio sites, and coverage design targets as

those considered for the development of Alternative 1. Refer to the appropriate sections in this report for more details regarding those system aspects.

5.1.2 Coverage Results

The site configuration and potential coverage of the P25 Phase 2 TDMA system for Alternative 2 are identical to those of Alternative 1. While P25 Phase 2 has a smaller channel bandwidth, most system manufacturers can achieve comparable coverage when designing either Phase 1 or Phase 2 P25 systems. There may be small differences in proposed designs, especially with regard to potential areas of simulcast interference, but for the purposes of this analysis, ***FE*** considers the overall coverage for both alternatives to be equivalent. Refer to the appropriate sections in the Alternative 1 section of this report for more details regarding the potential coverage.

5.1.3 Site List

As stated previously, the site configuration in Alternative 2 is identical to the site configuration for Alternative 1. The site list for Alternative 1 earlier in this report applies equally to Alternative 2. Refer to Section 4.1.5 for site details.

5.2 Capacity Analysis and Spectrum Availability

5.2.1 Channel Capacity

FE analyzed the capacity requirements for Alternative 2. Analyzing required capacity in a trunking system involves different methods than a conventional system. ***FE*** used existing and projected County subscriber unit quantities to perform an Erlang-C trunked system loading analysis, which determines the required number of channels needed to meet the County's system capacity needs. ***FE*** used the following design targets for the capacity analysis:

- The system would have a public-safety Grade of Service (GoS) less than or equal to 1%, meaning that less than 1% of all attempted calls would be queued (for more than one second) or blocked (i.e., rejected by the system).
- The system would support a subscriber unit growth factor of 1% per year for 10 years (for a projected subscriber unit total of 1175 radios).

FE made the following assumptions regarding the capacity analysis for the new system:

- P25 Phase 2 would provide two voice paths per radio licensed frequency pair using time division multiple access (TDMA) technology

- Due to a lack of existing traffic data, ***FE*** assumed projected push-to-talk (PTT) duration and PTTs per hour based on extensive experience analyzing public safety radio system traffic data
- The number of talk paths would support projected traffic in the Average Non-Busy Hour, as well as Busy Hour traffic scenarios

FE derived an Average Non-Busy Hour user traffic profile for the County by examining public safety traffic data obtained from other similar public safety radio projects. Based on evaluations by the Public Safety Wireless Advisory Committee (PSWAC)[4], Busy Hour traffic is typically 3 to 4 times the Average Non-Busy Hour traffic. ***FE*** used the Busy Hour traffic scenario as the minimum requirement for the channel capacity throughout the P25 system.

Based on the results of the Erlang-C analysis, **four P25 Phase 2 channels** would meet the GoS requirement during Busy Hour traffic scenarios. Four P25 Phase 2 channels would provide six talk paths (i.e., six distinct simultaneous conversations) and one trunking control channel.

5.2.2 Spectrum Availability

Based on the capacity analysis above, Santa Cruz County has the VHF spectrum necessary already licensed to support this alternative. As described earlier in Alternative 1, obtaining new licenses in VHF can be difficult. Within Santa Cruz County, it appears VHF spectrum is very scarce, and there may not be available "free and clear" channels that the County can license for Countywide operation. While there may be available VHF channels within the County that are currently licensed but not operational, in the worst-case scenario where no additional spectrum is available, the County may need to deactivate one or more existing channels, and temporarily migrate users to another channel during the transition.

It is important to note ***FE*** typically advocates for agencies to require any potential system vendors to perform a detailed frequency plan and ability to license analysis prior to submitting a proposal for a new radio system. This can be done by adding a requirement in a Request for Proposal (RFP) for system vendors to perform these evaluations as part of their proposal.

[4] Final Report of the Public Safety Wireless Advisory Committee to the Federal Communications Commission. September 11, 1996. https://www.apcointl.org/doc/spectrum-management/173-public-safety-wireless-pdf/file.html

6. Backhaul Network Modeling

FE developed an upgraded backhaul design for the potential County system (applicable to both Alternative 1 and Alternative 2). This subsection presents a summary of the conceptual backhaul design, which is a combination of existing backhaul and new microwave links. For all new microwave links, ***FE*** performed path profile analyses to determine the viability of potential paths. Ultimately, a system manufacturer will need to perform detailed path analyses to confirm any new microwave links will meet availability and throughput requirements.

All new microwave links in the design have redundant connectivity, with the exception of the spur from Kite Hill – Cowell State Park – Cadillac. Through communication with the County, this link was determined to not require redundant connectivity in this conceptual design; however, the County may wish to pursue redundancy in the future.

6.1.1 Conceptual Backhaul Design

Figure 15 shows a logical layout of the proposed backhaul system, highlighting the proposed radio sites in the County system, as well as any non-radio sites requiring connectivity. It is important to note there are still several links which do not have verified connectivity; for those “unverified” links, the County informed ***FE*** they are in the process of determining whether leased lines and/or fiber will be available to create those links.

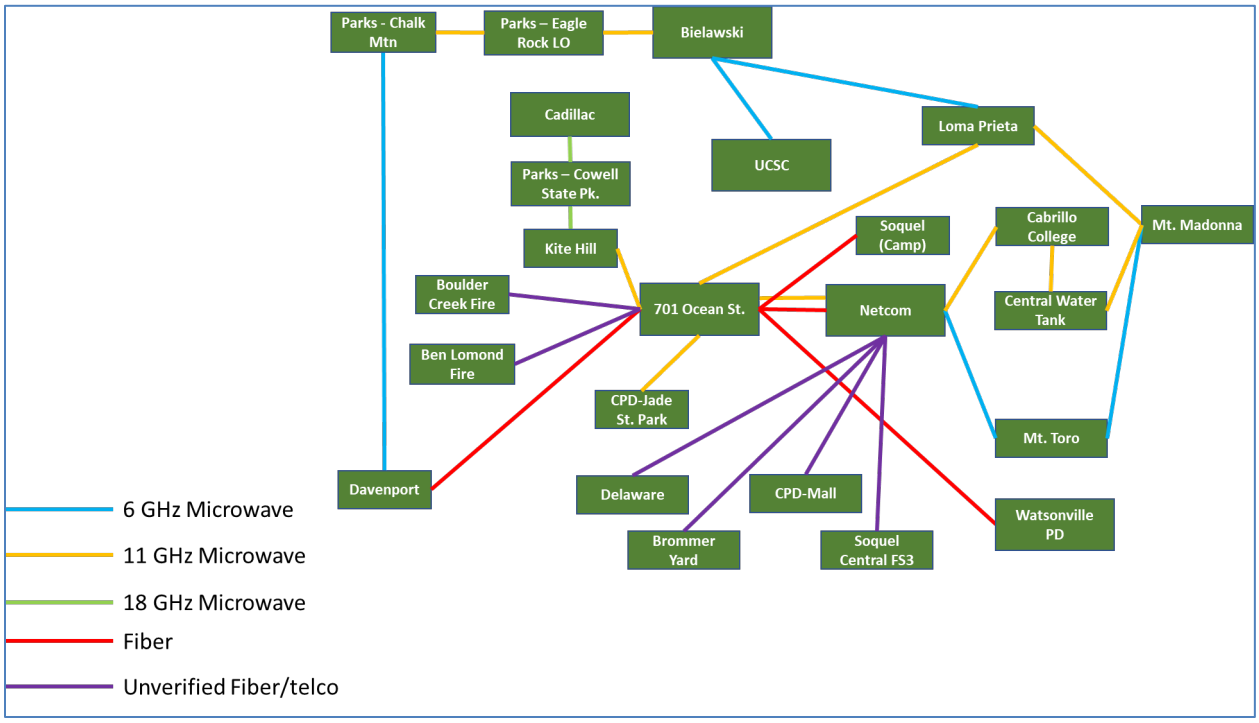


Figure 15 – Logical Layout of Proposed Santa Cruz County Backhaul System

6.1.2 Path Profiles

Appendix C contains path profiles for the nine new microwave links proposed as part of the conceptual backhaul design. All links appear to have Line of Sight (LOS) and Fresnel Zone (FZ) clearance over terrain for their respective frequency bands. Clutter height (i.e., land cover) may present obstacles on some paths, which may cause less than five 9's availability at currently modeled dish heights. Some dish heights are modeled higher than originally designed to overcome some obstacles in the model; however, a detailed design performed by a microwave equipment manufacturer will verify clearance between any prospective paths.

7. Interoperability and Regional Response Analysis

Compared to existing County radio system, the alternatives under consideration enhance interoperability among public safety agencies within the County and with external agencies and neighboring counties.

7.1 Interoperability Analysis

Interoperability is the ability for County departments and/or outside agencies to communicate during incidents that require the response of multiple departments or agencies. ***FE*** analyzed the radio interoperability capabilities for the upgrade alternatives in reference to the Cybersecurity and Infrastructure Security Agency's (CISA) SAFECOM program. Figure 16 illustrates the "five lanes" of the SAFECOM Interoperability Continuum as a tool to assist emergency response agencies and policy makers to plan and implement interoperability solutions.

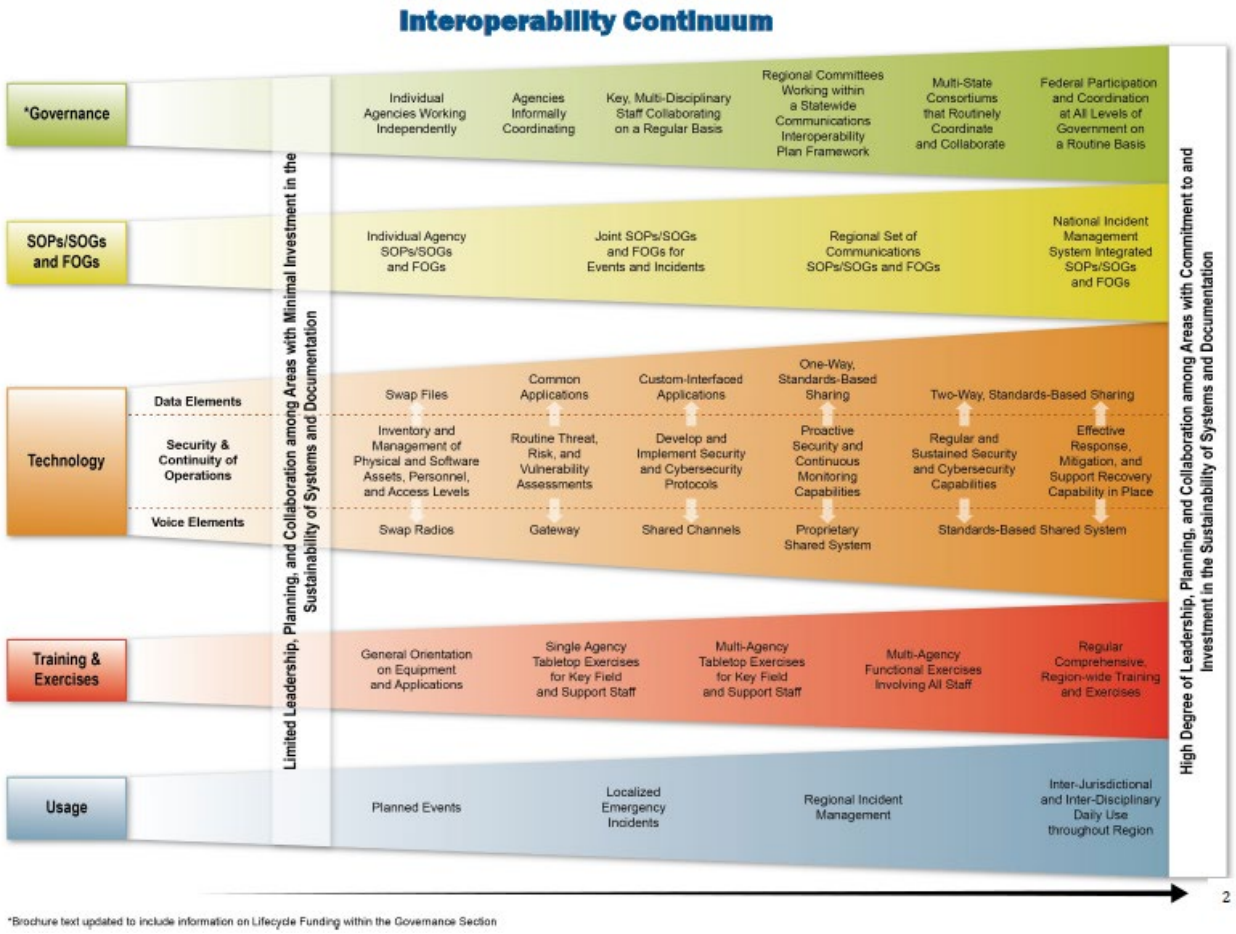


Figure 16 – DHS-OEC Interoperability Continuum

FE focused on the Voice Elements section of the Technology lane. Moving from left to right, the methods become more advanced and effective in their ability to address interoperability requirements, and rely more on technology to increase the ease of interoperability, as described in SAFECOM's June 2021 brochure[5]:

- **Swap Radios**. While expensive and human-resource intensive, swapping radios or maintaining a cache of standby radios is a reliable but least sophisticated solution to achieve interoperability.

- **Gateway**. Gateways retransmit across multiple frequencies and talk groups, and also allow access to phone and cellular systems. Gateways provide an interim interoperability solution as agencies move toward shared systems. However, gateways encumber spectrum because each participating agency must use at least one channel in each band per common talk path and because they are tailored for communications within the geographic coverage area common to all participating systems. A gateway may also create latency and other technical obstacles between push-to-talk and traffic reception which can be adjusted to decrease impact on operations.

- **Shared Channels**. Interoperability is enhanced when agencies share a common frequency, talk group, or air interface (analog or digital) and are able to agree on common channels. A clear understanding of the nature and availability of interoperable communications channels in a given area is essential to prevent congestion, and to assure that shared channels and/or talk groups can be assigned quickly and to appropriate end users when needed.

- **Proprietary Shared Systems and Standards-Based Shared Systems**. Regional shared systems are the optimal solution for interoperability. While proprietary systems limit the user's choice of product with regard to manufacturer and competitive procurement, standards-based shared systems promote competitive procurement and a wide selection of products to meet specific user needs. An optimal technology solution can be provided with proper talk group architecture and capacity planning, and both operability and interoperability addressed by system design.

FE recommends the use of a P25 Standards-Based Shared System for many reasons including P25 Common Air Interface (CAI), P25 Inter-RF Subsystem Interface (ISSI), backwards compatibility to analog systems, and U.S. Federal Government and state grant funding. The P25 CAI enables over-the-air interoperability between P25 radios regardless

[5] https://www.cisa.gov/sites/default/files/publications/21_0615_cisa_safecom_interoperability_continuum_brochure_final.pdf

of manufacturer. If another agency in the County had a P25 radio system, the County could program their P25 mobile and portable radios with talkgroups on the other P25 system, and vice versa. The P25 ISSI interconnects different P25 cores, regardless of frequency band or manufacturer, to allow roaming of user radios between networks. ISSI supports many common P25 features, including Caller ID, group calls, encryption, and emergency calls. A user roaming into a foreign system must have radios which are on the same frequency or multi-band compatible with the foreign host.

With a P25 radio system and P25 capable radios, the County would still be able to program other departments analog conventional channels in their mobile and portable radios and would be able to lend out portable radios, as needed. With use of gateways, a P25 trunked system could provide connectivity between the County and other analog or digital conventional system(s).

P25 is the predominant standard for public safety in North America. Most U.S. Federal Government and state grants require use of P25 based equipment. The P25 standard supports both conventional and trunked operations, with over 1,800 conventional systems and over 1,100 trunked systems in operation throughout the United States.

At the time of writing this report, there are 55 P25 Conventional[6] systems and 104 P25 Trunked[7] systems in the state of California, as reported by the P25 Technology Interest Group (PTIG). There are also many other P25 systems in adjacent states. Therefore, the use of P25 systems and subscribers provides the highest likelihood of achieving interoperability with other public safety users. P25 is a mature and robust standard, providing detailed specifications with a well-defined interface path for connecting with other P25 radio systems, even with potentially disparate manufacturers.

FE recommends that the new system maintain local and regional interoperability with law enforcement, Fire/EMS, and public works agencies, while improving interoperability with other county, state, federal and tribal agencies. Migrating to P25 increases interoperability opportunities with other P25 user(s) in the region. It is important to note that interoperability with other P25 system(s) may require additional system hardware and/or software, approval, agreement(s), planning, and programming on the foreign system and subscriber units, but the potential for increased interoperability is there. With multi-band radios (VHF, UHF, and 7/800 MHz), the County can retain existing interoperability with agencies on VHF but also program other UHF and 7/800 MHz channel(s) for mutual air

[6] https://www.project25.org/images/stories/ptig/P25_Conventional_Systems_List_Final_REV02_March_2020_200324.pdf
[7] https://www.project25.org/images/stories/ptig/P25_Trunking_Systems_Update_November_2021_REV_16_X.pdf

purposes. To achieve this level of interoperability, ***FE*** provides the following recommendations for site equipment, dispatch consoles, and subscriber units.

7.2 Site Equipment

7.2.1 System Control Equipment

The new radio system would have P25 system control equipment that includes voice processing, management, administration, and networking components that are utilized for control of the new P25 channels. The system control equipment could reside at any of the repeater sites. However, ***FE*** recommends that the P25 system control equipment be installed at a site that is easily accessible during the winter and have commercial AC power and UPS or generator backup, such as the Dispatch Center. To mitigate single point of failure, the alternative includes localized high availability servers and redundant networking equipment.

7.2.2 Simulcast Control Equipment

Both alternatives include new simulcast control and voting equipment for the P25 simulcast sites and receive-only sites. The simulcast control and voting equipment may reside at any of the sites, however, ***FE*** recommends installing it at sites that are easily accessible during the winter and have commercial AC power and UPS and/or generator backup. To mitigate single point of failure, the alternative includes redundant simulcast control and voting equipment at two geographically separated locations.

The simulcast control equipment maintains the frequency, phase, and amplitude stability of the VHF repeaters to minimize audio distortion for mobile and portable radios in areas where the transmit signals from multiple repeaters overlap. The voting comparator selects the highest quality audio from multiple sites and routes the selected audio to the simulcast control equipment and dispatch consoles. The simulcast control equipment then routes the audio to all repeater sites for retransmission. Audio from the dispatch consoles is routed to the simulcast control equipment for broadcast. The backhaul system would be used to transport audio between repeater sites, simulcast control and voting sites, and the dispatch consoles. Simulcast control and voting equipment sites would also include a Global Positioning System (GPS) receiver with a high-stability oscillator.

7.2.3 Repeater Site Equipment

Both alternatives include new repeater site equipment at the identified candidate sites with the recommended equipment as follows:

- New VHF P25 digital repeaters at 8 candidate sites
    - Sites include 701 Ocean St., Bielawski, Davenport (FG1523), Kite Hill, Loma Prieta, Mount Madonna, Parks-CHALK MTN, and Soquel (Camp)
    - Alternative 1 requires 6 channels, licensed and configured to operate in P25 Phase 1 Conventional Simulcast mode
    - Alternative 2 requires 4 channels, licensed and configured to operate in P25 Phase 2 Trunking Simulcast mode
- New VHF P25 digital receivers at 15 candidate sites
    - Sites include Ben Lomand Fire, Boulder Creek Fire, Cabrillo College, Cadillac, Central Water Tank, CPD-Jade St. Park, Mount Toro, Parks-COWELL PK, Parks-EAGLE ROCK LO, and Watsonville PD
    - Alternative 1 requires 6 channels, licensed and configured to operate in P25 Phase 1 Conventional mode
    - Alternative 2 requires 4 channels, licensed and configured to operate in P25 Phase 2 Trunking mode
- New VHF transmit and receive antennas, radio frequency (RF) cable and lightning protection devices (i.e., lightning arrestors and feedline ground kits).
- New VHF transmitter combiner and receiver multicoupler to mitigate RF site interference and allow repeaters to share the same transmit and receive antennas. All channels at a site would use the same transmit and receive antennas, with the receive antenna at the top of the tower and the transmit antenna mounted below the receive antenna with maximum separation to help mitigate RF interference.
- New redundant routing and switching equipment to help mitigate a single point of failure.

7.2.4 Network Management Equipment

For system management and remote monitoring, the conceptual design includes a new network management system (NMS) to accomplish the following functions:

- Remotely monitor radio system and site performance and alarms (e.g., equipment failures, elevated temperatures, and intrusion)
- Troubleshoot system outages
- Administer and manage system security, functionality, and software licenses

- Page or send emails to report system alarms or outages to staff required to respond
- Manage subscriber radio equipment database, profiles, and system access information

The NMS software interface identifies the current operating status of the equipment and sites and would flag 'out of tolerance' conditions via an audio/visual indication. The indication would return to a normal indication after correction of the out of tolerance condition. Types of the events and functions that the NMS could monitor and manage include:

- Transmitter low power output
- Antenna system high Voltage Standing Wave Ratio (VSWR)
- Transmitter power amplifier (PA) failure
- Base station power supply failure
- Router/switch failure
- Controller/gateway/server failure
- External interference detection
- Backhaul subsystem failure
- Configuration database changes

The NMS would archive system data and would maintain a history of alarm events in a searchable database for a minimum of 180 days. Storage of alarm events enables root cause analysis on infrequent recurring events.

7.3 Dispatch Equipment

Both alternatives include the replacement of the existing dispatch consoles at the primary and backup Center #1 facility. While not included in the current console count, the County may want to consider a new console position at either dispatch facility for training and maintenance.

FE understands that the County has the following configuration and redundancy:

1. Dispatch center has 15 console positions (ModUcom system)
2. Backup Dispatch Center # 1 is located at Watsonville with six (6) Raven consoles

3. Backup Dispatch Center # 2 is located at Hollister site and is shared with San Benito County. NETCOM is considering installing Mindshare consoles.

At the time of writing this report, it is unknown whether the existing dispatch consoles will function with the new radio system. The number of consoles at Dispatch Center #2 are also unknown. Therefore, the conceptual design includes only a total of 21 new dispatch consoles. It is important to note that the cost estimates do not include any building construction, new tower or shelter, new console furniture, or new secondary power sources at the current or backup dispatch center.

Primary Dispatch and Backup Dispatch Center # 1 require a highly reliable system with no single point of failure. Therefore, the design includes redundant networking equipment and backup RF control stations. The new console system would replace the existing backroom equipment with compact servers, routers, switches, and computers. Each console position would retain all functionality of the existing consoles, with the following additions:

- Radio systems talk group control (Alternative 2)
- Paging
- Fire station alerting
- Emergency alarms and calls
- Patching between talk groups and analog or conventional stations (Alternative 2)

Each console position would have a backup control station for use in the event of a console or microwave hop failure to the core. These control stations could be multi-band units to allow for operation on analog or P25 digital systems on VHF, UHF and/or 700/800 MHz channels.

The County may already have logging recorder vendor(s) that they are working with, which may be handled outside this project. However, for worst-case scenario the cost estimates assume the need for new logging recorders at primary and backup dispatch centers. The estimates do include any potential hardware, software and/or licensing costs needed to record the voice traffic on the new radio system.

7.4 Interface Requirements

The P25 ISSI and Console Subsystem Interface (CSSI) provide the ability to interconnect radio and console subsystems in Alternative 2, even when their manufacturers and software versions differ. This provides public safety agencies the opportunity to link their

networks together to create a “system of systems” architecture. The ISSI could allow for interconnection of the County system to other P25 core(s) with necessary hardware, software, and programming on both ends. Interoperability with County and other P25 system(s) would require backhaul connectivity and ISSI hardware, software, and licenses on both systems, with ISSI talkgroups programmed on the radio systems and subscriber units. To take advantage of system discount and lower integration costs, the County may negotiate and agree to procure this additional infrastructure for establishing ISSI connection(s) as part of the base bid. As part of a functional specification for Alternative 2, the County could specify the capacity for number of concurrent conversations. It is important to note that ISSI provides a subset of P25 features. However, ***FE*** recommends that the following features be supported between the County and the ISSI interconnected system:

1. Automatic (hands-free) roaming to both systems
2. Confirmed group call
3. Unconfirmed group call
4. Announcement group call
5. Emergency group call
6. Individual Call
7. Priority call (with and without preemption)
8. AES encryption
9. Call alert
10. Emergency alarm
11. Emergency clear
12. Unit ID

The CSSI could potentially allow for existing consoles on the new system core. At the time of writing this report, it is unknown whether the awarded vendor will propose to support CSSI. As such, a P25 Phase 2 Trunking control station for each of the consoles at primary and backup dispatch centers, as well as a control station antenna system(s), may be needed to access the P25 system. Setting up CSSI would require hardware, software, and licenses on the new system core(s), and potential certification/testing of the consoles to operate on the radio system. To take advantage of system discount and lower integration costs, the County may negotiate and agree to procure this additional infrastructure for establishing CSSI connection(s) as part of the base bid.

Although not listed in the Interoperability Continuum, a dispatcher can create a "patch" between the channels used by different agencies so that transmissions on either channel are heard on both channels. Dispatchers typically create console patches for short durations and for specific events, but it can lead to operational confusion because of infrequent use. Console patching is also inefficient in that it uses the channels of all involved agencies involved. Nevertheless, the conceptual design for both alternatives include interoperability gateways at primary and backup dispatch centers to allow for interfacing to analog and/or conventional channels to/from a P25 Phase 1 or Phase 2 radio system.

7.5 Subscriber Equipment

Section 8.1.5 provides a summary of existing subscriber unit inventory that the County and stakeholders can leverage on the new system. Either alternative requires that the County and stakeholders replace existing VHF, analog-only and end-of-life subscriber units. Our estimates conclude that approximately 1/3 of existing subscriber units require replacement with new radios equipped and licensed to operate on P25 Conventional or Trunking mode. We estimate that the County and stakeholders can re-use and re-program 2/3 of the existing fleet on the new system. Examples of radios that can operate on the new system include Kenwood VP6000 and NX-5200, Motorola APX6000, APX6500, APX7500, APX8000XE, and APX8500, and Tait TM9100 and TM9155. Without detailed information, ***FE*** assumes that existing P25 capable radios are equipped and licensed for either alternative. Therefore, the cost estimates do not include potential software upgrades for P25 Conventional and P25 Phase 2 Trunking mode. The cost estimates do include re-programming of these subscriber units to operate on the new system. It is unknown whether the County would retain an analog VHF channel for paging purposes. Therefore, the cost estimates include replacement of existing Motorola MINITOR VI pagers with new VHF P25 pagers to operate on the new radio system.

Given the need to interoperate with agencies on VHF channels, the cost estimate includes the replacement of existing non-P25 subscriber units with single-band VHF, mid-tier P25 radios. The use of these models provides a good average cost for budgetary purposes. Some departments may only purchase low-tier (single band) models, majority may purchase single-band VHF mid-tier, and others may purchase high-tier dual-band or all-band radios with added features. As part of the RFP, the County could specify the quantity and tier requirements for each department, which would allow the vendors to provide a more accurate cost proposal. Our cost estimates do include the delta for radios operating on the Alternative 1 P25 Phase 1 Conventional system vs. the Alternative 2 P25 Phase 2 Trunking system.

8. Cost Analysis and Recommendations

FE prepared high-level budgetary cost estimates using an in-house cost analysis tool for the new radio systems, backhaul network, dispatch consoles, network management system, subscriber units, site improvements, and implementation services. The cost estimates are based on:

- Data collected from previous projects
- Our knowledge of existing systems and publicly available industry information
- Information collected specifically for this project
- ***FE***'s experience designing comparable radio systems

Actual system costs are highly dependent upon final system design choices as well as conditions in the land mobile and microwave radio markets during the system procurement phase.

FE's budgetary estimates are intentionally conservative. Typically, vendor proposal pricing is unlikely to exceed ***FE***'s estimate, based on a comparable design as outlined in our assumptions. Our cost estimates are based upon recent non-discounted pricing. Frequently, system vendors provide discounts for large system and subscriber unit purchases, however dynamics in the competitive systems market make it impractical to forecast the specific discounts vendors may offer at the time of proposal submission. Global supply and labor shortages have also introduced more uncertainty in costs and this situation is unlikely to improve in the near to mid-term. Accordingly, ***FE*** includes a 20% continency for all cost estimates.

8.1 Cost Assumptions

8.1.1 Site Improvement Assumptions

As stated in the assessment section, this project did not include site surveys, tower structural analyses, or tower climbs. Therefore, our site improvement assumptions are based on information provided by the County rather than visual inspections. Following the coverage and backhaul workshops, ***FE*** worked with the County to identify existing and potential sites needed for the conceptual design and what assumptions should be used for inclusion in the cost estimates. Table 15 summarizes the site improvement assumptions that are common to both alternatives based on County feedback of currently known site conditions.

Table 15 – Site Improvement Assumptions

Site Improvement Assumptions	QTY	Notes
Civil/Site Improvements		
Existing Tower/Structure with Available Space	23	Based on information in County-provided documentation and/or feedback
Tower Structural Analysis Needed	8	Based on information in County-provided documentation and/or feedback
Existing Tower Mods Needed	0	Based on information in County-provided documentation and/or feedback
New Tower Structure Needed	0	Based on information in County-provided documentation and/or feedback
A&E, Environmental Compliance	0	Based on information in County-provided documentation and/or feedback
Existing Shelter/Bldg. with Available Space	23	Based on information in County-provided documentation and/or feedback
Site Grounding Updates Needed	23	Based on information in County-provided documentation and/or feedback
Existing Shelter/Bldg. Mods Needed	0	Based on information in County-provided documentation and/or feedback
New Prefab Shelter Needed	0	Based on information in County-provided documentation and/or feedback
New Outdoor Cabinet Needed	0	Based on information in County-provided documentation and/or feedback
Commercial AC Power Available	23	Based on information in County-provided documentation and/or feedback
Backup Power Source(s) Available	23	Based on information in County-provided documentation and/or feedback
DC Site/Battery Upgrades Needed	14	Based on information in County-provided documentation and/or feedback
New Generator Needed	1	Based on information in County-provided documentation and/or feedback
New UPS Needed	0	Based on information in County-provided documentation and/or feedback

Appendix D contains a complete matrix of site improvement assumptions on a per-site basis.

8.1.2 Alternative 1 LMR Assumptions

Based on results from the coverage and capacity studies, Table 16 outlines the LMR equipment assumptions for the Alternative 1 cost estimates.

Table 16 – Alternative 1 Cost Assumptions

Alternative 1 LMR Assumptions	QTY	Notes
System Control Equipment		
P25 Phase 1 Core Equipment	1	New P25 Phase 1 Conventional Core with localized high availability servers
Core Networking Equipment	1	New redundant networking equipment housed at the P25 Phase 1 Core location
Simulcast Control Equipment		
Simulcast Controller	2	New simulcast cell control equipment with geographically separated locations
GPS Frequency Standard	2	New simulcast cell frequency standard with geographically separated locations
Voting Equipment	6	New simulcast cell voting equipment (2 channels per chassis) with geographically separated locations
Networking Equipment	2	New simulcast cell networking equipment with geographically separated locations
Repeater Site Equipment		
VHF 6-CH TX/RX Site Equipment (Conventional Simulcast)	8	New P25 Phase 1 repeaters for these sites: 701 Ocean St., Bielawski, Davenport (FG1523), Kite Hill, Loma Prieta, Mount Madonna, Parks-CHALK MTN, and Soquel (Camp)
VHF TX/RX Antenna System	8	New VHF Transmit/Receive antennas, transmission lines, combiners, multicouplers, and lightning protection
VHF 6-CH RX-only Site Equipment	15	New P25 Phase 1 receivers for these sites: Ben Lomand Fire, Boulder Creek Fire, Cabrillo College, Cadillac, Central Water Tank, CPD-Jade St. Park, Mount Toro, Parks-COWELL PK, Parks-EAGLE ROCK LO, and Watsonville PD
VHF RX-only Antenna System	15	New VHF Receive antennas, transmission lines, multicouplers, and lightning protection
Site Networking Equipment	23	New, redundant routers and switches at each repeater and receiver site
LMR FCC License	48	Re-use of existing sites and frequencies; some licenses require modifications for new emissions and channels; new licenses needed for current receive sites and new candidate sites that will now be transmit sites
LMR Frequency Coordination	48	Re-use of existing sites and frequencies; some licenses require modifications for new emissions and channels; new licenses needed for current receive sites and new candidate sites that will now be transmit sites
LMR Engineering Services	48	Re-use of existing sites and frequencies; some licenses require modifications for new emissions and channels; new licenses needed for current receive sites and new candidate sites that will now be transmit sites

8.1.3 Alternative 2 LMR Assumptions

Based on results from the coverage and capacity studies, Table 17 outlines the LMR equipment assumptions for the Alternative 2 cost estimates.

Table 17 – Alternative 2 Cost Assumptions

Alternative 2 LMR Assumptions	QTY	Notes
System Control Equipment		
P25 Phase 2 Core Equipment	1	New P25 Phase 2 Trunking Core with localized high availability servers
Core Networking Equipment	1	New redundant networking equipment housed at the P25 Phase 2 Core location
Simulcast Control Equipment		
Simulcast Controller	2	New simulcast cell control equipment with geographically separated locations
GPS Frequency Standard	2	New simulcast cell frequency standard with geographically separated locations
Voting Equipment	4	New simulcast cell voting equipment (2 channels per chassis) with geographically separated locations
Networking Equipment	2	New simulcast cell networking equipment with geographically separated locations
Repeater Site Equipment		
VHF 4-CH TX/RX Site Equipment (Trunking Simulcast)	8	New P25 Phase 2 repeaters for these sites: 701 Ocean St., Bielawski, Davenport (FG1523), Kite Hill, Loma Prieta, Mount Madonna, Parks-CHALK MTN, and Soquel (Camp)
VHF 4-CH RX-only Site Equipment	8	New P25 Phase 2 receivers for these sites: Ben Lomand Fire, Boulder Creek Fire, Cabrillo College, Cadillac, Central Water Tank, CPD-Jade St. Park, Mount Toro, Parks-COWELL PK, Parks-EAGLE ROCK LO, and Watsonville PD
VHF TX/RX Antenna System	15	New VHF Transmit/Receive antennas, transmission lines, combiners, multicouplers, and lightning protection
VHF RX-only Antenna System	15	New VHF Receive antennas, transmission lines, multicouplers, and lightning protection
Site Networking Equipment	23	New, redundant routers and switches at each repeater and receiver site
LMR FCC License	32	Re-use of existing sites and frequencies; some licenses require modifications for new emissions and channels; new licenses needed for current receive sites and new candidate sites that will now be transmit sites
LMR Frequency Coordination	32	Re-use of existing sites and frequencies; some licenses require modifications for new emissions and channels; new licenses needed for current receive sites and new candidate sites that will now be transmit sites
LMR Engineering Services	32	Re-use of existing sites and frequencies; some licenses require modifications for new emissions and channels; new licenses needed for current receive sites and new candidate sites that will now be transmit sites

8.1.4 Alternatives Common Assumptions

Table 18 provides a list of common assumptions that pertain to both alternatives including, dispatch consoles, backhaul network, network management, subscriber units, and implementation services.

Table 18 – Alternatives Common Assumptions

Alternatives Common Assumptions	QTY	Notes
Primary Dispatch System Equipment		
Logging Recorder System	1	Assume replacement of existing logging recorder
Dispatch Console Position	15	Assume replacement of existing dispatch consoles
Backup RF Control Station	15	New backup RF control station per console position
Control Station Antenna System	2	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	4	4-port gateways for interfacing to Mutual Aid conventional channels
Networking Equipment	1	New, redundant routers and switches
Backup Dispatch System Equipment		
Logging Recorder System	1	Assume replacement of existing logging recorder
Dispatch Console Position	6	Assume replacement of existing dispatch consoles
Backup RF Control Station	6	New backup RF control station per console position
Control Station Antenna System	1	New Transmit/Receive Antenna, transmission line, control station combiner, and lightning protection
Conventional Channel Gateway	4	4-port gateways for interfacing to Mutual Aid conventional channels
Networking Equipment	1	New, redundant routers and switches
Microwave Backhaul Equipment		
New 6GHz Microwave Paths Needed	1	Parks-Chalk Mtn. to Davenport
New 11GHz Microwave Paths Needed	6	701 Ocean St. to CPD-Jade St. Park Bielawski to Parks-Eagle Rock LO Cabrillo College to NETCOM Central Water Tank to Cabrillo College Central Water Tank to Mt. Madonna Parks-Eagle Rock LO to Parks-Chalk Mtn.
New 18GHz Microwave Paths Needed	2	Kite Hill to Parks-Cowell State Pk Parks-Cowell State Pk to Cadillac
6 GHz Hot Standby Radio	2	New microwave radios for new links
11 GHz Hot Standby Radio	12	New microwave radios for new links
18 GHz Hot Standby Radio	4	New microwave radios for new links
6 GHz - 6' Dual-Polarization	2	New 6' Dual-Polarization dishes
11 GHz - 4' Dual-Polarization	12	New 4' Dual-Polarization dishes
18 GHz - 2' Dual-Polarization	4	New 2' Dual-Polarization dishes
Waveguide and Accessories	18	New Waveguide and Accessories
DC Plant	13	New Large DC Plant
Equipment Rack and Accessories	13	New Large Equipment Rack and Accessories
MPLS Router	13	New Large MPLS Router
Dehydrator	13	New Dehydrator

Alternatives Common Assumptions	QTY	Notes
MW FCC License	18	New MW site application(s) and/or existing license modification(s) for Conceptual Design
MW FCC License Coordination	9	New MW site application(s) and/or existing license modification(s) for Conceptual Design
Network Management System		
Network Management Server	1	New NMS equipment to be housed at a P25 Core location
Network Management Terminal	2	New NMT equipment; can be located anywhere in the County with access to radio/backhaul network
Remote Terminal Unit	23	New Alarms equipment to be housed at each of the core, dispatch, and remote sites
Implementation Services		
Spare / Test Equipment	5%	Based on ***FE*** historical / industry data
Project Management	10%	Based on ***FE*** historical / industry data
Installation	10%	Based on ***FE*** historical / industry data
Engineering	20%	Based on ***FE*** historical / industry data
Removal of Existing Equipment	2%	Based on ***FE*** historical / industry data
Training	1%	Based on ***FE*** historical / industry data
Staging	5%	Based on ***FE*** historical / industry data
Acceptance/Coverage Testing	1%	Based on ***FE*** historical / industry data
Documentation	1%	Based on ***FE*** historical / industry data
Sales Tax	9.25%	2022 sales tax rate for Santa Cruz, California
Contingency	20%	Based on ***FE*** historical / industry data and recent global supply chain issues

8.1.5 Subscriber Unit Assumptions

Table 19 provides a breakdown of subscriber unit assumptions on a departmental basis, outlining the radios accounts that require replacement for P25 Phase 1 Conventional or Phase 2 Trunking operation.

Table 19 – Subscriber Unit Assumptions

Subscriber Unit Assumptions						Re-use	
Agency	*Handheld*	*Mobile*	*Base Station*	*Pagers*	***Total***	*Yes*	*No*
Boulder Creek Fire	42	15	2	0	**59**	0	59
Central Fire District	205	50	8	40	**303**	205	98
County (multiple departments)	*Specific radio type breakdowns not provided						
District Attorney*					**41**	41	0
Emergency services	14				**14**	14	0

Subscriber Unit Assumptions						Re-use	
Agency	*Handheld*	*Mobile*	*Base Station*	*Pagers*	***Total***	*Yes*	*No*
Health Services	1				**1**	1	0
Social Services (HSD)	4				**4**	4	0
Parks	1				**1**	1	0
Probation*					**54**	54	0
Sheriff-Coroner, Jail*					**614**	614	0
Public Works*					**333**	333	0
GSD	1	1			**2**	2	0
Scotts Valley PD	29	14	3	0	**46**	0	46
Ben Lomond Fire	36	18	0	0	**54**	0	54
Scotts Valley Fire	32	15	2	0	**49**	0	49
Santa Cruz PD	180	63	0	0	**243**	0	243
Felton Fire Protection District	36	13	0	0	**49**	49	0
Watsonville PD	40	27	0	0	**67**	23	44
Watsonville Fire	40	4	0	0	**44**	22	22
Santa Cruz Fire	95	46	0	0	**141**	0	141
AMR** (count not provided)							
Capitola Police	31	30	0	0	**61**	61	0
Zayante	35	16	0	0	**51**	0	51
Total					**2231**	**1424**	**807**

8.1.6 Contingency

Recently, we are seeing multiple vendors identifying increased pricing between contract award and placing equipment orders, due to supply chain issues. This pricing model has included a 20% contingency to account for those potential increased costs.

8.2 Radio System Costs

FE provides the following cost estimates for Alternative 1 where the County migrates to a VHF P25 Phase 1 Conventional system or a VHF P25 Phase 2 Trunking system.

8.2.1 Alternative 1 Radio System Cost

Table 20 outlines the estimated costs for the radio system equipment and services for Alternative 1.

Table 20 – Alternative 1 Radio System Cost Estimate

Alternative 1 Radio System Cost Estimate			
Control Site Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
P25 Phase 1 Core Equipment	1	$529,000	$529,000
Core Networking Equipment	1	$147,000	$147,000
Spare / Test Equipment	5%		$34,000
Subtotal - Repeater Site Equipment			**$710,000**
Simulcast Site Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Simulcast Controller	2	$69,000	$138,000
GPS Frequency Standard	2	$37,000	$74,000
Voting Equipment	6	$30,000	$180,000
Networking Equipment	2	$37,000	$74,000
Spare / Test Equipment	5%		$24,000
Subtotal - Repeater Site Equipment			**$490,000**
P25 Phase 1 Site Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
VHF 6-CH TX/RX Equipment	8	$150,000	$1,200,000
VHF TX/RX Antenna System	8	$30,000	$240,000
VHF 6-CH RX-only Equipment	15	$58,000	$870,000
VHF RX-only Antenna System	15	$14,000	$210,000
Site Networking Equipment	23	$13,000	$299,000
Spare / Test Equipment	5%		$141,000
Subtotal - Repeater Site Equipment			**$2,960,000**
Equipment Subtotal			**$4,160,000**
FCC Licensing and Coordination		***Unit Cost***	***Extended Cost***
LMR FCC License Fees	48	$100	$4,800
LMR Frequency Coordination Fees	48	$300	$14,400
LMR Engineering Services Fees	48	$125	$6,000
Subtotal - FCC Licensing and Coordination (rounded)			**$26,000**

Implementation Services	*Quantity*	*Unit Cost*	*Extended Cost*
Project Management	10%		$416,000
Installation	10%		$416,000
Engineering	20%		$832,000
Removal of Existing Equipment	2%		$84,000
Training	1%		$42,000
Staging	5%		$208,000
Acceptance Testing	1%		$42,000
Documentation	1%		$42,000
Subtotal - Implementation Services			**$2,082,000**
Services Subtotal			**$2,108,000**
TOTAL - EQUIPMENT & SERVICES			**$6,268,000**
Sales Tax	9.25%		$385,000
Contingency	20%		$1,254,000
TOTAL - EQUIPMENT & SERVICES (with sales tax & contingency), rounded			**$7,910,000**

8.2.2 Alternative 2 Radio System Cost

Table 21 outlines the Alternative 2 estimated radio system equipment and services costs.

Table 21 – Alternative 2 Radio System Cost Estimate

Alternative 2 Radio System Cost Estimate			
Control Site Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
P25 Phase 2 Core Equipment	1	$1,079,000	$1,079,000
Core Networking Equipment	1	$147,000	$147,000
Spare / Test Equipment	5%		$62,000
Subtotal - Repeater Site Equipment			**$1,288,000**
Simulcast Site Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Simulcast Controller	2	$69,000	$138,000
GPS Frequency Standard	2	$37,000	$74,000
Voting Equipment	4	$64,000	$256,000
Networking Equipment	2	$37,000	$74,000
Spare / Test Equipment	5%		$28,000
Subtotal - Repeater Site Equipment			**$570,000**
P25 Phase 2 Site Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
VHF 4-CH TX/RX Equipment	8	$217,000	$1,736,000
VHF TX/RX Antenna System	8	$30,000	$240,000
VHF 4-CH RX-only Equipment	15	$88,000	$1,320,000
VHF RX-only Antenna System	15	$14,000	$210,000
Site Networking Equipment	23	$13,000	$299,000
Spare / Test Equipment	5%		$191,000
Subtotal - Repeater Site Equipment			**$3,996,000**
Equipment Subtotal			**$5,854,000**
FCC Licensing and Coordination		***Unit Cost***	***Extended Cost***
LMR FCC License Fees	32	$100	$3,200
LMR Frequency Coordination Fees	32	$300	$9,600

Alternative 2 Radio System Cost Estimate			
LMR Engineering Services Fees	32	$125	$4,000
Subtotal - FCC Licensing and Coordination (rounded)			**$17,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Project Management	10%		$586,000
Installation	10%		$586,000
Engineering	20%		$1,171,000
Removal of Existing Equipment	2%		$118,000
Training	1%		$59,000
Staging	5%		$293,000
Acceptance Testing	1%		$59,000
Documentation	1%		$59,000
Subtotal - Implementation Services			**$2,931,000**
Services Subtotal			**$2,948,000**
TOTAL - EQUIPMENT & SERVICES			**$8,802,000**
Sales Tax	9.25%		$542,000
Contingency	20%		$1,761,000
TOTAL - EQUIPMENT & SERVICES (with sales tax & contingency), rounded			**$11,110,000**

8.3 Backhaul Network Cost

Table 22 provides the estimated costs for the new backhaul network equipment and services for either Alternative.

Table 22 – Backhaul Network Cost Estimate

Backhaul System Cost Estimate			
Backhaul Site Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
6 GHz Hot Standby Radio	2	$30,000	$60,000
11 GHz Hot Standby Radio	12	$30,000	$360,000
18 GHz Hot Standby Radio	4	$4,000	$16,000
6 GHz - 6' Dual-Polarization	2	$9,000	$18,000
11 GHz - 4' Dual-Polarization	12	$5,000	$60,000
18 GHz - 2' Dual-Polarization	4	$1,500	$6,000
Waveguide and Accessories	18	$5,000	$90,000
DC Plant	13	$10,000	$130,000
Equipment Rack and Accessories	13	$5,000	$65,000
MPLS Router	13	$20,000	$260,000
Dehydrator	13	$4,000	$52,000
Spare / Test Equipment	5%		$56,000
Equipment Subtotal			**$1,173,000**
FCC Licensing and Coordination		***Unit Cost***	***Extended Cost***
MW FCC License Fees	18	$1,200	$21,600
MW Frequency Coordination Fees	9	$1,700	$15,300
Subtotal - FCC Licensing and Coordination (rounded)			**$37,000**

Implementation Services	*Quantity*	*Unit Cost*	*Extended Cost*
Project Management	10%		$118,000
Installation	10%		$118,000
Engineering	20%		$235,000
Removal of Existing Equipment	2%		$24,000
Training	1%		$12,000
Staging	5%		$59,000
Acceptance Testing	1%		$12,000
Documentation	1%		$12,000
Subtotal - Implementation Services			**$627,000**
TOTAL - EQUIPMENT & SERVICES			**$1,800,000**
Sales Tax	9.25%		$109,000
Contingency	20%		$360,000
TOTAL - EQUIPMENT & SERVICES (with sales tax & contingency), rounded			**$2,270,000**

8.4 Network Management Cost

Table 23 summarizes the estimated costs for the network management equipment and services for either Alternative.

Table 23 – Network Management Cost Estimate

Network Management Cost Estimate			
Network Management Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Network Management Server	1	$212,000	$212,000
Network Management Terminal	2	$15,000	$30,000
Remote Terminal Unit	23	$10,000	$230,000
Spare / Test Equipment	5%		$24,000
Equipment Subtotal			**$496,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Project Management	10%		$50,000
Installation	10%		$50,000
Engineering	20%		$100,000
Removal of Existing Equipment	2%		$10,000
Training	1%		$5,000
Staging	5%		$25,000
Acceptance Testing	1%		$5,000
Documentation	1%		$5,000
Subtotal - Implementation Services			**$250,000**
TOTAL - EQUIPMENT & SERVICES			**$746,000**
Sales Tax	9.25%		$46,000
Contingency	20%		$150,000
TOTAL - EQUIPMENT & SERVICES (with sales tax & contingency), rounded			**$950,000**

8.5 Site Improvements Cost

Table 24 provides a breakdown of the estimated costs for site improvements and services for either Alternative.

Table 24 – Site Improvements Cost Estimate

Site Improvements Cost Estimate			
Site Support Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Existing Tower/Structure with Available Space	23	$0	$0
Tower Structural Analysis Needed	8	$5,000	$40,000
Existing Tower Mods Needed	0	$75,000	$0
New Tower Structure Needed	0	$283,000	$0
A&E, Environmental Compliance	0	$14,000	$0
Existing Shelter/Bldg. with Available Space	23	$0	$0
Site Grounding Updates Needed	23	$25,000	$575,000
Existing Shelter/Bldg. Mods Needed	0	$50,000	$0
New Prefab Shelter Needed	0	$109,000	$0
New Outdoor Cabinet Needed	0	$10,000	$0
Commercial AC Power Available	23	$0	$0
Backup Power Source(s) Available	23	$0	$0
DC Site/Battery Upgrades Needed	14	$20,000	$280,000
New Generator Needed	1	$35,000	$35,000
New UPS Needed	0	$30,000	$0
Spare / Test Equipment	5%		$47,000
Equipment Subtotal			**$977,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Project Management	10%		$98,000
Installation	10%		$98,000
Engineering	20%		$196,000
Removal of Existing Equipment	2%		$20,000
Training	1%		$10,000
Staging	5%		$49,000
Acceptance Testing	1%		$10,000
Documentation	1%		$10,000
Subtotal - Implementation Services			**$491,000**
TOTAL - EQUIPMENT & SERVICES			**$1,468,000**
Sales Tax	9.25%		$91,000
Contingency	20%		$294,000
TOTAL - EQUIPMENT & SERVICES (with sales tax & contingency), rounded			**$1,860,000**

8.6 Dispatch System Cost

Table 25 shows the Alternative 1 estimated costs for the dispatch system equipment and services either Alternative.

Table 25 – Dispatch Equipment Cost Estimate

Dispatch System Cost Estimate			
Primary Dispatch Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Logging Recorder System	1	$175,000	$175,000
Dispatch Console Position	15	$85,500	$1,282,500
Backup RF Control Station	15	$9,500	$142,500
Control Station Antenna System	2	$18,000	$36,000
Conventional Channel Gateway	4	$7,000	$28,000
Networking Equipment	1	$13,000	$13,000
Spare / Test Equipment	5%		$84,000
Subtotal - Dispatch Equipment			**$1,761,000**
Backup Dispatch Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Logging Recorder System	1	$175,000	$175,000
Dispatch Console Position	6	$85,500	$513,000
Backup RF Control Station	6	$9,500	$57,000
Control Station Antenna System	1	$18,000	$18,000
Conventional Channel Gateway	4	$7,000	$28,000
Networking Equipment	1	$13,000	$13,000
Spare / Test Equipment	5%		$41,000
Subtotal - Dispatch Equipment			**$845,000**
Equipment Subtotal			**$2,606,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Project Management	10%		$261,000
Installation	10%		$261,000
Engineering	20%		$522,000
Removal of Existing Equipment	2%		$53,000
Training	1%		$27,000
Staging	5%		$131,000
Acceptance Testing	1%		$27,000
Documentation	1%		$27,000
Subtotal - Implementation Services			**$1,309,000**
TOTAL - EQUIPMENT & SERVICES			**$3,915,000**
Sales Tax	9.25%		$242,000
Contingency	20%		$783,000
TOTAL - EQUIPMENT & SERVICES (with sales tax & contingency), rounded			**$4,940,000**

8.7 Subscriber Units Cost

8.7.1 Alternative 1 Subscriber Unit Cost

Table 26 provides a summary of the Alternative 1 cost estimate to replace and reprogram subscriber units.

Table 26 – Alternative 1 Subscriber Unit Cost Estimate

Alternative 1 Subscriber Cost Estimate					
Department/Agency	*Equipment*	*Services*	*Sales Tax*	*Contingency*	*Total Cost*
Boulder Creek Fire	$378,000	$16,000	$35,000	$76,000	$505,000
Central Fire District	$460,000	$67,000	$43,000	$92,000	$662,000
County (multiple departments)	**Specific radio type breakdowns not provided*				
District Attorney*	$21,000	$5,000	$2,000	$5,000	$33,000
Emergency Services	$0	$2,000	$0	$0	$2,000
Health Services	$0	$1,000	$0	$0	$1,000
Social Services (HSD)	$0	$1,000	$0	$0	$1,000
Parks	$0	$1,000	$0	$0	$1,000
Probation*	$27,000	$6,000	$3,000	$6,000	$42,000
Sheriff-Coroner, Jail*	$307,000	$62,000	$29,000	$62,000	$460,000
Public Works*	$0	$34,000	$0	$0	$34,000
GSD	$0	$1,000	$0	$0	$1,000
Scotts Valley PD	$325,000	$17,000	$31,000	$65,000	$438,000
Ben Lomond Fire	$342,000	$13,000	$32,000	$69,000	$456,000
Scotts Valley Fire	$314,000	$11,000	$30,000	$63,000	$418,000
Santa Cruz PD	$1,643,000	$50,000	$152,000	$329,000	$2,174,000
Felton Fire Protection District	$0	$5,000	$0	$0	$5,000
Watsonville PD	$325,000	$18,000	$31,000	$65,000	$439,000
Watsonville Fire	$136,000	$6,000	$13,000	$28,000	$183,000
Santa Cruz Fire	$892,000	$33,000	$83,000	$179,000	$1,187,000
AMR** (radio count not provided)	$0	$0	$0	$0	$0
Capitola Police	$31,000	$7,000	$3,000	$7,000	$48,000
Zayante	$322,000	$12,000	$30,000	$65,000	$429,000
Total (rounded)					**$7,520,000**

Appendix E provides a detailed breakdown of subscriber unit costs on a per department per radio basis. Subscriber unit costs reflect AES encryption on mobile and portable radio counts provided by the County.

8.7.2 Alternative 2 Subscriber Unit Cost

Table 27 provides a summary of the Alternative 2 cost estimate to replace and reprogram subscriber units.

Table 27 – Alternative 2 Subscriber Unit Cost Estimate

Alternative 2 Subscriber Cost Estimate					
Department/Agency	*Equipment*	*Services*	*Sales Tax*	*Contingency*	*Total Cost*
Boulder Creek Fire	$408,000	$16,000	$38,000	$82,000	$544,000
Central Fire District	$489,000	$67,000	$46,000	$98,000	$700,000
County (multiple departments)	**Specific radio type breakdowns not provided*				
District Attorney*	$21,000	$5,000	$2,000	$5,000	$33,000
Emergency Services	$0	$2,000	$0	$0	$2,000
Health Services	$0	$1,000	$0	$0	$1,000
Social Services (HSD)	$0	$1,000	$0	$0	$1,000
Parks	$0	$1,000	$0	$0	$1,000
Probation*	$27,000	$6,000	$3,000	$6,000	$42,000
Sheriff-Coroner, Jail*	$307,000	$62,000	$29,000	$62,000	$460,000
Public Works*	$0	$34,000	$0	$0	$34,000
GSD	$0	$1,000	$0	$0	$1,000
Scotts Valley PD	$348,000	$17,000	$33,000	$70,000	$468,000
Ben Lomond Fire	$369,000	$13,000	$35,000	$74,000	$491,000
Scotts Valley Fire	$339,000	$11,000	$32,000	$68,000	$450,000
Santa Cruz PD	$1,764,000	$50,000	$164,000	$353,000	$2,331,000
Felton Fire Protection District	$0	$5,000	$0	$0	$5,000
Watsonville PD	$347,000	$18,000	$33,000	$70,000	$468,000
Watsonville Fire	$147,000	$6,000	$14,000	$30,000	$197,000
Santa Cruz Fire	$963,000	$33,000	$90,000	$193,000	$1,279,000
AMR** (radio count not provided)	$0	$0	$0	$0	$0
Capitola Police	$31,000	$7,000	$3,000	$7,000	$48,000
Zayante	$348,000	$12,000	$33,000	$70,000	$463,000
Total (rounded)					**$8,020,000**

Appendix F provides a detailed breakdown of subscriber unit costs on a per department per radio basis. Subscriber unit costs reflect AES encryption on mobile and portable radio counts provided by the County.

8.8 Total Cost Summary

The total cost summary for each alternative consists of the capital cost estimate and projected maintenance support over 10 years. The maintenance support calculations consist of the assumptions:

- System Lifecycle Period – 10 years
- Manufacturer's Warranty – 1 year
- Annual Inflation Rate – 3%
- System Remote Technical Support – 1%
- System Security/Information Assurance – 2%
- System Onsite Support and Repair – 2%
- System Upgrades (Hardware/Software) – 4.25%

Maintenance support costs reflect out-of-warranty support beginning in Year 2. The maintenance support costs are a percentage (as listed above) of system infrastructure cost, with annual inflation added in Years 3 – 10. It is important to note that the cost estimates do not include any existing maintenance contract(s), personnel or vehicle costs, site maintenance, utilities, and/or leases, or subscriber unit refreshes.

8.8.1 Alternative 1 Total Cost

Table 28 summarizes the total capital cost estimate for Alternative 1, including radio system, backhaul network, network management, site improvements, dispatch system, subscriber units, implementation services, sales tax, and contingency.

Table 28 – Alternative 1 Total Cost Estimate

Alternative 1 Total Cost Estimate					
Item	*Equipment*	*Services*	*Sales Tax*	*Contingency*	***Total (rounded)***
Radio System	$4,160,000	$2,108,000	$385,000	$1,254,000	**$7,910,000**
Backhaul System	$1,173,000	$627,000	$109,000	$360,000	**$2,270,000**
Network Management	$496,000	$250,000	$46,000	$150,000	**$950,000**
Site Improvements	$977,000	$491,000	$91,000	$294,000	**$1,860,000**
Dispatch System	$2,606,000	$1,309,000	$242,000	$783,000	**$4,940,000**
Subscriber Units	$5,523,000	$368,000	$517,000	$1,111,000	**$7,520,000**
Total (Rounded)					**$25,450,000**

8.8.2 Alternative 2 Total Cost

Table 29 summarizes the total capital cost estimate for Alternative 2, including radio system, backhaul network, network management, site improvements, dispatch system, subscriber units, implementation services, sales tax, and contingency.

Table 29 – Alternative 2 Total Cost Estimate

Alternative 2 Total Cost Estimate					
Item	*Equipment*	*Services*	*Sales Tax*	*Contingency*	***Total (rounded)***
Radio System	$5,854,000	$2,948,000	$542,000	$1,761,000	**$11,110,000**
Backhaul System	$1,173,000	$627,000	$109,000	$360,000	**$2,270,000**
Network Management	$496,000	$250,000	$46,000	$150,000	**$950,000**
Site Improvements	$977,000	$491,000	$91,000	$294,000	**$1,860,000**
Dispatch System	$2,606,000	$1,309,000	$242,000	$783,000	**$4,940,000**
Subscriber Units	$5,908,000	$368,000	$555,000	$1,188,000	**$8,020,000**
Total (Rounded)					**$29,150,000**

8.8.3 Total Cost Comparison

Table 30 provides a side-by-side comparison of the Alternatives 1 and 2 total costs, including capital cost, maintenance support, and the delta between them.

Table 30 – Alternatives Cost Estimate Comparison

Alternatives Cost Estimate Comparison			
Item	*Alternative 1 Conventional*	*Alternative 2 Trunking*	*Delta*
Radio System	$7,910,000	$11,110,000	$3,200,000
Backhaul System	$2,270,000	$2,270,000	$0
Network Management	$950,000	$950,000	$0
Site Improvements	$1,860,000	$1,860,000	$0
Dispatch System	$4,940,000	$4,940,000	$0
Subscriber Units	$7,520,000	$8,020,000	$500,000
Capital Cost	**$25,450,000**	**$29,150,000**	**$3,700,000**
Maintenance Support	**$16,950,000**	**$19,950,000**	**$3,000,000**
Total (Rounded)	**$42,400,000**	**$49,100,000**	**$6,700,000**

9. Recommendation and Next Steps

While both alternatives offer common benefits to users including improved coverage and new features, there are some aspects that differ between them as shown in Table 31.

Table 31 – System Alternatives Comparison

System Alternatives Comparison		
Item	***Alternative 1***	***Alternative 2***
Ownership and control	County-owned, Full control	
Configuration	8 Simulcast transmit sites, 23 Voted receive sites Standards-based Project 25 (P25) radio system	
Technology	P25 Phase 1 Conventional Frequency Division Multiple Access (FDMA); one talkpath per RF channel	P25 Phase 2 Trunking Time Division Multiple Access (TDMA); 2 talkpaths per RF channel (more spectral efficiency)
Spectrum	Very High Frequency (VHF)	
Channels / Talkpaths	6 Channels / 6 Talkpaths	4 Channels / 6 Talkpaths
Mobile radio coverage	>99% talk-in; 4% increase over existing system	
Portable on-street coverage	88% talk-in; 35% increase over existing system	
Features	P25 standard features Advance Encryption Standard (AES)	
		Over the air rekeying (OTAR) Over the air programming (OTAP) Unit Location Services (GPS) Smartphone Integration
Interoperability	Backwards compatible with analog conventional	
		Interoperability with surrounding P25 system(s) Backwards compatible with P25 Phase 1 Direct connectivity with surrounding P25 system(s) via Inter-RF Subsystem Interface (ISSI)
Backhaul network	Leverage existing backhaul where possible; 9 new licensed microwave hops	
Network management	New network management system (NMS), clients, and remote terminal units	
Dispatch consoles	2 new P25 logging recorders; 15 new consoles at primary Dispatch Center; 6 new consoles at Backup Dispatch Center #1	
Subscriber units	Leverage existing P25 capable radios Replace end-of-life and non-P25 radios	
	New radios include P25 FDMA Conventional software / licenses	New radios include P25 TDMA Trunking software / licenses
Total Cost Estimate (Capital and Maintenance Support)	**$42,400,000**	**$49,100,000**

Alternative 1 is the lowest cost solution and provides coverage enhancements over the existing radio system. Alternative 2 provides trunking technology, spectral efficiency, and additional features and interoperability compared to Alternative 1.

Based on our analysis of the existing radio systems and understanding of the County's needs and objectives, Z Consulting Group and ***FE*** recommend Alternative 2. This alternative addresses the stakeholder needs and requirements for P25 operation and improved coverage and provides additional features over Alternative 1 such as Over The Air Rekeying (OTAR), and Over The Air Programming (OTAP) and enhanced interoperability with surrounding P25 system(s).

The County should consider the following roadmap for implementing the new system:

1. Obtain funding for new system, subscribers, and consulting services.
2. Prepare a request for proposals (RFP) for purchasing the system, including:
    a. Instructions to proposers
    b. Technical specifications
    c. Compliance matrix
    d. Pricing sheets
3. Issue the RFP to potential vendors including:
    a. Publish any required notices and release the RFP.
    b. Conduct pre-proposal conference and site surveys.
    c. Issue RFP addenda, if needed, to answer any vendor question(s) and/or clarify any proposal and/or system requirement(s)
    d. Evaluate proposals which may include vendor demonstrations or presentations, best and final offers, and related negotiations.
    e. Select preferred solution and vendor.
    f. Obtain County Board of Supervisors ~~Commissioners~~ approval.
    g. Negotiate system design and options.
    h. Execute a contract with the awarded vendor.
4. Complete regulatory submittals for coordination of frequencies, FCC licenses, and any environmental (NEPA, SHPO, etc.) approvals, if applicable.

5. Monitor and supervise the vendor in implementing the system, including the following steps:

    a. Review, revise, and approve a detailed system design submitted by the vendor.

    b. Prepare a cut-over plan with the cooperation of the awarded vendor.

    c. Approve the acceptance testing plans for all components and for coverage verification.

    d. Approve equipment manufacturing and witness factory acceptance test.

    e. Prepare the sites by completing site improvements.

    f. Install the system and subscriber equipment, including base stations, antenna systems, backhaul components, and mobile radios.

    g. Program subscriber equipment, including mobile radios, portable radios, and control stations that will access the system.

    h. Testing the new system; perform acceptance testing and coverage testing.

    i. Complete all technical and operator training as close to cutover as possible.

    j. Execute cutover and move groups of users onto the new system by department.

6. Decommission or re-purpose the old systems.

The County can retain Z Consulting, supported by ***FE***, to develop technical specifications for inclusion in an RFP. These specifications describe the system functional requirements in sufficient detail for vendors to submit consistent proposals, verifiable through future acceptance testing. The detailed design of the systems will be the responsibility of the vendor to allow for a creative approach and to ensure they remain responsible for system performance in accordance with the specifications. The RFP process can allow the County to obtain multiple vendor proposals in a competitive environment.

Appendix A - Santa Cruz Steering Committee

See ***Santa Cruz Report Appendix A 20220609.pdf*** provided as a separate electronic file.

Appendix B - Subscriber Unit Inventory

See ***Santa Cruz Report Appendix B 20220609.pdf*** provided as a separate electronic file.

Appendix C - Microwave Path Profiles

See ***Santa Cruz Report Appendix C 20220609.pdf*** provided as a separate electronic file.

Appendix D - Site Improvement Matrix

See ***Santa Cruz Report Appendix D 20220609.pdf*** provided as a separate electronic file.

Appendix E - Detailed Alt-1 Subscriber Costs

See ***Santa Cruz Report Appendix E 20220609.pdf*** provided as a separate electronic file.

Appendix F - Detailed Alt-2 Subscriber Costs

See ***Santa Cruz Report Appendix F 20220609.pdf*** provided as a separate electronic file.

Appendix A - Santa Cruz Steering Committee

Working Group					
First Name	Last Name	Title	Department / Partner Agency	Phone	Email
Andy	Dally	Captain	Capitola Police	831-475-4242	adally@ci.capitola.ca.us
Brian	Cleveland	Lieutenant	Santa Cruz County Sheriff's Office	831-454-7633	Brian.Cleveland@santacruzcounty.us
Fred	Berge	Communication Manager	Santa Cruz County ISD	831-454-3091	Fred.Berge@santacruzcounty.us
Greg	Benson	Operations Manager	AMR Santa Cruz	408-307-3837	Gregory.Benson@GMR.NET
Michael	McKinley	Captain	Watsonville Police	831-768-3323	michael.mckinley@cityofwatsonville.org
Robert	Gray	Chief	Felton Fire	831-332-8865	rgray@feltonfire.com
Shea	Johnson	Sr. Management Analyst	Scotts Valley PD	831-345-3683	sjohnson@scottsvalley.org
Tammie	Weigl	Assistant Director	Santa Cruz County ISD	831-454-2030	Tammie.Weigl@santacruzcounty.us
Wes	Morey	Lieutenant	Santa Cruz PD	831-420-5857	wmorey@cityofsantacruz.com
Wolf	Bloss	Systems Supervisor	NETCOM	831-471-1019	wolff@scr911.org

Stakeholders Committee					
First Name	Last Name	Title	Department / Partner Agency	Phone	Email
Andy	Dally	Captain	CPD	831-475-4242	adally@ci.capitola.ca.us
Anthony	Cefaloni	Division Chief	Central Fire	831-345-6074	anthonyc@centralfpd.com
Aron	Tripp	Inspector III	Santa Cruz County District Attorney's Office	408-402-2282	aron.tripp@santacruzcounty.us
Dan	Freitas	Lieutenant	Santa Cruz County Sheriff's Office	831-454-7633	Daniel.Freitas@santacruzcounty.us
Gregg	Flippo	Lieutenant	UCSC Police	831 459 3323	gflippo@ucsc.edu
Ian	Jones	Captain	Felton Fire	650-464-6084	ijones@feltonfire.com
Jarod	Pistorino	Sergeant	Watsonville Police Department		jarrod.pisturino@cityofwatsonville.org
Joe	Walters	Captain	State Parks	831-901-7970	joe.walters@parks.ca.gov
Jose	Garcia	Lieutenant	Santa Cruz PD		jgarcia@cityofsantacruz.com
Natalie	Berns	Assistant Division Director	Santa Cruz County Probation	831-454-3803	natalie.berns@santacruzcounty.us
Robert	Gray	Chief	Felton Fire	831-332-8865	rgray@feltonfire.com
Ron	Whittle	Chief	Scotts Valley Fire	831-438-0211	rwhittle@scottsvalleyfire.com
Sarah	Fletcher	Adult Division Director	Santa Cruz County Probation	831-454-3204	sarah.fletcher@santacruzcounty.us
Tammie	Weigl	Assistant Director	Santa Cruz County ISD	831-454-2030	Tammie.Weigl@santacruzcounty.us
Tony	Figuera	Captain	Watsonville Police Department		antonio.figueroa@cityofwatsonville.org

Appendix B - Subscriber Unit Inventory

Existing Subscriber Unit Inventory (Raw)				
Agency: Boulder Creek Fire				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Handheld	BK P150	On Apparatus	BK	16
Handheld	Motorola XTS5000	On Apparatus	Motorola	20
Handheld	BK GPH CMD	On Apparatus	BK	6
Mobile	BK M150	On Apparatus	BK	15
Base Station	Motorola MCS2000	BOU Station 1	Motorola	1
Base Station	Motorola	BOU Station 2	Motorola	1
Agency: Central Fire District				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
handheld portable	Kenwood VP6000	District wide	Kenwood	205
mobile	Kenwood TK5710 or TK790	District wide	Kenwood	50
base station	Motorola various models	each station	Motorola	8
Rx only pagers	Motorola Min. VI	Personal issue	Motorola	40
Agency: County				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
District Attorney	APX 6000,APX 6500,APX 8500		Motorola	41
Emergency services	TK-5210,Apx 6000		Kenwood, Motorola	14
Health Services	APX 6000		Motorola	1
Social Services(HSD)	APX 6000		Motorola	4
Parks	APX 6000		Motorola	1
Probation	NX-5200, APX 6000, APX 8500		Kenwood, Motorola	54
Sheriff-Coroner, Jail	APX 8500,APX 6500,APX 6000, XTS 5000		Motorola	614
Public Works	TM 9100,TM9155, TK2302,nx5200,NX5220		Tait, Kenwood,	333
GSD	APX-6000, NX5700		Motorola, Kenwood	2

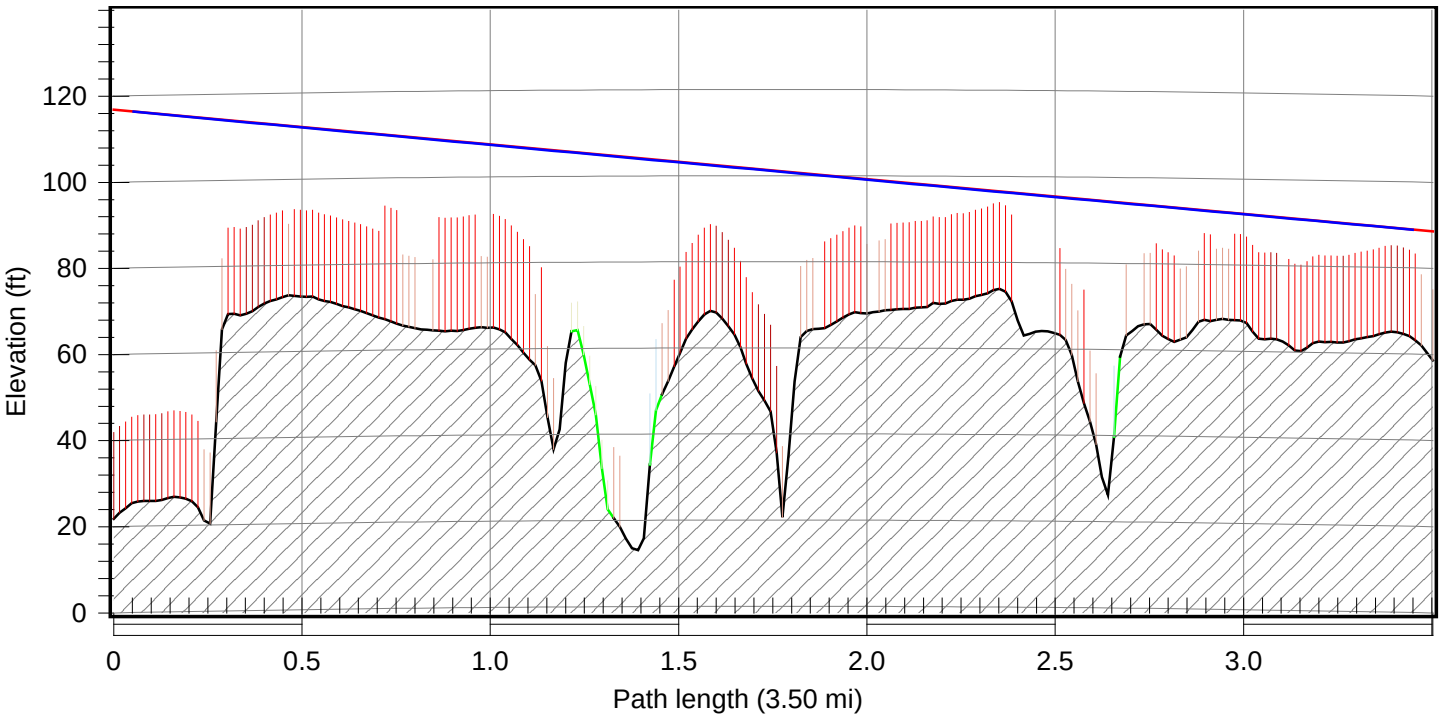
Existing Subscriber Unit Inventory (Raw)				
Agency: SVPD				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Handheld	Motorola XPR6550	Patrol/ Admin	Metro Mobile	16
Handheld	Motorola MTS 2000	Motors	Motorola	8
Handheld	Kenwood P25	Adm./ Dispatch/ Other	Kenwood	4
Handheld	Kenwood KSC-32	Detective	Kenwood	1
Mobile Radios	Kenwood	Adm./ Patrol/ Motors.	Kenwood	14
Dispatch	ZETRON	Dispatch Console 4018	Zetron	3
Agency: Ben Lomond Fire				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Handheld	BK150P	Ben Lomond	Bendicks	36
Mobile	BK150M	Ben Lomond	Bendicks	8
Mobile	TK790	Ben Lomond	Kenwood	8
Mobile	MCS2000	Ben Lomond	Motorola	2
Agency: Scotts Valley Fire				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Handheld	BK DPH	SCO1	BK Relm	23
Handheld	BK DPH	SCO2	BK Relm	3
Handheld	BK GPH	SCO1	BK Relm	1
Handheld	BK GPH	SCO2	BK Relm	5
Mobile	TK-790 Dual Head	SCO1	Kenwood	3
Mobile	TK-790 Dual Head	SCO2	Kenwood	3
Mobile	TK-790 Single Head	SCO1	Kenwood	5
Mobile	TK-5710 Single Head	SCO1	Kenwood	4
Base Station	CMD 1250	SCO1	Motorola	2
Agency: Santa Cruz PD				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
HH	Motorola MT1000	HH	Motorola	1
HH	Motorola HT1000	HH	Motorola	25
HH	Motorola PR1500	HH	Motorola	38
HH	Motorola XTS2500	HH	Motorola	116
Mobile	Kenwood TK5810	Vehicles	Kenwood	61
Mobile	Motorola	Vehicles	Motorola	2

Existing Subscriber Unit Inventory (Raw)				
Agency: Felton Fire Protection District				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Portable	APX8000XE VHF/7-800Mhz P25 Phase 2 and AES Enabled	All Fire Staff	Motorola	36
Mobile	APX8500 VHF/7-800Mhz P25 Phase 2 and AES Enabled	All District Vehicles	Motorola	10
Mobile	APX7500 VHF/7-800Mhz P25 Phase 2 and AES Enabled	Chief Vehicles	Motorola	3
Agency: WTS 2021				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Handheld	Motorola APX 6000	4412	Motorola	5
Handheld	Motorola APX 6000	4471	Motorola	5
Handheld	Motorola APX 6000	4411	Motorola	5
Handheld	Bendix King KNG P150	4436	BK	4
Handheld	Motorola XTS5000	4414	Motorola	5
Handheld	Motorola XTS5000	4470	Motorola	5
Handheld	Motorola XTS5000	4413	Motorola	1
Handheld	Motorola APX 6000	4400	Motorola	2
Handheld	Motorola XTS5000	4401	Motorola	2
Handheld	Motorola APX 6000	4403	Motorola	2
Handheld	Motorola APX 6000	4402	Motorola	2
Handheld	Motorola APX 6000	4404	Motorola	2
Mobile	Kenwood NX5700BK	4412	Kenwood	2
Mobile	Kenwood NX5700BK	4471	Kenwood	2
Mobile	Kenwood NX5700BK	4411	Kenwood	2
Mobile	Bendix King KNG M150	4436	BK	1
Mobile	Motorola XTL5000	4436	Motorola	1
Mobile	Motorola 05	4414	Motorola	1
Mobile	Motorola 05	4415	Motorola	1
Mobile	Motorola 05	4470	Motorola	1
Mobile	Motorola 05	4413	Motorola	5
Mobile	Motorola 05	4400	Motorola	2
Mobile	Motorola 05	4401	Motorola	2
Mobile	Motorola 05	4402	Motorola	2
Mobile	Motorola 05	4403	Motorola	2
Mobile	Motorola 05	4404	Motorola	2
Mobile	Motorola 05	4495	Motorola	1

Existing Subscriber Unit Inventory (Raw)				
Agency: Zayante				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Handheld	XTS 5000	R2466	Motorola	2
Handheld	KNB-CMD	R2466	BK	1
Handheld	XTS 5000	E2410	Motorola	4
Handheld	KNG-CMD	E2410	BK	2
Handheld	XTS 5000	E2414	Motorola	4
Handheld	XTS 5000	W2450	Motorola	4
Handheld	XTS 5000	E2411	Motorola	4
Handheld	HT 1250	E2411	Motorola	2
Handheld	KNG-CMD	E2436	BK	4
Handheld	XTS 5000	E2412	Motorola	3
Handheld	XTS 5000	U2496	Motorola	1
Handheld	XTS 5000	U2403	Motorola	1
Handheld	KNG-CMD	R2465	BK	1
Handheld	KNG-CMD	C2400	BK	1
Handheld	XTS 5000	U2499	Motorola	1
Mobile	KCH 11	Station 1	Kenwood	1
Mobile	KCH 11	Station 2	Kenwood	1
Mobile	KCH 11	R2466	Kenwood	1
Mobile	KCH 11	E2410	Kenwood	1
Mobile	KCH 11	E2414	Kenwood	1
Mobile	KCH 11	W2450	Kenwood	1
Mobile	KCH 11	E2411	Kenwood	1
Mobile	KCH 11	E2436	Kenwood	1
Mobile	KCH 11	E2412	Kenwood	1
Mobile	KCH 11	U2496	Kenwood	2
Mobile	KCH 11	U2403	Kenwood	2
Mobile	KNG-M Remote	R2465	BK	1
Mobile	KNG-M Remote	C2400	BK	1
Mobile	KCH 11	U2499	Kenwood	1
Agency: Santa Cruz Fire Department				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Handheld	TK5210		Kenwood	52
Handheld	TK5220		Kenwood	10
Handheld	VX		VX	8
Handheld	BK		BK	18
Handheld	Icom		Icom	7
Mobile	TK5710		Kenwood	46
Agency: Watsonville Fire Department				

Existing Subscriber Unit Inventory (Raw)				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Handheld	APX6000		Motorola	22
Handheld	XTS 5000		Motorola	18
Mobile	BK		BK	4
Agency: Capitola Police				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units
Handheld	APX6000, NX5200		Motorola, Kenwood	31
Mobile				30
Agency: AMR (radio count not provided)				
Type (handheld or Mobile Unit)	Item description (make and model)	Location	Vendor	Number of Units

Appendix C - Microwave Path Profiles

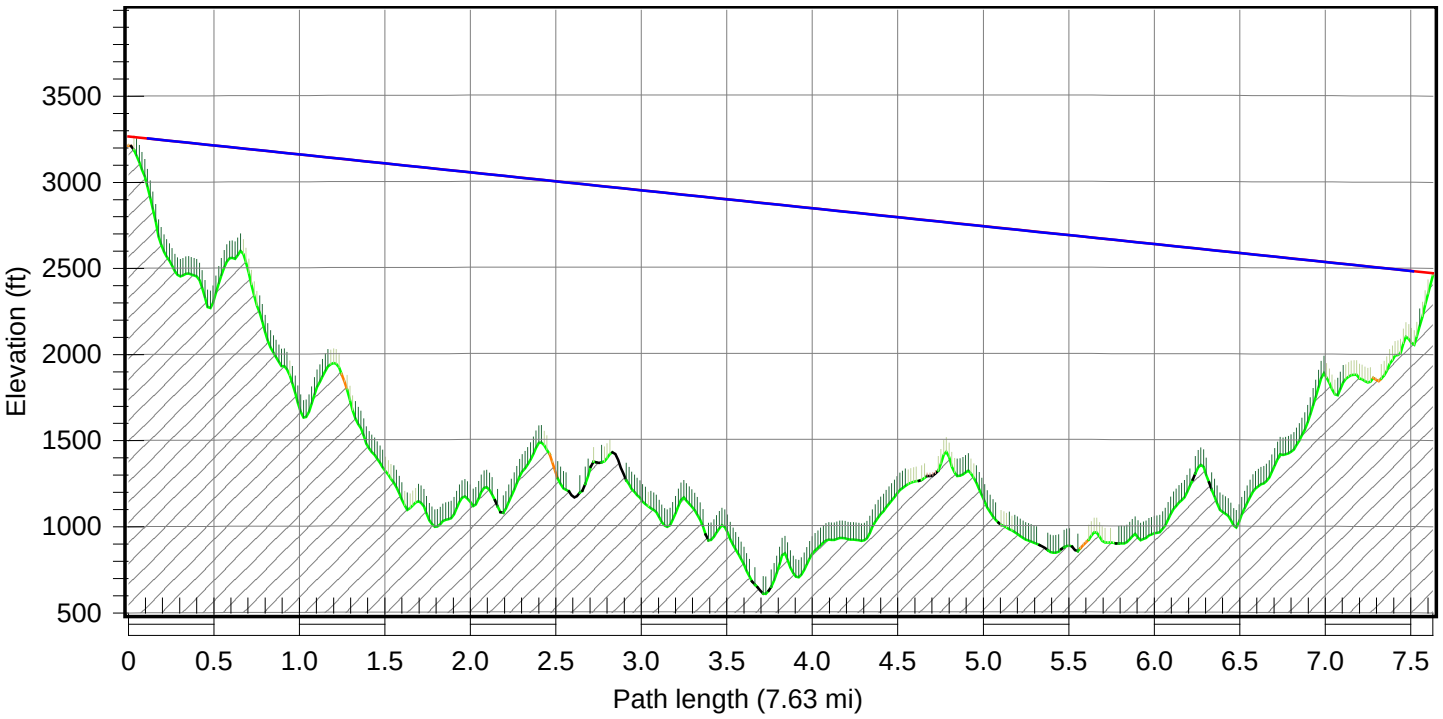


F = 11200.00 MHz K = 1.33 %F1 = 0.6, 0.6

	701 Ocean St.	CPD-Jade St. Park
Latitude	36 58 39.79 N	36 58 11.50 N
Longitude	122 01 21.40 W	121 57 36.29 W
True azimuth (°)	98.88	278.92
Vertical angle (°)	-0.11	0.07
Elevation (ft)	21.88	58.63
Tower height (ft)	90.00	30.00
Antenna model	SDX4-107BC (TR)	SDX4-107BC (TR)
Antenna gain (dBi)	40.40	40.40
Antenna height (ft)	95.00	30.00
TX line model	EWP90	EWP90
TX line length (ft)	125.00	60.00
TX loss (dB)	5.93	3.94
RX loss (dB)	6.93	4.94
Diffraction loss	4.31	
Radio model	9500 MPR - 11 GHz - Max SG - Std Pwr	9500 MPR - 11 GHz - Max SG - Std Pwr
TX power (dBm)	26.00	26.00
EIRP (dBm)	60.47	62.46
Receive signal (dBm)	-36.94	-36.94

	701 Ocean St.	CPD-Jade St. Park
Thermal fade margin (dB)	28.56	28.56
Effective fade margin (dB)	28.56	28.56
Annual 2 way multipath availability (%)	99.99981	
Annual 2 way multipath unavailability (sec)	60.84	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)

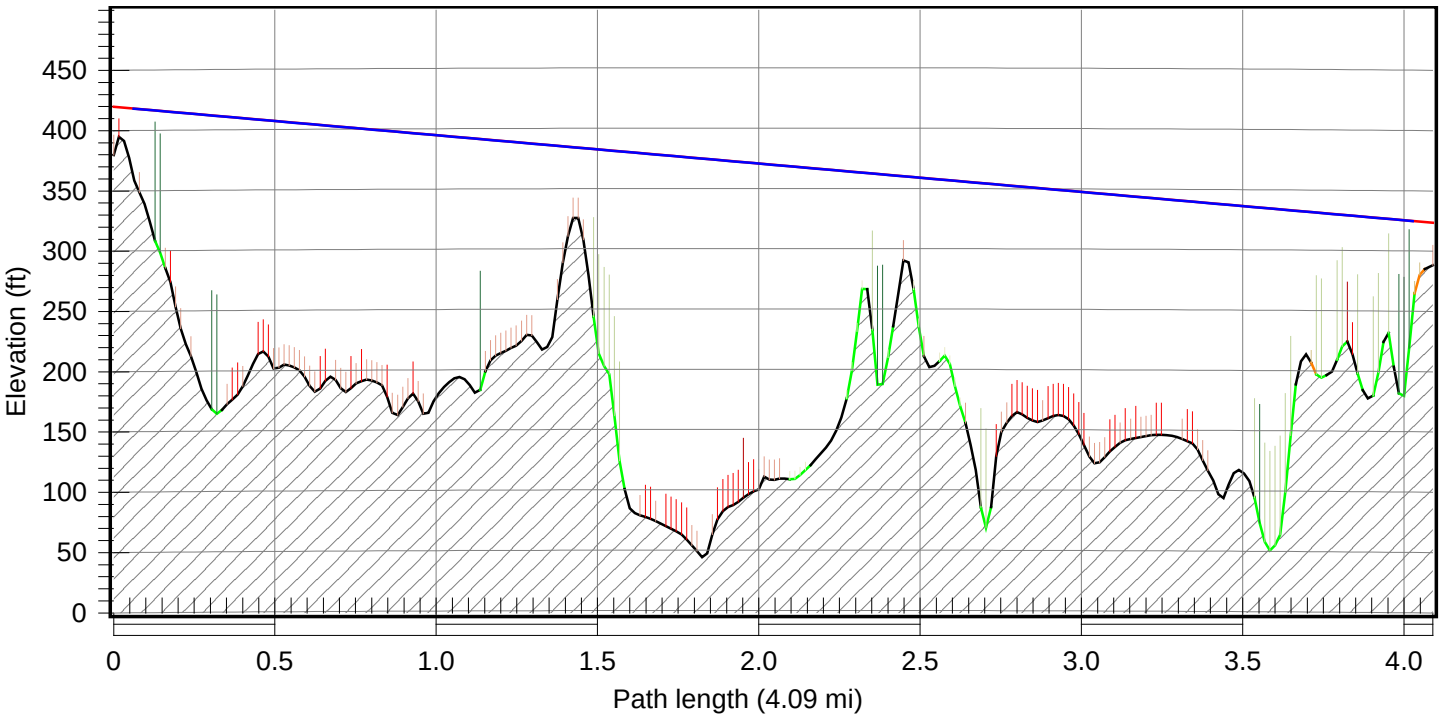


F = 11200.00 MHz K = 1.33 %F1 = 0.6, 0.6

	Bielawski	Parks-Eagle Rock LO
Latitude	37 13 22.01 N	37 08 50.78 N
Longitude	122 05 37.50 W	122 11 41.89 W
True azimuth (°)	227.10	47.04
Vertical angle (°)	-1.17	1.09
Elevation (ft)	3211.73	2457.11
Tower height (ft)	50.00	50.00
Antenna model	SDX4-107BC (TR)	SDX4-107BC (TR)
Antenna gain (dBi)	40.40	40.40
Antenna height (ft)	55.00	15.00
TX line model	EWP90	EWP90
TX line length (ft)	85.00	45.00
TX loss (dB)	4.70	3.48
RX loss (dB)	5.70	4.48
Diffraction loss	14.79	
Radio model	9500 MPR - 11 GHz - Max SG - Std Pwr	9500 MPR - 11 GHz - Max SG - Std Pwr
TX power (dBm)	26.00	26.00
EIRP (dBm)	61.70	62.92
Receive signal (dBm)	-52.60	-52.60

	Bielawski	Parks-Eagle Rock LO
Thermal fade margin (dB)	12.90	12.90
Effective fade margin (dB)	12.90	12.90
Annual 2 way multipath availability (%)	99.99414	
Annual 2 way multipath unavailability (sec)	1847.99	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)

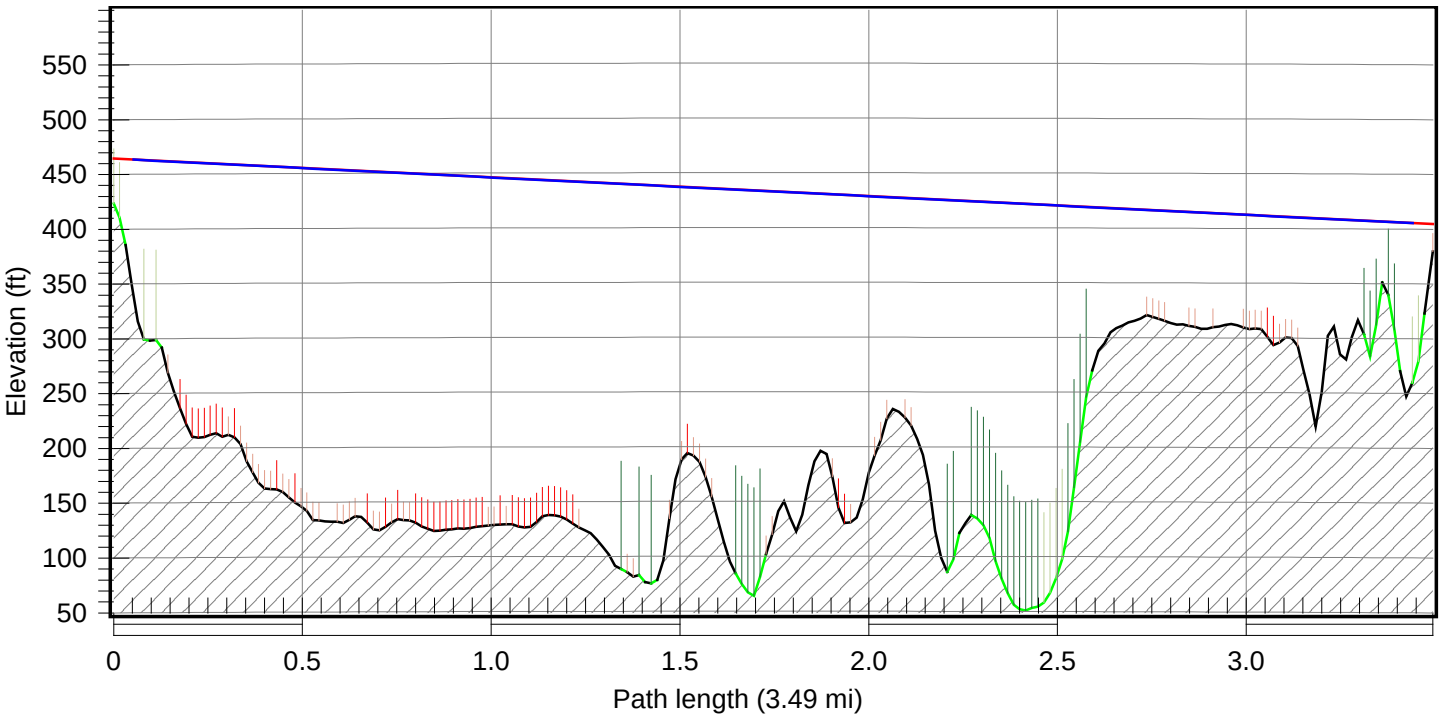


F = 11200.00 MHz K = 1.33 %F1 = 0.6, 0.6

	Cabrillo College	Netcom
Latitude	36 59 28.32 N	36 59 35.66 N
Longitude	121 55 21.25 W	121 59 47.18 W
True azimuth (°)	271.99	91.95
Vertical angle (°)	-0.28	0.23
Elevation (ft)	379.84	288.34
Tower height (ft)	25.00	80.00
Antenna model	SDX4-107BC (TR)	SDX4-107BC (TR)
Antenna gain (dBi)	40.40	40.40
Antenna height (ft)	40.00	35.34
TX line model	EWP90	EWP90
TX line length (ft)	70.00	65.00
TX loss (dB)	4.24	4.09
RX loss (dB)	5.24	5.09
Radio model	9500 MPR - 11 GHz - Max SG - Std Pwr	9500 MPR - 11 GHz - Max SG - Std Pwr
TX power (dBm)	26.00	26.00
EIRP (dBm)	62.16	62.31
Receive signal (dBm)	-32.46	-32.46
Thermal fade margin (dB)	33.04	33.04

	Cabrillo College	Netcom
Effective fade margin (dB)	33.04	33.04
Annual 2 way multipath availability (%)	99.99997	
Annual 2 way multipath unavailability (sec)	7.95	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)

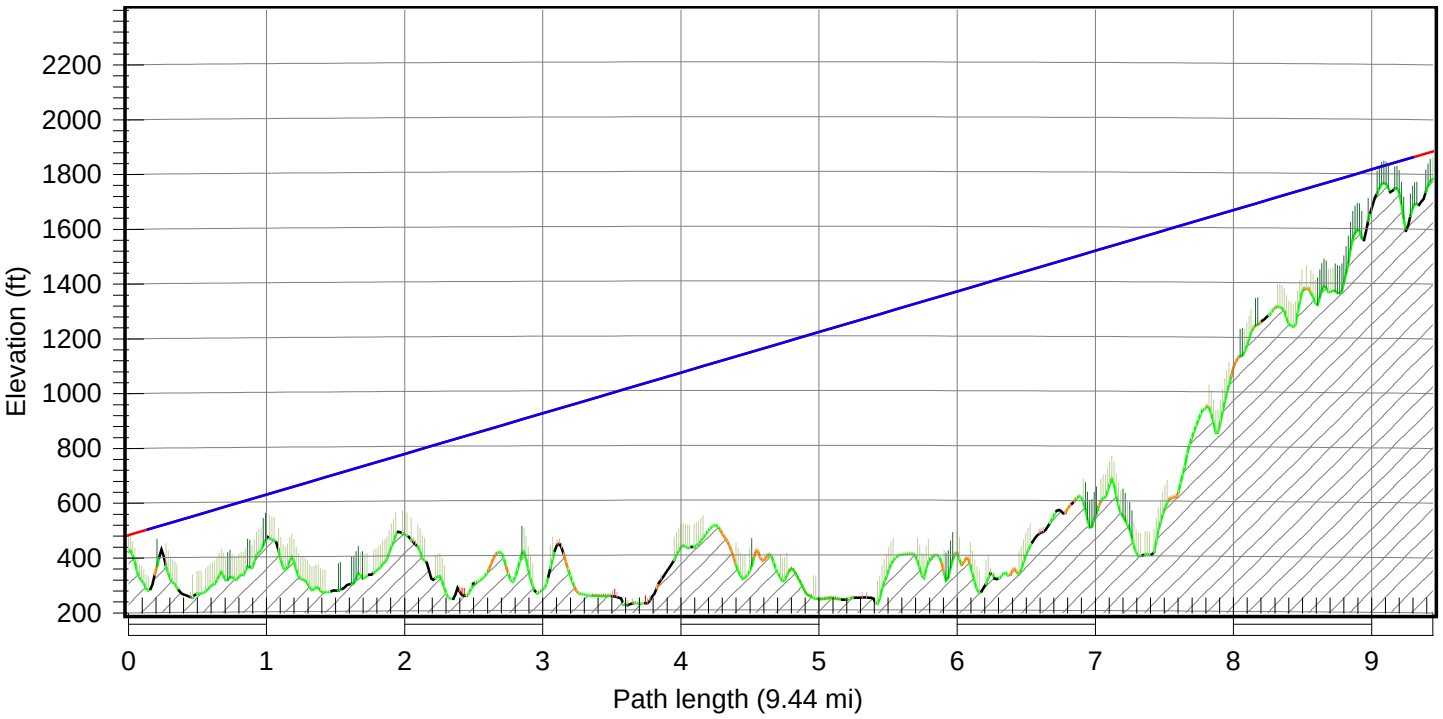


F = 11200.00 MHz K = 1.33 %F1 = 0.6, 0.6

	Central Water Tank	Cabrillo College
Latitude	36 58 01.31 N	36 59 28.32 N
Longitude	121 52 01.45 W	121 55 21.25 W
True azimuth (°)	298.51	118.48
Vertical angle (°)	-0.20	0.17
Elevation (ft)	423.46	379.84
Tower height (ft)	50.00	25.00
Antenna model	SDX4-107BC (TR)	SDX4-107BC (TR)
Antenna gain (dBi)	40.40	40.40
Antenna height (ft)	41.08	25.00
TX line model	EWP90	EWP90
TX line length (ft)	72.00	55.00
TX loss (dB)	4.31	3.78
RX loss (dB)	5.31	4.78
Radio model	9500 MPR - 11 GHz - Max SG - Std Pwr	9500 MPR - 11 GHz - Max SG - Std Pwr
TX power (dBm)	26.00	26.00
EIRP (dBm)	62.09	62.62
Receive signal (dBm)	-30.83	-30.83
Thermal fade margin (dB)	34.67	34.67

	Central Water Tank	Cabrillo College
Effective fade margin (dB)	34.67	34.67
Annual 2 way multipath availability (%)	99.99999	
Annual 2 way multipath unavailability (sec)	3.28	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)

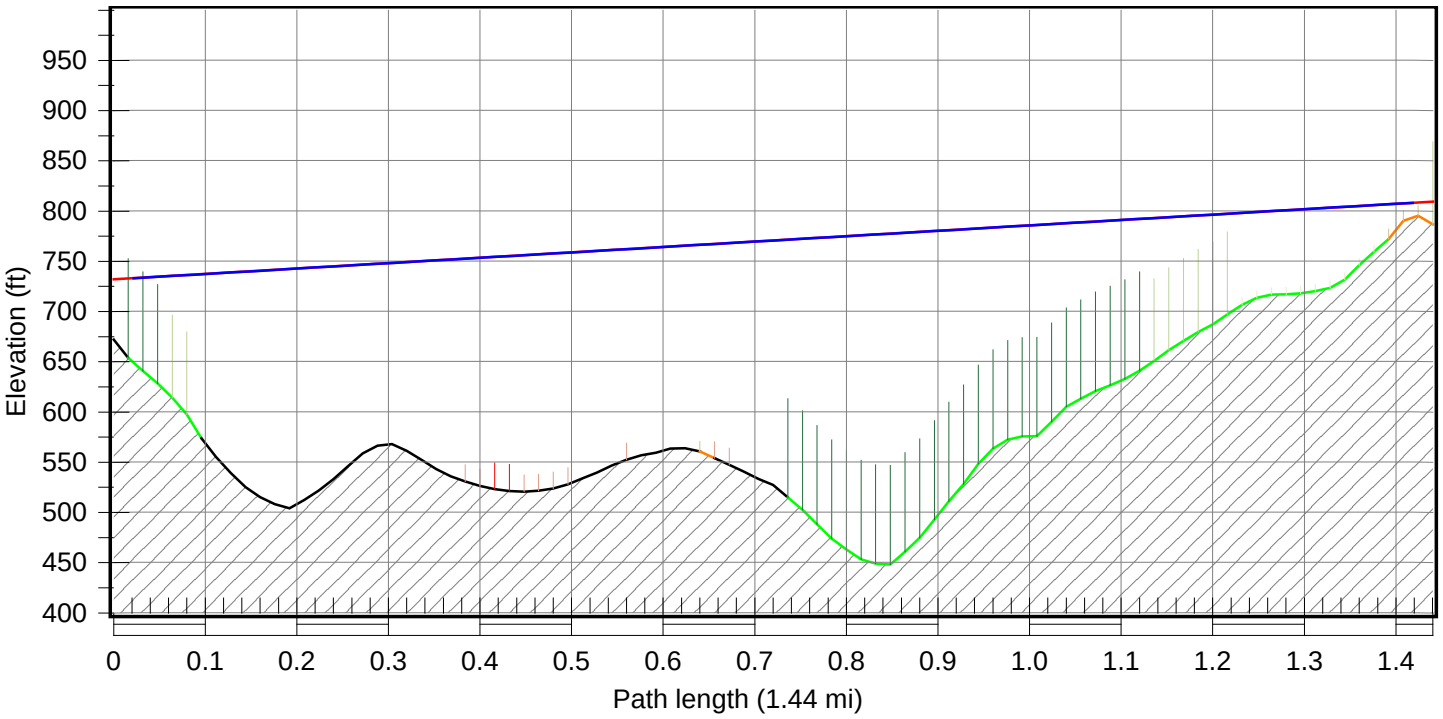


F = 11200.00 MHz K = 1.33 %F1 = 0.6, 0.6

	Central Water Tank	Mt. Madonna
Latitude	36 58 01.31 N	37 00 32.47 N
Longitude	121 52 01.45 W	121 42 16.60 W
True azimuth (°)	72.09	252.19
Vertical angle (°)	1.56	-1.66
Elevation (ft)	423.46	1784.55
Tower height (ft)	50.00	100.00
Antenna model	SDX4-107BC (TR)	SDX4-107BC (TR)
Antenna gain (dBi)	40.40	40.40
Antenna height (ft)	60.00	100.00
TX line model	EWP90	EWP90
TX line length (ft)	65.00	130.00
TX loss (dB)	4.09	6.08
RX loss (dB)	5.09	7.08
Diffraction loss	15.57	
Radio model	9500 MPR - 11 GHz - Max SG - Std Pwr	9500 MPR - 11 GHz - Max SG - Std Pwr
TX power (dBm)	26.00	26.00
EIRP (dBm)	62.31	60.32
Receive signal (dBm)	-57.27	-57.27

	Central Water Tank	Mt. Madonna
Thermal fade margin (dB)	8.23	8.23
Effective fade margin (dB)	8.23	8.23
Annual 2 way multipath availability (%)	99.94274	
Annual 2 way multipath unavailability (sec)	18058.32	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)

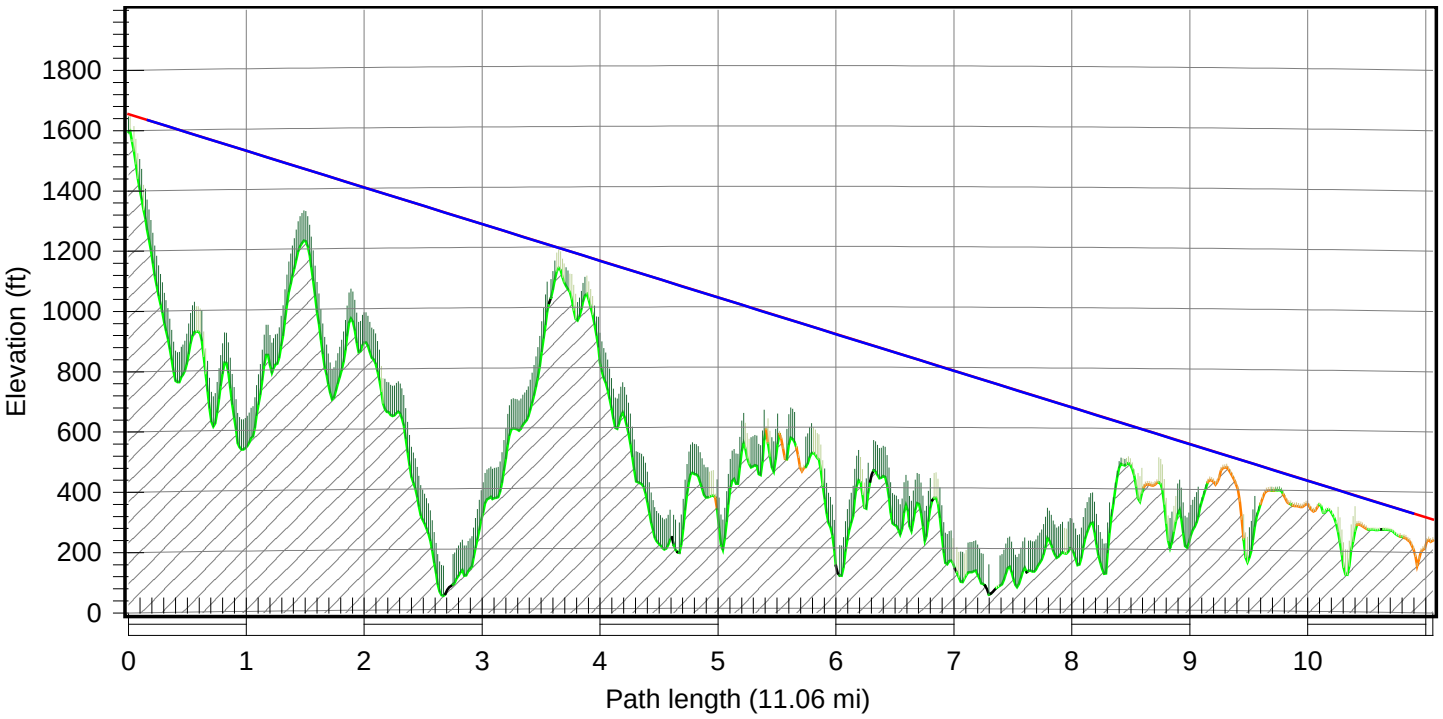


F = 18700.00 MHz K = 1.33 %F1 = 0.6, 0.6

	Kite Hill	Parks-Cowell State Pk
Latitude	37 00 43.81 N	37 01 34.79 N
Longitude	122 01 36.98 W	122 02 45.89 W
True azimuth (°)	312.70	132.69
Vertical angle (°)	0.58	-0.59
Elevation (ft)	672.05	786.93
Tower height (ft)	25.00	20.00
Antenna model	UXA2-190CB (TR)	UXA2-190CB (TR)
Antenna gain (dBi)	38.30	38.30
Antenna height (ft)	60.00	22.50
TX line model	Antenna to ODU	Antenna to ODU
TX loss (dB)	3.25	3.25
RX loss (dB)	3.25	3.25
Diffraction loss	26.07	
Radio model	9500 MPR - 18 GHz - Max SG - Std Pwr	9500 MPR - 18 GHz - Max SG - Std Pwr
TX power (dBm)	18.00	18.00
EIRP (dBm)	53.05	53.05
Receive signal (dBm)	-63.33	-63.33
Thermal fade margin (dB)	0.67	0.67

	Kite Hill	Parks-Cowell State Pk
Effective fade margin (dB)	0.67	0.67
Annual 2 way multipath availability (%)	99.99187	
Annual 2 way multipath unavailability (sec)	2562.32	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)

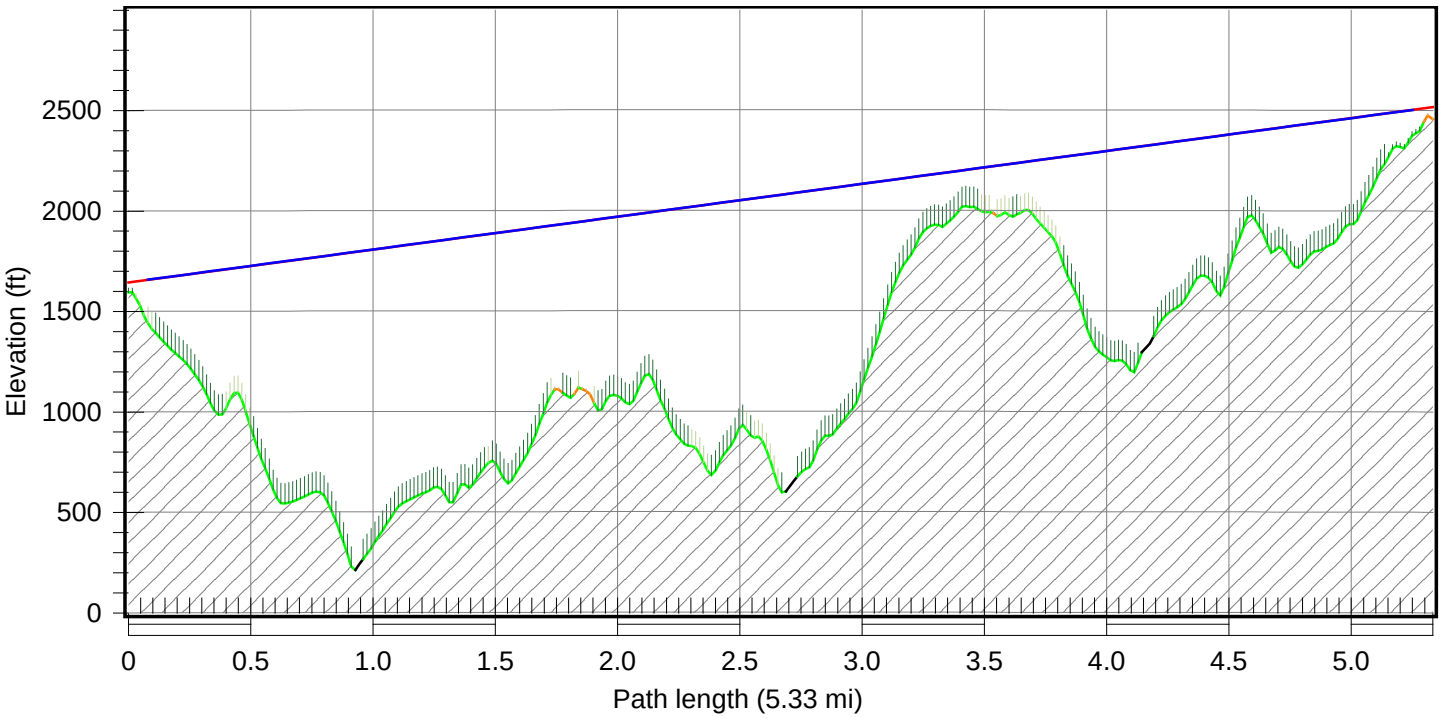


F = 6700.00 MHz K = 1.33 %F1 = 0.6, 0.6

	Parks-Chalk Mtn.	Davenport
Latitude	37 09 38.27 N	37 01 07.57 N
Longitude	122 17 24.58 W	122 11 48.55 W
True azimuth (°)	152.18	332.23
Vertical angle (°)	-1.38	1.26
Elevation (ft)	1595.31	239.60
Tower height (ft)	60.00	50.00
Antenna model	PAD6-W57BC (TR)	PAD6-W57BC (TR)
Antenna gain (dBi)	38.90	38.90
Antenna height (ft)	60.00	70.00
TX line model	EWP63	EWP63
TX line length (ft)	90.00	100.00
TX loss (dB)	3.33	3.46
RX loss (dB)	4.33	4.46
Diffraction loss	4.20	
Radio model	IRU 600 - L6 GHz - Max SG - Std Pwr	IRU 600 - L6 GHz - Max SG - Std Pwr
TX power (dBm)	28.00	28.00
EIRP (dBm)	63.57	63.44
Receive signal (dBm)	-40.35	-40.35

	Parks-Chalk Mtn.	Davenport
Thermal fade margin (dB)	28.15	28.15
Effective fade margin (dB)	28.08	28.08
Annual 2 way multipath availability (%)	99.99968	
Annual 2 way multipath unavailability (sec)	102.08	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)

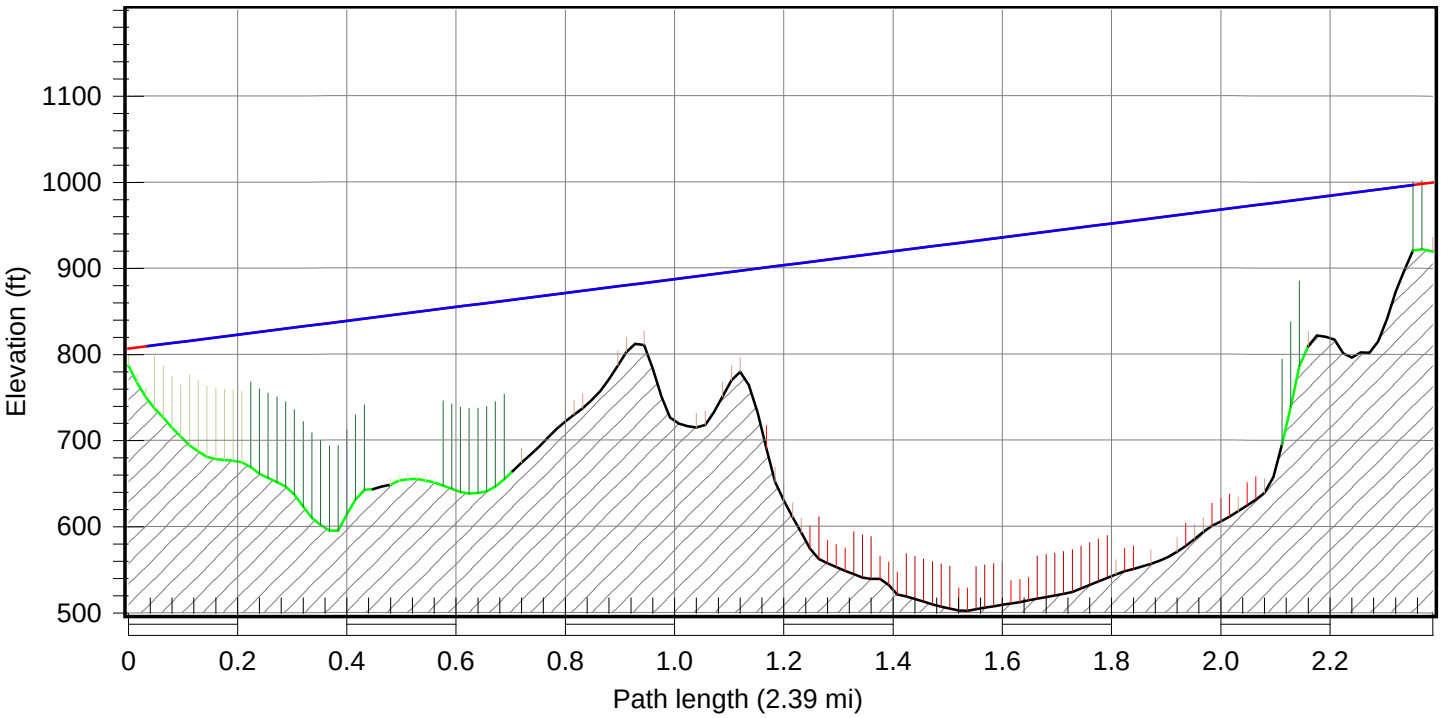


F = 11200.00 MHz K = 1.33 %F1 = 0.6, 0.6

	Parks-Chalk Mtn.	Parks-Eagle Rock LO
Latitude	37 09 38.27 N	37 08 50.78 N
Longitude	122 17 24.58 W	122 11 41.89 W
True azimuth (°)	99.79	279.85
Vertical angle (°)	1.74	-1.80
Elevation (ft)	1595.31	2457.11
Tower height (ft)	60.00	50.00
Antenna model	SDX4-107BC (TR)	SDX4-107BC (TR)
Antenna gain (dBi)	40.40	40.40
Antenna height (ft)	50.00	60.00
TX line model	EWP90	EWP90
TX line length (ft)	80.00	90.00
TX loss (dB)	4.55	4.86
RX loss (dB)	5.55	5.86
Radio model	9500 MPR - 11 GHz - Max SG - Std Pwr	9500 MPR - 11 GHz - Max SG - Std Pwr
TX power (dBm)	26.00	26.00
EIRP (dBm)	61.85	61.54
Receive signal (dBm)	-35.87	-35.87
Thermal fade margin (dB)	29.63	29.63

	Parks-Chalk Mtn.	Parks-Eagle Rock LO
Effective fade margin (dB)	29.63	29.63
Annual 2 way multipath availability (%)	99.99996	
Annual 2 way multipath unavailability (sec)	13.41	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)



F = 18700.00 MHz K = 1.33 %F1 = 0.6, 0.6

	Parks-Cowell State Pk	Cadillac
Latitude	37 01 34.79 N	37 03 12.89 N
Longitude	122 02 45.89 W	122 01 09.95 W
True azimuth (°)	38.09	218.10
Vertical angle (°)	0.86	-0.89
Elevation (ft)	786.93	919.72
Tower height (ft)	20.00	35.00
Antenna model	UXA2-190CB (TR)	UXA2-190CB (TR)
Antenna gain (dBi)	38.30	38.30
Antenna height (ft)	20.00	80.00
TX line model	Antenna to ODU	Antenna to ODU
TX loss (dB)	3.25	3.25
RX loss (dB)	3.25	3.25
Diffraction loss	14.86	
Radio model	9500 MPR - 18 GHz - Max SG - Std Pwr	9500 MPR - 18 GHz - Max SG - Std Pwr
TX power (dBm)	18.00	18.00
EIRP (dBm)	53.05	53.05
Receive signal (dBm)	-56.61	-56.61
Thermal fade margin (dB)	7.39	7.39

	Parks-Cowell State Pk	Cadillac
Effective fade margin (dB)	7.39	7.39
Annual 2 way multipath availability (%)	99.99732	
Annual 2 way multipath unavailability (sec)	845.00	

Multipath fading method - Vigants - Barnett
Rain fading method - Rec. ITU-R P.530-8/13 (R837-5)

Appendix D - Site Improvement Matrix

Site Infrastructure and Improvements	701 Ocean St.	Bielawski	Davenport (FG1523)	Kite Hill	Loma Prieta	Mount Madonna	Parks-CHALK MTN	Soquel (Camp)	Ben Lomand Fire	Boulder Creek Fire	Cabrillo College	Cadillac	Central Water Tank	CPD-Jade St. Park	Mount Toro	Parks-COWELL PK	Parks-EAGLE ROCK LO	Watsonville PD	Brommer Yard	CPD-Mall	Delaware	Netcom (Dispatch)	Soquel Central Fire S3
Existing Tower/Structure with Available Space	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Tower Structural Analysis Needed		Y		Y	Y	Y		Y							Y			Y				Y	
Existing Tower Mods Needed																							
New Tower Structure Needed																							
A&E, Environmental Compliance																							
Existing Shelter/Bldg. with Available Space	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Site Grounding Updates Needed	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Existing Shelter/Bldg. Mods Needed																							
New Prefab Shelter Needed																							
New Outdoor Cabinet Needed																							
Commercial AC Power Available	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Backup Power Source(s) Available	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
DC Site/Battery Upgrades Needed	Y	Y	Y	Y	Y	Y		Y			Y	Y	Y	Y	Y			Y			Y		
New Generator Needed						Y																	
New UPS Needed																							
Proposed TX/RX Site Proposed RX-only Site Current Site Type / Status	TX/RX	TX/RX	TX/RX	RX-Only	RX-Only	Candidate	CA Parks	Candidate	MDC-Only	MDC-Only	RX-Only	RX-Only	RX-Only	Capitola PD	RX-Only	CA Parks	CA Parks	Candidate	Candidate	Capitola PD	RX-Only	County Site	RX-Only

Appendix E - Detailed Alternative 1 Subscriber Costs

Boulder Creek Fire Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	15	$7,000	$105,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	42	$6,000	$252,000
New Base/Control Stations	2	$8,500	$17,000
Control Station Antenna System	2	$2,000	$4,000
Equipment Subtotal (rounded)			**$378,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	59	$100	$5,900
Mobile Radio Installation	15	$400	$6,000
Control Station Installation	2	$2,000	$4,000
Services Subtotal (rounded)			**$16,000**
Sales Tax	9.25%		$35,000
Spares/Contingency	20%		$76,000
Total Equipment and Services			**$505,000**

Central Fire District Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	50	$7,000	$350,000
Re-use Portable Radios	205	$0	$0
New Portable Radios	0	$6,000	$0
New Base/Control Stations	8	$8,500	$68,000
Control Station Antenna System	8	$2,000	$16,000
New P25 Pagers	40	$650	$26,000
Equipment Subtotal (rounded)			**$460,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	303	$100	$30,300
Mobile Radio Installation	50	$400	$20,000
Control Station Installation	8	$2,000	$16,000
Services Subtotal (rounded)			**$67,000**
Sales Tax	9.25%		$43,000
Spares/Contingency	20%		$92,000
Total Equipment and Services			**$662,000**

District Attorney* Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	41	$0	$0
New Portable Radios	0	$6,000	$0
P25 AES Encryption	41	$500	$20,500
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$21,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	41	$100	$4,100
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$5,000**
Sales Tax	9.25%		$2,000
Spares/Contingency	20%		$5,000
Total Equipment and Services			**$33,000**

Emergency Services Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	14	$0	$0
New Portable Radios	0	$6,000	$0
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	14	$100	$1,400
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$2,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$2,000**

Health Services Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	1	$0	$0
New Portable Radios	0	$6,000	$0
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	1	$100	$100
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$1,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$1,000**

Social Services (HSD) Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	4	$0	$0
New Portable Radios	0	$6,000	$0
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	4	$100	$400
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$1,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$1,000**

Parks Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	1	$0	$0
New Portable Radios	0	$6,000	$0
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	1	$100	$100
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$1,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$1,000**

Probation* Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	54	$0	$0
New Portable Radios	0	$6,000	$0
P25 AES Encryption	54	$500	$27,000
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$27,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	54	$100	$5,400
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$6,000**
Sales Tax	9.25%		$3,000
Spares/Contingency	20%		$6,000
Total Equipment and Services			**$42,000**

Sheriff-Coroner, Jail* Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	614	$0	$0
New Portable Radios	0	$6,000	$0
P25 AES Encryption	614	$500	$307,000
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$307,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	614	$100	$61,400
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$62,000**
Sales Tax	9.25%		$29,000
Spares/Contingency	20%		$62,000
Total Equipment and Services			**$460,000**

Public Works* Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	333	$0	$0
New Portable Radios	0	$6,000	$0
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	333	$100	$33,300
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$34,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$34,000**

GSD Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	2	$0	$0
New Portable Radios	0	$6,000	$0
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	2	$100	$200
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$1,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$1,000**

Scotts Valley PD Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	14	$7,000	$98,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	29	$6,000	$174,000
P25 AES Encryption	43	$500	$21,500
New Base/Control Stations	3	$8,500	$25,500
Control Station Antenna System	3	$2,000	$6,000
Equipment Subtotal (rounded)			**$325,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	46	$100	$4,600
Mobile Radio Installation	14	$400	$5,600
Control Station Installation	3	$2,000	$6,000
Services Subtotal (rounded)			**$17,000**
Sales Tax	9.25%		$31,000
Spares/Contingency	20%		$65,000
Total Equipment and Services			**$438,000**

Ben Lomond Fire Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	18	$7,000	$126,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	36	$6,000	$216,000
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$342,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	54	$100	$5,400
Mobile Radio Installation	18	$400	$7,200
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$13,000**
Sales Tax	9.25%		$32,000
Spares/Contingency	20%		$69,000
Total Equipment and Services			**$456,000**

Scotts Valley Fire Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	15	$7,000	$105,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	32	$6,000	$192,000
New Base/Control Stations	2	$8,500	$17,000
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$314,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	49	$100	$4,900
Mobile Radio Installation	15	$400	$6,000
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$11,000**
Sales Tax	9.25%		$30,000
Spares/Contingency	20%		$63,000
Total Equipment and Services			**$418,000**

Santa Cruz PD Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	63	$7,000	$441,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	180	$6,000	$1,080,000
P25 AES Encryption	243	$500	$121,500
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$1,643,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	243	$100	$24,300
Mobile Radio Installation	63	$400	$25,200
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$50,000**
Sales Tax	9.25%		$152,000
Spares/Contingency	20%		$329,000
Total Equipment and Services			**$2,174,000**

Felton Fire Protection District Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	13	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	36	$0	$0
New Portable Radios	0	$6,000	$0
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	49	$100	$4,900
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$5,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$5,000**

Watsonville PD Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	27	$7,000	$189,000
Re-use Portable Radios	23	$0	$0
New Portable Radios	17	$6,000	$102,000
P25 AES Encryption	67	$500	$33,500
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$325,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	67	$100	$6,700
Mobile Radio Installation	27	$400	$10,800
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$18,000**
Sales Tax	9.25%		$31,000
Spares/Contingency	20%		$65,000
Total Equipment and Services			**$439,000**

Watsonville Fire Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	4	$7,000	$28,000
Re-use Portable Radios	22	$0	$0
New Portable Radios	18	$6,000	$108,000
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$136,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	44	$100	$4,400
Mobile Radio Installation	4	$400	$1,600
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$6,000**
Sales Tax	9.25%		$13,000
Spares/Contingency	20%		$28,000
Total Equipment and Services			**$183,000**

Santa Cruz Fire Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	46	$7,000	$322,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	95	$6,000	$570,000
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$892,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	141	$100	$14,100
Mobile Radio Installation	46	$400	$18,400
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$33,000**
Sales Tax	9.25%		$83,000
Spares/Contingency	20%		$179,000
Total Equipment and Services			**$1,187,000**

Capitola Police Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	30	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	31	$0	$0
New Portable Radios	0	$6,000	$0
P25 AES Encryption	61	$500	$30,500
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$31,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	61	$100	$6,100
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$7,000**
Sales Tax	9.25%		$3,000
Spares/Contingency	20%		$7,000
Total Equipment and Services			**$48,000**

Zayante Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	16	$7,000	$112,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	35	$6,000	$210,000
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$322,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	51	$100	$5,100
Mobile Radio Installation	16	$400	$6,400
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$12,000**
Sales Tax	9.25%		$30,000
Spares/Contingency	20%		$65,000
Total Equipment and Services			**$429,000**

AMR** (Radio count not provided) Alternative 1 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,000	$0
Re-use Portable Radios	0	$0	$0
New Portable Radios	0	$6,000	$0
New Base/Control Stations	0	$8,500	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	0	$100	$0
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$0**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$0**

Appendix F - Detailed Alternative 2 Subscriber Costs

Boulder Creek Fire Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	15	$7,500	$112,500
Re-use Portable Radios	0	$0	$0
New Portable Radios	42	$6,500	$273,000
New Base/Control Stations	2	$9,000	$18,000
Control Station Antenna System	2	$2,000	$4,000
Equipment Subtotal (rounded)			**$408,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	59	$100	$5,900
Mobile Radio Installation	15	$400	$6,000
Control Station Installation	2	$2,000	$4,000
Services Subtotal (rounded)			**$16,000**
Sales Tax	9.25%		$38,000
Spares/Contingency	20%		$82,000
Total Equipment and Services			**$544,000**

Central Fire District Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	50	$7,500	$375,000
Re-use Portable Radios	205	$0	$0
New Portable Radios	0	$6,500	$0
New Base/Control Stations	8	$9,000	$72,000
Control Station Antenna System	8	$2,000	$16,000
New P25 Pagers	40	$650	$26,000
Equipment Subtotal (rounded)			**$489,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	303	$100	$30,300
Mobile Radio Installation	50	$400	$20,000
Control Station Installation	8	$2,000	$16,000
Services Subtotal (rounded)			**$67,000**
Sales Tax	9.25%		$46,000
Spares/Contingency	20%		$98,000
Total Equipment and Services			**$700,000**

District Attorney* Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	41	$0	$0
New Portable Radios	0	$6,500	$0
P25 AES Encryption	41	$500	$20,500
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$21,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	41	$100	$4,100
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$5,000**
Sales Tax	9.25%		$2,000
Spares/Contingency	20%		$5,000
Total Equipment and Services			**$33,000**

Emergency Services Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	14	$0	$0
New Portable Radios	0	$6,500	$0
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	14	$100	$1,400
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$2,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$2,000**

Health Services Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	1	$0	$0
New Portable Radios	0	$6,500	$0
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	1	$100	$100
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$1,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$1,000**

Social Services (HSD) Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	4	$0	$0
New Portable Radios	0	$6,500	$0
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	4	$100	$400
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$1,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$1,000**

Parks Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	1	$0	$0
New Portable Radios	0	$6,500	$0
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	1	$100	$100
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$1,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$1,000**

Probation* Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	54	$0	$0
New Portable Radios	0	$6,500	$0
P25 AES Encryption	54	$500	$27,000
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$27,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	54	$100	$5,400
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$6,000**
Sales Tax	9.25%		$3,000
Spares/Contingency	20%		$6,000
Total Equipment and Services			**$42,000**

Sheriff-Coroner, Jail* Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	614	$0	$0
New Portable Radios	0	$6,500	$0
P25 AES Encryption	614	$500	$307,000
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$307,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	614	$100	$61,400
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$62,000**
Sales Tax	9.25%		$29,000
Spares/Contingency	20%		$62,000
Total Equipment and Services			**$460,000**

Public Works* Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	333	$0	$0
New Portable Radios	0	$6,500	$0
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	333	$100	$33,300
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$34,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$34,000**

GSD Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	2	$0	$0
New Portable Radios	0	$6,500	$0
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	2	$100	$200
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$1,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$1,000**

Scotts Valley PD Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	14	$7,500	$105,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	29	$6,500	$188,500
P25 AES Encryption	43	$500	$21,500
New Base/Control Stations	3	$9,000	$27,000
Control Station Antenna System	3	$2,000	$6,000
Equipment Subtotal (rounded)			**$348,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	46	$100	$4,600
Mobile Radio Installation	14	$400	$5,600
Control Station Installation	3	$2,000	$6,000
Services Subtotal (rounded)			**$17,000**
Sales Tax	9.25%		$33,000
Spares/Contingency	20%		$70,000
Total Equipment and Services			**$468,000**

Ben Lomond Fire Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	18	$7,500	$135,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	36	$6,500	$234,000
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$369,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	54	$100	$5,400
Mobile Radio Installation	18	$400	$7,200
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$13,000**
Sales Tax	9.25%		$35,000
Spares/Contingency	20%		$74,000
Total Equipment and Services			**$491,000**

Scotts Valley Fire Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	15	$7,500	$112,500
Re-use Portable Radios	0	$0	$0
New Portable Radios	32	$6,500	$208,000
New Base/Control Stations	2	$9,000	$18,000
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$339,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	49	$100	$4,900
Mobile Radio Installation	15	$400	$6,000
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$11,000**
Sales Tax	9.25%		$32,000
Spares/Contingency	20%		$68,000
Total Equipment and Services			**$450,000**

Santa Cruz PD Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	63	$7,500	$472,500
Re-use Portable Radios	0	$0	$0
New Portable Radios	180	$6,500	$1,170,000
P25 AES Encryption	243	$500	$121,500
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$1,764,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	243	$100	$24,300
Mobile Radio Installation	63	$400	$25,200
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$50,000**
Sales Tax	9.25%		$164,000
Spares/Contingency	20%		$353,000
Total Equipment and Services			**$2,331,000**

Felton Fire Protection District Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	13	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	36	$0	$0
New Portable Radios	0	$6,500	$0
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	49	$100	$4,900
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$5,000**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$5,000**

Watsonville PD Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	27	$7,500	$202,500
Re-use Portable Radios	23	$0	$0
New Portable Radios	17	$6,500	$110,500
P25 AES Encryption	67	$500	$33,500
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$347,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	67	$100	$6,700
Mobile Radio Installation	27	$400	$10,800
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$18,000**
Sales Tax	9.25%		$33,000
Spares/Contingency	20%		$70,000
Total Equipment and Services			**$468,000**

Watsonville Fire Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	4	$7,500	$30,000
Re-use Portable Radios	22	$0	$0
New Portable Radios	18	$6,500	$117,000
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$147,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	44	$100	$4,400
Mobile Radio Installation	4	$400	$1,600
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$6,000**
Sales Tax	9.25%		$14,000
Spares/Contingency	20%		$30,000
Total Equipment and Services			**$197,000**

Santa Cruz Fire Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	46	$7,500	$345,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	95	$6,500	$617,500
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$963,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	141	$100	$14,100
Mobile Radio Installation	46	$400	$18,400
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$33,000**
Sales Tax	9.25%		$90,000
Spares/Contingency	20%		$193,000
Total Equipment and Services			**$1,279,000**

Capitola Police Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	30	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	31	$0	$0
New Portable Radios	0	$6,500	$0
P25 AES Encryption	61	$500	$30,500
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$31,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	61	$100	$6,100
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$7,000**
Sales Tax	9.25%		$3,000
Spares/Contingency	20%		$7,000
Total Equipment and Services			**$48,000**

Zayante Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	16	$7,500	$120,000
Re-use Portable Radios	0	$0	$0
New Portable Radios	35	$6,500	$227,500
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$348,000**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	51	$100	$5,100
Mobile Radio Installation	16	$400	$6,400
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$12,000**
Sales Tax	9.25%		$33,000
Spares/Contingency	20%		$70,000
Total Equipment and Services			**$463,000**

AMR** (Radio count not provided) Alternative 2 Subscriber Cost Estimate			
Subscriber Equipment	***Quantity***	***Unit Cost***	***Extended Cost***
Re-use Mobile Radios	0	$0	$0
New Mobile Radios	0	$7,500	$0
Re-use Portable Radios	0	$0	$0
New Portable Radios	0	$6,500	$0
New Base/Control Stations	0	$9,000	$0
Control Station Antenna System	0	$2,000	$0
Equipment Subtotal (rounded)			**$0**
Implementation Services	***Quantity***	***Unit Cost***	***Extended Cost***
Radio Programming	0	$100	$0
Mobile Radio Installation	0	$400	$0
Control Station Installation	0	$2,000	$0
Services Subtotal (rounded)			**$0**
Sales Tax	9.25%		$0
Spares/Contingency	20%		$0
Total Equipment and Services			**$0**