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Contra Costa County
Public Safety Mobile Radio
Master Plan
Final Report

June 18, 2002

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1. Overview & Executive Summary

Purpose of this Master Plan

Contra Costa County engaged Federal Engineering, Inc. in January 2002 to perform a needs assessment and prepare a public safety radio master plan. The Statement of Work for this project included the following language:

Contra Costa County (CCC) has identified the need to develop a Master Plan for its Public Safety Radio System and has awarded Federal Engineering, Inc. (FE) the opportunity to develop this plan on its behalf...The final plan...will address short- and medium-term and long-term strategies for implementation of the recommended Regional Public Safety Radio Communications System.

This Master Plan and a Needs Assessment report are the two written deliverables from the Federal Engineering project. Other deliverables include a database containing the results of an on-line survey, a study predicting coverage levels obtainable after completing recommended improvements to the existing countywide system, and a study of frequency use in all public safety frequency bands (see Appendix C).

This Master Plan provides a coherent framework within which technical, regulatory, and funding changes can occur without disrupting the overall plan. Section 2 presents a summary and detailed analysis of key requirements and reviews the current planning environment in Contra Costa County. Section 3 presents a series of specific Plan Elements, both Short/Mid-Term and Long-Term, that will significantly improve public safety communications in Contra Costa County. The implementation steps and resources needed for the Plan Elements appear in Section 4; and overall benefits are summarized in Section 5.

A summary of the major conclusions is presented below:

Key Improvements to Public Safety Radio Communications

(The items below are numbered for reference only, not in priority sequence)

1. **Upgrade Existing County Radio Systems.** At the present time, there is no viable short-term way to implement a unified countywide system with capacity for all public safety agencies in Contra Costa. However, there is a countywide VHF radio system in place, which currently serves the Sheriff's Office and several other agencies and departments. Key short/mid term improvements are needed to expand coverage, capacity, and functionality. These will include adding new channels and other technical changes, e.g., simulcast operation. Realignment of the Sheriff's beat boundaries would

add to the utility to these upgrades. Federal Engineering has provided a coverage study, in a separate report, to provide a baseline reference for these improvements.

2. **Initiate Long-Range System Replacement Program.** Opportunities are emerging to obtain sufficient frequencies to permit a unified countywide radio system (UCS). Taking advantage of these opportunities requires that planning and action begin now. These efforts must be undertaken with the joint and visible support of the County, municipal decision-makers, and the public safety community.
3. **Study and Improve Interoperability.** Interoperability is a priority concern in public safety today. Effective interoperability is very difficult within the fragmented systems currently in place in Contra Costa. Revising operational procedures can provide some limited improvements in interoperability. Meanwhile, specific interoperability requirements can be studied and defined so solutions can be developed. This additional information will guide new system planning and operations.
4. **Fully Deploy Mobile Data.** Public safety agencies in Contra Costa have implemented mobile data over the past decade. Leasing arrangements are in use that help control costs and provide to a degree for future changes in equipment. However, mobile data availability is not yet universal, so systems need to be expanded.

Key Action Items and Timetable

1. **Adopt Master Plan.** Formal approval of this Master Plan is the first step in creating coordinated public safety communications.
2. **Create a Permanent Public Safety Radio Board.** The Radio Board should have ongoing responsibility for (1) countywide system planning; (2) spectrum coordination; and (3) technical and operational policy setting. The board should be comprised of County and municipal public safety officials.
3. **Create a Public Safety Radio Authority.** Vest this body with bonding capability to provide reliable, programmatic funding for radio system replacement, upgrade, and ongoing improvement and maintenance.
4. **Initiate Campaigns to Obtain Funding and Public Support.** Lack of consistent funding has delayed or prevented system expansions and improvements in the past. Widespread understanding of the benefits of a cohesive interoperable public safety radio system and approvals of required funding levels are critical to the implementation of this Master Plan.
5. **Complete and Test System Upgrades.** As soon as funding allows, system upgrades should be completed and performance testing performed immediately following the implementation of these upgrades.
6. **Collect System Design Requirements.** Specification development for a new unified countywide system (UCS) will require detailed information about user quantities, areas of operation, standard operating procedures, airtime usage patterns and volumes, and other facts.
7. **Participate Actively in FCC Regulatory Processes.** Unified participation is urgently required in regulatory proceedings that will determine future availability of 700 and/or 800 MHz channels. Also include monitoring activities at the State level.

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8. **Proceed to System Procurement and Installation.** With the help of professional consultants, sufficient funding and frequency spectrum a countywide public safety radio system governed via the Radio Board will be able to specify, acquire, install and operate a unified, interoperable countywide system.

The summary timetable shown below, which is presented in more detail in Section 4 of this Plan, lays out an approximate timeline for the planned actions. This timetable is subject to change depending on a number of factors. Primary among these factors is the willingness of decision-makers to provide a rationalized funding mechanism both for the existing countywide system, and for the expanded replacement system.

2002	2003	2004	2005	2006	2007	2008
		Revise Sheriff's Beats				
		Upgrade Existing Sheriff's System				
	Budget----->> Public Awareness					
		New System Planning				
		Procurement				
				Installation		
				----->> Begin User Conversions		

Major Benefits of Implementing this Plan

Implementation of the Plan Elements included in this Master Plan will result in:

1. **State-of-the-art radio communications** as required for fulfilling public safety missions. Today's systems are hard-pressed to keep up with the growth in the County, and may be unable to respond to emergencies, especially when interoperability among agencies is needed.
2. **Phased and optimized implementation and expenditures.** It would be difficult to replace all public safety systems within the county at once, and imprudent to abandon recent investments of tax dollars in the various systems now in use. By following the plan, the County can transition first to an upgraded countywide system replacing the existing Sheriff's Office system, and then add users as and when they are ready. Costs can thus be distributed over several funding cycles as well as among the various jurisdictions, and the total cost burden can be shared fairly by all participants.
3. **Preservation of local autonomy.** The formation of a Radio Board, populated by public safety officials from user communities, will ensure that the interests and concerns of all users are represented. The Board's job will be to establish policy and resolve conflicts, as well as taking joint action in regulatory processes and in relationships with State and Federal agencies. Individual public safety agencies will be freed of these burdens and better able to concentrate on local priorities.

Index of Plan Elements

Short/Mid-Term Improvement Plan

- ◆ Plan Element S-1¹: Realign Sheriff's Beat Boundaries
- ◆ Plan Element S-2: Add Two VHF Channels
- ◆ Plan Element S-3: VHF System Simulcasting
- ◆ Plan Element S-4: System Microwave Interconnect
- ◆ Plan Element S-5: VHF System Coverage/Capacity Improvements
- ◆ Plan Element S-6: Interoperability Improvements
- ◆ Plan Element S-7: Rationalized Funding
- ◆ Plan Element S-8: Mobile Data Deployment
- ◆ Plan Element S-9: Legacy Low-band Systems
- ◆ Plan Element S-10: VHF Trunking, VHF Narrowband, and Project 25

Long-Term System Replacement Plan

- ◆ Plan Element L-1²: Permanent Contra Costa Public Safety Radio Board
- ◆ Plan Element L-2: Permanent Contra Costa Public Safety Authority
- ◆ Plan Element L-3: Active Spectrum Management & Participation
- ◆ Plan Element L-4: System Design Data Collection
- ◆ Plan Element L-5: System Technical Specifications
- ◆ Plan Element L-6: Operational Issues Resolution
- ◆ Plan Element L-7: Funding Mechanisms
- ◆ Plan Element L-8: Public Awareness Campaign

¹ In the following discussion and also in Section 3, Plan Elements are designated "S" for Short/Mid Term.

² In the following discussion and also in Section 4, Plan Elements are designated "L" for Long Term.

Explanation of Terms Used in this Plan

Although this Master Plan attempts to minimize technical terms and jargon, the definitions and acronyms below may be helpful:

Analog	A form of modulation in which information is encoded in its natural, continuously varying state.
Attenuation	Loss of energy during transmission.
Bandwidth	The capacity of a telecommunications pathway. Used to measure the amount of information that can flow through a channel in a given period. Measured in Hz for analog channels and in bits per second (bps) for digital channels.
Cellular	A type of wireless telephone service.
Channel	A set of frequencies of sufficient width to allow a single radio communication. Typically, when the term “channel” is used in connection with land mobile radio (LMR) systems, it means a pair of frequencies used together one for transmitting and one for receiving.
Coverage	The area reached by a communications medium.
Digital	A form of modulation in which information is encoded as variations between two states (0 and 1, on and off).
DoIT	The County Department of Information Technology
Existing Countywide Systems	Radio systems operated various County agencies, and the system operated by the Sheriff’s Office, providing countywide coverage.
FCC	Federal Communications Commission. The agency charged with managing the radio frequency spectrum, issuing licenses for its various uses, and mitigating interference issues.
FDMA	Frequency Division Multiple Access, one of several technologies used to separate multiple conversation transmissions over a finite frequency allocation over a finite over-the-air bandwidth.
Frequency	The number of repetitions (e.g., cycles per second) of a signal.
Hz kHz MHz GHz	Hertz. Same as cycles per second. Unit of measurement of frequency. kHz means kilohertz, or 1000 Hz MHz means megahertz, or 1,000,000 Hz GHz means gigahertz, or 1,000,000,000 Hz
Interference	Disruption of a radio signal caused by any undesired source that generates signals at the same or nearby frequency and along the same path as the desired signal.

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Interoperability	The ability for radio users in different agencies to communicate.
LMR	Land Mobile Radio
MUX	Equipment which multiplexes information channels
Narrowband	A strategy used to gain more channels and capacity by splitting wideband channels into narrower bandwidth multiples. However, the resulting narrow frequencies cannot be used to form transmit/receive channels because of the need to separate transmit frequencies from receive frequencies.
Noise	Unwanted electrical signals introduced into a communications pathway.
NPSPAC	National Public Safety Planning Advisory Committee. This committee established a nationwide plan for public safety use of frequencies in the 800 MHz band. Each state has its own NPSPAC plan.
PCS	A type of wireless telephone service.
PLMR	Private Land Mobile Radio
Project 25	Project 25 is the name of a set of technical standards endorsed over the past decade by industry associations and adopted by the FCC. The purpose of Project 25 standards is to facilitate interoperability and optimize spectrum use. Project 25 systems could use frequencies ranging from 100 to 1000 MHz, which includes VHF, UHF, 700, and 800 MHz. They employ a universal over-the-air protocol to foster competition in the industry by making equipment from different manufacturers compatible. Project 25 is a defacto standard for public safety 800 MHz and required for narrowband 700 MHz operation.
Project 39	APCO recently initiated Project 39 to provide remedies to the interference between public safety radio systems and wireless telephone systems.
Propagation	Radio signals travel from transmitting antenna to receiving antenna through or along the surface of the earth, through the atmosphere, or by reflection or scattering from natural or artificial reflectors.
Public Safety (PS)	Generally includes law enforcement, fire protection, emergency medical services, and on-going and emergency government functions, as included in the Plan. Includes public service functions in this plan.
Receiver	The portion of a radio device that recovers audio, video, or data from a radio signal.

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Refarming	Reassignments of portions of radio frequency band (narrowband channel usage) performed by the FCC in order to promote efficient use of the spectrum.
Repeater	A transceiver that automatically receives and retransmits a radio signal; used to extend the communications capability of mobile and portable radios.
Shortwave	Frequencies between 6 and 25 MHz that are generally used for international transmissions over long distances.
Simulcasting	Transmitting the same information over two or more radio transmitters located in contiguous areas.
Skip	Unintended reception of distant transmissions outside the normal system communications range.
SMR	Specialized Mobile Radio
Subscriber Units	Mobile and portable radios.
Talk Group	A feature of trunked radio in which selected subscriber units may contact one-another without interfering with the operation of the balance of the subscribers.
TDMA	Time Division Multiple Access, one of several technologies used to separate multiple conversation transmissions over a finite frequency allocation over a finite over-the-air bandwidth.
Transceiver	A radio that transmits and receives information, having both transmitter and receiver circuitry.
Transmitter	The device or portion of a radio device that sends out an RF signal.
Trunking	A system in which a number of radio channels are grouped together. A controller allocates any free channel to a user, which distributes traffic evenly on all trunks and maximizes the amount of traffic the group of channels can support.
UCS	See Unified Countywide System.
UHF	Ultra High Frequency: the portion of the electromagnetic spectrum between 300 and 3000 MHz
Unified Countywide System (UCS)	The radio system to be developed by following this Master Plan. Also referred to in the Federal Engineering Statement of Work as a "Regional Public Safety Radio Communications System."
VHF	Very High Frequency: the portion of the electromagnetic spectrum between 30 and 300 MHz

2. Situation Review

Federal Engineering studied Contra Costa County's current public safety radio situation and future requirements and reported the findings in the Needs Assessment Report. This Section of the Master Plan presents an analysis of how well the existing systems used by Contra Costa County and other public safety agencies address their identified needs.

Contents of Section 2

- Planning Goals
- Current Status of Public Safety Communications
- Intra- and Inter-County Coordination and Interoperability
- Radio Spectrum Alternatives
- Coverage and Availability Standards

Planning Goals

Public safety agencies in Contra Costa County share a common interest in ensuring the availability of cost-effective radio communications systems that provide maximum functionality and interoperability—a shared interest that forms the basis for this Plan. At the broadest level the goals of this Master Plan are as follows:

- ◆ Establish a frequency and technology platform that will meet the needs of public safety in Contra Costa County for the balance of the decade, and a migration strategy for the long term.
- ◆ Ensure that systems are capable of state-of-the-art functionality, are expandable, and provide the required coverage and capacity.
- ◆ Establish a fair and flexible framework for the members of the public safety community to work together.
- ◆ Chart a clear course so that administrators and funding authorities understand what decisions and expenditures are required to provide effective public safety communications.
- ◆ Maximize intercommunications among all public safety radio users within the County in a cost-efficient and service-oriented manner.
- ◆ Recognize today's economic realities and respect sunk existing system investments.
- ◆ Provide for autonomy for local jurisdictions while at the same time providing a common architecture.
- ◆ Build consensus among a wide range of disparate organizations of communities in order to move forward.

In earlier decades, individual communities existed in relative isolation, and the need for public safety agencies to intercommunicate was only occasional. Law enforcement, fire departments, and other agencies usually owned and operated their own two-way radio systems. Today, County agencies and municipalities—with their rapid growth rates, dense population centers, and large daily and seasonal population fluctuations—have many common linkages, and public safety officials collaborate and coordinate their efforts on a daily basis.

Separate, fragmented radio systems that persist in many parts of the country no longer adequately serve public safety. As a result, many counties, states, and federal agencies are moving as rapidly as possible toward more integrated and highly functional radio systems. Especially in the light of recent major-scale disasters such as the attacks on the Oklahoma City Federal building, the Columbine shooting, and the World Trade Center and the Pentagon, the potential benefits for systems that allow users to easily interoperate in emergencies have become very clear.

At the same time, building and maintaining state-of-the-art radio infrastructures and systems has become very costly. Individual local agencies are increasingly hard-pressed to fund common system elements. In addition, like other advanced technologies, radio systems require regular software upgrades, hardware equipment replacement, and ongoing training. This in turn requires not just occasional infusions of capital but continuous, ongoing investments. Furthermore, dollars spent must readily contribute both in reality *and in the public's perception* being most important among a community's competing priorities.

Amid the technical and financial pressures toward system consolidation, individual public safety agencies are rightly concerned about preserving the benefits of their strong ties to their local communities. Radio systems that do not support these relationships, do not present the desirable image, regardless of how technically advanced they are. The challenge is to accomplish both goals—integration and local autonomy—and to do so while minimizing the stranding of existing systems and the investments they represent.

In an earlier era, new spectrum inspired a general trend toward replacing older public safety systems with 800 MHz systems. Contra Costa's interest in this widespread trend, and the potential loss of any remaining 800 MHz frequencies should they be not used, initially motivated this Plan. A timely examination of the suitability of this technology for Contra Costa County was a fiscally responsible project goal. In addition, the County, the Sheriff's Office, and their advisers have repeatedly recognized the need for formal radio communications planning.³ This Master Plan is, however, more comprehensive in scope than previous studies and intends to provide a path forward for all public safety agencies within the county.

³For example, recommendation #13 of the "2001 Study of Communications" was that the County develops a Master Plan covering the local government functions for which the County Board of Supervisors is administratively or fiscally responsible.

Current Status of Public Safety Communications

Public safety agencies in Contra Costa County currently use a variety of radio technologies, frequencies, and dispatching arrangements. Many of these are working successfully. At the same time, there are serious issues and concerns about coverage, capacity, interoperability, operational efficiency, funding, and interference.

Effective planning requires a realistic and balanced understanding of the current baseline. In the first part of this planning project, Contra Costa County identified a sample of 54 public safety related entities operating within County boundaries, and arranged for 41 consultant interviews. Many of these interviews included multiple agencies and representatives, such as a city manager, communications manager, and a police chief from the same municipality. All 18 of the municipalities with a population of 12,000 or more were included in the interview sample, along with a sample of County agencies, schools, transit authorities, and others.⁴

In addition, County officials requested all agencies to complete an on-line survey. This survey had a twofold purpose: (1) to establish an inventory of existing radio systems; and (2) to capture information about agency concerns and comments. Since only 32 agencies responded to the survey, the information summarized below. The Needs Assessment report from the first phase of the consulting engagement presented these results⁵. A summary of these results and additional information are presented below.

Existing Sheriff's Office Radio System Technology

The existing system is conventional, analog and VHF. It uses three repeated, dispatched channels, plus various tactical channels. Figure 1 below shows the overall geographic coverage by "zones" of the three dispatched channels, which also correlate with Sheriff's patrol beats. Beats are further illustrated on the map in Figure 2.

⁴ A complete list of 77 municipal and regional entities, prepared by the County, appears in Appendix A: List of Municipal and Regional Public Safety Agencies in Contra Costa County. This list does not include any of the County departments or the Sheriff's Office.

⁵ See Appendix E. Contra Costa County Public Safety Radio Needs Assessment Report, Federal Engineering, April 2002, Table of Contents

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Channel	Geographic Coverage	Sheriff's Patrol Beats
P1	West County, including Lafayette, Moraga, and Orinda	1, 2, 3, 4, 5, and incorporated cities and unincorporated areas of West County
P2	Central County, Martinez to San Ramon	11, 12, 13, 20, 21, 22, 23
P3	East County, east of Mt. Diablo	All other beats in the eastern part of the county and Pittsburg

Figure 1: Existing Countywide System Dispatch Channel Use

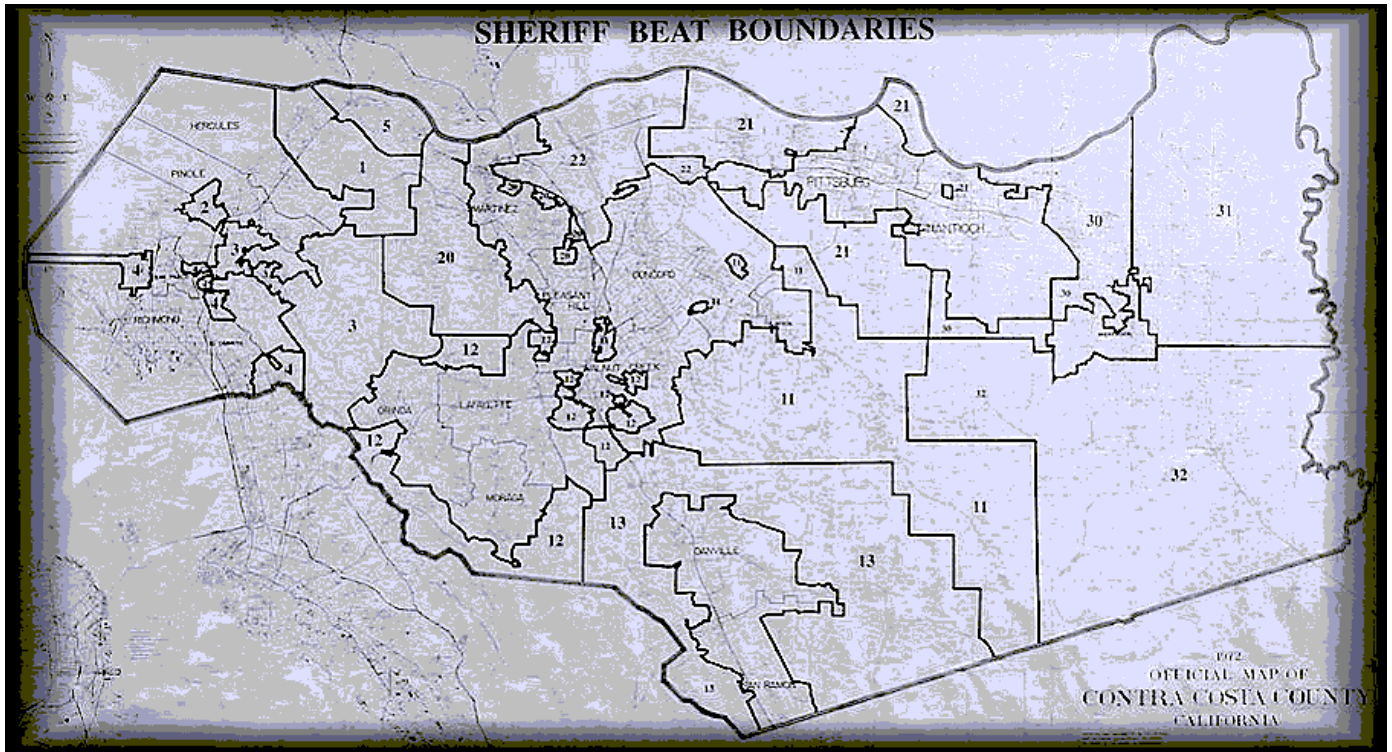


Figure 2: Sheriff's Patrol Beats

Although it is somewhat difficult to see in the photograph above, many of the beats in the western and central portion of the County are seriously fragmented. The reason derives from the historical pattern of municipalities engulfing formerly unincorporated County areas, and Sheriff patrols following suit. Beats 11 and 12 are particularly troublesome: channel P2 needs to cover a considerable swath of the County from just a few radio sites. The sprawl of these legacy beat boundaries contributes significantly to some of the system's capacity and coverage problems.

Two dispatch practices appear to contribute to the perception of channel congestion: (1) Dispatchers re-broadcasting inbound mobile calls. Sheriff's Office officials defend this practice as necessary to distribute deputy status information to sergeants in the field. (2) Dispatchers verbally transmit messages after first dispatching via mobile data terminal. This practice has been justified by the concern that deputies may be on-foot away from their mobile data terminal, or in the vehicle but not attentive to the data terminal display. These redundancies, although viewed by the Sheriff's Office as essential, nonetheless enlarge traffic volume on dispatch channels and thereby exacerbate congestion.

Microwave Infrastructure

Fixed microwave radio system equipment is installed at County-owned tower sites located on a series of high peaks around the area. The current microwave system is an original loop-protected analog configuration, which provides a capacity of 600 voice-channels.⁶ FCC rules permitted Pacific Bell Telephone (PacBell) to license the County's existing microwave frequencies in exchange for constructing an equivalent system in a different frequency band. PacBell was only required to replace the analog system; the County is responsible for upgrading the system to digital—an investment of about \$10 million—that is now taking place. Harris is the primary equipment supplier.

Even with the digital upgrade, the capacity of the new, soon to be activated system will be limited. The microwave network is used to serve the Sheriff's radio system, plus emergency backup telephone lines. Appendix G. County-Owned Microwave Interconnect contains three current diagrams (County provided) of the microwave network.

Congestion and Coverage Concerns

The Sheriff's Office radio system has reportedly experienced channel overloading for several years. This is not surprising given the County's population growth. The system appears to serve more mobile and portable units than its design can apparently support, at least on certain channels. Anecdotal estimates indicate each of the three main Sheriff's Office channels supports up to 60 or 70 users per channel at any given time.

In an attempt to quantify traffic volumes, the Sheriff's Office made a tally of dispatcher microphone key actions for 187 consecutive days between October 2001 and April 2002. Figure 3 below presents a summary of this data.

⁶ Voice channels are 3 kHz analog or 56 kbps digital.
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Channel	Coverage Area	Total Push-to-Talk	Average Per Day
P1	West County	439,437	2,350
P2	Central County	523,692	2,800
P3	East County	538,178	2,878
P7	Pittsburg	409,126	2,188
	Total	1,910,433	10,216
	Average	477,608	2,554

Figure 3: Existing System Push-to-Talk Statistics

This data represents the relative volume of traffic dispatched on each channel and the total for the dispatch center on a very gross level. The counts for P3 and P7 are sometimes linked, and there are multiple counts per conversation. Channel loading cannot, however, be estimated from this data. The corresponding duration of the conversations is not available, nor is the quantity or duration of mobile unit traffic. Furthermore, no information is available about the urgency of the communications, the number of field units involved, the time to clear an incident, and other factors. However, this data is useful as a broad index of radio system activity.

Appendix H: Analysis of Sheriff’s Office Radio Traffic Statistics, contains a full summary and analysis of these statistics. Traffic patterns are very consistent from channel-to-channel and day-to-day.

Most of the vehicles used by the Sheriff’s Office and participating city police departments are equipped with mobile data terminals (MDT); universal deployment to all system users could reduce radio traffic and congestion. Except for the Sheriff’s Office patrol cars, which use newer mobile data computers (MDC) exclusively, terminals elsewhere are generally older technology than the newer laptop-type computer. In addition, much of the system repeater and control equipment is very old, some dating from the original implementation of the system in the 1960s.

Coverage is notably inadequate in many valleys and canyons throughout the area and in other scattered areas as well. According to some reports, the existing countywide system provides overall coverage to approximately 70% of the county, although accurate statistics have not been collected.

Radio Usage Reported In County

The table below shows the number of mobile, portable, and control station radios in use by various County and local agencies. These statistics would be useful as a datum for sizing any new countywide radio system. By inspection, the County Sheriff and Fire Protection District are the majority users of radio systems in the County.

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Agency	Mobile Radio Units	Portable Radio Units	Control Stations
County Radios:			
Sheriff's Office	254	347	24
Danville Police	23	48	1
Lafayette Police	8	16	1
Oakley Police	12	10	1
Orinda Police	10	12	1
San Ramon Police	34	51	1
County Animal Health	12	9	1
County General Services	50	12	1
County Public Works	70	10	1
County Fire Protection Dist.	340	330	65
Non-County Radios:			
San Ramon Valley Fire Prot.	100	240	15
Rio Vista	7	15	1
Antioch Police	67	130	1
Moraga Police (Disp. Only)	7	15	1
Pittsburg Police (Disp. Only)	25	48	3
Totals	1019	1293	118

Figure 4: Radio Units Reported In Use by Agency

Summary of Radio System Concerns

Most agencies interviewed expressed several common concerns about their systems⁷ in addition to a few specific, localized issues. These common concerns are:

- ◆ Insufficient interagency operability, particularly between local police and fire agencies;
- ◆ Coverage gaps, i.e., areas in which the radios do not operate effectively within operational areas;
- ◆ Channel congestion, i.e., too much radio traffic on the system's radio frequencies;
- ◆ Dispatch performance issues, including length of dispatcher response time;
- ◆ Dispatch cost issues, reported by some agencies on a cost-per-call basis; and
- ◆ Preservation of local service flavor which might disappear if the agency were to transition to a countywide system.

Figure 5 summarizes information submitted by survey respondents regarding their overall concerns. Although survey responses were incomplete, and therefore do not support statistical analysis, these results likely present an accurate qualitative picture.

⁷ Previous consulting studies also found these concerns.
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Frequency Band	Capacity ⁸ Congestion	Coverage	Inter-ference	Inter-operability	Reliability
Low-band	3.8	3.4	4.2	2.7	2.8
VHF	3.4	3.2	3.6	4.0	3.6
UHF	3.8	3.4	3.8	2.6	4.2
800 MHz	3.2	1.6	4.2	3.1	2.6
Average	3.6	2.9	4.0	3.1	3.3
Ranking	4	1	5	2	3

Figure 5: Common Concerns Reported by Survey Respondents: Scale of 1 (High) to 5 (Low)

Common Radio System Needs

Surveys also requested information regarding specific current system requirements and future functional needs. Figures 6 and 7 summarize the results of these questions.

System Feature	Current System	Not Needed	Needed	Planned	Total Responses
Mobile Data Deployment	Low-band	10	3	1	14
	VHF	8	5	3	16
	UHF	6	2	0	8
	800 MHz	6	7	1	14
	Total	30	17	5	
Voice Encryption	Low-band	14	0	0	14
	VHF	16	0	0	16
	UHF	7	1	0	8
	800 MHz	14	0	0	14
	Total	51	1	0	
Trunking	Low-band	14	0	0	14
	VHF	14	1	1	16
	UHF	8	0	0	8
	800 MHz	11	3	0	14
	Total	47	4	1	
Digital Modulation	Low-band	14	0	0	14
	VHF	16	0	0	16
	UHF	7	1	0	8
	800 MHz	13	1	0	14
	Total	50	2	0	
Narrowband Channels	Low-band	14	0	0	14

⁸ Number of channels reported to be not adequate.
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System Feature	Current System	Not Needed	Needed	Planned	Total Responses
	VHF	16	0	0	16
	UHF	6	1	1	8
	800 MHz	11	3	0	14
	Total	47	4	1	

Figure 6: Unmet Current Needs Reported by Survey Respondents

Unmet Feature	High Important	Medium Importance	Low Importance	Totals
Automatic Vehicle Loc.	6	11	13	30
Mobile Card Swipe	5	10	15	30
Mobile Data	16	7	7	30
Mobile E-mail	6	14	10	30
Mobile Identification	15	7	8	30
Mobile Printing	4	10	16	30
Mobile Video	5	9	16	30
Mobile Voice Mail	4	10	16	30
Paging Capacity	9	13	8	30

Figure 7: Future Feature Needs Reported by Survey Respondents

Intra- and Inter-County Coordination and Interoperability

In the wake of many national emergencies and major incidents that require cross-jurisdictional cooperation, it is not surprising that interoperability is the most hotly discussed issues in public safety communications today. In addition, interoperability includes any or all of the means by which public safety officials cooperate with each other in the public interest. This may include agreements among agencies about joint

tactical procedures, development of multi-jurisdictional information systems, joint funding authorizations and grant applications, and, of course, radio system sharing.

The FCC's takes the position that interoperability is essential when different public safety agencies respond to emergencies using otherwise-incompatible equipment. The Commission has long noted that the inability of different public safety agencies to efficiently communicate with one another was a concern for the public safety community, and believes establishing rules for the interoperability channels will help prevent a physical disaster from becoming a communications disaster.

Perceived Need for Interoperability in Contra Costa County

Most participants in this project clearly recognize the importance of and requirement for interoperability among public safety agencies. County departments, for example, need direct field radio interoperability with many other jurisdictions, particularly during emergencies.

In terms of more routine operations, inter-system communications are needed between local police and fire departments; among local police, County deputies, California Highway Patrol, and Federal agencies; among local, County, State, and Federal fire agencies; and among various local and County administrative agencies. Police and fire departments require occasional communications with public service departments, such as public works and building inspection, and other public safety entities such as emergency medical and park authorities. School districts recognize the need for interoperability with field personnel, including transit authorities, County Health and HAZMAT personnel.

Many agencies provided specific interoperability requirements, which are summarized below in Figure 8.

Agency name	Interoperability Requirements
Antioch	All Contra Costa County agencies.
BART Police	Contra Costa, Alameda, San Francisco and San Mateo Counties
Central Contra Costa Sanitary District	Contra Costa Fire, San Ramon Fire, Contra Costa County Sheriff, cities in Central Contra Costa County.
Concord Police Dept.	Sheriff, Fire Department
Contra Costa Community College Police Dept.	West County Consolidated PD
Contra Costa County	Sheriff, other law enforcement, Office of Emergency Services
County Public Works	OES, Sheriff, Fire, Building Inspection, Animal Control, Environmental Health, Orinda and Lafayette Public Works
Contra Costa Sheriff	Alameda County, Sacramento County, CA Highway Patrol, East Bay Regional Parks PD, all cities in the County on UHF.
Danville Police Dept.	Sheriff, EOC, CA Highway Patrol, East Bay Regional Parks Police, State Parks Police, San Ramon Valley Fire and EMS, and Consolidated Fire
Lafayette	BART, CA Highway Patrol, East Bay Regional Parks District
Hercules Police Dept.	Alameda and Contra Costa Agencies, BART Police, East Bay Parks
Martinez Police Dept.	It would be nice to be able to communicate with public works,

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Agency name Interoperability Requirements

	Consolidated Fire Department, Pleasant Hill PD, Contra Costa County Sheriff's Department, Concord PD, Walnut Creek PD
Moraga Orinda Fire District	All public safety agencies.
Moraga Police Dept.	All agencies in Moraga, including Fire and Public Works, Other Contra Costa Police Depts., especially Walnut Creek and Greater Diablo Valley agencies.
Orinda	Walnut Creek Police Dept., East Bay Regional Parks District, East Bay Municipal Utility District, BART
Pleasant Hill Police Dept.	Sheriff, Consolidated Fire, CA Highway Patrol, All other Police Depts., OES, DOJ
Rio Vista Police Dept.	Agencies in Contra Costa County, Solano County, Sacramento County and the Delta area.
San Ramon Police Dept.	San Ramon Fire, Dublin (in Alameda County)
San Ramon Valley Fire District	San Ramon Police, Sheriff, City and County Public Works
Walnut Creek Police Department	Fire Dept., all law enforcement agencies

Figure 8: Summary of Reported Interoperability Requirements

Many agencies expressed concern over interoperability deficiencies and system overloading of the present systems. The specter of a major catastrophe only heightens these concerns. Some interviewed agencies doubted whether current systems would function at all in a major emergency.

Communities of interest also often form around similarity of mission. Of the 77 entities listed in Appendix C, Table 9 shows the population of agencies by type of function.

Type of Agency	Number of Agencies ⁹	Number Interviewed	Number Completing Surveys
Law Enforcement	19	18	15
Fire Departments	13	9	6
School Districts	19	4	3
Other: Administrative, Utilities, Transportation, Parks	26 ¹⁰	10	8
Totals	77	41	32

Figure 9: Population of Public Service Agencies by Type

⁹ From List in Appendix C

¹⁰ City Governments
Federal Engineering, Inc.
June 18, 2002

Challenges to Interoperability

Communications with adjacent counties is a general requirement for the County and many municipalities, especially those near county boundaries. This is a significant challenge in many cases, since so many different systems and protocols are in use. Even agencies with 800 MHz systems are not always able to interoperate easily: Alameda County, Sacramento County, and San Francisco all have 800 MHz Motorola systems, while the city of Oakland, the city of Richmond and its six shared users, and BART all have 800 MHz M/A-Com systems, and Marin County has a UHF system. None of these systems are directly compatible.

Channel overloading exaggerates interoperability problems by blocking even routine communications to some extent. Areas such as San Ramon experience massive daily fluctuations in population due to commuters working in the area and living elsewhere. Seasonal variations also affect many parts of the existing countywide system voice channels. This overloading has been somewhat mitigated using mobile data dispatch, which produces a burst of radio traffic that is considerably shorter than a voice call to accomplish the same task.¹¹ However, the use of data dispatch is not currently available to motorcycle patrols, emergency service personnel with portable radios, or universally to most users.

Given the level of concern both locally and nationally, interoperability should be urgently addressed in a coordinated manner. However, during the interviews conducted as part of this project, agencies reported the following mixed initial reactions to the concept of a single, unified countywide system: positive (22%), indifferent (54%), or opposed (24%). Earlier (February, 2001) users of existing countywide systems submitted letters of support, and included as part of a package directed toward the approving authorities for 800 MHz frequencies. These users remain largely supportive of upgrading the existing system.

A number of specific concerns accounted for the lack of widespread support, although many of these concerns appear to be based on misconceptions or misinformation regarding the design criteria and parameters of a unified countywide system (UCS). It is likely that the negative reactions do not pertain to the *concept* of a unified countywide system, but to the *specific* system recently proposed in the County.

The Needs Assessment study appears to show that if a new 800 MHz system were proposed, the Sheriff's Office, local municipalities that the Sheriff is currently supporting under contract, and a few other agencies indicated interest in participating. Clearly, a consensus must be built from a coalition of County and municipal decision makers as well as others in the public safety domain.

¹¹ Officers with computers are also more efficient in other time-intensive and repetitive duties such as report generation and time logging.

Existing Cooperative Agreements

The existing VHF countywide Sheriff system provides radio and/or dispatch services to several local police departments and County departments. Similarly, Richmond's 800 MHz system provides radio communications to six other police departments in the western end of the County. Unfortunately, these two systems cannot easily communicate with each other.

Several County departments provide contractual services to other jurisdictions both within and outside of Contra Costa County in addition to their County missions. The Building Inspection Department, for example, has 47 field units providing service to the County plus eight other municipalities. The Department of Animal Services serves the County plus 18 additional cities from 14 field offices. This department reports problems with their Low-band radio system including coverage "dead spots," "skip" interference from as far away as Florida, and channel traffic congestion. Because of these problems, and their inability to interoperate directly using radio with assisting law enforcement officers, Animal Services Department personnel are concerned about officer safety. Both departments rely heavily on wireless telephone services from Nextel.¹²

The County Fire Protection District provides primary or secondary dispatching to all the Fire Protection Districts. In addition, Antioch Police dispatch and Concord Police dispatch each provide service to one other police department. Figure 10 illustrates the existing cooperative agreements:

¹² Serious interference issues with Nextel are discussed elsewhere in this Plan. In addition, commercial services such as Nextel's are not appropriate for any type of emergency service, since they are among the first communications pathways to become blocked and unavailable at such times. Commercial services can be used successfully by public safety agencies that do not have adequate two-way radio, but only for routine/non-critical matters.

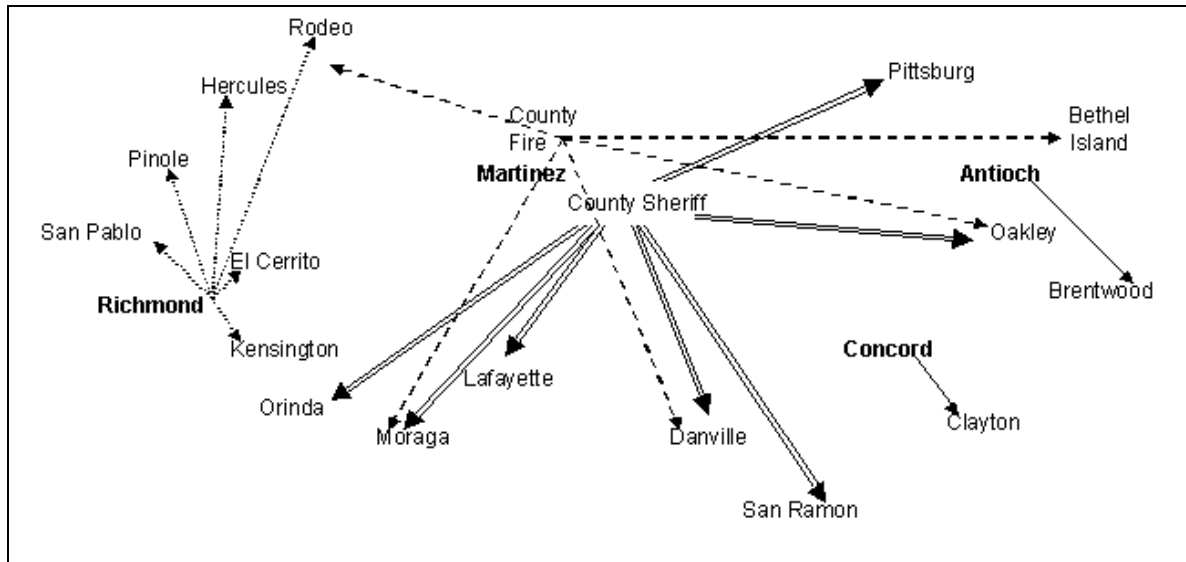


Figure 10: Existing Sharing Arrangements

Strategies for Increasing Interoperability

Ideally, interoperability can be achieved by using a single, unified radio system, serving the entire public safety community. Such a system provides automatic interoperability, not limited by different frequency bands or even by manufacturer proprietary protocols in the same frequency band. Many unified systems have been built in the past decade or more in the 800 MHz band due to the early-on availability of channels and vendor equipment.

Fortunately, interoperability can be achieved through a variety of other solutions. One of the simplest forms is the use of mutual aid channels—channels designated for interoperability use only. The FCC has set aside a limited set of channels in each frequency band for these purposes. Agencies can establish their own mutual aid channels as well. This however, may require that some users have multiple radios in their vehicles. It is very common for agencies to have two, three, or even more separate radios in vehicles in order to talk to each other. This solution is expensive, causes critical crowding in vehicles, and does not help when portable radios are in use. In Contra Costa County, 13 of 32 survey respondents report using more than one frequency band, and therefore, more than one radio.

Another common and technically simple way of achieving a degree of interoperability is to use dispatcher services. Dispatchers can patch two radio channels together—if the technology in use can support this—or relay messages, often by telephone. Verbally relaying a message is the least preferred approach. At times, a message will need to go through two or more dispatchers, which is time-consuming, very inefficient, and potentially inaccurate.

Users of trunked radio systems (in which groups of channels are shared) have the option of establishing *talk groups* specifically for interoperability purposes. In order for this to occur, however, users must have access to the same or compatible radio equipment. In addition, compatible trunked systems can be easily linked to each other or to the public switched telephone network.

The use of standard protocols by different public safety radio systems can bring order to the interoperability scene. Project 25 is a leading standard that has been established in this country. Standards allow users of equipment from different manufacturers to interoperate provided they use the same radio frequency band.

A single, unified system serving the entire public safety community would achieve the best level of interoperability, provide the most features, and be the simplest to operate. A shared system can take many forms, but normally includes a common infrastructure and technology, even though channels, base stations, dispatching, and user equipment may be separately acquired and managed by different user agencies. A single system can be cost effective in the long run.

To work around the difficulties in establishing a single system, public safety agencies have been experimenting with tactical interconnects, over-the-air interfaces, and cross-band repeaters. The technologies to support these alternatives are becoming increasingly available. However, at this point in time these alternatives have their limits and are not a viable long-term solution.

Given the variety of strategies to support intercommunications, it seems that solutions would be easy to find. Such is not the case, however. There are many barriers to radio system interoperability, including age and condition of systems, incompatible technologies, proprietary protocols, the use of many different frequency bands, mission and political differences, operating policy differences, funding differences, and user resistance to change. So many different systems and procedures have proliferated over the years that a variety of solutions are required to fill all the gaps.¹³ Systems of all types, technologies, ages, and frequency bands are in use at this time. This fact alone accounts for much of the urgency with which improvements are being sought. Without both short-term and long-term solutions to the problem of multiple, uncoordinated systems, the capacity to jointly respond to emergencies cannot be accomplished.

Contra Costa County has a number of channels designated for interoperability. For example, Appendix D shows the variety of channels programmed into Search and Rescue radios for use during incidents, including NOAA Weather Channels. For the most part, however, public safety agencies in the County rely on dispatchers and multiple radios.

¹³ The Needs Assessment Report described the variety of systems currently in use throughout the County. Federal Engineering, Inc.
June 18, 2002

Radio Spectrum Alternatives

The key consideration for the planning of shared-use public safety radio systems is the selection of spectrum or frequency band. Sufficient capacity, requirements for coverage, building penetration, interference, and interoperability should influence selection of the appropriate frequency band. Antenna size may also be a factor, especially if portable radio units are extensively used. In practice, the availability of frequencies for licensure may narrow the options considerably, and the availability or non-availability of commercial off-the-shelf equipment may preclude some choices.

Overall, the electromagnetic spectrum available for radio communications is about 30 kHz to 300 GHz (or more). Current Private Land Mobile Radio (PLMR) frequencies are located mostly below 1 GHz. Several different frequency bands accommodate the needs of the public safety sector within this range. Appendix B: Public Safety Agencies Holding Frequencies in Contra Costa County, lists the public safety entities that hold licenses in each public safety frequency band. A combination of databases provided by the County and the Federal Communications Commission sources for information in Appendix B (this information was not taken from the on-line survey).

In addition, Appendix C: Roster of Public Safety Frequencies Licensed in Contra Costa County contains a detailed list of public safety frequencies in each frequency band licensed to public safety users.

Four frequency bands make suitable candidates for a unified countywide radio system in Contra Costa County. Each is discussed briefly below.

VHF High-band (150 MHz)

General Issues and Characteristics of VHF

- ◆ Propagation: Of the four choices considered in this section, VHF High-band provides the best propagation at any given power level. Therefore, High-band systems require fewer tower/transmitter sites to cover a given area.
- ◆ Building Penetration: High-band systems provide poorer penetration of buildings in comparison with higher frequency systems due to lesser capability of the relatively longer High-band wavelengths to penetrate structural openings, and higher absorption by building materials.
- ◆ Interference: Longer High-band radio waves suffer less attenuation or loss of volume during transmission than higher frequencies. Factors such as absorption, reflection, diffusion, scattering, deflection or scattering cause attenuation. VHF is subject to skip interference periodically, but to a lesser degree than experienced on Low-band.

Issues and Characteristics of VHF for Public Safety Radio

- ◆ Availability of Frequencies: High-band frequencies are scarce in the Contra Costa County area. However, Federal Engineering was able to assist the County in identifying

two channels for addition in the short term. Section 3 of this Plan provides details. Furthermore, splitting existing frequencies from wideband (25 kHz) to narrowband (12.5 kHz) use potentially doubles the available channels and clears the path to take advantage of new narrowband equipment features and technologies. Additional frequencies may become available in the future through negotiations with other jurisdictions that currently hold VHF licenses.

- ◆ Radio Standards Supported and Planned: High-band is the primary frequency band used by most federal government agencies, as well as being very widely used by states and counties. Standards have been upgraded in recent years to include, for example, trunking, narrowbanding, digital transmission and encryption. Many federal agencies and a number of states have implemented a suite of Project 25 standards for High-band. These upgraded standards are positive in that they provide for increased interoperability.
- ◆ Number of Manufacturers: The large number of current users ensures continuing supplies of a wide range of state-of-the-art High-band equipment from all major manufacturers such as: Motorola, M/A-Com, Datron, Racal, Kenwood, and Johnson.
- ◆ Data Applications and Bandwidth: Older wideband channels permit 9.6 kbps data transmission; new narrowband channels provide varying bandwidths depending on the modulation and the compression used.
- ◆ Commercial Wireless Telephone Provider Interference: Does not apply.

Issues and Characteristics of VHF for Contra Costa County

- ◆ Number of Current Users: Of the 32 agencies submitting surveys, 15 report using High-band.
- ◆ Number of Licenses: 42 currently held by public safety agencies in the county
- ◆ The number of High-band channels potentially available for use with a countywide radio system could be expanded through pooling of many channels used by municipalities throughout the County and the introduction of trunking to improve channel use efficiency.

UHF (450 MHz)

General Issues and Characteristics of UHF

- ◆ Propagation: UHF signals cover a smaller footprint than VHF, although larger than 800 MHz. Nationwide, many public safety agencies and medical users such as hospitals have upgraded from Low-band to UHF because it is less subject to various kinds of interference such as skip.
- ◆ Building Penetration: The ability of UHF to penetrate buildings better than lower frequencies is widely recognized.
- ◆ Interference: Interference is not significant due to proper frequency coordination and the absence of skip.

Issues and Characteristics of UHF for Public Safety Radio

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- ◆ Availability of Frequencies: Sufficient UHF frequencies for a countywide system are not readily available. As mentioned earlier, the FCC in 1998 established measures to promote interoperability among frequencies under 512 MHz. Five channels have been set aside in the VHF band and four in the UHF band for this purpose.
- ◆ Radio Standards Supported and Planned: There are several channels set aside in the UHF band for medical use such as ambulance-to-hospital and helicopter-to-base communications
- ◆ Number of Manufacturers: Several leading manufacturers supply this market. UHF mobile repeaters, which provide vehicle-to-portable pathways for use at emergency sites, are a common application for public safety users. Manufactures include Motorola, M/A-Com, Kenwood, and Johnson.
- ◆ Data Applications and Bandwidth: 25 kHz channels are generally limited to 9.6 kbps.
- ◆ Commercial Wireless Telephone Provider Interference: Does not apply

Issues and Characteristics of UHF for Contra Costa County

- ◆ Number of Current Users: Of the 32 agencies submitting surveys, 8 report using UHF.
- ◆ Number of Licenses: 33 currently held by public safety agencies in the county

700 MHz

General Issues and Characteristics of 700 MHz

- ◆ Propagation: Laws of physics predict that the propagation characteristics of 700 MHz would be similar to 800 MHz. The use of this band is still somewhat experimental, so its behavior is not fully documented. However, documentation of 800 MHz systems indicates this band will be quite effective. 800 MHz propagation is generally described as Line-of-Sight.
- ◆ Building Penetration: Should provide very good building penetration characteristics. Ample data from actual user field experience is lacking.
- ◆ Interference: Similar to 800 MHz in that it should be immune to interference given proper frequency coordination.

Issues and Characteristics of 700 MHz for Public Safety Radio

- ◆ Availability of Frequencies: The 700 MHz band has yet to be allocated so the potential for sufficient quantities of frequencies exists. Northern California (Region 6) is just now beginning its planning process for use of this band. It is expected that a window of opportunity will exist for obtaining licenses once plans are finalized. When the FCC reallocated this band from television to mobile radio, each State was allowed to apply for up to 2.4 MHz for public safety use. California did apply by the required deadline of December 31, 2001, but much work remains.
- ◆ Radio Standards Supported and Planned: A total of 24 MHz of radio spectrum in the 700 MHz band was reallocated to private land mobile radio in 1998 by the FCC. These frequencies were previously assigned to television broadcasters. Both narrowband and wideband (up to 150 kHz) applications are allowed. The FCC, in establishing the 700

MHz public safety band, stated its intention to satisfy public safety communications needs “into the 21st century”, and to provide for nationwide interoperability. It set aside 2.4 MHz (10% of the band) for interoperable channels to be under the coordination of the states. In 2001, the FCC also adopted a suite of Project 25 standards for both voice and data. This move should ensure that equipment developed by different manufacturers would be largely compatible and interoperable.

- ◆ Number of Manufacturers: The FCC is specifically encouraging radio manufacturers to design and produce radios capable of operating in both the 700 and 800 MHz bands. Motorola is reportedly offering a 700/800 Mhz portable currently, with mobiles and repeaters shipping next year.
- ◆ More spectrum than all other public safety bands combined.
- ◆ Data Applications and Bandwidth: The 700 MHz band plan allows combining contiguous channels for wideband applications, such video, image, multimedia, and high-speed data—up to 691.2 kbps.
- ◆ Commercial Wireless Telephone Provider Interference: unknown at this time, but adopting 700 MHz should greatly reduce the interference problems currently experienced at 800 MHz from commercial carriers. There is no interleaving of PSMR and CMRS services, and wide guardbands are planned.

Issues and Characteristics of 700 MHz for Contra Costa County

- ◆ Number of Current Users: None
- ◆ Number of Licenses: None known at this time. In addition, there are a number of low power television broadcasters (channels 60-69) in the region that will need to vacate the 700 MHz band prior to this band being truly viable. Currently broadcaster relocation is set to occur by 2006, or when the majority of television viewers in the area have adopted HDTV, whichever is earlier.

Previously authorized television broadcasters will have a transition period to move their licenses. This transition is by no means complete, and it is uncertain exactly how long it will take existing stations to vacate, since the FCC has discretion in granting extensions.

800 MHz

General Issues and Characteristics of 800 MHz

- ◆ Propagation: Line-of-Sight, earth and man-made obstacles decrease propagation significantly.
- ◆ Building Penetration: Superior to lower bands.
- ◆ Interference: Not significant. Skip is not an operative factor. While most interference within the service allocation is not a factor given proper frequency coordination, 800 MHz suffers from interference from adjacent commercial carriers such as Nextel—a significant issue now with the public safety community. Quick resolution is unlikely. The FCC is currently reviewing Nextel’s proposed solution.

Issues and Characteristics of 800 MHz for Public Safety Radio

- ◆ Availability of Frequencies: NPSPAC channels available in Region 6 (Northern California) have been heavily used by adjacent counties that have implemented systems in previous years. Approximately 13 channels (frequency pairs) currently remain which could provide limited coverage (see Section 3.0 for details).

When the FCC originally allocated 800 MHz frequencies for public safety, they allowed each State to apply for the number of channels it needed if it developed a unified plan for all public safety users. The National Public Safety Planning Advisory Committee or NPSPAC formulated the plans. Most such plans set aside certain frequencies for statewide use and others for local and regional use.

- ◆ Radio Standards Supported and Planned: Project 25 and various mutually incompatible vendor proprietary technologies.
- ◆ Number of Manufacturers: 800 MHz equipment is supplied by many radio system manufacturers: Motorola, M/A-Com, Kenwood, and Johnson.
- ◆ Data Applications and Bandwidth: Wideband channels only at 806-821 MHz; higher frequency assignments limited to 9.6 kbps.
- ◆ Commercial Wireless Telephone Provider Interference: Serious concern: see discussion below.

Issues and Characteristics of 800 MHz for Contra Costa

- ◆ Number of Current Users: Of the 32 agencies submitting surveys, 15 report using 800 MHz.
- ◆ Number of Licenses: 15 currently held by public safety agencies in the county

Three additional frequency bands available for public safety deserve mention, although they are not viable alternatives for a unified countywide system.

VHF Low-band (30-50 MHz)

Low-band frequencies are at the lower end of the Very High Frequency (VHF) band. Since there is an inverse relationship between frequency and propagation at a given power level, Low-band systems have the widest “footprint” around their transmitter sites.

Low-band spectrum exists just above the short-wave band. Paging, television channels 2 through 6, the military, and other communications interests around the world effectively use Low-band. It is particularly adept at ground wave fill-in of valleys of the type found in the County. Just a few Low-band transmitters can cover an entire state. Smaller fire, emergency medical and miscellaneous local agencies also use Low-band successfully.

There is nothing inherently inferior about Low-band radio systems; they suffer an undeservedly poor reputation for mainly economic reasons. Failure to maintain these once state-of-art systems of 25 years ago allowed them to deteriorate to the point of unreliability. Two distinct drawbacks to Low-band operation are the lack of currently

manufactured base station equipment and atmospheric interference. This interference or skip is the unintentional importation of distant signals. The skip problem ebbs and flows with the 11-year sunspot cycle. It can be mitigated *somewhat* with judicious use of squelch tones, directional antennas and other technology, but cannot be totally eliminated.

There is a dearth of recently manufactured base station equipment today, since vendors abandoned this market in favor of other frequency bands years ago when 800 MHz became available. Used and reconditioned equipment remains plentiful on the secondary market, and some vendors still offer new mobile and portable radios.

220 MHz

The 220 MHz band has a wider footprint than higher frequency bands such as UHF and 800 MHz frequencies, but less than low-band, and appears to be somewhat less subject to interference. The 220 MHz band is slowly gaining users particularly in commercial applications. However, the Federal Communications Commission only recently allocated 220 MHz for public safety use, so equipment and standards designed for this market are not as available. There are no reported government users of 220 MHz in Contra Costa County. The 220 MHz band is not seen as a viable frequency band alternative for the County.

4.9 GHz

One other new development related to frequencies for public safety radio is the very recent allocation of bandwidth in the 4.9 GHz band. This new allocation is intended for point-to-point, fixed broadband applications—data, image, and video—not land mobile radio; therefore this Master Plan will not discuss it.

Other Frequency Band Selection Factors

Capacity Planning

As discussed earlier, sufficient capacity is a key concern in selecting a frequency band for an expanded countywide system. There is little data currently available to calculate system sizing. Channel loading is affected by many factors, including: number of units supported, usage practices, dispatch practices, training and adherence to procedures, length of transmissions, technical aspects of how users access the system and how the system processes transmissions, and signal quality/coverage.

The trunking of radio channels is a load distribution technique that greatly enhances system efficiency by providing maximum use (minimum idle time) of all channels in the system, and is strongly recommended for the benefit of the County.

Commercial Wireless Telephone Interference

When public safety agencies began to use 800 MHz extensively, commercial wireless telephone services known today were not anticipated. Certainly there were no precedents for the explosive growth of these technologies in the past decade. Commercial wireless telephone systems are licensed and operate in parts of the 800 MHz band, as well as other bands. In fact, both public safety systems and wireless telephone systems have experienced rapid growth, at a time when public safety systems are also being called upon to provide massive emergency response capabilities.

Interference with 800 MHz public safety communications from these commercial cellular/PCS systems is now well documented. In areas like Contra Costa County, where Nextel has a large user base, for example, public safety users have experienced marked degradation from previous service levels. Coverage losses may be audible in analog systems, or in digital systems may result in signal quality problems and/or problems when users try to access towers. For example:

The State Department of Transportation agency in Richmond reported problems in a study by the Association of Public Safety Communications Officials (APCO) in October 2001. They operate on an 800 MHz, trunked, analog system, and believe that the interference is due to Nextel operations. According to the report, their radios are unable to access their trunk site in Big Rock, and experience interference near Richmond/San Rafael Bridge.

For the many documented cases of interference with public safety communications, various causes are suggested. In general, however, the interference stems from differences in the ways these systems are designed.

- ◆ Public safety systems serve relatively few users across large areas. They use limited numbers of well-placed, powerful sites. Sites tend to be in remote locations, so users are often operating at the edges of their ranges. There is little overlap between footprints of adjacent sites—mobiles radios on these systems must be able to select signals from distant sites. Such systems maximize coverage and are cost-effective.
- ◆ Commercial wireless telephone systems, by contrast, consist of many smaller, less powerful transmitters, with considerable overlap in footprints, especially along streets and highways. Maximizing coverage is less important than maximizing use of the spectrum and ensuring a continuous hand-off from site to site; system designs ensure that a user is usually close to more than one transmitter. As this intention becomes fully realized, such systems are able to offer excellent service to their customers. Unfortunately, wireless telephone signals blanketing an area can affect public safety radios at the same time. The probability that a mobile radio will be near a wireless telephone site while being far from a public safety transmitter is high. It is in such locations that interference will most likely be experienced.
- ◆ Normally, the two-way radios used for public safety are able to select their own frequencies and ignore other signals. Interference occurs when the public safety radio is not able to select a signal from its own *remote* site, over the strong signal(s) from *nearby* wireless telephone site(s). From the user's viewpoint, loss of coverage is immediately apparent, and if the control channel of a trunked group of channels is disrupted, the

radio may become totally inoperative. The problem becomes worse as public safety officials make more use of less-powerful handheld portable units instead of mobile (vehicular) units.

Interference of this type is occurring principally in the 800 MHz band. The use of 700 MHz for public safety is a recent development. Agencies planning to switch to frequencies in the 700 MHz range probably will not encounter 800 MHz-like interference problems, since the 700 MHz band plan was designed with no commercial interweaving and significant guardbands.

The Association of Public Safety Communications Officials (APCO) has identified this interference as a major concern, and has created Project 39 to investigate the extent of the problem and identify possible remedies. In March 2002, the Federal Communications Commission (FCC) also recognized the seriousness of the problem by initiating a rulemaking process. This process may result, among other things, in orders to reallocate 800 MHz frequencies used by public safety, commercial providers, or both. In the longer term, public safety may benefit, but coverage and interference problems may worsen for some time.

In addition, there are many complex technical issues having to do with the way private and commercial systems are designed. Some observers believe that there is no easy solution, given the escalating competition for frequency spectrum. There are two probable solutions: either (1) swap frequencies within the 800 MHz allocation to eliminate the interleaving of commercial and public safety licensees, or (2) the wholesale relocation of public safety licensees or the commercial interests to another band.

For existing 800 MHz users, the issue of who will pay for any changes is also still an open question. Nextel has written a white paper on their proposed solution, which is among those being considered by the FCC.

Coverage and Availability Standards

Coverage deals with whether a mobile (or portable) radio is within range of a receiver¹⁴ site, or the transmitter is within range of the mobile (or portable) radios. Coverage refers to the area surrounding a tower site within which a mobile or portable radio can receive a base transmitter and the mobile or portable transmitter can radiate to the base receiver. The discussion below explains general coverage issues in non-technical terms as much as possible.

A number of factors affect coverage, including but not limited to: frequency band, transmitter power, transmission line losses, antenna height, gain, antenna directional pattern, environmental losses,¹⁵ terrain, receiver sensitivity, and frequency band.

¹⁴ Base station or repeater.

¹⁵ Such as absorption by foliage or sand.

Many of these factors are different for the various frequency bands, as discussed earlier. In hilly Contra Costa County, some degree of signal blockage is probably inevitable, and terrain dominates system design. In addition, the type of user radio unit affects coverage. Mobiles are more powerful than portables and antenna gain is higher, so coverage from a given site is significantly greater for mobiles. With portables, even the height at which the user wears the portable on the body affects coverage; it is greater for antennas¹⁶ worn at shoulder height than at belt height.

Propagation studies intend to predict coverage. Complicated computer modeling techniques are used which take into account many or all of the factors mentioned above. These models predict the points at which a given signal level is met or exceeded and are predicted with various levels of probability, such as 80%, 90% or 95%. The points having the same signal strength probability form contours around the repeater site. Some models superimpose a grid on the area surrounding the proposed site and predict signal strength probability in each grid square. Squares can range in size from a few feet to a few miles, depending on how the model is constructed and used. These models are more precise, and can more realistically show predicted “holes” in coverage, for example, caused by landforms or large structures.

Models differ in level of detail—how many factors they can take into account—and in the way they analyze the detail. In addition, they are only models; there is no guarantee their predictions will match reality exactly. There are too many unknowns and variables in the geophysical “real world” to be precisely and accurately simulated.

The system owners—with input from the user community—must specify the minimum geographical coverage percentage required of the system as the key performance factor for conceptual system design. Coverage percentage is the greatest factor affecting overall system cost. Between 90 and 100 percent coverage, the cost curve is practically exponential.

Once the coverage percentage (probability) has been specified, the outermost signal contour can be calculated by modeling software and plotted. For example, when a system is designed for 90% contour reliability, this actually means there is a 90% probability that the signal strength will be at least equal to a given value at the outermost edge of the calculated contour. Nearer and nearer the transmission site, the coverage probability approaches 100%.¹⁷

A different way to view coverage is to measure signal *availability* at points in the coverage area. Measurements are also in percentages, but availability measures the percentage of the points tested at which the signal strength met or exceeded the desired level. 90% availability, for example, means the signal strength met or exceeded the desired level at 9 out of every 10 points where measurements were made. Since actual measurements rather than predictions are taken throughout the area, a realistic contour map can be developed.

¹⁶ Some portable manufacturers offer epaulette microphones featuring extension antennas.

¹⁷ The probability approaches 100%, but never reaches it. Coverage of 100% is not possible.

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Achieving the target geographical coverage is often an iterative process, particularly given the hilly County terrain. Even using the best available modeling software, actual performance of the initial system configuration will likely not exactly match the predicted coverage results. “Real world factors” including antenna gain, directionality, orientation and position on the support structure plus noise generated by other nearby transmitters affect coverage in ways that often defy theoretical prediction.

At the start of this project, the County identified an interest in planning for “97%” coverage as a required standard. This standard presumably follows conventional terminology and refers to the contour predictions for sites at their outermost edges. It is important to understand the implications of such a statement, and the variations in interpretation of such a figure.

- ◆ A contour prediction of 97%, as explained above, would actually result in a higher level of coverage across the area. This over-engineering comes with a huge price tag. In fact, the cost of achieving higher levels of coverage increases asymptotically as they approach 100%. It would take a theoretically infinite number of dollars to increase coverage from 99.99% to 100%—clearly impossible. Nor would enough channels be available to support the high degree of required overlap.
- ◆ Vendors naturally tend to maximize their offerings, promising ever-higher coverage figures to compete with each other. These are usually contour type predictions of coverage, rather than measured performance levels. However, the effect is to create a perception that very high coverage levels are needed, thus driving systems toward over-engineering, and thus more revenue for the vendor.
- ◆ Measurements of the system after construction cannot be made along the predicted contours, which do not follow streets or highways. Nor can every building and corridor in a city be entered and tested. Thus it is literally not possible to determine if the specified level has been met. A coverage standard that cannot be measured or enforced has very little utility in ensuring vendor compliance with specifications.
- ◆ The real criterion for coverage is not directly related to either the predicted contour or the measured availability, but the perceptions of the system’s users, and perhaps of decision-makers who may want to monitor the system. These perceptions are conditioned primarily by two factors: comparison with the perceived coverage level provided by whatever system was in place before; and whether or not the radio signal is sufficient at specific important locations, such as key public buildings or known crime areas. If an officer cannot use his or her radio in the hallway of police headquarters, or if he or she has to drive up and around a major freeway overpass to use the radio, coverage is clearly not sufficient regardless of the numbers.
- ◆ Perhaps most importantly, the same levels of coverage are actually not needed at all locations. As a result, many public safety systems are designed to provide different coverage levels—for example, 97% along major roadways, 95% in urbanized areas, and 90% in open countryside.

In conclusion, there is no single, clearly defined “standard” for coverage. Jurisdictions across the country use various levels of coverage and/or availability, with various interpretations and methods of measuring them. In addition, although good coverage is a top priority, there are clear tradeoffs between coverage and costs.

3. Public Safety Radio Improvement Plan

This Section includes planned public safety radio enhancements and expansions that are designed to accomplish the planning goals established in Section 1 and within the constraints discussed in Section 2. Both technical and non-technical changes are considered.

Contents of Section 3

- Challenges and Strategic Approach
- Long-Term System Replacement Plan
- Short/Mid-Term Improvement Plan

Challenges and Overall Solution Approach

The strategic approach offered in this Master Plan charts a course among many challenges. This section draws key conclusions about the specific shortfalls of the existing countywide system. The following two sections outline technical and operating solutions in two distinct stages: first, the long-term replacement of this system with a new integrated, countywide system; and second, the short/mid-term developments to improve the existing system. Presenting long-term plans first emphasizes the need to prepare for system replacement *now* to take advantage of the next opportunity.

The situation in which Contra Costa public safety agencies find themselves now is a challenging one.

- ◆ Despite diligent effort by the County, Sheriff's Office and others, key opportunities to establish an effective, integrated countywide system have been unsuccessful to date.
- ◆ The countywide system as it exists is post-mature; having accumulated many technical and operational shortcomings, it is not capable of fulfilling today's or tomorrow's requirements. Technical solutions are not simple at this point. Inaction and funding shortfalls have blocked both upkeep of the current system and needed improvements.
- ◆ Scarcity of radio channels precludes most of the technology options in the short term. There appear to be good prospects for the future, although the eventual solution is not available yet.
- ◆ There is a long way to go to identify and resolve many pending issues—policy, financial, and technical—on the path toward creating a true countywide solution. Public safety communications as a whole are fragmented among many different systems, agencies, and overlapping jurisdictions. There are discrepancies in understanding what an integrated countywide system could or should be.

Cumulative Effects of Under-funding and Postponed Decisions

Parts of the existing countywide system and many other local public safety systems are antiquated and marginally functional owing to historically low investments in mobile and portable radios, repeaters, buildings and towers. Three areas of concern now exist surrounding the existing countywide radio system: channel congestion, coverage gaps, and interoperability with other agencies. (Interference is also a concern, especially in connection with 800 MHz.)

Radio technology has an intended design life before it becomes functionally obsolete or simply worn out, a fact not taken into account in many cases when decisions were made surrounding system maintenance or capital replacement funding. Reliable funding for the costs of coordination among jurisdictions and training for officers and dispatchers has also apparently not been available. Lack of coordinated, centralized purchasing of radio equipment exacerbates the problem.

Key missed opportunities include: obtaining adequate channels in the 800 MHz band to support a unified system; building adequate microwave capacity to support a trunked radio system; and developing strong inter- and intra county agency alliances.

Scarcity of Frequencies

The recommendations made to and by Contra Costa County over the past two years¹⁸ have revolved primarily around the consideration of an 800 MHz system and around the question of frequency availability in general. Scarcity of channels is nothing new in the public safety arena, but the boom in wireless telephony coupled with Contra Costa's population growth have created a situation in which there are a limited number of realistic options for a state-of-the-art countywide system.

Figure 11 on the following page summarizes the characteristics of the four frequency options that were discussed in Section 2.

¹⁸ Motorola's feasibility study dated December, 2000; CSI's White Paper reviewing this study, and Alan Burton's study dated June, 2001, which reviewed both of the others and considered many additional matters. These papers were provided as input to this Master Plan. A great deal of earlier material, including work from the County and the Sheriff's Office, was also reviewed for this Master Plan. Federal Engineering, the author of this Master Plan, also finds that the two consulting papers are creditable work products that drew reasonable conclusions. However, this Master Plan takes into account more recent technical information, later actions of the County and the Sheriff's Office, and the wealth of input provided by all the public safety agencies who participated in Needs Assessment.

Contra Costa County Public Safety Mobile Radio Master Plan

Characteristics	VHF	UHF	700 MHz	800 MHz
Frequencies	138-144 MHz, 148-174 MHz	406-420 MHz, 450-494 MHz	764-776 MHz, 794-806 MHz	806-824 MHz, 851-869 MHz
Equipment Availability	Excellent	Good	Under Development	Excellent
New Channel Availability Generally	Yes, if narrowband and/or trunked	Yes, if narrowband and/or trunked	Newly allocated; narrowband or wideband	No, unless part of NPSPAC Plan
Channel Availability in Contra Costa area	Scarce and fragmented; two have been identified	Scarce and fragmented	Theoretically wide open	Scarce and fragmented
Interoperability Potential in Contra Costa County	Existing countywide system, other local agencies, State interop channels, most federal agencies	Several municipal agencies in the County and surrounding counties	2.6 MHz set aside for extra-County interoperability	Several surrounding cities, counties, Richmond system; systems have incompatible protocols
Antenna Size	Larger than UHF	Smaller than VHF	Similar to 800 MHz	Smallest
Availability of Trunking	Yes	Yes	Yes	Yes
Applicability of Project 25 Standards	Yes	No	Yes	Yes
Propagation/Coverage (at a given power level)	Good. Wide areas, states, regions	Less than VHF. Towns and smaller regions	Similar to 800 MHz	Metro areas and urban counties
Building Penetration	Moderate	Better	Similar to 800 MHz	Best
Interference and noise	Little skip, less noise than Low-band	No skip, less noise than VHF	Essentially none at this time	Cellular/PCS system intermodulation can be serious
Data Capabilities	9.6 kbps	9.6 kbps	77-691 kbps ¹⁹	+9.6 kbps
Primary Usefulness	Expand existing systems, larger areas, federal agencies	Expand existing systems, smaller regional systems	Supplement 800 MHz, wideband data, future new systems	Cities and urbanized areas where VHF/UHF not viable

Figure 11: Summary of Frequency Band Characteristics

¹⁹ Depends on range (distance from repeater site) and number of 50 kHz channels used. Demonstration 700 MHz Project Greenhouse in Pinellas County, FL uses voice, data, and video over IP.
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Short/Mid-Term Frequency Solution

The recommended short/medium-term strategy to improve and expand the Sheriff's Office system is to retain VHF High-band and significantly upgrade system technology to: (1) improve coverage by filling gaps, (2) multiply channels through narrowband, trunked operation, (3) facilitate faster system access through simulcasting, and (4) pool municipal VHF frequencies to boost system channel capacity. The County would offer talk groups (trunking) to municipalities to create the functionality of independent systems for them, but with the added benefits of better system performance, distributed infrastructure cost, and greatly improved interoperability.

800 MHz Issues

Estimated channel requirements. The charter of this Master Plan is to provide a roadmap to a comprehensive, countywide radio service for use by most or all County agencies in the long-term. *FE's* experience—gained through analyzing and designing public safety radio systems for comparable municipalities, counties, and states; and studying other exemplary system designs throughout the U.S.—argues that between 40 and 50 channels would be required to adequately service the *long-term requirements of most or all of the constituent agency requirements of the County.*

800 MHz Channels Potentially Available. Sheriff's Office personnel reported twenty-one 800 MHz NPSPAC channels as technically available for use by the County. *FE* was asked to also consider incorporating the five 800 MHz channels licensed by the City of Richmond in the mix. Reportedly: (1) the Cities of San Francisco and Sacramento are using approximately seven of the NPSPAC channels for their systems, and (2) their radio traffic (interference) can be monitored on these channels in various areas of the County. Thus, the effective, *usable* number of 800 MHz NPSPAC channels *actually available for service* in the County is approximately thirteen.

Re-use of West County Channels. *FE* views as marginal the suggestion to include the five 800 MHz channels used by the City of Richmond in West County, because these channels are reportedly heavily used already; their inclusion in the mix would therefore not materially contribute net additional capacity to a countywide system. However, re-use of these same channels in East County might be viable pending an interference and adjacent licensure study.

Motorola Engineering Study¹⁸. *FE* believes the Motorola engineering study recommending a low-level 800 MHz system for use by the Sheriff's Office has limited technical and political merit. Successful implementation of this design requires construction of a cellular-like infrastructure, i.e., frequency re-use achieved through numerous low-level sites separated by natural topography. Clearly, this is a very costly approach, dictating many more transmitters. Even with the frequency re-use plan proposed in the study, *FE* believes the number of resultant available

channels (discussion above) is sub-critical mass when compared to the expected aggregate countywide channel requirement *in the long-term to service most or all county agencies*.

In addition, obtaining permits to construct the 29 or so low-level sites likely would most certainly be strenuous undertaking involving years of grueling combat with organized opposition from citizens and environmental groups—a well-known, modern fact of life throughout the U.S., manifested with particular vengeance in California. The schedule to implement such an approach would therefore stretch out into years.

Accordingly, the Motorola low-level 800 MHz design does not appear in *FE*'s judgment to satisfy the charter of this Master Plan because it does not appear uphold two key requirements of the Plan—technical and political practicality.

Conclusion Regarding 800 MHz Viability. Owing to: (1) the apparent lack of overall channel capacity, (2) diminished capacity due to interference problems from nearby cities, and (3) political issues pertaining to implementing low-level tower sites around the County, *FE* concludes that a low-level 800 MHz solution is not a viable short-, medium-, or long-term option for a countywide radio system intended to encompass most potential agency participants.

Long-Term Frequency Solution

No single frequency band selection is a clear and perfect choice for Contra Costa. Each band has its adherents and installed base, representing significant investments. Terrain considerations appear to favor VHF for a cost-effective long-term countywide implementation. The existing system is VHF, and—although as stated earlier—most of the existing system requires upgrade and replacement. Exhaustive frequency research reveals little or no prospect for garnering sufficient additional VHF capacity without frequency pooling by all PSMR participants.

UHF works well for the departments who use it, but the same frequency availability constraints apply as for VHF. Many of the existing UHF systems have also been in use for some time, and are nearing end-of-life.

For the longer term, possible solutions include both 700 and 800 MHz—but there is much about these options that is not known at this point, and neither will remain options unless the public safety community takes steps now to secure channels and be ready to use them.

Multi-User System Issues

If multi-user and interoperability initiatives are to succeed, all participants must give them ongoing priority. Contra Costa's history illustrates this lesson—earlier studies recall attempts at joint use arrangements that ended after a few years.

Such joint use agreements are like all long-term contracts—they are a *means* of establishing mutually beneficial goal but they do not *guarantee* achievement of the goals. Parties to agreements still have different priorities and needs. Successful contract administration—or joint use governance—does not happen automatically but requires a continuous commitment of effort, time, and goodwill. Among public safety officials, goodwill is usually abundant. Nevertheless, competing priorities can overwhelm good intentions, confuse decisions, and drain needed resources.

Short/Mid-Term Improvement Plan

In the near-term, improvements should be made to existing countywide radio systems to alleviate channel congestion, enhance coverage, and improve interoperability with other agencies.

Plan Element S-1²⁰: Realign Sheriff’s Beat Boundaries

The Sheriff’s patrol beat structure described in Section 2 is fragmented, and would benefit from recasting into contiguous areas. Such beat realignment will allow radio channel coverage to more closely match patrol beat communication requirements. Realigning beat boundaries is not a prerequisite but it would significantly improve communications efficiencies.

Plan Element S-2: Add Two VHF Channels

The Sheriff’s Office has had a long-standing request for two additional dispatched repeated channels for the existing countywide system. Federal Engineering assisted a group convened in early April 2002 to review the results of frequency research. This group was successful in discovering two frequency pairs potentially useful for the additional two channels sought by the Sheriff.²¹ Adding these two VHF channels will increase the existing system capacity by 50% and should be accomplished as soon as possible.

- ◆ Suggesting replacement of the two County jail VHF systems with 800 MHz systems yielded the first new channel. The County jails use two simplex channels (155.625 and 159.150 MHz) for their low-power, short-range internal systems. Replacement of these VHF systems with self-contained, limited-range 800 MHz systems for internal use only would free the VHF frequencies for countywide use.
- ◆ Redeploying two other existing County frequencies provides the second channel.

²⁰ In the following discussion and also in Section 3, Plan Elements are designated either “L” for Long Term, or “S” for Short/Mid Term.

²¹ Following the discovery of the two new additional channels, Steve Overacker discovered a letter (see Appendix F) from his files dated August 27, 2001, which outlined a five-channel scheme for the Sheriff radio system. With minor changes, this earlier plan appears nearly identical to the plan derived from the day’s meeting. This plan was shelved for lack of funding.

In addition to re-dedicating frequencies to construct viable frequency pairs for repeater service, additional voting receivers are to be strategically located to improve portable talk-in performance, particularly in building basements and in the unincorporated brush areas.

The County has also debated implementing a separate channel for warrants checking. This idea has merit as a method for taking some of the loading from the other dispatched channels. However, the increasing adoption of mobile and handheld data terminals by users of the existing countywide system have superceded its potential usefulness.

Plan Element S-3: VHF System Simulcasting

As applicable to Private Land Mobile Radio (PLMR) systems, simulcasting means transmitting the same information, on the same frequency at the same time over two or more radio transmitters located in contiguous areas. The Sheriff's radio system does not presently simulcast its repeated dispatch channels. This will bring the benefits of significantly reducing channel overload and thus in a sense improving coverage.

Plan Element S-4: System Microwave Interconnect

A replacement digital microwave system is currently under construction as a County DoIT project. The new system will provide DS-3 (28 T1s) capacity,²² equivalent to the existing 600 channel analog system.

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PARS rings require 19 of the 28 T1 digital circuits. The proposed simulcast upgrade uses Interplex²³ multiplexing equipment and will consume 2 or 3 additional T1s, leaving 6 or 7 T1s for all future County expansion for whatever purpose. Trunking the radio system would require at least 10 T1 circuits, exceeding the capacity of the new microwave system.

Plan Element S-5: VHF System Coverage/Capacity Improvements

Community policing requires officers to patrol on foot, emphasizing portable radio coverage in buildings and in the County's unincorporated areas, where coverage is reportedly marginal. Additional base stations and channels could ease congestion and improve coverage of the existing system.

For the City of Pittsburg (a contract dispatch municipality for the Sheriff's Office), serious coverage issues have raised officer safety concerns. Pittsburg owns and

²² Equivalent to 28 DS-1 circuits. Each DS-1 (1.544 Mbps) is equivalent to 24 voice-grade channels; one T1. Therefore, a DS-3 is equivalent to 672 voice grade circuits. DS-3 is also referred to as T3.

²³ Equipment manufacturer

*Redacted pursuant to Government Code Sections 6254(f) and 6254(aa).

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operates a UHF radio system for its police department, consisting of primary and secondary simplex channels 460.375 and 460.175 MHz. The Sheriff's Office performs dispatch service for this system, as discussed previously. Furthermore, 1400 new houses are under construction in a valley just south of Highway 4, where coverage is virtually non-existent. To address this problem, The County Department of Information Technology (DoIT) has redesigned the system to improve function and coverage. The project will reverse the primary and secondary designations of these channels because of moderate existing interference from nearby co-channel licensees on the current primary channel.

Locating the main transmitters at a City Water Department site on a hill southeast of the new development will enhance coverage. This site will also cover Bailey Road to the south on the opposite side of the hill. The project will retain the present main site at the City fire station and will furnish new repeaters and antennas. The two sites will be linked and simulcast using Pittsburg's microwave link at Station 85 to the County microwave system and timing equipment. The City Water Department will share some costs as it expressed interest in using the new repeater system and abandoning the legacy VHF system that suffers from lack of maintenance.

The opportunity does not exist for the County to re-use these abandoned VHF channels on a high-level, countywide basis, due to interference considerations; currently these channels are used in the limited vicinity of Pittsburg on a low-level basis.

Plan Element S-6: Interoperability Improvements

It's noteworthy that although VHF interoperability channels exist throughout the County and State for fire²⁴ and law enforcement²⁵ (See Appendix D), widespread use is reportedly not made of them. These lightly used channels may be candidates for pooling into a trunked VHF system. The reason stems from traditional and customary patterns of police and fire agency operations. Many agency operations personnel prefer to relay messages through their respective dispatchers rather than communicate directly radio-to-radio. Procedural differences including "10" Codes and other issues appear to discourage direct interoperability although the technical capability exists. Pooling these frequencies, resolution of these differences and streamlining operations requires a specific initiative.

Plan Element S-7: Rationalized Funding

The Sheriff and other County officials lament about the lack of funding for repairs and systematic upgrade and replacement of radio system components. While vehicles, computers and phone systems are known to require upgrade and replacement, radio systems do not share that favor. A program of sustainable

²⁴ The "white" channel

²⁵ CLEMARS, others.
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funding is required to keep the radio system and allied systems evergreen. In addition, a mechanism must be put in place to generate the required funding.

Plan Element S-8: Mobile Data Deployment

The existing countywide system provides mobile data service to deputy patrol vehicles and participating contract city police departments via two 800 MHz channels. The Sheriff's Office contemplates conversion of this system to IP-based data within the year, driven by the requirement for 128-bit encryption imposed by one of the information database systems in use (the California Law Enforcement Telecommunications System, also known as CLETS).

In addition, the San Ramon Valley Fire District uses Cellular Digital Packet Data (CDPD) mobile data. CDPD is a commercial radio technology that supports data transmission at speeds up to 19.2 kbps over existing cellular facilities. The data is structured in packets that are sent during pauses in cellular conversations.

The CDPD system is now scheduled to be upgraded to General Packet Radio Service (GPRS) technology. GPRS is a packet-switched mobile data service now in use in Europe, to which commercial networks are converting. Eventually, it is expected deputies will use GPRS-based handheld data devices. With these portable data devices, deputies will have access to data both in their vehicles and while on foot. This should eliminate the need to dispatch messages verbally as well as in data format.

The Contra Costa County Fire District and San Ramon Valley Fire Districts use their legacy VHF Low-band radio systems to provide mobile data communications with their fire vehicles, and are examining their options to use the Sheriff's Office mobile data system. Consolidating and centralizing mobile data services countywide would provide the opportunity for technological uniformity and scale economies.

The County has already initiated a project to improve 800 MHz data coverage in the northwestern part of the county by adding a repeater site at Turquoise. The decision to proceed with this project is currently pending.

The above data changes will enhance current user performance and should allow for additional data users.

Plan Element S-9: Legacy Low-band Systems

The existing VHF system cannot be expanded to accommodate County agencies that presently rely on Low-band or Nextel services. However, the County could improve and enhance the various existing Low-band systems by converting them to repeater service to provide vehicle-to-vehicle and portable-to-portable communications. The County Animal Control agency, for example, could make use of repeated Low-band systems operating on already-licensed County frequencies to complement their cellular phones. Refurbishment and/or replacement of most existing Low-band

components including base stations, antennas, and transmission lines would be required. A separate assessment of cost-effectiveness should be performed before moving forward with these changes.

Plan Element S-10: VHF Trunking, VHF Narrowband, and Project 25

◆ Trunking

Conventional radio systems, including the existing countywide system in Contra Costa, use dedicated base stations or repeaters. They operate much like telephone party lines, in that any user who has access to the frequency can hear information transmitted, and must listen in to determine if the channel is available. Specific frequencies and repeaters correlate with specific agencies or users, and cannot be “borrowed” by other users. One side effect of this procedure is that some frequencies experience overload while others remain lightly used much of the time, a problem that characterizes Contra Costa’s current system.

By contrast, trunking is a process originated in the telephone industry, whereby all users share a group of channels. Channels are dynamically allocated to users on demand by a computerized controller—the specific channel selected is transparent to the user, even when it changes during the course of a communication. Once the channel is allocated, the communication can be directed to small groups of users rather than being overheard by all users. Trunked systems can be set up to assign priorities to different users, allow certain users to pre-empt all other traffic, and permit automatic interconnection with the telephone network. In addition, trucking prevents users from “stepping on” each other on the air, which often happens with conventional systems when they become congested.

Since the controller selects the channels, it allocates usage evenly among all the channels in the group. As a result, trunking maximizes the system’s capacity.²⁶ The larger the group of channels, the more efficiently each channel can be used. Because radio frequency spectrum is a scarce resource, current FCC rules now require that any new system with five or more channels (ten frequency pairs) must be trunked²⁷. Suppliers of trunked systems include Motorola, M/A-Com (Ericsson), and Transcrypt (EF Johnson). Unfortunately, the architectures of these systems and they ways they have implemented trunking are proprietary and largely incompatible. Thus, it may not help—or may even hinder—interoperability with agencies outside the trunked system.

Trunking would be the next logical level of improvement for the existing radio system. Typical trunking designs involve network controllers and T1 data channels in addition to voice channels. The dearth of remaining available channel capacity on the County microwave system precludes the support of trunking. Leasing landline T1 circuits from the telephone companies and other carrier-based services provides a technical alternative to the County microwave system, if available.

◆ VHF Narrowband

Under the rationale of emerging technological advance promoted by the radio manufacturing industry, over a decade ago the FCC mandated splitting then-standard “wideband” VHF High-band 25 kHz channels into two “narrowband” 12.5 kHz

²⁶ At sites with three or more repeaters.

²⁷ “Grandfathered” systems permit single repeaters.

channels²⁸. Known as refarming, the initiative applied to all High-band licensees. It was an un-funded mandate, and as such, it generated broad objection from government licensees concerned about stranding substantial investments in perfectly functional in-place systems. Because of the resistance encountered, the FCC revised its mandate to apply only to commercial licensees and expansion of existing public safety systems. Government licensees are now grandfathered as wideband users indefinitely. However, all new applications for VHF frequencies—government and commercial—are required to be narrowband assignments; no new wideband frequencies are licensable.

Changing to narrowband implies a doubling of available channels, but this is not the case. The state-of-the-art of modulation and filtering techniques incorporated into current equipment offerings does not permit using frequencies spaced literally side-by-side. Such operation creates adjacent channel interference within the system itself. Modern radio receivers require a number of channels of separation to operate effectively. Thus, the challenge of narrowbanding consists of devising a frequency use plan to use the new narrowband frequencies without creating or receiving interference either from other licensees or the system itself. Changing to narrowband operation requires intensive frequency planning.

◆ Project 25

Federal government agencies received a mandate to convert to narrowband operation by January 1, 2005. Large VHF users including the U.S. Departments of Justice, Treasury, Interior, and Agriculture are converting to narrowband systems to meet the deadline. Many individual Bureaus in these Departments have also adopted the P25 standard to be able to purchase equipment from a variety of manufacturers.

The P25 standard requires mobile and portable radios claiming to be “P25 compatible” to function as traditional wideband FM radios as well as offering the P25 feature set; the purpose is “backward compatibility” with existing infrastructures so the radios can be used prior to infrastructure conversions. Phase I of Project 25 has been implemented using frequency division multiplexing (FDMA). The FDMA-based P25 feature set includes narrowband (12.5 kHz) operation, true digital modulation, a variety of encryption schemes, improved analog-to-digital speech conversion for greater clarity (“vocoding”), and trunking. As the P25 standard evolves, Phase II will eventually include a second standard, time division multiplexing (TDMA) functionality. Currently, the technology to equip radios with both FDMA and TDMA over-the-air protocols is not ready for deployment.

The Federal government encourages state and local government VHF users to convert to narrowband operation and adopt the P25 standard to provide direct interoperability during incidents requiring combined agency operations. However, narrowband channels are a prerequisite to implement the P25 feature set.

Long-Term System Replacement Plan

Suggested improvements, described in detail in the next section, to the Sheriff’s VHF radio system will extend the useful service life of this system for an estimated five-to-seven years. Beyond the seven-year mark, the system becomes inadequate due to capacity constraints based on projected population growth and related factors.

²⁸ A further “narrowband” reduction under discussion is 6.25 kHz, although this is largely experimental at this time.

Although modern replacement equipment will likely be available, channels will be even more congested and increasingly scarce.

The primary requirement for greater channel capacity and other requirements for modern technology such as trunking, digital modulation, encryption, and wideband mobile data applications (such as mug shots and fingerprints) dictate migrating to another frequency band where channels are more plentiful and high-speed data transmission will be available.

The following section reviews the prerequisite considerations for planning for a replacement system to provide countywide radio coverage for use by all entities desiring to participate. As discussed earlier, the likely alternative will be either 700 MHz or 800 MHz, depending largely upon the outcomes of pending regulatory and planning processes.

Plan Element L-1²⁹: Permanent Contra Costa Public Safety Radio Board

Fundamental assumptions underlying the concept of a countywide public safety radio system are shared benefits and funding. The experience of other multi-jurisdictional systems clearly demonstrates that joint governance is the key to general acceptance and success. Although the County needs to provide leadership in starting the process, genuine shared governance must be a commitment.

County and municipal public safety officials are the ideal candidates for membership on a Contra Costa Public Safety Radio Board (“Radio Board”). The Radio Board should immediately begin the process of planning, system design; subsequent procurement and implementation. It would have ongoing roles to play in overseeing system operations and proportionate allocation of the system’s resources.

Initially, the Radio Board would take on active spectrum management, coordination, and development of a shared view of the long-term integrated system. Public awareness efforts would be coordinated by the board, which would also discuss and resolve operational procedures and shared funding mechanisms. The strengths of the Radio Board will become most apparent in applying for necessary channel licenses, garnering political support for the new system, and making the numerous decisions needed during system design and installation.

Plan Element L-2: Permanent Contra Costa Public Safety Radio Authority

Numerous persons interviewed in the course of this study cited the lack of consistently available funding as the reason for the antiquated and deteriorated condition of the several radio systems under the County’s jurisdiction. Some assert that these systems were purchased and installed with no thought given to on-going upkeep and replacement of failed, aged units. While many demands compete for tax

²⁹ In the following discussion and also in Section 4, Plan Elements are designated either “L” for Long Term, or “S” for Short/Mid Term.
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dollars, other County resources such as vehicles, computers, weapons, and fire hoses, undergo scheduled maintenance and replacement in due course. *This strategy must be applied to County radio systems.*

The size and scope of countywide public safety radio communications systems are easily comparable to vehicle fleets and highway projects, and as such require analogous budgeting and funding. The County should establish a funding authority dedicated to the initial purchase and on-going maintenance and upgrade of existing and assumed eventual replacement radio systems. This funding authority should have bonding authority in order to raise the significant funds required to support this effort.

Plan Element L-3: Active Spectrum Management & Participation

The next—and possibly last—major spectrum opportunity for the foreseeable future lies with the newly available 700 MHz band. County officials must aggressively pursue sufficient 700 MHz spectrum for a multi-user countywide replacement system. Overcoming multiple obstacles to implementation, including incumbent television stations and the current limited equipment offerings from traditional manufacturers will be required. In the ensuing five or more years, these television stations will be re-locating into other spectrum. Manufacturers are developing and marketing new radio equipment for this new band. With sufficient virgin 700 MHz spectrum, County hilltop transmitter sites now in use will likely be usable for 700 MHz service.

A possible alternative could emerge from the rulemaking process regarding 800 MHz interference. Among the proposals the FCC will consider would increase the number of channels available for public safety. Should one of these proposals become viable, Contra Costa might find itself in the position of having another chance to operate in this band. An 800 MHz solution for the County is moot at this point because of the dearth of adequate spectrum to fulfill expected channel capacity requirements for the long-term. In addition, the prospect of the 800 MHz band to provide high-speed data transmission does not look as promising as the 700 MHz band.

Plan Element L-4: Detailed System Design Data Collection

Detailed design of a new countywide radio system requires vital data to plan the system scope, size, capacity, geographic coverage, technological features and other general capabilities. Costs are derivative of the foregoing.

Beginning with completion of the survey data started in this planning process, each public safety agency should develop comprehensive profiles of its existing systems including: number of channels, number of mobiles and portables, geographical coverage, channel traffic loading data, current costs, design life of existing components, and funding considerations.

A vital part of the data collection process should include a comprehensive review of interoperability needs. The three level model of requirements (day-to-day, mutual aid, and task force) identified by the Public Safety Wireless Advisory Committee³⁰ could serve as the basis for this database.

Plan Element L-5: System Technical Specification

Key technical system design factors include: (1) the number of mobile and portable radios supported by the system, present and projected; (2) geographical system coverage expressed as a percentage; (3) system access reliability expressed as a percentage; (4) present and projected: (a) number of individual agencies/entities, (b) interoperability requirements with non-system agencies/entities, (c) data capability requirements, (d) microwave or other site interconnection requirements; (5) technological functions and features: (a) analog vs. digital modulation capabilities, (b) encryption, (c) conventional vs. trunked operation, (d) simulcast operation, and (e) capacity for unforeseen applications; (6) number of talk groups required, (7) number of dispatching entities, and (8) transmission site acquisitions.

Determining system capacity will be a challenge. The number of current and prospective user agencies includes approximately 54 district and municipal law enforcement; fire protection, school districts, transit and utility districts operate in the county boundaries, plus the County Sheriff's Office. Add to this the County government agencies with administrative radio requirements³¹ and the 19 largest incorporated cities and towns, which may have administrative radio users.

A number of interacting factors determine capacity—the number of channels required—in addition to the number of users. These include the amount of usage or traffic generated by users, the call lengths, the methods used to access the system, and how users respond when the system is busy or unavailable. If sufficient data are available regarding the system and its usage patterns, mathematical calculations can estimate capacity requirements. The results of capacity analysis influence channel and component specifications and quantities. History's guide is to overbuild capacity; as with lessons from landline communications, ultimately there is never enough.

An alternative approach is to assume virtually unlimited capacity requirements. Stated another way, assume that the tolerance for channel unavailability in public safety is extremely low. Under this approach, the maximum number of users at any given time drives equipment specifications and quantities. Although this approach may result in some degree of over-engineering, this may be justified on two grounds: first, that spare capacity is required during major emergencies, which have become more common; and second, that it is good management practice to encourage, rather than discourage, use of the system by public safety officials when in the field.

³⁰ Described in the "2001 Study of Communications".

³¹ An earlier study estimated that there are 17 County departments with such requirements.

Significant cost ramifications also surround the coverage issue. It is not simply a matter of defining the percentage of coverage. The County should empower the Radio Board with the tasks of (1) developing an understanding of the technical and cost ramifications of coverage, and (2) specifying the required coverage ultimately for use by a system supplier.

Mobile data deployment can affect capacity requirements in various ways. Since it adds usage to an existing system, it may increase congestion. This will be especially true when transmitting a large quantity of information, such as a mug shot or crime scene photograph. On the other hand, greater use of mobile data for quick transmissions of text information, such as license plate lookups or forms completions, can actually increase channel capacity by eliminating longer and often repeated voice messages. Mobile data is often—though not always—placed on separate channels.

Projected system design and projected costs would be a derivative of the planning process. Knowing legacy system original acquisition costs plus costs of maintenance, repair, and improvement in the ensuing years, adjusted for inflation, serves as a reference point for justifying replacement of otherwise sound existing systems.

Plan Element L-6: Operational Issues Resolution

Autonomy in a shared environment. Two apparently conflicting objectives of a consolidated countywide radio system are the requirement to preserve individual agency control and identity while also participating in a common communications medium. However, within a shared system, *users may continue to maintain autonomy and control over their radio communications needs and functionality*, separate talk groups are available and separate dispatching can persist. Furthermore, operations of participating agencies within a shared system can remain similar, if desired, to prior operations within the legacy systems.

Joint operations. For joint agency operations that take advantage of the shared system, some compromise is inevitable to provide seamless interoperability among the various users, including uniform codes, jargon, and standard operating procedures. System users must promulgate and adopt a common set of codes and procedures before system commissioning involving joint operations. User training is therefore a major requirement.

Plan Element L-7: Funding Mechanisms

One glaring discovery by the FE consulting team was the state of disrepair of many systems, particularly Low-band, throughout the County. As originally built, these systems used high quality, state-of-art components. However, according to agency representatives, little or no funding has been available for ongoing maintenance and repair of the radio systems as there is for vehicles, telephone systems, computers and other necessary technology of modern government.

Funding for the new countywide public safety radio system must depart from past County practice by providing: (1) adequate capital sources for system initial costs, and (2) programmatic funding for ongoing maintenance, repair, replacement and upgrade of system components and software over time. Law enforcement and fire fighting agencies have come to regard radio communications equipment on a par with guns, vehicles, and fire fighting apparatus in the effective execution of their respective missions.

Possible funding mechanisms vary. It is outside the scope of this report to analyze the county's funding structure and process. However, for the future, the Contra Costa Public Safety Radio Board should consider a program revenue supported operation. The County has experience in establishing such a revolving fund with the Wide Area Network operation administered by DoIT.

Plan Element L-8: Public Awareness Campaign

Successful construction, commissioning and on-going support of the new countywide radio system requires adequate initial and on-going programmatic funding. Such funding obviously places demands upon taxation and competing government budget priorities.

While taxes are almost universally disliked, polls taken around April 15th this year reportedly reflected positive public sentiment toward government—and taxes—in relation to the terrorist activities at the World Trade Center and Pentagon. Although surely fleeting, current public perception appears to favor government efforts in the public safety arena; “homeland security” has become a catchword for police, fire, and EMS activities.

A timely campaign to raise County citizen awareness for the need for expenditures (taxes, fees, or bonds) to provide vital public safety communications might potentially ease skepticism and resentment when plans for the new system are finally unveiled.

4. Implementation Plan

This Section outlines specific action steps to support the planned system enhancements and changes, both in the short and long terms. A high-level timetable showing how these steps are linked is also included. Assumptions underlying each set of action steps are included in the following subsections.

Contents of Section 4

- Steps Toward a Unified Countywide System (UCS)
- Steps To Optimize the Existing Countywide System
- Procurement and Performance Based Assessment
- Implementation Timetable

Steps to Optimize Existing County Systems

Implementation of Plan Element S-1: Realign Sheriff's Beat Boundaries

- ◆ **Status:** A representative of the Sheriff's Office discussed revising the patrol beat structure.
- ◆ **Contingencies & Resources:** Success depends upon the Sheriff's Office willingness to accept modifications to the patrol beats structure. Resources are internal.
- ◆ **Next Actions:** Request the plan from the Sheriff's Office to optimize the patrol beats structure.
- ◆ **Timetable:** Change within one year of this report would be optimally beneficial to coincide with simulcasting and channel resource-loading plans under discussion.

Implementation of Plan Element S-2: Add Two VHF Channels

- ◆ **Current Status:** The new channel plan increases the total complement of repeated, dispatched Sheriff's Law Channels from three to five. The utility of this plan would be enhanced were the patrol beats to be revised, as discussed earlier. The Sheriff's Office dispatch center will monitor and dispatch all five channels; four will be simulcast.

New Channel Name	Transmit Freq.	Receive Freq.	Simul-cast	Site Names	Revised Coverage Areas
P1	155.790	155.640	Yes	Bald Peak, Cummings Peak, Nichol Knob	West County
P2	155.115	159.150	Yes	Bald Peak, Rocky Ridge	Southwest County: Lafayette, Orinda, Moraga areas
P3	155.190	155.640 ³²	Yes	Cummings Peak, Kregor Peak, Highland Peak	North Central County to Bay Point
P4	155.790	154.755	Yes	Bald Peak, Highland Peak, Kregor Peak, Rocky Ridge	South Central County; Danville, San Ramon, Lafayette, Orinda, Moraga
P5	155.625	159.150	Maybe	Oakley	Far East County
T4	155.040	155.040	No	All	For use by Law Enforcement and Fire Districts for Countywide, simplex interoperability
T5	TBD	TBD	No	All	Countywide incident channel

Figure 12: New VHF Channel Plan

- ◆ Contingencies & Resources: Implementing the new channel is contingent upon: (1) replacing the County Jail radio systems so the presently-used frequencies may be reassigned for use; (2) licensing the second frequency pair for use with the Sheriff's Office, (3) adopting revisions of the Sheriff patrol beat structure. Resources required reside within the County and Sheriff technical departments.
- ◆ Next Actions: (1) Replace the County Jail radio systems, (2) license the two new frequency pairs, (3) adopt changes to the Sheriff patrol beat structure.
- ◆ Timetable: Sheriff's Office and County representatives estimate one year or less to accomplish the addition of the two channels to the existing system.

³² Using a different squelch tone from P1
 Federal Engineering, Inc.
 June 18, 2002

Implementation of Plan Element S-3: VHF System Simulcasting

- ◆ **Current Status:** The County microwave system incorporates components to enable simulcasting. Both key Fire Districts have ordered simulcast-capable repeaters. The Sheriff Office must order required equipment to implement simulcast on its system; it should also be capable at least of narrowband operation, and optionally P25.

Implementing simulcasting presents the technical challenges of controlling and minimizing the mutual interference occurring in the overlapping signal zones, analogous to the area where the ever-widening circles intersect resultant of two stones tossed into a pond. This type of mutual signal interference in radio systems is called “simulcast noise” and appears as distortion in receivers operating in these zones. Unless simulcast noise is minimized, intelligibility suffers. Controlling simulcast noise requires precisely timing the output energy of each transmitter so the peaks and valleys of the signal waveforms mesh correctly when they meet in the overlap zones. An ultra-precise reference frequency standard plus a means of delaying the signal of each transmitter provides the control to optimize simulcast noise. Voting receivers are an integral part of the current system, and require accommodation in the simulcast design.

For Contra Costa County, Global Positioning System (GPS) receivers connected to the transmitters will furnish the frequency standard, and other equipment will provide the signal delay by manipulating the T1 path on the County microwave backbone delivering audio to the affected transmitters.

The County microwave system distributes audio and control signals between transmitters and dispatch centers owned and operated respectively by the Sheriff’s Office and the two aforementioned Fire Districts. Although these three systems function separately and independently, simulcast technology will be selectively applied to each system, thereby deriving maximum benefit from the GPS and signal delay equipment to be installed. The table below shows the current plan for simulcasting County agency transmitters located at the listed tower sites.

Site Name	Sheriff’s Office	CCC Fire District	SRV Fire District
Glacier	--	Central	--
Bald Peak	P1, P2, P4	West	Yes
Cummings Peak	P1	West	--
Highland Peak	P2, P3, P4	East	Yes
Kregor Peak	P2, P3, P4	East and Central	Yes
Nichol Knob	P1	West	--
Pine Street	P2	--	--
Rocky Ridge	P1, P2, P4	West and Central	--
Stoneman	--	East	--

Figure 13: New VHF Channel Alignment Required for Simulcasting

- ◆ **Contingencies & Resources:** Implementation of simulcasting requires: (1) completion of the new County microwave system, (2) completion of the addition of two new channels for the Sheriff’s radio system, (3) adopt revision of the Sheriff patrol beats structure. Resources required reside within the County and Sheriff technical departments.

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- ◆ Next Actions: (1) Completion of the new County microwave system, (2) Completion of the addition of two new channels for the Sheriff's radio system, (3) Adoption of the suggested revision of the Sheriff patrol beats structure.
- ◆ Timetable: The Sheriff's Office suggests one year from now as the timeframe for implementation of the improvements to the radio system. Three key milestones to success: (1) implementing changes to Sheriff patrol beats structure, (2) upgrading the microwave system for simulcast, (3) obtaining and licensing the frequencies required for channels P5 and P6.

Implementation of Plan Element S-4: System Microwave Interconnect

- ◆ Status: The microwave transmitter/receiver, portion of the system is installed and functional. Bald Peak remains to be completed. Final network testing and vendor acceptance is scheduled for the August-September timeframe
- ◆ Contingencies & Resources: Bald Peak alone remains to be completed; the Emergency Board Order required seismic stability improvements. This work started at Bald Peak on April 29, 2002, and will require 60 working days to finish. Cutover to the new system requires completion of the Bald Peak site followed by vendor acceptance testing. Resources required reside within the County and Sheriff technical departments.
- ◆ Next Actions: Complete Bald Peak, perform acceptance testing, and commission system.
- ◆ Timetable The County microwave replacement and upgrade project should be complete before December 2002. When all digital circuits are completed, the vendor will perform acceptance testing. Testing is conducted on 28 T-1 circuits require 24 hours each, about 1.5 months total duration. The system could be commissioned by mid-September, 2002. At this point the conversion to simulcasting could begin.

Implementation of Plan Element S-5: VHF System Coverage Improvements

- ◆ Status: The addition of two new channels will provide coverage improvements.
- ◆ Contingencies & Resources: Implementation of simulcasting involves: (1) completion of the new County microwave system, (2) completion of the addition of two new channels for the existing Sheriff's radio system, (3) revision of the Sheriff patrol beat structure to optimize channel use efficiency. Resources required reside within the County and Sheriff technical departments.
- ◆ Next Actions: (1) Completion of the new County microwave system, (2) Completion of the addition of two new channels for the existing Sheriff's radio system, (3) Adoption of proposed revision of the Sheriff patrol beats structure.
- ◆ Timetable: The timeframe for the system upgrades is contingent on the completion of the County microwave system – possible commissioning in mid-September 2002, appropriations for purchases, plus lead-times from the electric utility to provide primary power to the hilltop site.

Implementation of Plan Element S-6: Interoperability Improvements

- ◆ Current Status: A countywide channel, T5, is planned to provide interoperability between law enforcement agencies and fire agencies.
- ◆ Contingencies & Resources: This plan is contingent upon obtaining and licensing the simplex frequency proposed, followed by procurement and implementation of the required equipment
- ◆ Next Actions: Obtaining and licensing the frequency, installing the required transmitters to accomplish the task.
- ◆ Timetable: Ideally, by January, 2003

Implementation of Plan Element S-7: Rationalized Funding

- ◆ Status: No programmed funding mechanisms appear to exist within the County to provide on-going support for maintenance, repair, and upgrade of legacy systems.
- ◆ Contingencies & Resources: Providing programmed funding requires the County to budget for the on-going support for maintenance, repair, and upgrade of legacy systems.
- ◆ Next Actions: The County should propose a funding mechanism and associated budget for on-going support for maintenance, repair, and upgrade of legacy systems.
- ◆ Timetable: Within the upcoming FY 2003 budget cycle.

Implementation of Plan Element S-8: Mobile Data Deployment

- ◆ Status: The Sheriff's Office provides mobile (vehicle) data service using 800 MHz frequencies. The Sheriff plans portable devices for data service.
- ◆ Contingencies & Resources: It would seem data deployment to additional officers would at least require additional hardware be ordered and installed. If there are plans for portable devices, it stands to reason those units must be ordered. Both of these activities require funding.
- ◆ Next Actions: Implement portable data capability: portable units and necessary support infrastructure.
- ◆ Timetable: Within the year. Second Quarter 2003

Implementation of Plan Element S-9: Legacy Low-band Systems

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- ◆ Status: Legacy Low-band VHF systems are in a state of disrepair and disuse.
- ◆ Contingencies & Resources: Improving existing County Low-band systems requires consensus to undertake such action, funding, and follow-through.
- ◆ Next Actions: Propose a Low-band improvement and enhancement project for County public service agency systems. Consider conversion to repeater service to provide unit-to-unit communications.
- ◆ Timetable: Undetermined at this time.

Implementation of Plan Element S-10: Trunking, Narrowband, P25

- ◆ Status: Not under consideration at this time.
- ◆ Contingencies & Resources: Implementing trunking and other advanced system improvements require greater capacity than potential available on the digital microwave system in its present manifestation. All repeaters (base stations), portable and mobile radios must be capable of the improve technologies. A new band plan must be crafted.
- ◆ Next Actions: Design an expansion of the digital microwave system to accommodate trunking. Devise a narrowband band plan. Budget (but do not implement yet) for wholesale replacement of all VHF system components, including repeaters, portable and mobile radios.

Steps Toward a Unified Countywide System (UCS)

Implementation of Plan Element L-1³³: Permanent Contra Costa Public Safety Radio Board

- ◆ Status: A loosely defined group of interested officials has supported communication studies in the past. Ideally, however, a permanent and authorized, formal board should be established.
- ◆ Contingencies & Resources: The experiences of other counties, such as San Diego County, should be taken as a model by the newly formed board. Resources required would be minimal, other than release time for the board members to participate.
- ◆ Next Actions: Create a statement of membership and functions to propose to the County Board.
- ◆ Timetable: As soon as possible; the board should be one of the first steps taken in implementing this plan.

³³ In the following discussion (same in previous Section), Plan Elements are designated either “L” for Long Term, or “S” for Short/Mid Term.
Federal Engineering, Inc.
June 18, 2002

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Implementation of Plan Element L-2: Permanent Contra Costa Public Safety Radio Authority

- ◆ Status: A defined County agency having the power and purpose of providing reliable funding for the creation, maintenance, and continuing technical and performance upgrade and improvement of the countywide radio system.
- ◆ Contingencies & Resources: Requires the creation and staffing of a new County political entity.
- ◆ Next Actions: Create a statement of purpose and staffing requirements to propose to the County Board.
- ◆ Timetable: Creation of the Authority should be one of the first steps taken in the Plan.

Implementation of Plan Element L-3: Active Spectrum Management & Participation

- ◆ Status: There is no formal effort in-place to coordinate frequencies. This could be one of the first responsibilities of the Radio Board. In addition, participating in the processes regarding 700 and 800 MHz is a critical-path first step in developing a replacement system and locating additional VHF frequencies.
- ◆ Contingencies & Resources: Formal assignment of responsibilities; costs associated with full and active participation at the State, Regional, and FCC levels as required.
- ◆ Next Actions: Join the Region 6 700 MHz planning process. Develop a response to the 800 MHz rulemaking notice. It is highly preferable that both these should be joint responses for all public safety entities in the County.
- ◆ Timetable Immediate start; continuing activity.

Implementation of Plan Element L-4: Detailed System Design Data Collection

- ◆ Status: Some County agencies and departments have responded to the on-line survey. The County is pursuing additional responses as well.
- ◆ Contingencies & Resources: An outside consultant could take on the task of designing the data collection effort.
- ◆ Next Actions: The County can follow up to ensure all agencies complete basic surveys. Soon after the adoption of this Master Plan by the County, the current informal public safety committee or the new formal Board can develop a specification for the information needed, and resolve any barriers to accomplishing this task.
- ◆ Timetable: Immediate start for surveys. Data collection could be designed within the next few months and information collection could begin by the end of the year.

Implementation of Plan Element L-5: System Technical Specification

- ◆ Status: All the information collected to date in this project will be of assistance when the time comes to create the technical specifications. Therefore, this effort is actually off to a healthy start.
- ◆ Contingencies & Resources: Development of procurement specifications will require the services of an objective expert consulting firm. This process would not start until about mid-2002, by which time the NPRM regarding 800 MHz and the initial plans for 700 MHz should be well along toward completion.
- ◆ Next Actions: The Radio Board should initiate discussions regarding coverage and availability alternatives.
- ◆ Timetable: January 2003. The study, design, and specification of a new system would start in about a year.

Implementation of Plan Element L-6: Operational Issues Resolution

- ◆ Status: Minimal development.
- ◆ Contingencies & Resources: Assignable to the Radio Board for consideration with key specifications such as coverage standards. There are close ties between system performance and operational practices.
- ◆ Next Actions: The Board needs to take on the arduous task of examining operating policies and procedures and reviewing training programs.
- ◆ Timetable: This is a continuous effort. The initial stages before new system specification may require at least a year.

Implementation of Plan Element L-7: Funding Mechanisms

- ◆ Status: No dedicated funding source or mechanisms have been uncovered to-date. Establishing a Public Safety Radio Authority would open new vistas on permanent system funding thereby enhancing system dependability and continuity.
- ◆ Contingencies & Resources: Consulting assistance could be applied, under Radio Board oversight.
- ◆ Next Actions: Preparation of appropriate funding requests.
- ◆ Timetable: Contingent on County budget cycle.

Implementation of Plan Element L-8: Public Awareness Campaign

- ◆ **Current Status:** The lack of widespread support for the earlier 800 MHz proposal demonstrates that awareness of the benefits of a shared system has not been adequately communicated. Therefore, it could be said that the campaign is behind the curve.
- ◆ **Contingencies & Resources:** The Radio Board will be the key to an effective campaign to add all public safety users in the County to the new system. Efforts of the Board will be greatly enhanced by a specific program designed to inform both voters and county/city legislative bodies about the benefits and costs of the new system.
- ◆ **Next Actions:** Contingent on the appointment of the Radio Board.
- ◆ **Timetable:** Contingent on the appointment of the Radio Board. This should begin immediately.

Procurement and Performance Based Assessment

RFP Approaches

Overview. There are multitude approach options available to developing specifications for inclusion in requests for proposal (RFP). The risks and costs to the Contra Costa County can vary significantly depending upon the approach taken. In addition, the RFP approach to be used later impacts the current telecommunications planning process since the work performed during this phase will feed into the RFP development phase. In this section we discuss several RFP approaches and make recommendations as to the optimum methodology.

The “detailed design specifications” approach has been promoted in the past by several consulting firms. In this approach, a great deal of time, effort, and money are spent designing the system during the planning phase of the program. Theoretical coverage analyses are completed and verified by actual measurements in the field. Detailed equipment inventories are made and drawings depicting actual installation completed. New designs are then created with tradeoff analyses and rack level drawings. Equipment lists are then generated specifying specific systems and features. On the surface, this approach sounds very attractive because it generates very detailed specifications, which imply reduced risks to the County. It also happens to generate a great deal of revenue for the consulting firm performing the work.

History has taught us, unfortunately, that just the opposite actually occurs. When the County purchases a system via a detailed design RFP, the burden of risk immediately shifts from the equipment vendor to the County. For example, by performing a detailed coverage analysis and selecting the sites for the vendor, the County has

accepted the burden for coverage. If the actual coverage is inferior, the vendor is not responsible since it was the County who dictated the tower sites. Likewise, should an equipment compatibility issue arise, it is again the County's problem since the County called out specific equipment rather than leaving such issues to the vendor.

Detailed specifications are counter-intuitive. They are limiting in nature, stifle creativity and have just the opposite consequences as originally intended. Detailed specifications tend to drive up system costs significantly. Innovation is suppressed, competition reduced, and the choice of equipment limited. Did you ever wonder how the Federal Government ended up with \$600 toilet seats in its airplanes?

FE is a strong proponent of a different approach to systems procurement, "functional specifications." We have found, based upon hundreds of state and local government engagements, that this approach minimizes costs during the planning phase of the program, reduces the resultant overall system cost, and keeps the burden of risk on the equipment vendor where it, in fact, belongs. When this approach is used, the work performed during the planning phase is to determine the requirements of the County and to establish budgetary costs. Coverage analyses would be performed to determine what the attainable coverage might be, to establish the number of new sites for budgeting purposes, and to serve as *suggested* new sites for the equipment vendors. It is presumed, however, that the equipment vendor will perform his own coverage analysis thereby take responsibility for final coverage. Likewise, equipment lists generated during the planning phase are used primarily for budgeting purposes and are not intended to be a design.

Design-Build. Properly developed functional specifications describe the functional and performance requirements of the system in sufficient detail to be verifiable through acceptance testing. The actual detailed design of the system is left to the vendor. Some vendors, therefore, refer to this approach as a "design-build" RFP. The specifications will also describe acceptance criteria but, again, leave the design of the acceptance test plan to the vendor. If the specifications are crafted properly, performance is tightly defined while at the same time encouraging competition and innovation.

FE consistently and successfully uses functional specifications and recommends this approach to Contra Costa County.

RFP for Contra Costa County. A Request for Proposals (RFP) should be the basis for the County to obtain the required system upgrades and enhancements, as well as the new replacement system. The RFP is a competitive procurement method that written correctly can address both costs and performance in evaluating vendor proposals. RFPs thus provide maximum flexibility in selecting the proposal that best meets the total requirements as defined in the specifications. However, expert assistance in the development of RFPs and evaluation methodologies is required.

An RFP is recommended because it is a powerful performance enforcement tool, after award has been made and the RFP specifications become part of a contract between the County and the selected vendor. It places responsibility for system performance on the vendor along with flexibility to engineer the solutions that best meet the County's requirements as specified.

Performance-based specifications for the replacement system will need to be carefully developed when sufficient design information has been collected. Again, professional consulting assistance is strongly recommended.

The most important of these specifications is **coverage**. As discussed in Section 2, traditional coverage specifications actually call for the results of statistical modeling techniques. The problem with these specifications is that they do not necessarily reflect coverage as it is implemented. A 95% outer contour, for example, could actually include dead spots, while other spots outside the contour could have 95% or even better coverage. Reliance on statistical predictions can thus lead to over-engineering and thus over-spending, or simply not accomplish the real coverage goals of the buyer. Instead, coverage should be specified in terms of the performance measurements to be made during acceptance testing.

Coverage and reliability testing should be extensive. It should start as soon as each segment of the system has been completed, but before it has been placed in service. The specifications should include a detailed definition of the testing methodology to be used and the measurements to be taken. It is not possible to include the appropriate specifications here, since they need to be developed in conjunction with the Radio Board, representing the entire user group.

Standards appropriate to the requirements of Contra Costa County should be developed in the following context:

- ◆ In general, the County should aim for a multi-level standard, with different performance levels for areas with denser populations, higher crime rates, or more challenging terrain.
- ◆ Coverage standards that are expressed in terms of measurable performance often appear lower than traditional coverage specifications, because they are measurable across an entire area, rather than only along a hypothetical outer contour.
- ◆ The standards should also indicate where measurements can and should be taken. Measurements should be taken from a variety of real life situations and typically but not always from wide streets and major roads.
- ◆ Key locations, where particular hazards are present or coverage is especially important, are extremely important to define.

In the shorter term, the County should also consider making maximum use of all available government contracts. Centralized purchasing can also be implemented on a countywide basis by mutual agreement with all public safety jurisdictions. Alameda County is reported to have been exemplary in the centralized purchasing of radio equipment. In addition, the State of California maintains contracts for many types of

radio equipment. Typically, these contracts offer more favorable prices, which can be extended to political subdivisions of the State.

Implementation Timetable

Under ideal conditions, with both County funding approvals and regulatory changes being made expeditiously, the implementation of the long-term planning elements will extend through the decade. Figure 14 below summarizes the sequence of events. This chart assumes that the existing countywide system users will be initially placed on the new system, and that additional users will be added over a period of years.

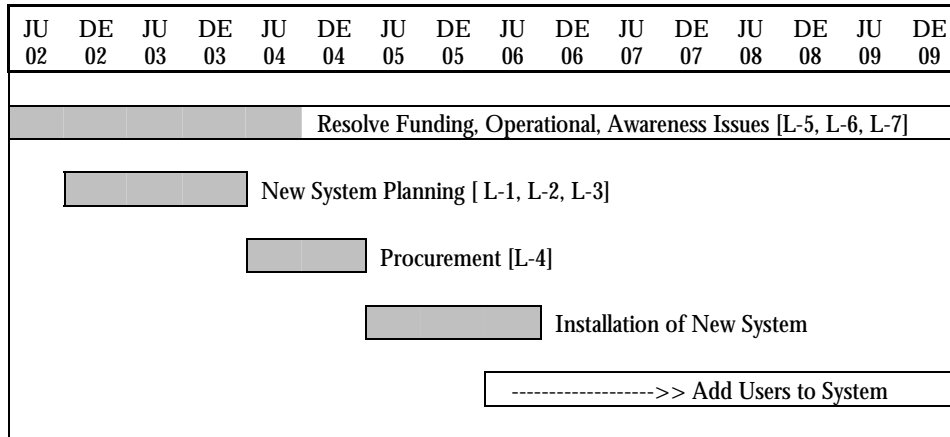


Figure 14: Long Term Plan Timetable

For the improvements to the existing countywide system in the short/mid term, the chart below in Figure 15 summarizes the estimated timeframes required.

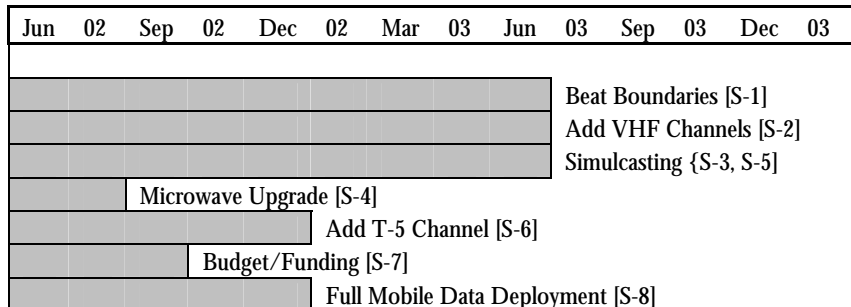


Figure 15: Short/Mid Term Plan Timetable

5. Analysis of Benefits and Costs

Benefits of the plans presented previously are tied directly to the planning goals established in Section 1. Below, these benefits are explained in further detail. In addition, a projection of estimated costs to accomplish the planned changes is provided. This cost analysis is correlated to the implementation timetable in Section 4.

Contents of Section 5

- State-of-the-Art System
- Climate for Continued Development
- Phased and Optimized Costs

The public safety community in Contra Costa County needs flexible, unified, cost-effective radio communications systems in order to fulfill their missions. Postponed decisions and missed opportunities to obtain the needed channels have foreclosed the implementation of such a system for the time being. Furthermore, it is known that shared governance is the key ingredient for successful system development—a step that has yet to be taken in Contra Costa County. By implementing the planning elements in this Master Plan, the public safety community will accomplish the following benefits:

State-of-the-Art System

The new countywide system³⁴ herein recommended will be a state-of-the-art implementation—providing funding and cost sharing issues can be resolved. The Sheriff's Office priorities for coverage, capacity, reliability and interoperability can be satisfied, other users can be incorporated as necessary, and the system positioned to provide high-speed communications in the future can be realized.

Most of the individual public safety radio systems in the county range from state-of-the-art to marginally satisfactory. The existing countywide system has shortfalls in coverage and capacity, but is undergoing constant improvements to keep it operational. Completion of the short/mid-term plan elements will fill the gaps in the existing system until a new, replacement system can be specified and developed.

Estimated System Cost

Estimating the cost of a radio system accurately requires analysis of a detail system design from the base level to the apex of the system. This effort was NOT undertaken here; only general system blocks and top-level assumptions were made. Figure 17 shows an estimated system cost ranging from approximately \$40 million initially and \$62.2 million to fully implement.

³⁴ Distinguished from upgrades to the existing Sheriff's Office VHF System
Federal Engineering, Inc.
June 18, 2002

Working Assumptions: No conceptual or detail system design was performed to derive the estimated cost figures shown in the tables below. Rather, known parameters for comparable systems around the U.S. plus *FE's* experienced judgment were employed to provide a *broad estimate* of system cost and implementation timeframe. *These estimates are top-level only and should not be relied upon as "hard numbers;" a detail system design is the only reliable basis for cost estimation for budgetary purposes.*

System. A countywide 700 MHz trunked, simulcast radio system serving most constituent agencies. No salvage of existing sites or equipment was factored in.

Number of Sites: The number of tower sites required for 800 MHz systems—and presumably 700 MHz systems also—compared with VHF systems is approximately 2 to 2.5 times the comparable VHF system tower site count. Thus, sixteen 700 MHz sites are assumed to be the minimum, with twenty a more realistic fully capable system count.

Elapsed Project Time: Five years to complete startup system, typical; seven years to complete mature system.

Unit Cost Basis: Unit costs shown in Figure 16 are typical figures for components taken from other actual or proposed PSMR systems around the U.S.

Labor Costs: Costs for Project Management and Consultant were estimated using an average of \$200 per hour, 40 hours per week per full-time equivalent (FTE).

Consultant Tasks: Assumes a dotted-line relationship to the County's Program Management Officer. Responsibilities include project management and tracking project progress to completion, assisting in vendor dispute resolution, designing (and optionally conducting) user training, other appropriate independent third-party responsibilities.

Item or Element	Unit Cost
Hilltop radio site: slab, tower, building, generator	\$175,000
Site microwave equipment, 2 x DS3	\$150,000
Repeater	\$ 23,000
Mobile radio	\$ 3,700
Site antennas, combiners, duplexers, etc.	\$100,000
Satellite receiver site & equipment	\$ 15,000
Portable radio	\$ 3,700
Control station	\$ 4,200
Site, Zone controller	\$125,000
Network Operations Center	\$550,000

Figure 16: Estimated Unit Costs

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Item or Element	Quantities		Extended Unit Costs	
	Startup	Mature	Startup	Mature
Sites	16	20	\$2,800,000	\$3,500,000
Microwave Equipment	16	20	2,400,000	3,000,000
Antennas, etc.	16	29	1,600,000	2,000,000
Repeaters/Site	10	15	3,680,000	6,900,000
Mobiles	1500	2500	5,550,000	9,250,000
Portables	1500	2500	5,550,000	9,250,000
Control Stations	20	35	84,000	147,000
Satellite Receivers	25	50	375,000	750,000
Site/Zone Controllers	4	7	500,000	875,000
Network Operations Center	1	2	550,000	1,100,000
Subtotal-1			23,089,000	36,772,000
Direct Labor			2,308,900	3,677,200
Project Management	10 person- yrs 2 FTE	15 person- yrs 2 FTE	4,160,000	6,240,000
Consultant	5 person- yrs 1 FTE	7 person- yrs 1 FTE	2,080,000	3,120,000
Subtotal-2			31,637,900	49,809,200
25% Contingency			7,909,475	12,452,300
Total			\$39,547,375	\$62,261,500

Figure 17: Estimated System Cost

Climate for Continued Development

By instituting a Radio Board and proceeding with coordinated planning, the stage will be set for expansion as agencies and communities are ready. Autonomy can be preserved, and communities are not forced to abandon investments prematurely. Shared governance also provides a mechanism for all members of the public safety community to participate in key policy decisions, cost sharing formulas, and operational planning.

Phased and Optimized Costs

Although jurisdictions must ultimately provide the funding needed in order to obtain the kind of public safety communications they need, this Plan will phase investments as much as possible, and allow each jurisdiction to optimize its participation.

In the first stage, the Sheriff's Office will oversee improvements in the existing countywide system without making significant expansions. In the second stage of development, with the guidance of the Radio Board (presumably including representatives from the user community), the replacement system will be implemented primarily for the same set of users. Additional users can be accommodated at their option during the third stage, eventually culminating in the single unified system envisioned.

Cost estimates for the plan elements can be developed coincident with the detailed system design. At that time, a cost model can be developed that will permit various options to be evaluated for cost-effectiveness. Most of the steps leading up to that point—such as creation of a Radio Board and participation in regulatory proceedings—do not incur significant costs. However, professional consulting assistance would be of benefit in the following areas:

- ◆ Development of Radio Board responsibilities.
- ◆ Development of a funding mechanism including chargeback schemes and a cost recovery model.
- ◆ Development of budget proposals and public awareness campaign.
- ◆ Implementation of system information collection program and analysis of design information. Development of options and additional cost models can be included in this project.
- ◆ Preparation of system specifications and assistance with system procurement/contract negotiations.

Appendix A: List of Municipal and Regional Public Safety Agencies in Contra Costa County

Police Departments

Antioch	Kensington	Pittsburg
Brentwood	Lafayette	Pleasant Hill
Concord	Martinez	Richmond
Danville	Moraga	San Pablo
El Cerrito	Orinda	San Ramon
Hercules	Pinole	Walnut Creek

Fire Protection Districts or Authorities

Bethel Island	Kensington	Rodeo-Hercules
Contra Costa County	Moraga	San Ramon Valley
Crockett	Oakley-Knightsen	Pinole
Dougherty Regional Fire Authority	Orinda	Moraga-Orinda
East Diablo		

Cities

Antioch	Lafayette	Pittsburg
Brentwood	Martinez	Pleasant Hill
Clayton	Moraga	Richmond
Concord	Oakley	San Pablo
Danville	Orinda	San Ramon
El Cerrito	Pinole	Walnut Creek
Hercules		

School Districts

Acalanes Union HSD, Lafayette	John Swett Unified SD, Crockett	Oakley Union SD, Oakley
Antioch Unified SD, Antioch	Knightsen SD, Knightsen	Orinda SD, Orinda Pittsburg
Brentwood Union SD, Brentwood	Lafayette SD, Lafayette	Unified SD, Pittsburg
Byron Union SD, Byron	Liberty Union HSD, Brentwood	San Ramon Valley Unified SD
Canyon SD, Canyon	Martinez Unified SD, Martinez	Walnut Creek SD, Walnut Creek
Contra Costa Community College District, Martinez	Moraga SD, Moraga	West Contra County Unified SD, Richmond
	Mt. Diablo Unified SD, Concord	

Other Districts

AC Transit District	East Bay Regional Parks District	Tri Delta Transit Authority
Bay Area Rapid Transit	East Bay Municipal Utility District	WestCat Transit Authority
Central Costa County Transit Dist.		

Appendix B: Public Safety Agencies Holding Frequencies in Contra Costa County

Low-band: 30-50 MHz

American National Red Cross	East Diablo Fire District
American Red Cross Bay Area	John Muir Medical Center
CCC (Building Inspections)	Liberty Union High School
CCC (Communications Services)	Mount Diablo Hospital
Central Contra Costa Sanitary District	Mount Diablo Unified School District
City of Pinole	Riverview Fire Protection District
City of Richmond	Rodeo Fire District
Contra Costa County	San Ramon Valley Fire Protection District
Contra Costa County Fire Protection District	State of California
Contra Costa County Water District	Steger Sanitation District
Dublin-San Ramon Services District	Town of Moraga
East Bay Regional Park District	West County Wastewater District

VHF: 138-144 MHz, 148-174 MHz

California State University	Dublin San Ramon Services District
Central Contra Costa Sanitary District	East Bay Regional Park District
City of Albany	East Diablo Fire District
City of Antioch	John Muir Medical Center
City of Brentwood	Kaiser Foundation Health Plan Inc.
City of Concord	Los Medanos Community Hospital
City of Danville	Medic Ambulance Service
City of El Cerrito	Medical Center
City of Hercules	Metrocall USA Inc.
City of Lafayette	Mount Diablo Hospital
City of Los Angeles	Mount View Sanitary District
City of Martinez	Orinda Union School District
City of Pinole	Pittsburg Unified School District
City of Pittsburg	Riverview Fire Protection District
City of Richmond	San Francisco Bay Area Rapid Transit District (BART)
City of San Ramon	San Ramon Regional Medical Center
City of Walnut Creek	San Ramon Valley Fire Protection District
Contra Costa Community College District	State of California
Contra Costa County	Tenet Health System Hospitals Inc.
Contra Costa County Fire Protection District	Town of Moraga
Contra Costa County Hospital	
Diablo Valley College	

220: 220-222 MHz

No known users

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UHF: 406-420 MHz, 450-494 MHz

Alameda Contra Costa Transit District	City of Walnut Creek
Central Contra Costa Sanitary District	Contra Costa County
Central Contra Costa Transit Authority	Contra Costa County Flood Control
City of Antioch	Contra Costa County Hospital
City of Brentwood	Contra Costa Water District
City of Concord	East Bay Municipal Utility District
City of Danville	Eastern Contra Costa Transit District
City of El Cerrito	Golden Gate Bridge Highway & Transportation District
City of Hercules	Kaiser Foundation Health Plan Inc.
City of Lafayette	Medic Ambulance Service
City of Martinez	Metrocall USA Inc.
City of Oakley	Richmond Housing Authority
City of Pinole	Bay Area Rapid Transit District (BART)
City of Pleasant Hill	San Ramon Valley Fire Protection District
City of Pittsburg	State of California
City of Richmond	West Contra Costa Unified School District
City of San Pablo	

700: 764-776 MHz, 794-806 MHz

No Users

800: 806-824 MHz, 851-869 MHz

Alameda County	City of Walnut Creek
American Red Cross Bay Area	Contra Costa Community College District
City of Antioch	Contra Costa County
City of Concord	East Bay Municipal Utility District
City of Danville	Mount Diablo Unified School District
City of Oakland	Regents of the University of California
City of Pleasant Hill	Bay Area Rapid Transit District (BART)
City of Richmond	State of California

Appendix C: Roster of Public Safety Frequencies Licensed in Contra Costa County

Federal Engineering has performed a FCC database frequency search and developed a database of frequencies currently licensed in Contra Costa County. The database also includes a worksheet combining FCC information with data supplied by the County for VHF frequencies.

The resulting database is provided in electronic form. Below are the contents of the database and a summary of data on each page.

Contents of Worksheets

Tab GF	Public Safety National Plan, 821-824/866-869,
Tab GP	Public Safety/Special Emergency 806-821/851-8.
Tab PW	Public Safety Pool, [AM, Low-band, VHF, UHF] Conventional.
Tab YF	Public Safety National Plan, 821-824/866-869, Trunked
Tab YW	Public Safety Pool, UHF, Trunked
Tab All	Contra Costa County, CA - Public Safety, All Licensees.
Tab VHF	Contra Costa County Public Safety VHF Licensees, 150-174 MHz.

Summary of Information

GF	20 frequencies in use, none are shared, 5 licensees
GP	40 frequencies in use, 12 are shared, 11 licensees
PW	277 frequencies in use, 109 are shared, 53 licensees
YF	37 frequencies in use, none are shared, 3 licensees
YW	13 frequencies in use, none are shared, 1 licensee
VHF	84 frequencies, 44 shared in FCC records 290 entries in combined FCC + CCC records: <ul style="list-style-type: none"> • Unique frequencies = 90 • Shared frequencies = 43 • Unique Licensees = 41

Public Safety National Plan, 821-824/866-869 MHz, Conventional [GF]

Licensee Name	Callsign / File Number	Frequency
CALIFORNIA, STATE OF	WPMH823	821.0125
CALIFORNIA, STATE OF	WPMH823	821.2
AMERICAN RED CROSS BAY AREA	WPFS905	821.2875
WALNUT CREEK, CITY OF	WNXE866	821.3375
CALIFORNIA, STATE OF	WPMH823	821.5125
CALIFORNIA, STATE OF	WPMH823	821.9125
CALIFORNIA, STATE OF	WPMH823	822.0125
CALIFORNIA, STATE OF	WPMH823	822.5125
CALIFORNIA, STATE OF	WPMH823	823.0125
CALIFORNIA, STATE OF	WPEH575	823.3875
CONTRA COSTA, COUNTY OF	WPNT643	823.4125
CALIFORNIA, STATE OF	WPMH823	823.5125
CALIFORNIA, STATE OF	WPMH823	823.9875
CALIFORNIA, STATE OF	WPMH823	866.0125
AMERICAN RED CROSS BAY AREA	WPFS905	866.2875
WALNUT CREEK, CITY OF	WNXE866	866.3375
CALIFORNIA, STATE OF	WPEH575	868.3875
CONTRA COSTA, COUNTY OF	WPNT643	868.4125
CALIFORNIA, STATE OF	WPMH823	868.5125
CALIFORNIA, STATE OF	WPMH823	868.9875

Note: 20 frequencies in use, none are shared, 5 licensees

Public Safety/Special Emergency, 806-821/851-866 MHz [GP]

Licensee Name	Callsign / File Number	Frequency
CONTRA COSTA, COUNTY OF	KNFW213	809.3375
CONTRA COSTA, COUNTY OF	WNFK308	809.3375
MOUNT DIABLO UNIFIED SCHOOL DISTRICT	WNBU652	809.9375
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	810.4875
CALIFORNIA, STATE OF	KNCZ499	810.9625
CALIFORNIA, STATE OF	KNEH721	810.9625
CALIFORNIA, STATE OF	WNFQ768	810.9625
CALIFORNIA, STATE OF	WPIW965	810.9625
CONTRA COSTA, COUNTY OF	WNKN697	810.9875
WALNUT CREEK, CITY OF	0000764137	811.2625
ANTIOCH, CITY OF	WPIR316	811.4875
CALIFORNIA, STATE OF	KNEH765	811.9375
CALIFORNIA, STATE OF	WPER997	811.9875
CALIFORNIA, STATE OF	KNEH790	812.9375
CALIFORNIA, STATE OF	WQO941	813.7375
CONCORD, CITY OF	WPKK795	814.4375
RICHMOND, CITY OF	WPKG577	814.4625
DANVILLE, TOWN OF	WPFX881	814.9375
CONTRA COSTA COMMUNITY COLLEGE DISTRICT	WNMM865	815.2375
CONTRA COSTA COMMUNITY COLLEGE DISTRICT	WNMM866	815.2375
PLEASANT HILL, CITY OF	WNMP521	815.4375
CALIFORNIA, STATE OF	WPER997	815.7625
CONTRA COSTA, COUNTY OF	KNFW213	854.3375
CONTRA COSTA, COUNTY OF	WNFK308	854.3375
MOUNT DIABLO UNIFIED SCHOOL DISTRICT	WNBU652	854.9375
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	854.9625

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EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	855.4875
CALIFORNIA, STATE OF	KNCZ499	855.9625
CALIFORNIA, STATE OF	KNEH721	855.9625
CALIFORNIA, STATE OF	WNFQ768	855.9625
CALIFORNIA, STATE OF	WPIW965	855.9625
CONTRA COSTA, COUNTY OF	WNKN697	855.9875
WALNUT CREEK, CITY OF	0000764137	856.2625
ANTIOCH, CITY OF	WPIR316	856.4875
CALIFORNIA, STATE OF	KNEH765	856.9375
CALIFORNIA, STATE OF	WPER997	856.9875
CALIFORNIA, STATE OF	WPAI466	857.7375
CALIFORNIA, STATE OF	KNEH790	857.9375
CALIFORNIA, STATE OF	WQO941	858.7375
CALIFORNIA, STATE OF	WPAI465	858.9875
CONCORD, CITY OF	WPKK795	859.4375
RICHMOND, CITY OF	WPKG577	859.4625
DANVILLE, TOWN OF	WPFX881	859.9375
CONTRA COSTA COMMUNITY COLLEGE DISTRICT	WNMM865	860.2375
CONTRA COSTA COMMUNITY COLLEGE DISTRICT	WNMM866	860.2375
PLEASANT HILL, CITY OF	WNMP521	860.4375
CALIFORNIA, STATE OF	WPER997	860.7625

Note: 40 frequencies in use, 12 are shared, 11 licensees

Public Safety Pool, Conventional [PW]

Licensee Name	Callsign / File Number	Frequency
MARTINEZ, CITY OF	WPTD253	0.53
MARTINEZ, CITY OF	WPTR552	0.53
RICHMOND, CITY OF	WPED339	0.79
PITTSBURG, CITY OF	WPEI436	0.79
CALIFORNIA, STATE OF	WNVQ787	0.84
CALIFORNIA, STATE OF	WPEI434	0.84
SAN RAMON, CITY OF	WNUW920	1.61
CONTRA COSTA, COUNTY OF	KMF371	33.44
CONTRA COSTA, COUNTY OF	KA3744	33.48
CONTRA COSTA, COUNTY OF	KMF371	33.48
CONTRA COSTA, COUNTY OF	WNCE416	33.48
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	33.48
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	33.48
CONTRA COSTA, COUNTY OF	WNSS746	33.48
CALIFORNIA, STATE OF	KZE65	33.66
DUBLIN SAN RAMON SERVICES DISTRICT	KJK522	33.92
CALIFORNIA, STATE OF	KZE65	33.98
MT DIABLO HOSPITAL	KWI758	35.68
CONTRA COSTA, COUNTY OF	WPHG665	37.12
CALIFORNIA, STATE OF	WPDA311	37.14
CONTRA COSTA, COUNTY OF	WPPV535	37.98
CALIFORNIA, STATE OF	WNWH830	42.12
CALIFORNIA, STATE OF	WNEA278	42.18
CALIFORNIA, STATE OF	KMB442	42.34
CALIFORNIA, STATE OF	WNEA278	42.34
CALIFORNIA, STATE OF	WPCZ972	42.34
CALIFORNIA, STATE OF	WPDA311	42.34
CALIFORNIA, STATE OF	WYK572	42.34
CALIFORNIA, STATE OF	WNVK355	42.44
CALIFORNIA, STATE OF	WNUH520	42.62
CALIFORNIA, STATE OF	WNEA278	42.74
CALIFORNIA, STATE OF	KMB442	42.92
CALIFORNIA, STATE OF	WNEA278	42.92
CALIFORNIA, STATE OF	WNVK354	42.92
JOHN MUIR MEDICAL CENTER	KSP200	43.68
EAST BAY REGIONAL PARK DISTRICT	KBB840	44.64
EAST BAY REGIONAL PARK DISTRICT	KNAH351	44.64
EAST BAY REGIONAL PARK DISTRICT	KNGV248	44.64
EAST BAY REGIONAL PARK DISTRICT	KRI536	44.64
EAST BAY REGIONAL PARK DISTRICT	WNJR820	44.64
EAST BAY REGIONAL PARK DISTRICT	WYP336	44.64
EAST BAY REGIONAL PARK DISTRICT	WNVK857	44.68
EAST BAY REGIONAL PARK DISTRICT	KBB840	44.76

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EAST BAY REGIONAL PARK DISTRICT	KNGV248	44.76
EAST BAY REGIONAL PARK DISTRICT	WNJR820	44.76
EAST BAY REGIONAL PARK DISTRICT	WYP336	44.76
EAST BAY REGIONAL PARK DISTRICT	KBB840	44.96
EAST BAY REGIONAL PARK DISTRICT	KNGV248	44.96
EAST BAY REGIONAL PARK DISTRICT	KRI536	44.96
EAST BAY REGIONAL PARK DISTRICT	WNJR820	44.96
EAST BAY REGIONAL PARK DISTRICT	WYP336	44.96
EAST BAY REGIONAL PARK DISTRICT	WNVK857	45
EAST BAY REGIONAL PARK DISTRICT	KBB840	45.04
MORAGA, TOWN OF	KNFN709	45.08
CONTRA COSTA, COUNTY OF	WNKB690	45.08
CONTRA COSTA, COUNTY OF	WNLG669	45.08
CONTRA COSTA, COUNTY OF	KD8107	45.24
CONTRA COSTA, COUNTY OF	KDA346	45.24
CONTRA COSTA, COUNTY OF	KMJ935	45.24
CONTRA COSTA, COUNTY OF	KNDV996	45.24
CONTRA COSTA, COUNTY OF	KQT927	45.24
CONTRA COSTA, COUNTY OF	KTZ366	45.24
WEST COUNTY WASTEWATER DISTRICT	KML786	45.28
STEGE SANITATION DISTRICT	WNLL530	45.28
CONTRA COSTA, COUNTY OF	KB32638	45.44
CONTRA COSTA, COUNTY OF	KRO353	45.56
CONTRA COSTA, COUNTY OF	KBM806	45.68
CONTRA COSTA, COUNTY OF	KF4115	45.68
CONTRA COSTA, COUNTY OF	KIB411	45.68
CONTRA COSTA, COUNTY OF	KMJ939	45.68
CONTRA COSTA, COUNTY OF	KQT928	45.68
CONTRA COSTA, COUNTY OF	KTZ365	45.68
CONTRA COSTA, COUNTY OF	WNJS512	45.82
CONTRA COSTA, COUNTY OF	WPDI316	45.82
CONTRA COSTA, COUNTY OF	WPDI317	45.82
CONTRA COSTA, COUNTY OF	WPDI318	45.82
SAN RAMON VALLEY F P D	KMA635	45.88
SAN RAMON VALLEY FIRE DISTRICT	WNNV616	45.88
SAN RAMON VALLEY FIRE DISTRICT	WNQW789	45.88
LIBERTY UNION HIGH SCHOOL	KNHC279	46
CONTRA COSTA, COUNTY OF	WNCP387	46.04
CONTRA COSTA, COUNTY OF	KA3744	46.06
CONTRA COSTA, COUNTY OF	KBQ628	46.06
CONTRA COSTA, COUNTY OF	KMA463	46.06
RICHMOND, CITY OF	KMB332	46.06
CONTRA COSTA, COUNTY OF	KMB591	46.06
CONTRA COSTA, COUNTY OF	KYG655	46.06
RICHMOND, CITY OF	WPPF928	46.06
RICHMOND, CITY OF	WPPF929	46.06
CONTRA COSTA, COUNTY OF	KA3744	46.1

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CONTRA COSTA, COUNTY OF	KBQ628	46.1
CONTRA COSTA, COUNTY OF	KDN478	46.1
CONTRA COSTA, COUNTY OF	KDU876	46.1
CONTRA COSTA, COUNTY OF	KEY923	46.1
CONTRA COSTA, COUNTY OF	KEY924	46.1
CONTRA COSTA, COUNTY OF	KJE268	46.1
CONTRA COSTA, COUNTY OF	KMA463	46.1
CONTRA COSTA, COUNTY OF	KMA470	46.1
SAN RAMON VALLEY F P D	KMA635	46.1
RICHMOND, CITY OF	KMB332	46.1
CONTRA COSTA, COUNTY OF	KMB392	46.1
CONTRA COSTA, COUNTY OF	KMB591	46.1
CONTRA COSTA, COUNTY OF	KMB592	46.1
CONTRA COSTA, COUNTY OF	KMD397	46.1
CONTRA COSTA, COUNTY OF	KMD877	46.1
PINOLE, CITY OF	KME945	46.1
CONTRA COSTA, COUNTY OF	KMF371	46.1
CONTRA COSTA, COUNTY OF	KMG983	46.1
CONTRA COSTA, COUNTY OF	KMH429	46.1
CONTRA COSTA, COUNTY OF	KMK522	46.1
CONTRA COSTA, COUNTY OF	KNAK321	46.1
CONTRA COSTA, COUNTY OF	KNGL582	46.1
CONTRA COSTA, COUNTY OF	KNGL583	46.1
RODEO FIRE DISTRICT	KNIZ530	46.1
CONTRA COSTA, COUNTY OF	KTS610	46.1
CONTRA COSTA, COUNTY OF	KYG655	46.1
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNCA815	46.1
CONTRA COSTA, COUNTY OF	WNHN757	46.1
CONTRA COSTA, COUNTY OF	WNHN758	46.1
CONTRA COSTA, COUNTY OF	WNHN759	46.1
CONTRA COSTA, COUNTY OF	WNHN760	46.1
CONTRA COSTA, COUNTY OF	WNHN761	46.1
CONTRA COSTA, COUNTY OF	WNHN762	46.1
CONTRA COSTA, COUNTY OF	WNHN763	46.1
CONTRA COSTA, COUNTY OF	WNHN764	46.1
CONTRA COSTA, COUNTY OF	WNHN765	46.1
CONTRA COSTA, COUNTY OF	WNHN766	46.1
CONTRA COSTA, COUNTY OF	WNHN767	46.1
CONTRA COSTA, COUNTY OF	WNHN768	46.1
CONTRA COSTA, COUNTY OF	WNHN769	46.1
CONTRA COSTA, COUNTY OF	WNHN770	46.1
CONTRA COSTA, COUNTY OF	WNHN771	46.1
CONTRA COSTA, COUNTY OF	WNHN772	46.1
CONTRA COSTA, COUNTY OF	WNHN773	46.1
CONTRA COSTA, COUNTY OF	WNHN774	46.1
EAST DIABLO FIRE DISTRICT	WNHN946	46.1

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RODEO FIRE DISTRICT	WNHN947	46.1
CONTRA COSTA, COUNTY OF	WNHV253	46.1
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	46.1
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	46.1
CONTRA COSTA, COUNTY OF	WNNN497	46.1
SAN RAMON VALLEY FIRE DISTRICT	WNNV616	46.1
CONTRA COSTA, COUNTY OF	WNPL783	46.1
CONTRA COSTA, COUNTY OF	WNQQ717	46.1
CONTRA COSTA, COUNTY OF	WPLG973	46.1
RICHMOND, CITY OF	WPPF928	46.1
RICHMOND, CITY OF	WPPF929	46.1
CONTRA COSTA, COUNTY OF	WSY471	46.1
CONTRA COSTA, COUNTY OF	WXP667	46.1
CONTRA COSTA, COUNTY OF	KMF371	46.14
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	46.14
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	46.14
CONTRA COSTA, COUNTY OF	WNNN497	46.14
CONTRA COSTA, COUNTY OF	KA3744	46.16
CONTRA COSTA, COUNTY OF	KMA470	46.16
CONTRA COSTA, COUNTY OF	KMB592	46.16
PINOLE, CITY OF	KME945	46.16
RODEO FIRE DISTRICT	KNIZ530	46.16
CONTRA COSTA, COUNTY OF	KA3744	46.18
CONTRA COSTA, COUNTY OF	KDU876	46.18
CONTRA COSTA, COUNTY OF	KEY923	46.18
CONTRA COSTA, COUNTY OF	KEY924	46.18
CONTRA COSTA, COUNTY OF	KJE268	46.18
CONTRA COSTA, COUNTY OF	KMB392	46.18
CONTRA COSTA, COUNTY OF	KMF371	46.18
CONTRA COSTA, COUNTY OF	KMH429	46.18
CONTRA COSTA, COUNTY OF	KNGL582	46.18
CONTRA COSTA, COUNTY OF	KYS919	46.18
EAST DIABLO FIRE DISTRICT	WNHN946	46.18
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	46.18
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	46.18
CONTRA COSTA, COUNTY OF	WNNN497	46.18
CONTRA COSTA, COUNTY OF	WSY471	46.18
CONTRA COSTA, COUNTY OF	KA3744	46.22
CONTRA COSTA, COUNTY OF	KMB392	46.22
CONTRA COSTA, COUNTY OF	KMD877	46.22
CONTRA COSTA, COUNTY OF	KMF371	46.22
CONTRA COSTA, COUNTY OF	KMG983	46.22
CONTRA COSTA, COUNTY OF	KNAK321	46.22
CONTRA COSTA, COUNTY OF	KNCZ430	46.22
CONTRA COSTA, COUNTY OF	KNGL583	46.22
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNCA815	46.22

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CONTRA COSTA, COUNTY OF	WNHN757	46.22
CONTRA COSTA, COUNTY OF	WNHN758	46.22
CONTRA COSTA, COUNTY OF	WNHN759	46.22
CONTRA COSTA, COUNTY OF	WNHN760	46.22
CONTRA COSTA, COUNTY OF	WNHN761	46.22
CONTRA COSTA, COUNTY OF	WNHN762	46.22
CONTRA COSTA, COUNTY OF	WNHN763	46.22
CONTRA COSTA, COUNTY OF	WNHN764	46.22
CONTRA COSTA, COUNTY OF	WNHN765	46.22
CONTRA COSTA, COUNTY OF	WNHN766	46.22
CONTRA COSTA, COUNTY OF	WNHN767	46.22
CONTRA COSTA, COUNTY OF	WNHN768	46.22
CONTRA COSTA, COUNTY OF	WNHN769	46.22
CONTRA COSTA, COUNTY OF	WNHN770	46.22
CONTRA COSTA, COUNTY OF	WNHN771	46.22
CONTRA COSTA, COUNTY OF	WNHN772	46.22
CONTRA COSTA, COUNTY OF	WNHN773	46.22
CONTRA COSTA, COUNTY OF	WNHN774	46.22
CONTRA COSTA, COUNTY OF	WNQQ717	46.22
CONTRA COSTA, COUNTY OF	WPLG973	46.22
RICHMOND, CITY OF	WPPF929	46.22
CONTRA COSTA, COUNTY OF	KA3744	46.24
CONTRA COSTA, COUNTY OF	KEY923	46.24
CONTRA COSTA, COUNTY OF	KEY924	46.24
CONTRA COSTA, COUNTY OF	KJE268	46.24
CONTRA COSTA, COUNTY OF	KMB392	46.24
CONTRA COSTA, COUNTY OF	KMF371	46.24
CONTRA COSTA, COUNTY OF	KMH429	46.24
CONTRA COSTA, COUNTY OF	KNGL582	46.24
CONTRA COSTA, COUNTY OF	KYS919	46.24
EAST DIABLO FIRE DISTRICT	WNHN946	46.24
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	46.24
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	46.24
CONTRA COSTA, COUNTY OF	WNNN497	46.24
CONTRA COSTA, COUNTY OF	KA3744	46.26
CONTRA COSTA, COUNTY OF	KMD877	46.26
CONTRA COSTA, COUNTY OF	KMF371	46.26
CONTRA COSTA, COUNTY OF	KMG983	46.26
CONTRA COSTA, COUNTY OF	KNCZ430	46.26
CONTRA COSTA, COUNTY OF	KNGL583	46.26
CONTRA COSTA, COUNTY OF	KYS919	46.26
CONTRA COSTA, COUNTY OF	WNHN757	46.26
CONTRA COSTA, COUNTY OF	WNHN758	46.26
CONTRA COSTA, COUNTY OF	WNHN759	46.26
CONTRA COSTA, COUNTY OF	WNHN760	46.26
CONTRA COSTA, COUNTY OF	WNHN761	46.26
CONTRA COSTA, COUNTY OF	WNHN762	46.26

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CONTRA COSTA, COUNTY OF	WNHN763	46.26
CONTRA COSTA, COUNTY OF	WNHN764	46.26
CONTRA COSTA, COUNTY OF	WNHN765	46.26
CONTRA COSTA, COUNTY OF	WNHN766	46.26
CONTRA COSTA, COUNTY OF	WNHN767	46.26
CONTRA COSTA, COUNTY OF	WNHN768	46.26
CONTRA COSTA, COUNTY OF	WNHN769	46.26
CONTRA COSTA, COUNTY OF	WNHN770	46.26
CONTRA COSTA, COUNTY OF	WNHN771	46.26
CONTRA COSTA, COUNTY OF	WNHN772	46.26
CONTRA COSTA, COUNTY OF	WNHN773	46.26
CONTRA COSTA, COUNTY OF	WNHN774	46.26
CONTRA COSTA, COUNTY OF	WNQQ717	46.26
CONTRA COSTA, COUNTY OF	WPLG973	46.26
CONTRA COSTA, COUNTY OF	KA3744	46.32
CONTRA COSTA, COUNTY OF	KMB392	46.32
CONTRA COSTA, COUNTY OF	KMD877	46.32
CONTRA COSTA, COUNTY OF	KMF371	46.32
CONTRA COSTA, COUNTY OF	KMG983	46.32
CONTRA COSTA, COUNTY OF	KNAK321	46.32
CONTRA COSTA, COUNTY OF	KNGL583	46.32
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNCA815	46.32
CONTRA COSTA, COUNTY OF	WNHN757	46.32
CONTRA COSTA, COUNTY OF	WNHN758	46.32
CONTRA COSTA, COUNTY OF	WNHN759	46.32
CONTRA COSTA, COUNTY OF	WNHN760	46.32
CONTRA COSTA, COUNTY OF	WNHN761	46.32
CONTRA COSTA, COUNTY OF	WNHN762	46.32
CONTRA COSTA, COUNTY OF	WNHN763	46.32
CONTRA COSTA, COUNTY OF	WNHN764	46.32
CONTRA COSTA, COUNTY OF	WNHN765	46.32
CONTRA COSTA, COUNTY OF	WNHN766	46.32
CONTRA COSTA, COUNTY OF	WNHN767	46.32
CONTRA COSTA, COUNTY OF	WNHN768	46.32
CONTRA COSTA, COUNTY OF	WNHN769	46.32
CONTRA COSTA, COUNTY OF	WNHN770	46.32
CONTRA COSTA, COUNTY OF	WNHN771	46.32
CONTRA COSTA, COUNTY OF	WNHN772	46.32
CONTRA COSTA, COUNTY OF	WNHN773	46.32
CONTRA COSTA, COUNTY OF	WNHN774	46.32
CONTRA COSTA, COUNTY OF	WNNN497	46.32
CONTRA COSTA, COUNTY OF	WNQQ717	46.32
CONTRA COSTA, COUNTY OF	WPLG973	46.32
CONTRA COSTA, COUNTY OF	KA3744	46.34
SAN RAMON VALLEY F P D	KMA635	46.34
CONTRA COSTA, COUNTY OF	KMK522	46.34

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SAN RAMON VALLEY FIRE DISTRICT	WNNV616	46.34
CONTRA COSTA, COUNTY OF	WXP667	46.34
CONTRA COSTA, COUNTY OF	KA3744	46.38
CONTRA COSTA, COUNTY OF	KBQ628	46.38
CONTRA COSTA, COUNTY OF	KDN478	46.38
CONTRA COSTA, COUNTY OF	KDU876	46.38
CONTRA COSTA, COUNTY OF	KEY923	46.38
CONTRA COSTA, COUNTY OF	KEY924	46.38
CONTRA COSTA, COUNTY OF	KJE268	46.38
CONTRA COSTA, COUNTY OF	KMA463	46.38
CONTRA COSTA, COUNTY OF	KMA470	46.38
SAN RAMON VALLEY F P D	KMA635	46.38
RICHMOND, CITY OF	KMB332	46.38
CONTRA COSTA, COUNTY OF	KMB392	46.38
CONTRA COSTA, COUNTY OF	KMB591	46.38
CONTRA COSTA, COUNTY OF	KMB592	46.38
CONTRA COSTA, COUNTY OF	KMD397	46.38
CONTRA COSTA, COUNTY OF	KMD877	46.38
PINOLE, CITY OF	KME945	46.38
CONTRA COSTA, COUNTY OF	KMF371	46.38
CONTRA COSTA, COUNTY OF	KMG983	46.38
CONTRA COSTA, COUNTY OF	KMH429	46.38
CONTRA COSTA, COUNTY OF	KMK522	46.38
CONTRA COSTA, COUNTY OF	KNAK321	46.38
CONTRA COSTA, COUNTY OF	KNGL582	46.38
CONTRA COSTA, COUNTY OF	KNGL583	46.38
RODEO FIRE DISTRICT	KNIZ530	46.38
CONTRA COSTA, COUNTY OF	KTS610	46.38
CONTRA COSTA, COUNTY OF	KYG655	46.38
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNCA815	46.38
CONTRA COSTA, COUNTY OF	WNHN757	46.38
CONTRA COSTA, COUNTY OF	WNHN758	46.38
CONTRA COSTA, COUNTY OF	WNHN759	46.38
CONTRA COSTA, COUNTY OF	WNHN760	46.38
CONTRA COSTA, COUNTY OF	WNHN761	46.38
CONTRA COSTA, COUNTY OF	WNHN762	46.38
CONTRA COSTA, COUNTY OF	WNHN763	46.38
CONTRA COSTA, COUNTY OF	WNHN764	46.38
CONTRA COSTA, COUNTY OF	WNHN765	46.38
CONTRA COSTA, COUNTY OF	WNHN766	46.38
CONTRA COSTA, COUNTY OF	WNHN767	46.38
CONTRA COSTA, COUNTY OF	WNHN768	46.38
CONTRA COSTA, COUNTY OF	WNHN769	46.38
CONTRA COSTA, COUNTY OF	WNHN770	46.38
CONTRA COSTA, COUNTY OF	WNHN771	46.38
CONTRA COSTA, COUNTY OF	WNHN772	46.38

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CONTRA COSTA, COUNTY OF	WNHN773	46.38
CONTRA COSTA, COUNTY OF	WNHN774	46.38
EAST DIABLO FIRE DISTRICT	WNHN946	46.38
RODEO FIRE DISTRICT	WNHN947	46.38
CONTRA COSTA, COUNTY OF	WNHV253	46.38
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	46.38
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	46.38
CONTRA COSTA, COUNTY OF	WNNN497	46.38
SAN RAMON VALLEY FIRE DISTRICT	WNNV616	46.38
CONTRA COSTA, COUNTY OF	WNPL783	46.38
CONTRA COSTA, COUNTY OF	WNQQ717	46.38
CONTRA COSTA, COUNTY OF	WPLG973	46.38
RICHMOND, CITY OF	WPPF928	46.38
RICHMOND, CITY OF	WPPF929	46.38
CONTRA COSTA, COUNTY OF	WSY471	46.38
CONTRA COSTA, COUNTY OF	WXP667	46.38
CONTRA COSTA, COUNTY OF	KA3744	46.42
CONTRA COSTA, COUNTY OF	KBQ628	46.42
CONTRA COSTA, COUNTY OF	KMA463	46.42
RICHMOND, CITY OF	KMB332	46.42
CONTRA COSTA, COUNTY OF	KMB591	46.42
CONTRA COSTA, COUNTY OF	KYG655	46.42
RICHMOND, CITY OF	WPPF928	46.42
RICHMOND, CITY OF	WPPF929	46.42
CONTRA COSTA, COUNTY OF	KA3744	46.44
CONTRA COSTA, COUNTY OF	KDN478	46.44
SAN RAMON VALLEY F P D	KMA635	46.44
CONTRA COSTA, COUNTY OF	KMK522	46.44
SAN RAMON VALLEY FIRE DISTRICT	WNQW789	46.44
CONTRA COSTA, COUNTY OF	WXP667	46.44
CONTRA COSTA, COUNTY OF	KA3744	46.48
CONTRA COSTA, COUNTY OF	KMA470	46.48
RICHMOND, CITY OF	KMB332	46.48
CONTRA COSTA, COUNTY OF	KMB592	46.48
PINOLE, CITY OF	KME945	46.48
RODEO FIRE DISTRICT	KNIZ530	46.48
RODEO FIRE DISTRICT	WNHN947	46.48
RICHMOND, CITY OF	WPPF929	46.48
CALIFORNIA, STATE OF	KFR657	47.02
CALIFORNIA, STATE OF	KFR657	47.04
CALIFORNIA, STATE OF	KFR657	47.06
CALIFORNIA, STATE OF	KFR657	47.08
AMERICAN NATIONAL RED CROSS	KDQ287	47.42
AMERICAN RED CROSS BAY AREA	WPHI754	47.46
AMERICAN RED CROSS BAY AREA	WPHI754	47.5
AMERICAN RED CROSS BAY AREA	WPHI754	47.54
AMERICAN RED CROSS BAY AREA	WPHI754	47.58

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AMERICAN RED CROSS BAY AREA	WPHI754	47.62
AMERICAN RED CROSS BAY AREA	WPHI754	47.66
MORAGA, TOWN OF	WPAU780	150.995
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNYM827	151.025
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNYM827 / 0000767860	151.025
CALIFORNIA, STATE OF	KIZ343	151.205
CALIFORNIA, STATE OF	KMK913	151.205
CALIFORNIA, STATE OF	WPEM924	151.205
CALIFORNIA, STATE OF	WNKY521	151.235
CALIFORNIA, STATE OF	WPDB986	151.355
CALIFORNIA, STATE OF	WPDB985	151.415
CALIFORNIA, STATE OF	WPDB985	151.43
CALIFORNIA, STATE OF	WPDB986	151.445
CALIFORNIA, STATE OF	KDJ572	153.74
CALIFORNIA, STATE OF	KGR355	153.755
CALIFORNIA, STATE OF	KYE982	153.755
RICHMOND, CITY OF	KMM574	153.8
CONCORD, CITY OF	KMK772	153.815
CONCORD, CITY OF	KMK772	153.815
CONTRA COSTA, COUNTY OF	WPSP325	153.815
SAN RAMON VALLEY FIRE DISTRICT	WPUC470	153.815
CONTRA COSTA, COUNTY OF	KA3744	153.83
RICHMOND, CITY OF	KMB332	153.83
PINOLE, CITY OF	KME945	153.83
MT VIEW SANITARY DISTRICT	WPQY787	153.965
CONCORD, CITY OF	KMK772	153.995
CONTRA COSTA, COUNTY OF	WPSP325	153.995
SAN RAMON VALLEY FIRE DISTRICT	WPUC470	153.995
CONCORD, CITY OF	KMK772	154.025
EAST BAY REGIONAL PARK DISTRICT	WRL694	154.07
CALIFORNIA, STATE OF	KMF694	154.16
CONTRA COSTA, COUNTY OF	KA3744	154.205
CONTRA COSTA, COUNTY OF	KBQ628	154.205
CONTRA COSTA, COUNTY OF	KDB502	154.205
CONTRA COSTA, COUNTY OF	KMF371	154.205
CONTRA COSTA, COUNTY OF	KNCZ430	154.205
CONTRA COSTA, COUNTY OF	KYG655	154.205
CONTRA COSTA, COUNTY OF	KYS919	154.205
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	154.205
DUBLIN SAN RAMON SERVICES DISTRICT	KJK522	154.235
EAST BAY REGIONAL PARK DISTRICT	WRL694	154.235
CONTRA COSTA, COUNTY OF	KA3744	154.265
PINOLE, CITY OF	KME945	154.265
CONTRA COSTA, COUNTY OF	KA3744	154.28
CONTRA COSTA, COUNTY OF	KDB502	154.28
DUBLIN SAN RAMON SERVICES DISTRICT	KJK522	154.28

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SAN RAMON VALLEY F P D	KMA635	154.28
RICHMOND, CITY OF	KMB332	154.28
PINOLE, CITY OF	KME945	154.28
CONTRA COSTA, COUNTY OF	KMF371	154.28
EAST BAY REGIONAL PARK DISTRICT	WRL694	154.28
CONTRA COSTA, COUNTY OF	KA3744	154.295
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	KNFZ630	154.295
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WP11570	154.295
EAST BAY REGIONAL PARK DISTRICT	WRL694	154.355
CONTRA COSTA, COUNTY OF	KA3744	154.385
CONTRA COSTA, COUNTY OF	KBQ628	154.385
CONTRA COSTA, COUNTY OF	KDB502	154.385
RICHMOND, CITY OF	KMB332	154.385
CONTRA COSTA, COUNTY OF	KMF371	154.385
CONTRA COSTA, COUNTY OF	KYG655	154.385
CONTRA COSTA, COUNTY OF	KYS919	154.385
EL CERRITO, CITY OF	WPJH417	154.385
CALIFORNIA, STATE OF	KMG445	154.68
CALIFORNIA, STATE OF	WPAD599	154.68
CALIFORNIA, STATE OF	KYE982	154.71
CONTRA COSTA, COUNTY OF	KA2988	154.755
CONTRA COSTA, COUNTY OF	KMG264	154.755
CONTRA COSTA, COUNTY OF	KNCE507	154.755
CONTRA COSTA, COUNTY OF	WNZF354	154.755
CONTRA COSTA, COUNTY OF	WPKN371	154.755
CONTRA COSTA, COUNTY OF	WPKN372	154.755
CONTRA COSTA, COUNTY OF	WPKN373	154.755
CONTRA COSTA, COUNTY OF	WPKN374	154.755
CONTRA COSTA, COUNTY OF	WPKN376	154.755
ANTIOCH, CITY OF	WNSB257	154.845
ANTIOCH, CITY OF	WPOX277	154.845
CALIFORNIA STATE UNIVERSITY	KNNK407	154.89
CALIFORNIA, STATE OF	KLU341	154.92
CALIFORNIA, STATE OF	KNHU669	154.92
CALIFORNIA, STATE OF	KNHU670	154.92
CALIFORNIA, STATE OF	KNHU671	154.92
CALIFORNIA, STATE OF	KNHU672	154.92
CALIFORNIA, STATE OF	KNHW257	154.92
CALIFORNIA, STATE OF	KNHY376	154.92
CALIFORNIA, STATE OF	KNHY377	154.92
CALIFORNIA, STATE OF	KNHY378	154.92
CALIFORNIA, STATE OF	KNHY379	154.92
CALIFORNIA, STATE OF	KNHY380	154.92
CALIFORNIA, STATE OF	KQR620	154.92
CALIFORNIA, STATE OF	KRA565	154.92
CALIFORNIA, STATE OF	KRO411	154.92

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CALIFORNIA, STATE OF	KRZ240	154.92
CALIFORNIA, STATE OF	WNUX719	154.92
CALIFORNIA, STATE OF	WPBM353	154.92
CALIFORNIA, STATE OF	WPBM355	154.92
CALIFORNIA, STATE OF	WPBM356	154.92
CALIFORNIA, STATE OF	WYK436	154.92
CONTRA COSTA, COUNTY OF	KA2988	154.95
CONTRA COSTA, COUNTY OF	KMG264	154.95
CONTRA COSTA, COUNTY OF	KNCE507	154.95
CONTRA COSTA, COUNTY OF	KNHP708	154.95
CONTRA COSTA, COUNTY OF	WNZF354	154.95
CONTRA COSTA, COUNTY OF	WPKN371	154.95
CONTRA COSTA, COUNTY OF	WPKN372	154.95
CONTRA COSTA, COUNTY OF	WPKN373	154.95
CONTRA COSTA, COUNTY OF	WPKN374	154.95
CONTRA COSTA, COUNTY OF	WPKN376	154.95
CALIFORNIA, STATE OF	KGR355	154.98
CONCORD, CITY OF	KMK772	154.995
CONTRA COSTA, COUNTY OF	WPSP325	154.995
SAN RAMON VALLEY FIRE DISTRICT	WPUC470	154.995
CONTRA COSTA, COUNTY OF	KNCR633	155.04
CONTRA COSTA, COUNTY OF	KYD927	155.04
CONTRA COSTA, COUNTY OF	WNPM636	155.04
CONTRA COSTA, COUNTY OF	WNPM681	155.04
CONTRA COSTA, COUNTY OF	WPIR557	155.04
ANTIOCH, CITY OF	WNSB257	155.07
ANTIOCH, CITY OF	WPMZ453	155.07
ANTIOCH, CITY OF	WPOX277	155.07
LAFAYETTE, CITY OF	KNJP768	155.115
ORINDA UNION SCHOOL DISTRICT	WNAD765	155.16
PITTSBURG UNIFIED SCHOOL DISTRICT	WNJX883	155.16
CONTRA COSTA, COUNTY OF	KA2988	155.19
CONTRA COSTA, COUNTY OF	KMA371	155.19
CONTRA COSTA, COUNTY OF	KMA499	155.19
CONTRA COSTA, COUNTY OF	KMG264	155.19
CONTRA COSTA, COUNTY OF	KNCE507	155.19
CONTRA COSTA, COUNTY OF	WNZF354	155.19
CONTRA COSTA, COUNTY OF	WPKN371	155.19
CONTRA COSTA, COUNTY OF	WPKN372	155.19
CONTRA COSTA, COUNTY OF	WPKN373	155.19
CONTRA COSTA, COUNTY OF	WPKN374	155.19
CONTRA COSTA, COUNTY OF	WPKN376	155.19
KAISER FOUNDATION HEALTH PLAN INC	KXC738	155.22
CONTRA COSTA, COUNTY OF	KA2988	155.25
CONTRA COSTA, COUNTY OF	KMA371	155.25
CONTRA COSTA, COUNTY OF	KMG264	155.25
CONTRA COSTA, COUNTY OF	KNCE507	155.25

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CONTRA COSTA, COUNTY OF	WNZF354	155.25
CONTRA COSTA, COUNTY OF	WPKN371	155.25
CONTRA COSTA, COUNTY OF	WPKN372	155.25
CONTRA COSTA, COUNTY OF	WPKN373	155.25
CONTRA COSTA, COUNTY OF	WPKN374	155.25
CONTRA COSTA, COUNTY OF	WPKN376	155.25
CONTRA COSTA, COUNTY OF	WPNU981	155.25
CONTRA COSTA, COUNTY OF	KB27868	155.28
JOHN MUIR MEDICAL CENTER	KSP200	155.28
CONTRA COSTA, COUNTY OF	KA2988	155.31
CONTRA COSTA, COUNTY OF	KMA371	155.31
CONTRA COSTA, COUNTY OF	KMA371	155.31
CONTRA COSTA, COUNTY OF	KMG264	155.31
CONTRA COSTA, COUNTY OF	KNCE507	155.31
CONTRA COSTA, COUNTY OF	KNGL587	155.31
WALNUT CREEK, CITY OF	KZE704	155.31
CONTRA COSTA, COUNTY OF	WNZF354	155.31
CONTRA COSTA, COUNTY OF	WPKN371	155.31
CONTRA COSTA, COUNTY OF	WPKN372	155.31
CONTRA COSTA, COUNTY OF	WPKN373	155.31
CONTRA COSTA, COUNTY OF	WPKN374	155.31
CONTRA COSTA, COUNTY OF	WPKN376	155.31
MEDIC AMBULANCE SERVICE	KD50347	155.4
TENET HEALTH SYSTEM HOSPITALS INC	KQO219	155.4
JOHN MUIR MEDICAL CENTER	KSP200	155.4
MT DIABLO HOSPITAL	KWI758	155.4
LOS MEDANOS COMMUNITY HOSPITAL	KWJ288	155.4
CONTRA COSTA, COUNTY OF	KWO571	155.4
COUNTY HOSPITAL	KWO573	155.4
CONTRA COSTA, COUNTY OF	KWO574	155.4
SAN RAMON REGIONAL MEDICAL CENTER	WNQW992	155.4
MEDICAL CENTER	WSZ655	155.4
BRENTWOOD, CITY OF	KMA691	155.55
ANTIOCH, CITY OF	WPMZ453	155.55
ANTIOCH, CITY OF	WPOX277	155.55
ANTIOCH, CITY OF	WNSB257	155.61
ANTIOCH, CITY OF	WPOX277	155.61
CONTRA COSTA, COUNTY OF	KA2988	155.625
CONTRA COSTA, COUNTY OF	KMA499	155.625
CONTRA COSTA, COUNTY OF	WNQE218	155.625
CONTRA COSTA, COUNTY OF	WRU892	155.625
CONTRA COSTA, COUNTY OF	KA2988	155.64
CONTRA COSTA, COUNTY OF	KMA499	155.64
CONTRA COSTA, COUNTY OF	KMG264	155.64
CONTRA COSTA, COUNTY OF	KNCE507	155.64
CONTRA COSTA, COUNTY OF	WNZF354	155.64
CONTRA COSTA, COUNTY OF	WPKN371	155.64

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CONTRA COSTA, COUNTY OF	WPKN372	155.64
CONTRA COSTA, COUNTY OF	WPKN373	155.64
CONTRA COSTA, COUNTY OF	WPKN374	155.64
CONTRA COSTA, COUNTY OF	WPKN376	155.64
RICHMOND, CITY OF	KMA358	155.67
PITTSBURG, CITY OF	KMA779	155.67
CONCORD, CITY OF	KMC308	155.67
PINOLE, CITY OF	KMJ446	155.67
CALIFORNIA, STATE OF	KYE982	155.67
WALNUT CREEK, CITY OF	KZE704	155.67
CONTRA COSTA, COUNTY OF	WCH762	155.67
DANVILLE, CITY OF	KNGN893	155.79
RICHMOND, CITY OF	KMM574	155.82
ANTIOCH, CITY OF	KIZ211	155.88
CONCORD, CITY OF	KMK772	155.88
MARTINEZ, CITY OF	KML203	155.88
LAFAYETTE, CITY OF	KNJP768	155.88
PINOLE, CITY OF	KRM778	155.88
PITTSBURG, CITY OF	KVJ754	155.88
EL CERRITO, CITY OF	KXA218	155.88
HERCULES, CITY OF	WNVX752	155.88
ANTIOCH, CITY OF	WPNX326	155.88
EL CERRITO, CITY OF	WYZ469	155.88
CONTRA COSTA, COUNTY OF	KA2988	155.955
CONTRA COSTA, COUNTY OF	KMG264	155.955
CONTRA COSTA, COUNTY OF	KNCE507	155.955
CONTRA COSTA, COUNTY OF	WNZF354	155.955
CONTRA COSTA, COUNTY OF	WPKN371	155.955
CONTRA COSTA, COUNTY OF	WPKN372	155.955
CONTRA COSTA, COUNTY OF	WPKN373	155.955
CONTRA COSTA, COUNTY OF	WPKN374	155.955
CONTRA COSTA, COUNTY OF	WPKN376	155.955
CONTRA COSTA, COUNTY OF	KD8107	156
CONTRA COSTA, COUNTY OF	KD8107	156.015
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNYM827	156.045
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNYM827 / 0000767860	156.045
MORAGA, TOWN OF	WPAU780	156.06
WALNUT CREEK, CITY OF	WYK413	156.165
CONTRA COSTA, COUNTY OF	KF4115	156.195
SAN RAMON, CITY OF	WNMG614	156.225
ANTIOCH, CITY OF	WNUK908	156.225
ANTIOCH, CITY OF	WPNX326	156.225
JOHN MUIR MEDICAL CENTER	KNFC871	157.45
ANTIOCH, CITY OF	WPOX277	158.76
MT VIEW SANITARY DISTRICT	WPFS279	158.805
ANTIOCH, CITY OF	WNUK908	158.985

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ANTIOCH, CITY OF	WPNX326	158.985
WALNUT CREEK, CITY OF	WYK413	159.12
CALIFORNIA, STATE OF	KZE65	159.135
CONTRA COSTA, COUNTY OF	WNQE218	159.15
SAN RAMON, CITY OF	WNMG614	159.165
CALIFORNIA, STATE OF	KZE65	159.195
CALIFORNIA, STATE OF	KIZ343	159.24
CALIFORNIA, STATE OF	WPEM924	159.24
EAST BAY REGIONAL PARK DISTRICT	KBB840	159.255
CALIFORNIA, STATE OF	KIZ343	159.255
CALIFORNIA, STATE OF	WPEM924	159.255
CALIFORNIA, STATE OF	WNYS818	159.285
CALIFORNIA, STATE OF	WDK23	159.3
CALIFORNIA, STATE OF	WNYS818	159.3
CALIFORNIA, STATE OF	WDK23	159.345
CALIFORNIA, STATE OF	WNYS818	159.345
CALIFORNIA, STATE OF	KNGG687	159.435
CALIFORNIA, STATE OF	KIZ343	159.465
CALIFORNIA, STATE OF	WPEM924	159.465
CONTRA COSTA, COUNTY OF	WPLT748	159.615
CONTRA COSTA, COUNTY OF	WPLT747	159.735
CONTRA COSTA, COUNTY OF	WPLT749	160.11
METROCALL USA INC	WNAF392	163.25
METROCALL USA INC	WNJG997	163.25
METROCALL USA INC	WNJH205	163.25
METROCALL USA INC	WNXU925	163.25
METROCALL USA INC	WPQD743	163.25
CALIFORNIA, STATE OF	WRV51	169.575
CALIFORNIA, STATE OF	WRV52	169.575
CALIFORNIA, STATE OF	WPDW790	171.825
CALIFORNIA, STATE OF	WPJI545	171.825
CALIFORNIA, STATE OF	WPJM984	171.825
LOS ANGELES, CITY OF	WPQG846	173.075
CONTRA COSTA, COUNTY OF	WGI954	173.39625
CONTRA COSTA, COUNTY OF	WNDT949	453.025
KAISER FOUNDATION HEALTH PLAN INC	WNSC442	453.025
CONTRA COSTA, COUNTY OF	KD30519	453.05
RICHMOND HOUSING AUTHORITY	WPLU389	453.05
CONTRA COSTA, COUNTY OF	WPRH384	453.075
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	KRB579	453.15
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPAT712	453.15
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPAT714	453.15
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPAT715	453.15
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPIP224	453.15
PLEASANT HILL, CITY OF	WPRI244	453.175

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RICHMOND, CITY OF	WNUP633	453.1875
WALNUT CREEK, CITY OF	WPGU707	453.2
CONCORD, CITY OF	KD52959	453.2125
CONCORD, CITY OF	WPMM874	453.225
ANTIOCH, CITY OF	WPFE269	453.2375
CONCORD, CITY OF	WPMM874	453.3
CONCORD, CITY OF	KD52959	453.3625
CONCORD, CITY OF	WPQG744	453.3625
SAN RAMON VALLEY FIRE DISTRICT	WPRG951	453.425
CONCORD, CITY OF	WPMM874	453.525
CALIFORNIA, STATE OF	WPGA994	453.5375
PLEASANT HILL, CITY OF	KLE677	453.6
WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT	WPLP534	453.65
CONCORD, CITY OF	WPMM874	453.675
CONTRA COSTA, COUNTY OF	WPMG808	453.7
RICHMOND, CITY OF	WPLD261	453.7125
CALIFORNIA, STATE OF	KYJ333	453.825
OAKLEY, CITY OF	WNXN534	453.8375
CALIFORNIA, STATE OF	WPPD860	453.9
CONTRA COSTA, COUNTY OF	KB92941	453.9125
BRENTWOOD, CITY OF	WPTP981	453.9625
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WNQO261	453.975
CONTRA COSTA, COUNTY OF	WNDT949	458.025
CONTRA COSTA, COUNTY OF	KD30519	458.05
RICHMOND HOUSING AUTHORITY	WPLU389	458.05
SAN RAMON VALLEY FIRE DISTRICT	KB45832	458.075
DANVILLE, TOWN OF	WPMI229	458.1125
LAFAYETTE, CITY OF	WPTS924	458.1125
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPAT714	458.15
PLEASANT HILL, CITY OF	WPRI244	458.175
RICHMOND, CITY OF	WNUP633	458.1875
WALNUT CREEK, CITY OF	WPGU707	458.2
CONCORD, CITY OF	KD52959	458.2125
CONCORD, CITY OF	WPMM874	458.225
ANTIOCH, CITY OF	WPFE269	458.2375
CONCORD, CITY OF	WPMM874	458.3
CONCORD, CITY OF	KD52959	458.3625
CONCORD, CITY OF	WPQG744	458.3625
SAN RAMON VALLEY FIRE DISTRICT	WPRG951	458.425
CONCORD, CITY OF	WPMM874	458.525
CALIFORNIA, STATE OF	WPGA994	458.5375
EAST BAY MUNICIPAL UTILITY DISTRICT	KD35239	458.5875
PLEASANT HILL, CITY OF	KLE677	458.6
WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT	WPLP534	458.65
CONCORD, CITY OF	WPMM874	458.675
EAST BAY MUNICIPAL UTILITY DISTRICT	KD35239	458.6875

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CONTRA COSTA, COUNTY OF	WPMG808	458.7
OAKLEY, CITY OF	WNXN534	458.8375
CALIFORNIA, STATE OF	WPPD860	458.9
CONTRA COSTA, COUNTY OF	KD20127	458.9125
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WNQO261	458.975
CALIFORNIA, STATE OF	KNAK237	460.025
CALIFORNIA, STATE OF	KNFF498	460.025
CALIFORNIA, STATE OF	KRX568	460.025
CALIFORNIA, STATE OF	KWX458	460.025
CALIFORNIA, STATE OF	KZO392	460.025
WALNUT CREEK, CITY OF	WNPQ684	460.0625
CONTRA COSTA, COUNTY OF	KA84976	460.1
CONTRA COSTA, COUNTY OF	KNCM852	460.1
CONTRA COSTA, COUNTY OF	KNCM853	460.1
CONTRA COSTA, COUNTY OF	KNCM854	460.1
CONTRA COSTA, COUNTY OF	KNCM855	460.1
CONTRA COSTA, COUNTY OF	KNCM856	460.1
CONTRA COSTA, COUNTY OF	KNCM857	460.1
CONTRA COSTA, COUNTY OF	KNCM858	460.1
CONTRA COSTA, COUNTY OF	KNCM860	460.1
CONTRA COSTA, COUNTY OF	KNCM862	460.1
CONCORD, CITY OF	KLP745	460.15
SAN PABLO, CITY OF	WXA612	460.15
CONTRA COSTA, COUNTY OF	KNEQ466	460.175
CONCORD, CITY OF	KLP745	460.25
CONTRA COSTA, COUNTY OF	WNVK325	460.275
RICHMOND, CITY OF	KMA358	460.3
PLEASANT HILL, CITY OF	KQS776	460.3
PINOLE, CITY OF	KMJ446	460.325
WALNUT CREEK, CITY OF	KZE704	460.325
HERCULES, CITY OF	WYC681	460.325
PITTSBURG, CITY OF	KM6564	460.375
PITTSBURG, CITY OF	KMA779	460.375
EL CERRITO, CITY OF	KTU275	460.375
RICHMOND, CITY OF	KMA358	460.4
EL CERRITO, CITY OF	KTU275	460.4
WALNUT CREEK, CITY OF	KZE704	460.425
HERCULES, CITY OF	WPAM865	460.425
CONTRA COSTA, COUNTY OF	KD24230	460.4375
CALIFORNIA, STATE OF	KYJ333	460.45
CALIFORNIA, STATE OF	WBC384	460.45
RICHMOND, CITY OF	KMA358	460.475
MARTINEZ, CITY OF	KMG537	460.475
CONTRA COSTA, COUNTY OF	KB80939	460.4875
PLEASANT HILL, CITY OF	KQS776	460.5
CONCORD, CITY OF	WPKV955	460.55

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METROCALL USA INC	WNXU925	460.5625
SAN RAMON VALLEY F P D	KMA635	460.575
CONTRA COSTA, COUNTY OF	WNZP225	460.575
MEDIC AMBULANCE SERVICE	KD50347	463
MEDIC AMBULANCE SERVICE	KD50347	463.025
MEDIC AMBULANCE SERVICE	KD50347	463.05
MEDIC AMBULANCE SERVICE	KD50347	463.075
MEDIC AMBULANCE SERVICE	KD50347	463.1
MEDIC AMBULANCE SERVICE	KD50347	463.125
MEDIC AMBULANCE SERVICE	KD50347	463.15
MEDIC AMBULANCE SERVICE	KD50347	463.175
CALIFORNIA, STATE OF	KLU341	465.025
CALIFORNIA, STATE OF	KNAK237	465.025
WALNUT CREEK, CITY OF	WNPQ684	465.0625
CONCORD, CITY OF	KLP745	465.15
CONTRA COSTA, COUNTY OF	KM6567	465.15
SAN PABLO, CITY OF	WXA612	465.15
CONCORD, CITY OF	KLP745	465.25
CONTRA COSTA, COUNTY OF	KM6567	465.25
CONTRA COSTA, COUNTY OF	WNVK325	465.275
CONTRA COSTA, COUNTY OF	KM6567	465.3
RICHMOND, CITY OF	KMA358	465.3
PLEASANT HILL, CITY OF	KQS776	465.3
CONTRA COSTA, COUNTY OF	KM6567	465.325
PINOLE, CITY OF	KMJ446	465.325
WALNUT CREEK, CITY OF	KZE704	465.325
HERCULES, CITY OF	WYC681	465.325
PITTSBURG, CITY OF	KM6564	465.375
CONTRA COSTA, COUNTY OF	KM6567	465.375
EL CERRITO, CITY OF	KTU275	465.375
CONTRA COSTA, COUNTY OF	KM6567	465.4
RICHMOND, CITY OF	KMA358	465.4
EL CERRITO, CITY OF	KTU275	465.4
CONTRA COSTA, COUNTY OF	KM6567	465.425
WALNUT CREEK, CITY OF	KZE704	465.425
HERCULES, CITY OF	WPAM865	465.425
CALIFORNIA, STATE OF	WBC384	465.45
CONTRA COSTA, COUNTY OF	KM6567	465.475
RICHMOND, CITY OF	KMA358	465.475
PLEASANT HILL, CITY OF	KQS776	465.5
METROCALL USA INC	WNXU925	465.5375
CONCORD, CITY OF	WPKV955	465.55
SAN RAMON VALLEY F P D	KMA635	465.575
MEDIC AMBULANCE SERVICE	KD50347	467.95
MEDIC AMBULANCE SERVICE	KD50347	467.975
MEDIC AMBULANCE SERVICE	KD50347	468
MEDIC AMBULANCE SERVICE	KD50347	468.025

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MEDIC AMBULANCE SERVICE	KD50347	468.05
MEDIC AMBULANCE SERVICE	KD50347	468.075
MEDIC AMBULANCE SERVICE	KD50347	468.1
MEDIC AMBULANCE SERVICE	KD50347	468.125
MEDIC AMBULANCE SERVICE	KD50347	468.15
MEDIC AMBULANCE SERVICE	KD50347	468.175
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	KYF631	482.3875
CENTRAL CONTRA COSTA TRANSIT AUTHORITY	WIE818	482.4375
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII639	482.5375
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII640	482.6875
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII641	482.8375
MARTINEZ, CITY OF	WIM386	484.3625
MARTINEZ, CITY OF	WIM386	484.6375
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	KYF631	485.3875
CENTRAL CONTRA COSTA TRANSIT AUTHORITY	WIE818	485.4375
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII639	485.5375
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII640	485.6875
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII641	485.8375
MARTINEZ, CITY OF	WIM386	487.3625
MARTINEZ, CITY OF	WIM386	487.6375
CONTRA COSTA, COUNTY OF	KBF738	488.4375
CONTRA COSTA, COUNTY OF	KBF740	488.4375
CONTRA COSTA, COUNTY OF	KT2538	488.4375
CONTRA COSTA, COUNTY OF	KWX592	488.4375
CONTRA COSTA, COUNTY OF	KWX593	488.4375
CONTRA COSTA, COUNTY OF	KWX594	488.4375
CONTRA COSTA, COUNTY OF	KZD410	488.4375
CONTRA COSTA, COUNTY OF	KZD412	488.4375
CONTRA COSTA, COUNTY OF	WIK382	488.4375
CONTRA COSTA, COUNTY OF	WIK592	488.6125
CONTRA COSTA, COUNTY OF	WIK866	488.6125
EASTERN CONTRA COSTA TRANSIT DISTRICT	WPMV757	488.6375
CONTRA COSTA, COUNTY OF	WIK592	488.6625
CONTRA COSTA, COUNTY OF	KBF738	488.9125
CONTRA COSTA, COUNTY OF	KBF739	488.9125
CONTRA COSTA, COUNTY OF	KBF740	488.9125
CONTRA COSTA, COUNTY OF	KBF741	488.9125
CONTRA COSTA, COUNTY OF	KNS654	488.9125
CONTRA COSTA, COUNTY OF	KT2538	488.9125
CONTRA COSTA, COUNTY OF	KWX591	488.9125
CONTRA COSTA, COUNTY OF	KWX592	488.9125
CONTRA COSTA, COUNTY OF	KWX593	488.9125
CONTRA COSTA, COUNTY OF	KWX594	488.9125
CONTRA COSTA, COUNTY OF	KZD403	488.9125

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CONTRA COSTA, COUNTY OF	KZD404	488.9125
CONTRA COSTA, COUNTY OF	KZD406	488.9125
CONTRA COSTA, COUNTY OF	KZD407	488.9125
CONTRA COSTA, COUNTY OF	KZD408	488.9125
CONTRA COSTA, COUNTY OF	KZD409	488.9125
CONTRA COSTA, COUNTY OF	KZD410	488.9125
CONTRA COSTA, COUNTY OF	KZD411	488.9125
CONTRA COSTA, COUNTY OF	KZD412	488.9125
CONTRA COSTA, COUNTY OF	WIK382	488.9125
CONTRA COSTA, COUNTY OF	WIL202	488.9125
CONTRA COSTA, COUNTY OF	WNAS446	488.9125
CENTRAL CONTRA COSTA TRANSIT AUTHORITY	WIE818	489.9625
CONTRA COSTA, COUNTY OF	KT2538	491.4375
CONTRA COSTA, COUNTY OF	WIK382	491.4375
CONTRA COSTA, COUNTY OF	WPMV687	491.4375
CONTRA COSTA, COUNTY OF	WIK592	491.6125
EASTERN CONTRA COSTA TRANSIT DISTRICT	WPMV757	491.6375
EASTERN CONTRA COSTA TRANSIT DISTRICT	WPMV757 / 0000765482	491.6375
CONTRA COSTA, COUNTY OF	WIK592	491.6625
CONTRA COSTA, COUNTY OF	WIL309	491.6625
CONTRA COSTA, COUNTY OF	KT2538	491.9125
CONTRA COSTA, COUNTY OF	WAL251	491.9125
CONTRA COSTA, COUNTY OF	WAL252	491.9125
CONTRA COSTA, COUNTY OF	WAL254	491.9125
CONTRA COSTA, COUNTY OF	WBL497	491.9125
CONTRA COSTA, COUNTY OF	WBL498	491.9125
CONTRA COSTA, COUNTY OF	WBL500	491.9125
CONTRA COSTA, COUNTY OF	WBL501	491.9125
CONTRA COSTA, COUNTY OF	WBL502	491.9125
CONTRA COSTA, COUNTY OF	WBL503	491.9125
CONTRA COSTA, COUNTY OF	WBL504	491.9125
CONTRA COSTA, COUNTY OF	WBL505	491.9125
CONTRA COSTA, COUNTY OF	WBL506	491.9125
CONTRA COSTA, COUNTY OF	WIK382	491.9125
CONTRA COSTA, COUNTY OF	WNAS446	491.9125
CONTRA COSTA, COUNTY OF	WPMV687	491.9125
CENTRAL CONTRA COSTA TRANSIT AUTHORITY	WIE818	492.9625

Note: Totals - 277 frequencies in use, 109 are shared,
53 licensees

By band:

AM: 4 frequencies, 3 shared

30-50: 58 frequencies, 26 shared

150-174: 84 frequencies, 44 shared

450-500: 131 frequencies, 36 shared

Public Safety National Plan, 821-824/866-869, Trunked [YF]

Licensee Name	Callsign / File Number	Frequency
RICHMOND, CITY OF	WPGR333	821.1
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	821.175
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	821.4875
RICHMOND, CITY OF	WPGR333	821.75
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	821.9875
RICHMOND, CITY OF	WPGR333	822.1
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	822.4875
RICHMOND, CITY OF	WPGR333	822.625
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPSH605	822.75
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	822.9875
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	823.4875
RICHMOND, CITY OF	WPGR333	823.6125
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	823.8625
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	866.075
RICHMOND, CITY OF	WPGR333	866.1
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	866.175
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	866.4875
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	866.725
RICHMOND, CITY OF	WPGR333	866.75
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	866.8875
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	866.9875
RICHMOND, CITY OF	WPGR333	867.1
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	867.375
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	867.4875
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	867.6
RICHMOND, CITY OF	WPGR333	867.625
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPSH605	867.75
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	867.8
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	867.85
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	867.9625
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	867.9875
RICHMOND, CITY OF	WPGR333	868.1
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	868.15
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	868.4875
RICHMOND, CITY OF	WPGR333	868.6125
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	868.6875
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	868.8625

Note: 37 frequencies in use, none are shared, 3 licensees

Public Safety Pool, UHF, Trunked [YW]

Licensee Name	Callsign / File Number	Frequency
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	488.3625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	488.7
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	488.7625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	490.4625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	490.5625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	490.6125
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	490.6625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	491.3625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	491.7625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	493.4625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	493.5625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	493.6125
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	493.6625

Note: 13 frequencies in use, none are shared, 1 licensee

Contra Costa County Public Safety, All Licensees

Licensee Name	Callsign / File Number	Service Code	Frequency
MARTINEZ, CITY OF	WPTD253	PW	0.53
MARTINEZ, CITY OF	WPTR552	PW	0.53
PITTSBURG, CITY OF	WPEI436	PW	0.79
RICHMOND, CITY OF	WPED339	PW	0.79
CALIFORNIA, STATE OF	WNVQ787	PW	0.84
CALIFORNIA, STATE OF	WPEI434	PW	0.84
SAN RAMON, CITY OF	WNUW920	PW	1.61
CONTRA COSTA, COUNTY OF	KMF371	PW	33.44
CONTRA COSTA, COUNTY OF	KA3744	PW	33.48
CONTRA COSTA, COUNTY OF	KMF371	PW	33.48
CONTRA COSTA, COUNTY OF	WNCE416	PW	33.48
CONTRA COSTA, COUNTY OF	WNSS746	PW	33.48
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	PW	33.48
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	PW	33.48
CALIFORNIA, STATE OF	KZE65	PW	33.66
DUBLIN SAN RAMON SERVICES DISTRICT	KJK522	PW	33.92
CALIFORNIA, STATE OF	KZE65	PW	33.98
MT DIABLO HOSPITAL	KWI758	PW	35.68
CONTRA COSTA, COUNTY OF	WPHG665	PW	37.12
CALIFORNIA, STATE OF	WPDA311	PW	37.14
CONTRA COSTA, COUNTY OF	WPPV535	PW	37.98
CALIFORNIA, STATE OF	WNWH830	PW	42.12
CALIFORNIA, STATE OF	WNEA278	PW	42.18
CALIFORNIA, STATE OF	KMB442	PW	42.34
CALIFORNIA, STATE OF	WNEA278	PW	42.34
CALIFORNIA, STATE OF	WPCZ972	PW	42.34
CALIFORNIA, STATE OF	WPDA311	PW	42.34
CALIFORNIA, STATE OF	WYK572	PW	42.34
CALIFORNIA, STATE OF	WNVK355	PW	42.44
CALIFORNIA, STATE OF	WNUH520	PW	42.62
CALIFORNIA, STATE OF	WNEA278	PW	42.74
CALIFORNIA, STATE OF	KMB442	PW	42.92
CALIFORNIA, STATE OF	WNEA278	PW	42.92
CALIFORNIA, STATE OF	WNVK354	PW	42.92
JOHN MUIR MEDICAL CENTER	KSP200	PW	43.68
EAST BAY REGIONAL PARK DISTRICT	KBB840	PW	44.64
EAST BAY REGIONAL PARK DISTRICT	KNAH351	PW	44.64
EAST BAY REGIONAL PARK DISTRICT	KNGV248	PW	44.64
EAST BAY REGIONAL PARK DISTRICT	KRI536	PW	44.64
EAST BAY REGIONAL PARK DISTRICT	WNJR820	PW	44.64
EAST BAY REGIONAL PARK DISTRICT	WYP336	PW	44.64
EAST BAY REGIONAL PARK DISTRICT	WNVK857	PW	44.68
EAST BAY REGIONAL PARK DISTRICT	KBB840	PW	44.76

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EAST BAY REGIONAL PARK DISTRICT	KNGV248	PW	44.76
EAST BAY REGIONAL PARK DISTRICT	WNJR820	PW	44.76
EAST BAY REGIONAL PARK DISTRICT	WYP336	PW	44.76
EAST BAY REGIONAL PARK DISTRICT	KBB840	PW	44.96
EAST BAY REGIONAL PARK DISTRICT	KNGV248	PW	44.96
EAST BAY REGIONAL PARK DISTRICT	KRI536	PW	44.96
EAST BAY REGIONAL PARK DISTRICT	WNJR820	PW	44.96
EAST BAY REGIONAL PARK DISTRICT	WYP336	PW	44.96
EAST BAY REGIONAL PARK DISTRICT	WNVK857	PW	45
EAST BAY REGIONAL PARK DISTRICT	KBB840	PW	45.04
CONTRA COSTA, COUNTY OF	WNKB690	PW	45.08
CONTRA COSTA, COUNTY OF	WNLG669	PW	45.08
MORAGA, TOWN OF	KNFN709	PW	45.08
CONTRA COSTA, COUNTY OF	KD8107	PW	45.24
CONTRA COSTA, COUNTY OF	KDA346	PW	45.24
CONTRA COSTA, COUNTY OF	KMJ935	PW	45.24
CONTRA COSTA, COUNTY OF	KNDV996	PW	45.24
CONTRA COSTA, COUNTY OF	KQT927	PW	45.24
CONTRA COSTA, COUNTY OF	KTZ366	PW	45.24
STEGE SANITATION DISTRICT	WNLL530	PW	45.28
WEST COUNTY WASTEWATER DISTRICT	KML786	PW	45.28
CONTRA COSTA, COUNTY OF	KB32638	PW	45.44
CONTRA COSTA, COUNTY OF	KRO353	PW	45.56
CONTRA COSTA, COUNTY OF	KBM806	PW	45.68
CONTRA COSTA, COUNTY OF	KF4115	PW	45.68
CONTRA COSTA, COUNTY OF	KIB411	PW	45.68
CONTRA COSTA, COUNTY OF	KMJ939	PW	45.68
CONTRA COSTA, COUNTY OF	KQT928	PW	45.68
CONTRA COSTA, COUNTY OF	KTZ365	PW	45.68
CONTRA COSTA, COUNTY OF	WNJS512	PW	45.82
CONTRA COSTA, COUNTY OF	WPDI316	PW	45.82
CONTRA COSTA, COUNTY OF	WPDI317	PW	45.82
CONTRA COSTA, COUNTY OF	WPDI318	PW	45.82
SAN RAMON VALLEY F P D	KMA635	PW	45.88
SAN RAMON VALLEY FIRE DISTRICT	WNNV616	PW	45.88
SAN RAMON VALLEY FIRE DISTRICT	WNQW789	PW	45.88
LIBERTY UNION HIGH SCHOOL	KNHC279	PW	46
CONTRA COSTA, COUNTY OF	WNCP387	PW	46.04
CONTRA COSTA, COUNTY OF	KA3744	PW	46.06
CONTRA COSTA, COUNTY OF	KBQ628	PW	46.06
CONTRA COSTA, COUNTY OF	KMA463	PW	46.06
CONTRA COSTA, COUNTY OF	KMB591	PW	46.06
CONTRA COSTA, COUNTY OF	KYG655	PW	46.06
RICHMOND, CITY OF	KMB332	PW	46.06
RICHMOND, CITY OF	WPPF928	PW	46.06
RICHMOND, CITY OF	WPPF929	PW	46.06
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNCA815	PW	46.1

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CONTRA COSTA, COUNTY OF	KA3744	PW	46.1
CONTRA COSTA, COUNTY OF	KBQ628	PW	46.1
CONTRA COSTA, COUNTY OF	KDN478	PW	46.1
CONTRA COSTA, COUNTY OF	KDU876	PW	46.1
CONTRA COSTA, COUNTY OF	KEY923	PW	46.1
CONTRA COSTA, COUNTY OF	KEY924	PW	46.1
CONTRA COSTA, COUNTY OF	KJE268	PW	46.1
CONTRA COSTA, COUNTY OF	KMA463	PW	46.1
CONTRA COSTA, COUNTY OF	KMA470	PW	46.1
CONTRA COSTA, COUNTY OF	KMB392	PW	46.1
CONTRA COSTA, COUNTY OF	KMB591	PW	46.1
CONTRA COSTA, COUNTY OF	KMB592	PW	46.1
CONTRA COSTA, COUNTY OF	KMD397	PW	46.1
CONTRA COSTA, COUNTY OF	KMD877	PW	46.1
CONTRA COSTA, COUNTY OF	KMF371	PW	46.1
CONTRA COSTA, COUNTY OF	KMG983	PW	46.1
CONTRA COSTA, COUNTY OF	KMH429	PW	46.1
CONTRA COSTA, COUNTY OF	KMK522	PW	46.1
CONTRA COSTA, COUNTY OF	KNAK321	PW	46.1
CONTRA COSTA, COUNTY OF	KNGI582	PW	46.1
CONTRA COSTA, COUNTY OF	KNGI583	PW	46.1
CONTRA COSTA, COUNTY OF	KTS610	PW	46.1
CONTRA COSTA, COUNTY OF	KYG655	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN757	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN758	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN759	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN760	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN761	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN762	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN763	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN764	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN765	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN766	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN767	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN768	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN769	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN770	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN771	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN772	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN773	PW	46.1
CONTRA COSTA, COUNTY OF	WNHN774	PW	46.1
CONTRA COSTA, COUNTY OF	WNHV253	PW	46.1
CONTRA COSTA, COUNTY OF	WNNN497	PW	46.1
CONTRA COSTA, COUNTY OF	WNPL783	PW	46.1
CONTRA COSTA, COUNTY OF	WNQQ717	PW	46.1
CONTRA COSTA, COUNTY OF	WPLG973	PW	46.1
CONTRA COSTA, COUNTY OF	WSY471	PW	46.1

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CONTRA COSTA, COUNTY OF	WXP667	PW	46.1
EAST DIABLO FIRE DISTRICT	WNHN946	PW	46.1
PINOLE, CITY OF	KME945	PW	46.1
RICHMOND, CITY OF	KMB332	PW	46.1
RICHMOND, CITY OF	WPPF928	PW	46.1
RICHMOND, CITY OF	WPPF929	PW	46.1
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	PW	46.1
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	PW	46.1
RODEO FIRE DISTRICT	KNIZ530	PW	46.1
RODEO FIRE DISTRICT	WNHN947	PW	46.1
SAN RAMON VALLEY F P D	KMA635	PW	46.1
SAN RAMON VALLEY FIRE DISTRICT	WNNV616	PW	46.1
CONTRA COSTA, COUNTY OF	KMF371	PW	46.14
CONTRA COSTA, COUNTY OF	WNNN497	PW	46.14
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	PW	46.14
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	PW	46.14
CONTRA COSTA, COUNTY OF	KA3744	PW	46.16
CONTRA COSTA, COUNTY OF	KMA470	PW	46.16
CONTRA COSTA, COUNTY OF	KMB592	PW	46.16
PINOLE, CITY OF	KME945	PW	46.16
RODEO FIRE DISTRICT	KNIZ530	PW	46.16
CONTRA COSTA, COUNTY OF	KA3744	PW	46.18
CONTRA COSTA, COUNTY OF	KDU876	PW	46.18
CONTRA COSTA, COUNTY OF	KEY923	PW	46.18
CONTRA COSTA, COUNTY OF	KEY924	PW	46.18
CONTRA COSTA, COUNTY OF	KJE268	PW	46.18
CONTRA COSTA, COUNTY OF	KMB392	PW	46.18
CONTRA COSTA, COUNTY OF	KMF371	PW	46.18
CONTRA COSTA, COUNTY OF	KMH429	PW	46.18
CONTRA COSTA, COUNTY OF	KNGL582	PW	46.18
CONTRA COSTA, COUNTY OF	KYS919	PW	46.18
CONTRA COSTA, COUNTY OF	WNNN497	PW	46.18
CONTRA COSTA, COUNTY OF	WSY471	PW	46.18
EAST DIABLO FIRE DISTRICT	WNHN946	PW	46.18
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	PW	46.18
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	PW	46.18
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNCA815	PW	46.22
CONTRA COSTA, COUNTY OF	KA3744	PW	46.22
CONTRA COSTA, COUNTY OF	KMB392	PW	46.22
CONTRA COSTA, COUNTY OF	KMD877	PW	46.22
CONTRA COSTA, COUNTY OF	KMF371	PW	46.22
CONTRA COSTA, COUNTY OF	KMG983	PW	46.22
CONTRA COSTA, COUNTY OF	KNAK321	PW	46.22
CONTRA COSTA, COUNTY OF	KNCZ430	PW	46.22
CONTRA COSTA, COUNTY OF	KNGL583	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN757	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN758	PW	46.22

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CONTRA COSTA, COUNTY OF	WNHN759	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN760	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN761	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN762	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN763	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN764	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN765	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN766	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN767	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN768	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN769	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN770	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN771	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN772	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN773	PW	46.22
CONTRA COSTA, COUNTY OF	WNHN774	PW	46.22
CONTRA COSTA, COUNTY OF	WNQQ717	PW	46.22
CONTRA COSTA, COUNTY OF	WPLG973	PW	46.22
RICHMOND, CITY OF	WPPF929	PW	46.22
CONTRA COSTA, COUNTY OF	KA3744	PW	46.24
CONTRA COSTA, COUNTY OF	KEY923	PW	46.24
CONTRA COSTA, COUNTY OF	KEY924	PW	46.24
CONTRA COSTA, COUNTY OF	KJE268	PW	46.24
CONTRA COSTA, COUNTY OF	KMB392	PW	46.24
CONTRA COSTA, COUNTY OF	KMF371	PW	46.24
CONTRA COSTA, COUNTY OF	KMH429	PW	46.24
CONTRA COSTA, COUNTY OF	KNGL582	PW	46.24
CONTRA COSTA, COUNTY OF	KYS919	PW	46.24
CONTRA COSTA, COUNTY OF	WNNN497	PW	46.24
EAST DIABLO FIRE DISTRICT	WNHN946	PW	46.24
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	PW	46.24
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	PW	46.24
CONTRA COSTA, COUNTY OF	KA3744	PW	46.26
CONTRA COSTA, COUNTY OF	KMD877	PW	46.26
CONTRA COSTA, COUNTY OF	KMF371	PW	46.26
CONTRA COSTA, COUNTY OF	KMG983	PW	46.26
CONTRA COSTA, COUNTY OF	KNCZ430	PW	46.26
CONTRA COSTA, COUNTY OF	KNGL583	PW	46.26
CONTRA COSTA, COUNTY OF	KYS919	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN757	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN758	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN759	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN760	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN761	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN762	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN763	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN764	PW	46.26

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CONTRA COSTA, COUNTY OF	WNHN765	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN766	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN767	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN768	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN769	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN770	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN771	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN772	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN773	PW	46.26
CONTRA COSTA, COUNTY OF	WNHN774	PW	46.26
CONTRA COSTA, COUNTY OF	WNQQ717	PW	46.26
CONTRA COSTA, COUNTY OF	WPLG973	PW	46.26
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNCA815	PW	46.32
CONTRA COSTA, COUNTY OF	KA3744	PW	46.32
CONTRA COSTA, COUNTY OF	KMB392	PW	46.32
CONTRA COSTA, COUNTY OF	KMD877	PW	46.32
CONTRA COSTA, COUNTY OF	KMF371	PW	46.32
CONTRA COSTA, COUNTY OF	KMG983	PW	46.32
CONTRA COSTA, COUNTY OF	KNAK321	PW	46.32
CONTRA COSTA, COUNTY OF	KNGL583	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN757	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN758	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN759	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN760	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN761	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN762	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN763	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN764	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN765	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN766	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN767	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN768	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN769	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN770	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN771	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN772	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN773	PW	46.32
CONTRA COSTA, COUNTY OF	WNHN774	PW	46.32
CONTRA COSTA, COUNTY OF	WNNN497	PW	46.32
CONTRA COSTA, COUNTY OF	WNQQ717	PW	46.32
CONTRA COSTA, COUNTY OF	WPLG973	PW	46.32
CONTRA COSTA, COUNTY OF	KA3744	PW	46.34
CONTRA COSTA, COUNTY OF	KMK522	PW	46.34
CONTRA COSTA, COUNTY OF	WXP667	PW	46.34
SAN RAMON VALLEY F P D	KMA635	PW	46.34
SAN RAMON VALLEY FIRE DISTRICT	WNNV616	PW	46.34
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNCA815	PW	46.38

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CONTRA COSTA, COUNTY OF	KA3744	PW	46.38
CONTRA COSTA, COUNTY OF	KBQ628	PW	46.38
CONTRA COSTA, COUNTY OF	KDN478	PW	46.38
CONTRA COSTA, COUNTY OF	KDU876	PW	46.38
CONTRA COSTA, COUNTY OF	KEY923	PW	46.38
CONTRA COSTA, COUNTY OF	KEY924	PW	46.38
CONTRA COSTA, COUNTY OF	KJE268	PW	46.38
CONTRA COSTA, COUNTY OF	KMA463	PW	46.38
CONTRA COSTA, COUNTY OF	KMA470	PW	46.38
CONTRA COSTA, COUNTY OF	KMB392	PW	46.38
CONTRA COSTA, COUNTY OF	KMB591	PW	46.38
CONTRA COSTA, COUNTY OF	KMB592	PW	46.38
CONTRA COSTA, COUNTY OF	KMD397	PW	46.38
CONTRA COSTA, COUNTY OF	KMD877	PW	46.38
CONTRA COSTA, COUNTY OF	KMF371	PW	46.38
CONTRA COSTA, COUNTY OF	KMG983	PW	46.38
CONTRA COSTA, COUNTY OF	KMH429	PW	46.38
CONTRA COSTA, COUNTY OF	KMK522	PW	46.38
CONTRA COSTA, COUNTY OF	KNAK321	PW	46.38
CONTRA COSTA, COUNTY OF	KNGL582	PW	46.38
CONTRA COSTA, COUNTY OF	KNGL583	PW	46.38
CONTRA COSTA, COUNTY OF	KTS610	PW	46.38
CONTRA COSTA, COUNTY OF	KYG655	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN757	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN758	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN759	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN760	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN761	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN762	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN763	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN764	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN765	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN766	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN767	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN768	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN769	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN770	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN771	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN772	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN773	PW	46.38
CONTRA COSTA, COUNTY OF	WNHN774	PW	46.38
CONTRA COSTA, COUNTY OF	WNHV253	PW	46.38
CONTRA COSTA, COUNTY OF	WNNN497	PW	46.38
CONTRA COSTA, COUNTY OF	WNPL783	PW	46.38
CONTRA COSTA, COUNTY OF	WNQQ717	PW	46.38
CONTRA COSTA, COUNTY OF	WPLG973	PW	46.38
CONTRA COSTA, COUNTY OF	WSY471	PW	46.38

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CONTRA COSTA, COUNTY OF	WXP667	PW	46.38
EAST DIABLO FIRE DISTRICT	WNHN946	PW	46.38
PINOLE, CITY OF	KME945	PW	46.38
RICHMOND, CITY OF	KMB332	PW	46.38
RICHMOND, CITY OF	WPPF928	PW	46.38
RICHMOND, CITY OF	WPPF929	PW	46.38
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	PW	46.38
RIVERVIEW FIRE PROTECTION DISTRICT	WNKJ969	PW	46.38
RODEO FIRE DISTRICT	KNIZ530	PW	46.38
RODEO FIRE DISTRICT	WNHN947	PW	46.38
SAN RAMON VALLEY F P D	KMA635	PW	46.38
SAN RAMON VALLEY FIRE DISTRICT	WNNV616	PW	46.38
CONTRA COSTA, COUNTY OF	KA3744	PW	46.42
CONTRA COSTA, COUNTY OF	KBQ628	PW	46.42
CONTRA COSTA, COUNTY OF	KMA463	PW	46.42
CONTRA COSTA, COUNTY OF	KMB591	PW	46.42
CONTRA COSTA, COUNTY OF	KYG655	PW	46.42
RICHMOND, CITY OF	KMB332	PW	46.42
RICHMOND, CITY OF	WPPF928	PW	46.42
RICHMOND, CITY OF	WPPF929	PW	46.42
CONTRA COSTA, COUNTY OF	KA3744	PW	46.44
CONTRA COSTA, COUNTY OF	KDN478	PW	46.44
CONTRA COSTA, COUNTY OF	KMK522	PW	46.44
CONTRA COSTA, COUNTY OF	WXP667	PW	46.44
SAN RAMON VALLEY F P D	KMA635	PW	46.44
SAN RAMON VALLEY FIRE DISTRICT	WNQW789	PW	46.44
CONTRA COSTA, COUNTY OF	KA3744	PW	46.48
CONTRA COSTA, COUNTY OF	KMA470	PW	46.48
CONTRA COSTA, COUNTY OF	KMB592	PW	46.48
PINOLE, CITY OF	KME945	PW	46.48
RICHMOND, CITY OF	KMB332	PW	46.48
RICHMOND, CITY OF	WPPF929	PW	46.48
RODEO FIRE DISTRICT	KNIZ530	PW	46.48
RODEO FIRE DISTRICT	WNHN947	PW	46.48
CALIFORNIA, STATE OF	KFR657	PW	47.02
CALIFORNIA, STATE OF	KFR657	PW	47.04
CALIFORNIA, STATE OF	KFR657	PW	47.06
CALIFORNIA, STATE OF	KFR657	PW	47.08
AMERICAN NATIONAL RED CROSS	KDQ287	PW	47.42
AMERICAN RED CROSS BAY AREA	WPHI754	PW	47.46
AMERICAN RED CROSS BAY AREA	WPHI754	PW	47.5
AMERICAN RED CROSS BAY AREA	WPHI754	PW	47.54
AMERICAN RED CROSS BAY AREA	WPHI754	PW	47.58
AMERICAN RED CROSS BAY AREA	WPHI754	PW	47.62
AMERICAN RED CROSS BAY AREA	WPHI754	PW	47.66
MORAGA, TOWN OF	WPAU780	PW	150.995
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNYM827	PW	151.025

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CALIFORNIA, STATE OF	KIZ343	PW	151.205
CALIFORNIA, STATE OF	KMK913	PW	151.205
CALIFORNIA, STATE OF	WPEM924	PW	151.205
CALIFORNIA, STATE OF	WNKY521	PW	151.235
CALIFORNIA, STATE OF	WPDB986	PW	151.355
CALIFORNIA, STATE OF	WPDB985	PW	151.415
CALIFORNIA, STATE OF	WPDB985	PW	151.43
CALIFORNIA, STATE OF	WPDB986	PW	151.445
CALIFORNIA, STATE OF	KDJ572	PW	153.74
CALIFORNIA, STATE OF	KGR355	PW	153.755
CALIFORNIA, STATE OF	KYE982	PW	153.755
RICHMOND, CITY OF	KMM574	PW	153.8
CONCORD, CITY OF	KMK772	PW	153.815
CONCORD, CITY OF	KMK772	PW	153.815
CONTRA COSTA, COUNTY OF	WPSP325	PW	153.815
SAN RAMON VALLEY FIRE DISTRICT	WPUC470	PW	153.815
CONTRA COSTA, COUNTY OF	KA3744	PW	153.83
PINOLE, CITY OF	KME945	PW	153.83
RICHMOND, CITY OF	KMB332	PW	153.83
MT VIEW SANITARY DISTRICT	WPQY787	PW	153.965
CONCORD, CITY OF	KMK772	PW	153.995
CONTRA COSTA, COUNTY OF	WPSP325	PW	153.995
SAN RAMON VALLEY FIRE DISTRICT	WPUC470	PW	153.995
CONCORD, CITY OF	KMK772	PW	154.025
EAST BAY REGIONAL PARK DISTRICT	WRL694	PW	154.07
CALIFORNIA, STATE OF	KMF694	PW	154.16
CONTRA COSTA, COUNTY OF	KA3744	PW	154.205
CONTRA COSTA, COUNTY OF	KBQ628	PW	154.205
CONTRA COSTA, COUNTY OF	KDB502	PW	154.205
CONTRA COSTA, COUNTY OF	KMF371	PW	154.205
CONTRA COSTA, COUNTY OF	KNCZ430	PW	154.205
CONTRA COSTA, COUNTY OF	KYG655	PW	154.205
CONTRA COSTA, COUNTY OF	KYS919	PW	154.205
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	PW	154.205
DUBLIN SAN RAMON SERVICES DISTRICT	KJK522	PW	154.235
EAST BAY REGIONAL PARK DISTRICT	WRL694	PW	154.235
CONTRA COSTA, COUNTY OF	KA3744	PW	154.265
PINOLE, CITY OF	KME945	PW	154.265
CONTRA COSTA, COUNTY OF	KA3744	PW	154.28
CONTRA COSTA, COUNTY OF	KDB502	PW	154.28
CONTRA COSTA, COUNTY OF	KMF371	PW	154.28
DUBLIN SAN RAMON SERVICES DISTRICT	KJK522	PW	154.28
EAST BAY REGIONAL PARK DISTRICT	WRL694	PW	154.28
PINOLE, CITY OF	KME945	PW	154.28
RICHMOND, CITY OF	KMB332	PW	154.28
SAN RAMON VALLEY F P D	KMA635	PW	154.28
CONTRA COSTA, COUNTY OF	KA3744	PW	154.295

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SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	KNFZ630	PW	154.295
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPJ1570	PW	154.295
EAST BAY REGIONAL PARK DISTRICT	WRL694	PW	154.355
CONTRA COSTA, COUNTY OF	KA3744	PW	154.385
CONTRA COSTA, COUNTY OF	KBQ628	PW	154.385
CONTRA COSTA, COUNTY OF	KDB502	PW	154.385
CONTRA COSTA, COUNTY OF	KMF371	PW	154.385
CONTRA COSTA, COUNTY OF	KYG655	PW	154.385
CONTRA COSTA, COUNTY OF	KYS919	PW	154.385
EL CERRITO, CITY OF	WPJH417	PW	154.385
RICHMOND, CITY OF	KMB332	PW	154.385
CALIFORNIA, STATE OF	KMG445	PW	154.68
CALIFORNIA, STATE OF	WPAD599	PW	154.68
CALIFORNIA, STATE OF	KYE982	PW	154.71
CONTRA COSTA, COUNTY OF	KA2988	PW	154.755
CONTRA COSTA, COUNTY OF	KMG264	PW	154.755
CONTRA COSTA, COUNTY OF	KNCE507	PW	154.755
CONTRA COSTA, COUNTY OF	WNZF354	PW	154.755
CONTRA COSTA, COUNTY OF	WPKN371	PW	154.755
CONTRA COSTA, COUNTY OF	WPKN372	PW	154.755
CONTRA COSTA, COUNTY OF	WPKN373	PW	154.755
CONTRA COSTA, COUNTY OF	WPKN374	PW	154.755
CONTRA COSTA, COUNTY OF	WPKN376	PW	154.755
ANTIOCH, CITY OF	WNSB257	PW	154.845
ANTIOCH, CITY OF	WPOX277	PW	154.845
CALIFORNIA STATE UNIVERSITY	KNNK407	PW	154.89
CALIFORNIA, STATE OF	KLU341	PW	154.92
CALIFORNIA, STATE OF	KNHU669	PW	154.92
CALIFORNIA, STATE OF	KNHU670	PW	154.92
CALIFORNIA, STATE OF	KNHU671	PW	154.92
CALIFORNIA, STATE OF	KNHU672	PW	154.92
CALIFORNIA, STATE OF	KNHW257	PW	154.92
CALIFORNIA, STATE OF	KNHY376	PW	154.92
CALIFORNIA, STATE OF	KNHY377	PW	154.92
CALIFORNIA, STATE OF	KNHY378	PW	154.92
CALIFORNIA, STATE OF	KNHY379	PW	154.92
CALIFORNIA, STATE OF	KNHY380	PW	154.92
CALIFORNIA, STATE OF	KQR620	PW	154.92
CALIFORNIA, STATE OF	KRA565	PW	154.92
CALIFORNIA, STATE OF	KRO411	PW	154.92
CALIFORNIA, STATE OF	KRZ240	PW	154.92
CALIFORNIA, STATE OF	WNUX719	PW	154.92
CALIFORNIA, STATE OF	WPBM353	PW	154.92
CALIFORNIA, STATE OF	WPBM355	PW	154.92
CALIFORNIA, STATE OF	WPBM356	PW	154.92
CALIFORNIA, STATE OF	WYK436	PW	154.92
CONTRA COSTA, COUNTY OF	KA2988	PW	154.95

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CONTRA COSTA, COUNTY OF	KMG264	PW	154.95
CONTRA COSTA, COUNTY OF	KNCE507	PW	154.95
CONTRA COSTA, COUNTY OF	KNHP708	PW	154.95
CONTRA COSTA, COUNTY OF	WNZF354	PW	154.95
CONTRA COSTA, COUNTY OF	WPKN371	PW	154.95
CONTRA COSTA, COUNTY OF	WPKN372	PW	154.95
CONTRA COSTA, COUNTY OF	WPKN373	PW	154.95
CONTRA COSTA, COUNTY OF	WPKN374	PW	154.95
CONTRA COSTA, COUNTY OF	WPKN376	PW	154.95
CALIFORNIA, STATE OF	KGR355	PW	154.98
CONCORD, CITY OF	KMK772	PW	154.995
CONTRA COSTA, COUNTY OF	WPSP325	PW	154.995
SAN RAMON VALLEY FIRE DISTRICT	WPUC470	PW	154.995
CONTRA COSTA, COUNTY OF	KNCR633	PW	155.04
CONTRA COSTA, COUNTY OF	KYD927	PW	155.04
CONTRA COSTA, COUNTY OF	WNPM636	PW	155.04
CONTRA COSTA, COUNTY OF	WNPM681	PW	155.04
CONTRA COSTA, COUNTY OF	WPIR557	PW	155.04
ANTIOCH, CITY OF	WNSB257	PW	155.07
ANTIOCH, CITY OF	WPMZ453	PW	155.07
ANTIOCH, CITY OF	WPOX277	PW	155.07
LAFAYETTE, CITY OF	KNJP768	PW	155.115
ORINDA UNION SCHOOL DISTRICT	WNAD765	PW	155.16
PITTSBURG UNIFIED SCHOOL DISTRICT	WNJX883	PW	155.16
CONTRA COSTA, COUNTY OF	KA2988	PW	155.19
CONTRA COSTA, COUNTY OF	KMA371	PW	155.19
CONTRA COSTA, COUNTY OF	KMA499	PW	155.19
CONTRA COSTA, COUNTY OF	KMG264	PW	155.19
CONTRA COSTA, COUNTY OF	KNCE507	PW	155.19
CONTRA COSTA, COUNTY OF	WNZF354	PW	155.19
CONTRA COSTA, COUNTY OF	WPKN371	PW	155.19
CONTRA COSTA, COUNTY OF	WPKN372	PW	155.19
CONTRA COSTA, COUNTY OF	WPKN373	PW	155.19
CONTRA COSTA, COUNTY OF	WPKN374	PW	155.19
CONTRA COSTA, COUNTY OF	WPKN376	PW	155.19
KAISER FOUNDATION HEALTH PLAN INC	KXC738	PW	155.22
CONTRA COSTA, COUNTY OF	KA2988	PW	155.25
CONTRA COSTA, COUNTY OF	KMA371	PW	155.25
CONTRA COSTA, COUNTY OF	KMG264	PW	155.25
CONTRA COSTA, COUNTY OF	KNCE507	PW	155.25
CONTRA COSTA, COUNTY OF	WNZF354	PW	155.25
CONTRA COSTA, COUNTY OF	WPKN371	PW	155.25
CONTRA COSTA, COUNTY OF	WPKN372	PW	155.25
CONTRA COSTA, COUNTY OF	WPKN373	PW	155.25
CONTRA COSTA, COUNTY OF	WPKN374	PW	155.25
CONTRA COSTA, COUNTY OF	WPKN376	PW	155.25
CONTRA COSTA, COUNTY OF	WPNU981	PW	155.25

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CONTRA COSTA, COUNTY OF	KB27868	PW	155.28
JOHN MUIR MEDICAL CENTER	KSP200	PW	155.28
CONTRA COSTA, COUNTY OF	KA2988	PW	155.31
CONTRA COSTA, COUNTY OF	KMA371	PW	155.31
CONTRA COSTA, COUNTY OF	KMA371	PW	155.31
CONTRA COSTA, COUNTY OF	KMG264	PW	155.31
CONTRA COSTA, COUNTY OF	KNCE507	PW	155.31
CONTRA COSTA, COUNTY OF	KNGL587	PW	155.31
CONTRA COSTA, COUNTY OF	WNZF354	PW	155.31
CONTRA COSTA, COUNTY OF	WPKN371	PW	155.31
CONTRA COSTA, COUNTY OF	WPKN372	PW	155.31
CONTRA COSTA, COUNTY OF	WPKN373	PW	155.31
CONTRA COSTA, COUNTY OF	WPKN374	PW	155.31
CONTRA COSTA, COUNTY OF	WPKN376	PW	155.31
WALNUT CREEK, CITY OF	KZE704	PW	155.31
CONTRA COSTA, COUNTY OF	KWO571	PW	155.4
CONTRA COSTA, COUNTY OF	KWO574	PW	155.4
COUNTY HOSPITAL	KWO573	PW	155.4
JOHN MUIR MEDICAL CENTER	KSP200	PW	155.4
LOS MEDANOS COMMUNITY HOSPITAL	KWJ288	PW	155.4
MEDIC AMBULANCE SERVICE	KD50347	PW	155.4
MEDICAL CENTER	WSZ655	PW	155.4
MT DIABLO HOSPITAL	KWI758	PW	155.4
SAN RAMON REGIONAL MEDICAL CENTER	WNQW992	PW	155.4
TENET HEALTH SYSTEM HOSPITALS INC	KQO219	PW	155.4
ANTIOCH, CITY OF	WPMZ453	PW	155.55
ANTIOCH, CITY OF	WPOX277	PW	155.55
BRENTWOOD, CITY OF	KMA691	PW	155.55
ANTIOCH, CITY OF	WNSB257	PW	155.61
ANTIOCH, CITY OF	WPOX277	PW	155.61
CONTRA COSTA, COUNTY OF	KA2988	PW	155.625
CONTRA COSTA, COUNTY OF	KMA499	PW	155.625
CONTRA COSTA, COUNTY OF	WNQE218	PW	155.625
CONTRA COSTA, COUNTY OF	WRU892	PW	155.625
CONTRA COSTA, COUNTY OF	KA2988	PW	155.64
CONTRA COSTA, COUNTY OF	KMA499	PW	155.64
CONTRA COSTA, COUNTY OF	KMG264	PW	155.64
CONTRA COSTA, COUNTY OF	KNCE507	PW	155.64
CONTRA COSTA, COUNTY OF	WNZF354	PW	155.64
CONTRA COSTA, COUNTY OF	WPKN371	PW	155.64
CONTRA COSTA, COUNTY OF	WPKN372	PW	155.64
CONTRA COSTA, COUNTY OF	WPKN373	PW	155.64
CONTRA COSTA, COUNTY OF	WPKN374	PW	155.64
CONTRA COSTA, COUNTY OF	WPKN376	PW	155.64
CALIFORNIA, STATE OF	KYE982	PW	155.67
CONCORD, CITY OF	KMC308	PW	155.67
CONTRA COSTA, COUNTY OF	WCH762	PW	155.67

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PINOLE, CITY OF	KMJ446	PW	155.67
PITTSBURG, CITY OF	KMA779	PW	155.67
RICHMOND, CITY OF	KMA358	PW	155.67
WALNUT CREEK, CITY OF	KZE704	PW	155.67
DANVILLE, CITY OF	KNGN893	PW	155.79
RICHMOND, CITY OF	KMM574	PW	155.82
ANTIOCH, CITY OF	KIZ211	PW	155.88
ANTIOCH, CITY OF	WPNX326	PW	155.88
CONCORD, CITY OF	KMK772	PW	155.88
EL CERRITO, CITY OF	KXA218	PW	155.88
EL CERRITO, CITY OF	WYZ469	PW	155.88
HERCULES, CITY OF	WNVX752	PW	155.88
LAFAYETTE, CITY OF	KNJP768	PW	155.88
MARTINEZ, CITY OF	KML203	PW	155.88
PINOLE, CITY OF	KRM778	PW	155.88
PITTSBURG, CITY OF	KVJ754	PW	155.88
CONTRA COSTA, COUNTY OF	KA2988	PW	155.955
CONTRA COSTA, COUNTY OF	KMG264	PW	155.955
CONTRA COSTA, COUNTY OF	KNCE507	PW	155.955
CONTRA COSTA, COUNTY OF	WNZF354	PW	155.955
CONTRA COSTA, COUNTY OF	WPKN371	PW	155.955
CONTRA COSTA, COUNTY OF	WPKN372	PW	155.955
CONTRA COSTA, COUNTY OF	WPKN373	PW	155.955
CONTRA COSTA, COUNTY OF	WPKN374	PW	155.955
CONTRA COSTA, COUNTY OF	WPKN376	PW	155.955
CONTRA COSTA, COUNTY OF	KD8107	PW	156
CONTRA COSTA, COUNTY OF	KD8107	PW	156.015
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNYM827	PW	156.045
MORAGA, TOWN OF	WPAU780	PW	156.06
WALNUT CREEK, CITY OF	WYK413	PW	156.165
CONTRA COSTA, COUNTY OF	KF4115	PW	156.195
ANTIOCH, CITY OF	WNUK908	PW	156.225
ANTIOCH, CITY OF	WPNX326	PW	156.225
SAN RAMON, CITY OF	WNMG614	PW	156.225
JOHN MUIR MEDICAL CENTER	KNFC871	PW	157.45
ANTIOCH, CITY OF	WPOX277	PW	158.76
MT VIEW SANITARY DISTRICT	WPFS279	PW	158.805
ANTIOCH, CITY OF	WNUK908	PW	158.985
ANTIOCH, CITY OF	WPNX326	PW	158.985
WALNUT CREEK, CITY OF	WYK413	PW	159.12
CALIFORNIA, STATE OF	KZE65	PW	159.135
CONTRA COSTA, COUNTY OF	WNQE218	PW	159.15
SAN RAMON, CITY OF	WNMG614	PW	159.165
CALIFORNIA, STATE OF	KZE65	PW	159.195
CALIFORNIA, STATE OF	KIZ343	PW	159.24
CALIFORNIA, STATE OF	WPEN924	PW	159.24
CALIFORNIA, STATE OF	KIZ343	PW	159.255

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CALIFORNIA, STATE OF	WPEM924	PW	159.255
EAST BAY REGIONAL PARK DISTRICT	KBB840	PW	159.255
CALIFORNIA, STATE OF	WNYS818	PW	159.285
CALIFORNIA, STATE OF	WDK23	PW	159.3
CALIFORNIA, STATE OF	WNYS818	PW	159.3
CALIFORNIA, STATE OF	WDK23	PW	159.345
CALIFORNIA, STATE OF	WNYS818	PW	159.345
CALIFORNIA, STATE OF	KNGG687	PW	159.435
CALIFORNIA, STATE OF	KIZ343	PW	159.465
CALIFORNIA, STATE OF	WPEM924	PW	159.465
CONTRA COSTA, COUNTY OF	WPLT748	PW	159.615
CONTRA COSTA, COUNTY OF	WPLT747	PW	159.735
CONTRA COSTA, COUNTY OF	WPLT749	PW	160.11
METROCALL USA INC	WNAF392	PW	163.25
METROCALL USA INC	WNJG997	PW	163.25
METROCALL USA INC	WNJH205	PW	163.25
METROCALL USA INC	WNXU925	PW	163.25
METROCALL USA INC	WPQD743	PW	163.25
CALIFORNIA, STATE OF	WRV51	PW	169.575
CALIFORNIA, STATE OF	WRV52	PW	169.575
CALIFORNIA, STATE OF	WPDW790	PW	171.825
CALIFORNIA, STATE OF	WPJI545	PW	171.825
CALIFORNIA, STATE OF	WPJM984	PW	171.825
LOS ANGELES, CITY OF	WPQG846	PW	173.075
CONTRA COSTA, COUNTY OF	WG1954	PW	173.39625
CONTRA COSTA, COUNTY OF	WNDT949	PW	453.025
KAISER FOUNDATION HEALTH PLAN INC	WNSC442	PW	453.025
CONTRA COSTA, COUNTY OF	KD30519	PW	453.05
RICHMOND HOUSING AUTHORITY	WPLU389	PW	453.05
CONTRA COSTA, COUNTY OF	WPRH384	PW	453.075
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	KRB579	PW	453.15
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPAT712	PW	453.15
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPAT714	PW	453.15
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPAT715	PW	453.15
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPIP224	PW	453.15
PLEASANT HILL, CITY OF	WPRI244	PW	453.175
RICHMOND, CITY OF	WNUP633	PW	453.1875
WALNUT CREEK, CITY OF	WPGU707	PW	453.2
CONCORD, CITY OF	KD52959	PW	453.2125
CONCORD, CITY OF	WPMM874	PW	453.225
ANTIOCH, CITY OF	WPF269	PW	453.2375
CONCORD, CITY OF	WPMM874	PW	453.3
CONCORD, CITY OF	KD52959	PW	453.3625
CONCORD, CITY OF	WPQG744	PW	453.3625
SAN RAMON VALLEY FIRE DISTRICT	WPRG951	PW	453.425
CONCORD, CITY OF	WPMM874	PW	453.525
CALIFORNIA, STATE OF	WPGA994	PW	453.5375

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PLEASANT HILL, CITY OF	KLE677	PW	453.6
WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT	WPLP534	PW	453.65
CONCORD, CITY OF	WPMM874	PW	453.675
CONTRA COSTA, COUNTY OF	WPMG808	PW	453.7
RICHMOND, CITY OF	WPLD261	PW	453.7125
CALIFORNIA, STATE OF	KYJ333	PW	453.825
OAKLEY, CITY OF	WNXN534	PW	453.8375
CALIFORNIA, STATE OF	WPPD860	PW	453.9
CONTRA COSTA, COUNTY OF	KB92941	PW	453.9125
BRENTWOOD, CITY OF	WPTP981	PW	453.9625
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WNQO261	PW	453.975
CONTRA COSTA, COUNTY OF	WNDR949	PW	458.025
CONTRA COSTA, COUNTY OF	KD30519	PW	458.05
RICHMOND HOUSING AUTHORITY	WPLU389	PW	458.05
SAN RAMON VALLEY FIRE DISTRICT	KB45832	PW	458.075
DANVILLE, TOWN OF	WPMI229	PW	458.1125
LAFAYETTE, CITY OF	WPTS924	PW	458.1125
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPAT714	PW	458.15
PLEASANT HILL, CITY OF	WPRI244	PW	458.175
RICHMOND, CITY OF	WNUP633	PW	458.1875
WALNUT CREEK, CITY OF	WPGU707	PW	458.2
CONCORD, CITY OF	KD52959	PW	458.2125
CONCORD, CITY OF	WPMM874	PW	458.225
ANTIOCH, CITY OF	WPFE269	PW	458.2375
CONCORD, CITY OF	WPMM874	PW	458.3
CONCORD, CITY OF	KD52959	PW	458.3625
CONCORD, CITY OF	WPQG744	PW	458.3625
SAN RAMON VALLEY FIRE DISTRICT	WPRG951	PW	458.425
CONCORD, CITY OF	WPMM874	PW	458.525
CALIFORNIA, STATE OF	WPGA994	PW	458.5375
EAST BAY MUNICIPAL UTILITY DISTRICT	KD35239	PW	458.5875
PLEASANT HILL, CITY OF	KLE677	PW	458.6
WEST CONTRA COSTA UNIFIED SCHOOL DISTRICT	WPLP534	PW	458.65
CONCORD, CITY OF	WPMM874	PW	458.675
EAST BAY MUNICIPAL UTILITY DISTRICT	KD35239	PW	458.6875
CONTRA COSTA, COUNTY OF	WPMG808	PW	458.7
OAKLEY, CITY OF	WNXN534	PW	458.8375
CALIFORNIA, STATE OF	WPPD860	PW	458.9
CONTRA COSTA, COUNTY OF	KD20127	PW	458.9125
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WNQO261	PW	458.975
CALIFORNIA, STATE OF	KNAK237	PW	460.025
CALIFORNIA, STATE OF	KNFF498	PW	460.025
CALIFORNIA, STATE OF	KRX568	PW	460.025
CALIFORNIA, STATE OF	KWX458	PW	460.025
CALIFORNIA, STATE OF	KZO392	PW	460.025
WALNUT CREEK, CITY OF	WNPQ684	PW	460.0625
CONTRA COSTA, COUNTY OF	KA84976	PW	460.1

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CONTRA COSTA, COUNTY OF	KNCM852	PW	460.1
CONTRA COSTA, COUNTY OF	KNCM853	PW	460.1
CONTRA COSTA, COUNTY OF	KNCM854	PW	460.1
CONTRA COSTA, COUNTY OF	KNCM855	PW	460.1
CONTRA COSTA, COUNTY OF	KNCM856	PW	460.1
CONTRA COSTA, COUNTY OF	KNCM857	PW	460.1
CONTRA COSTA, COUNTY OF	KNCM858	PW	460.1
CONTRA COSTA, COUNTY OF	KNCM860	PW	460.1
CONTRA COSTA, COUNTY OF	KNCM862	PW	460.1
CONCORD, CITY OF	KLP745	PW	460.15
SAN PABLO, CITY OF	WXA612	PW	460.15
CONTRA COSTA, COUNTY OF	KNEQ466	PW	460.175
CONCORD, CITY OF	KLP745	PW	460.25
CONTRA COSTA, COUNTY OF	WNVK325	PW	460.275
PLEASANT HILL, CITY OF	KQS776	PW	460.3
RICHMOND, CITY OF	KMA358	PW	460.3
HERCULES, CITY OF	WYC681	PW	460.325
PINOLE, CITY OF	KMJ446	PW	460.325
WALNUT CREEK, CITY OF	KZE704	PW	460.325
EL CERRITO, CITY OF	KTU275	PW	460.375
PITTSBURG, CITY OF	KM6564	PW	460.375
PITTSBURG, CITY OF	KMA779	PW	460.375
EL CERRITO, CITY OF	KTU275	PW	460.4
RICHMOND, CITY OF	KMA358	PW	460.4
HERCULES, CITY OF	WPAM865	PW	460.425
WALNUT CREEK, CITY OF	KZE704	PW	460.425
CONTRA COSTA, COUNTY OF	KD24230	PW	460.4375
CALIFORNIA, STATE OF	KYJ333	PW	460.45
CALIFORNIA, STATE OF	WBC384	PW	460.45
MARTINEZ, CITY OF	KMG537	PW	460.475
RICHMOND, CITY OF	KMA358	PW	460.475
CONTRA COSTA, COUNTY OF	KB80939	PW	460.4875
PLEASANT HILL, CITY OF	KQS776	PW	460.5
CONCORD, CITY OF	WPKV955	PW	460.55
METROCALL USA INC	WNXU925	PW	460.5625
CONTRA COSTA, COUNTY OF	WNZP225	PW	460.575
SAN RAMON VALLEY F P D	KMA635	PW	460.575
MEDIC AMBULANCE SERVICE	KD50347	PW	463
MEDIC AMBULANCE SERVICE	KD50347	PW	463.025
MEDIC AMBULANCE SERVICE	KD50347	PW	463.05
MEDIC AMBULANCE SERVICE	KD50347	PW	463.075
MEDIC AMBULANCE SERVICE	KD50347	PW	463.1
MEDIC AMBULANCE SERVICE	KD50347	PW	463.125
MEDIC AMBULANCE SERVICE	KD50347	PW	463.15
MEDIC AMBULANCE SERVICE	KD50347	PW	463.175
CALIFORNIA, STATE OF	KLU341	PW	465.025
CALIFORNIA, STATE OF	KNAK237	PW	465.025

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WALNUT CREEK, CITY OF	WNPQ684	PW	465.0625
CONCORD, CITY OF	KLP745	PW	465.15
CONTRA COSTA, COUNTY OF	KM6567	PW	465.15
SAN PABLO, CITY OF	WXA612	PW	465.15
CONCORD, CITY OF	KLP745	PW	465.25
CONTRA COSTA, COUNTY OF	KM6567	PW	465.25
CONTRA COSTA, COUNTY OF	WNVK325	PW	465.275
CONTRA COSTA, COUNTY OF	KM6567	PW	465.3
PLEASANT HILL, CITY OF	KQS776	PW	465.3
RICHMOND, CITY OF	KMA358	PW	465.3
CONTRA COSTA, COUNTY OF	KM6567	PW	465.325
HERCULES, CITY OF	WYC681	PW	465.325
PINOLE, CITY OF	KMJ446	PW	465.325
WALNUT CREEK, CITY OF	KZE704	PW	465.325
CONTRA COSTA, COUNTY OF	KM6567	PW	465.375
EL CERRITO, CITY OF	KTU275	PW	465.375
PITTSBURG, CITY OF	KM6564	PW	465.375
CONTRA COSTA, COUNTY OF	KM6567	PW	465.4
EL CERRITO, CITY OF	KTU275	PW	465.4
RICHMOND, CITY OF	KMA358	PW	465.4
CONTRA COSTA, COUNTY OF	KM6567	PW	465.425
HERCULES, CITY OF	WPAM865	PW	465.425
WALNUT CREEK, CITY OF	KZE704	PW	465.425
CALIFORNIA, STATE OF	WBC384	PW	465.45
CONTRA COSTA, COUNTY OF	KM6567	PW	465.475
RICHMOND, CITY OF	KMA358	PW	465.475
PLEASANT HILL, CITY OF	KQS776	PW	465.5
METROCALL USA INC	WNXU925	PW	465.5375
CONCORD, CITY OF	WPKV955	PW	465.55
SAN RAMON VALLEY F P D	KMA635	PW	465.575
MEDIC AMBULANCE SERVICE	KD50347	PW	467.95
MEDIC AMBULANCE SERVICE	KD50347	PW	467.975
MEDIC AMBULANCE SERVICE	KD50347	PW	468
MEDIC AMBULANCE SERVICE	KD50347	PW	468.025
MEDIC AMBULANCE SERVICE	KD50347	PW	468.05
MEDIC AMBULANCE SERVICE	KD50347	PW	468.075
MEDIC AMBULANCE SERVICE	KD50347	PW	468.1
MEDIC AMBULANCE SERVICE	KD50347	PW	468.125
MEDIC AMBULANCE SERVICE	KD50347	PW	468.15
MEDIC AMBULANCE SERVICE	KD50347	PW	468.175
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	KYF631	PW	482.3875
CENTRAL CONTRA COSTA TRANSIT AUTHORITY	WIE818	PW	482.4375
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII639	PW	482.5375
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII640	PW	482.6875
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII641	PW	482.8375
MARTINEZ, CITY OF	WIM386	PW	484.3625
MARTINEZ, CITY OF	WIM386	PW	484.6375

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GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	KYF631	PW	485.3875
CENTRAL CONTRA COSTA TRANSIT AUTHORITY	WIE818	PW	485.4375
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII639	PW	485.5375
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII640	PW	485.6875
GOLDEN GATE BRIDGE HIGHWAY & TRANSPORTATION DISTRICT	WII641	PW	485.8375
MARTINEZ, CITY OF	WIM386	PW	487.3625
MARTINEZ, CITY OF	WIM386	PW	487.6375
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	488.3625
CONTRA COSTA, COUNTY OF	KBF738	PW	488.4375
CONTRA COSTA, COUNTY OF	KBF740	PW	488.4375
CONTRA COSTA, COUNTY OF	KT2538	PW	488.4375
CONTRA COSTA, COUNTY OF	KWX592	PW	488.4375
CONTRA COSTA, COUNTY OF	KWX593	PW	488.4375
CONTRA COSTA, COUNTY OF	KWX594	PW	488.4375
CONTRA COSTA, COUNTY OF	KZD410	PW	488.4375
CONTRA COSTA, COUNTY OF	KZD412	PW	488.4375
CONTRA COSTA, COUNTY OF	WIK382	PW	488.4375
CONTRA COSTA, COUNTY OF	WIK592	PW	488.6125
CONTRA COSTA, COUNTY OF	WIK866	PW	488.6125
EASTERN CONTRA COSTA TRANSIT DISTRICT	WPMV757	PW	488.6375
CONTRA COSTA, COUNTY OF	WIK592	PW	488.6625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	488.7
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	488.7625
CONTRA COSTA, COUNTY OF	KBF738	PW	488.9125
CONTRA COSTA, COUNTY OF	KBF739	PW	488.9125
CONTRA COSTA, COUNTY OF	KBF740	PW	488.9125
CONTRA COSTA, COUNTY OF	KBF741	PW	488.9125
CONTRA COSTA, COUNTY OF	KNS654	PW	488.9125
CONTRA COSTA, COUNTY OF	KT2538	PW	488.9125
CONTRA COSTA, COUNTY OF	KWX591	PW	488.9125
CONTRA COSTA, COUNTY OF	KWX592	PW	488.9125
CONTRA COSTA, COUNTY OF	KWX593	PW	488.9125
CONTRA COSTA, COUNTY OF	KWX594	PW	488.9125
CONTRA COSTA, COUNTY OF	KZD403	PW	488.9125
CONTRA COSTA, COUNTY OF	KZD404	PW	488.9125
CONTRA COSTA, COUNTY OF	KZD406	PW	488.9125
CONTRA COSTA, COUNTY OF	KZD407	PW	488.9125
CONTRA COSTA, COUNTY OF	KZD408	PW	488.9125
CONTRA COSTA, COUNTY OF	KZD409	PW	488.9125
CONTRA COSTA, COUNTY OF	KZD410	PW	488.9125
CONTRA COSTA, COUNTY OF	KZD411	PW	488.9125
CONTRA COSTA, COUNTY OF	KZD412	PW	488.9125
CONTRA COSTA, COUNTY OF	WIK382	PW	488.9125
CONTRA COSTA, COUNTY OF	WIL202	PW	488.9125
CONTRA COSTA, COUNTY OF	WNAS446	PW	488.9125
CENTRAL CONTRA COSTA TRANSIT AUTHORITY	WIE818	PW	489.9625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	490.4625

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ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	490.5625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	490.6125
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	490.6625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	491.3625
CONTRA COSTA, COUNTY OF	KT2538	PW	491.4375
CONTRA COSTA, COUNTY OF	WIK382	PW	491.4375
CONTRA COSTA, COUNTY OF	WPMV687	PW	491.4375
CONTRA COSTA, COUNTY OF	WIK592	PW	491.6125
EASTERN CONTRA COSTA TRANSIT DISTRICT	WPMV757	PW	491.6375
CONTRA COSTA, COUNTY OF	WIK592	PW	491.6625
CONTRA COSTA, COUNTY OF	WIL309	PW	491.6625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	491.7625
CONTRA COSTA, COUNTY OF	KT2538	PW	491.9125
CONTRA COSTA, COUNTY OF	WAL251	PW	491.9125
CONTRA COSTA, COUNTY OF	WAL252	PW	491.9125
CONTRA COSTA, COUNTY OF	WAL254	PW	491.9125
CONTRA COSTA, COUNTY OF	WBL497	PW	491.9125
CONTRA COSTA, COUNTY OF	WBL498	PW	491.9125
CONTRA COSTA, COUNTY OF	WBL500	PW	491.9125
CONTRA COSTA, COUNTY OF	WBL501	PW	491.9125
CONTRA COSTA, COUNTY OF	WBL502	PW	491.9125
CONTRA COSTA, COUNTY OF	WBL503	PW	491.9125
CONTRA COSTA, COUNTY OF	WBL504	PW	491.9125
CONTRA COSTA, COUNTY OF	WBL505	PW	491.9125
CONTRA COSTA, COUNTY OF	WBL506	PW	491.9125
CONTRA COSTA, COUNTY OF	WIK382	PW	491.9125
CONTRA COSTA, COUNTY OF	WNAS446	PW	491.9125
CONTRA COSTA, COUNTY OF	WPMV687	PW	491.9125
CENTRAL CONTRA COSTA TRANSIT AUTHORITY	WIE818	PW	492.9625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	493.4625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	493.5625
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	493.6125
ALAMEDA CONTRA COSTA TRANSIT DISTRICT	WPNT785	YM	493.6625
CONTRA COSTA, COUNTY OF	KNFW213	GP	809.3375
CONTRA COSTA, COUNTY OF	WNFK308	GP	809.3375
MOUNT DIABLO UNIFIED SCHOOL DISTRICT	WNBU652	GP	809.9375
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	GP	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	GP	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	GP	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	GP	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	GP	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	GP	809.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	GP	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	GP	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	GP	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	GP	810.2125

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EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	GP	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	GP	810.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	GP	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	GP	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	GP	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	GP	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	GP	810.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	GP	810.4875
CALIFORNIA, STATE OF	KNCZ499	GP	810.9625
CALIFORNIA, STATE OF	KNEH721	GP	810.9625
CALIFORNIA, STATE OF	WNFQ768	GP	810.9625
CALIFORNIA, STATE OF	WPIW965	GP	810.9625
CONTRA COSTA, COUNTY OF	WNKN697	GP	810.9875
WALNUT CREEK, CITY OF	0000764137	GP	811.2625
ANTIOCH, CITY OF	WPIR316	GP	811.4875
CALIFORNIA, STATE OF	KNEH765	GP	811.9375
CALIFORNIA, STATE OF	WPER997	GP	811.9875
CALIFORNIA, STATE OF	KNEH790	GP	812.9375
CALIFORNIA, STATE OF	WQO941	GP	813.7375
CONCORD, CITY OF	WPKK795	GP	814.4375
RICHMOND, CITY OF	WPKG577	GP	814.4625
DANVILLE, TOWN OF	WPFX881	GP	814.9375
CONTRA COSTA COMMUNITY COLLEGE DISTRICT	WNMM865	GP	815.2375
CONTRA COSTA COMMUNITY COLLEGE DISTRICT	WNMM866	GP	815.2375
PLEASANT HILL, CITY OF	WNMP521	GP	815.4375
CALIFORNIA, STATE OF	WPER997	GP	815.7625
CALIFORNIA, STATE OF	WPMH823	GF	821.0125
RICHMOND, CITY OF	WPGR333	YF	821.1
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	821.175
CALIFORNIA, STATE OF	WPMH823	GF	821.2
AMERICAN RED CROSS BAY AREA	WPFS905	GF	821.2875
WALNUT CREEK, CITY OF	WNXE866	GF	821.3375
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	821.4875
CALIFORNIA, STATE OF	WPMH823	GF	821.5125
RICHMOND, CITY OF	WPGR333	YF	821.75
CALIFORNIA, STATE OF	WPMH823	GF	821.9125
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	821.9875
CALIFORNIA, STATE OF	WPMH823	GF	822.0125
RICHMOND, CITY OF	WPGR333	YF	822.1
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	822.4875
CALIFORNIA, STATE OF	WPMH823	GF	822.5125
RICHMOND, CITY OF	WPGR333	YF	822.625
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPSH605	YF	822.75
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	822.9875
CALIFORNIA, STATE OF	WPMH823	GF	823.0125
CALIFORNIA, STATE OF	WPEH575	GF	823.3875

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CONTRA COSTA, COUNTY OF	WPNT643	GF	823.4125
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	823.4875
CALIFORNIA, STATE OF	WPMH823	GF	823.5125
RICHMOND, CITY OF	WPGR333	YF	823.6125
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	823.8625
CALIFORNIA, STATE OF	WPMH823	GF	823.9875
CONTRA COSTA, COUNTY OF	KNFW213	GP	854.3375
CONTRA COSTA, COUNTY OF	WNFK308	GP	854.3375
MOUNT DIABLO UNIFIED SCHOOL DISTRICT	WNBU652	GP	854.9375
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	GP	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	GP	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	GP	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	GP	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	GP	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	GP	854.9625
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	GP	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	GP	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	GP	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	GP	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	GP	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	GP	855.2125
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC644	GP	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC646	GP	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC647	GP	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC648	GP	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC649	GP	855.4875
EAST BAY MUNICIPAL UTILITY DISTRICT	WNMC650	GP	855.4875
CALIFORNIA, STATE OF	KNCZ499	GP	855.9625
CALIFORNIA, STATE OF	KNEH721	GP	855.9625
CALIFORNIA, STATE OF	WNFQ768	GP	855.9625
CALIFORNIA, STATE OF	WPIW965	GP	855.9625
CONTRA COSTA, COUNTY OF	WNKN697	GP	855.9875
WALNUT CREEK, CITY OF	0000764137	GP	856.2625
ANTIOCH, CITY OF	WPIR316	GP	856.4875
CALIFORNIA, STATE OF	KNEH765	GP	856.9375
CALIFORNIA, STATE OF	WPER997	GP	856.9875
CALIFORNIA, STATE OF	WPAI466	GP	857.7375
CALIFORNIA, STATE OF	KNEH790	GP	857.9375
CALIFORNIA, STATE OF	WQO941	GP	858.7375
CALIFORNIA, STATE OF	WPAI465	GP	858.9875
CONCORD, CITY OF	WPKK795	GP	859.4375
RICHMOND, CITY OF	WPKG577	GP	859.4625
DANVILLE, TOWN OF	WPFX881	GP	859.9375
CONTRA COSTA COMMUNITY COLLEGE DISTRICT	WNMM865	GP	860.2375
CONTRA COSTA COMMUNITY COLLEGE DISTRICT	WNMM866	GP	860.2375
PLEASANT HILL, CITY OF	WNMP521	GP	860.4375
CALIFORNIA, STATE OF	WPER997	GP	860.7625

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CALIFORNIA, STATE OF	WPMH823	GF	866.0125
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	866.075
RICHMOND, CITY OF	WPGR333	YF	866.1
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	866.175
AMERICAN RED CROSS BAY AREA	WPFS905	GF	866.2875
WALNUT CREEK, CITY OF	WNXE866	GF	866.3375
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	866.4875
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	866.725
RICHMOND, CITY OF	WPGR333	YF	866.75
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	866.8875
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	866.9875
RICHMOND, CITY OF	WPGR333	YF	867.1
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	867.375
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	867.4875
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	867.6
RICHMOND, CITY OF	WPGR333	YF	867.625
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPSH605	YF	867.75
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	867.8
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	867.85
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	867.9625
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	867.9875
RICHMOND, CITY OF	WPGR333	YF	868.1
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	868.15
CALIFORNIA, STATE OF	WPEH575	GF	868.3875
CONTRA COSTA, COUNTY OF	WPNT643	GF	868.4125
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	868.4875
CALIFORNIA, STATE OF	WPMH823	GF	868.5125
RICHMOND, CITY OF	WPGR333	YF	868.6125
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPPF534	YF	868.6875
REGENTS OF THE UNIVERSITY OF CALIFORNIA	WNWX384	YF	868.8625
CALIFORNIA, STATE OF	WPMH823	GF	868.9875

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Contra Costa County Public Safety, VHF Licensees

Licensee Name	Callsign / File Number	Service Code	Frequency (MHz)
MORAGA, TOWN OF	WPAU780	PW/PH	150.995
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNYM827	PW/PH	151.025
CALIFORNIA, STATE OF	KIZ343	PW	151.205
CALIFORNIA, STATE OF	KMK913	PW	151.205
CALIFORNIA, STATE OF	WPEN924	PW	151.205
CALIFORNIA, STATE OF	WNKY521	PW	151.235
CALIFORNIA, STATE OF	WPDB986	PW	151.355
CALIFORNIA, STATE OF	WPDB985	PW	151.415
CALIFORNIA, STATE OF	WPDB985	PW	151.43
CALIFORNIA, STATE OF	WPDB986	PW	151.445
CENTRAL CONTRA COSTA SANITARY DISTRICT	KA80144	IW	153.665
CALIFORNIA, STATE OF	KDJ572	PW	153.74
CALIFORNIA, STATE OF	KGR355	PW/PL	153.755
CALIFORNIA, STATE OF	KYE982	PW	153.755
RICHMOND, CITY OF	KMM574	PW	153.8
CONCORD, CITY OF	KMK772	PW	153.815
CONCORD, CITY OF	WNJM788	PL	153.815
CONTRA COSTA, COUNTY OF	WPSP325	PW	153.815
SAN RAMON VALLEY FIRE PROTECTION DISTRICT	WPUC470	PW	153.815
CONTRA COSTA, COUNTY OF	KA3744	PW/PF	153.83
RICHMOND, CITY OF	KMB332	PW	153.83
PINOLE, CITY OF	KME945	PW	153.83
MT VIEW SANITARY DISTRICT	WPQY787	PW	153.965
CONCORD, CITY OF	KMK772	PW	153.995
CONCORD, CITY OF	WNJM788	PL	153.995
CONTRA COSTA, COUNTY OF	WPSP325	PW	153.995
SAN RAMON VALLEY FIRE PROTECTION DISTRICT	WPUC470	PW	153.995
CONCORD, CITY OF	KMK772	PW	154.025
EAST BAY REGIONAL PARK DISTRICT	WRL694	PW/PF	154.07
CALIFORNIA, STATE OF	KMF694	PW	154.16
CONTRA COSTA, COUNTY OF	KA3744	PW/PF	154.205
CONTRA COSTA, COUNTY OF	KBQ628	PW/PF	154.205
CONTRA COSTA, COUNTY OF	KDB502	PW/PF	154.205
CONTRA COSTA, COUNTY OF	KMF371	PW/PF	154.205
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	KNCZ430	PW/PF	154.205
CONTRA COSTA, COUNTY OF	KYG655	PW	154.205
CONTRA COSTA, COUNTY OF	KYS918	PF	154.205
CONTRA COSTA, COUNTY OF	KYS919	PW/PF	154.205
RIVERVIEW FIRE PROTECTION DISTRICT	WNKC953	PW/PF	154.205
DUBLIN SAN RAMON SERVICES DISTRICT	KJK522	PW	154.235
EAST BAY REGIONAL PARK DISTRICT	WRL694	PW/PF	154.235
CONTRA COSTA, COUNTY OF	KA3744	PW	154.265
PINOLE, CITY OF	KME945	PW	154.265
CONTRA COSTA, COUNTY OF	KA3744	PW/PF	154.28
CONTRA COSTA, COUNTY OF	KDB502	PW/PF	154.28
ALBANY, CITY OF	KFO541	PF	154.28
ALBANY, CITY OF	KG3347	PF	154.28

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DUBLIN SAN RAMON SERVICES DISTRICT	KJK522	PW	154.28
SAN RAMON VALLEY FIRE PROTECTION DISTRICT	KMA635	PW	154.28
RICHMOND, CITY OF	KMB332	PW	154.28
PINOLE, CITY OF	KME945	PW	154.28
CONTRA COSTA, COUNTY OF	KMF371	PW/PF	154.28
CONTRA COSTA, COUNTY OF	KYS918	PF	154.28
EAST BAY REGIONAL PARK DISTRICT	WRL694	PW/PF	154.28
CONTRA COSTA, COUNTY OF	KA3744	PW/PF	154.295
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	KNFZ630	PW	154.295
SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT	WPJ570	PW	154.295
EAST BAY REGIONAL PARK DISTRICT	WRL694	PW/PF	154.355
CONTRA COSTA, COUNTY OF	KA3744	PW/PF	154.385
CONTRA COSTA, COUNTY OF	KBQ628	PW/PF	154.385
CONTRA COSTA, COUNTY OF	KDB502	PW/PF	154.385
ALBANY, CITY OF	KFO541	PF	154.385
ALBANY, CITY OF	KG3347	PF	154.385
RICHMOND, CITY OF	KMB332	PW	154.385
CONTRA COSTA, COUNTY OF	KMF371	PW/PF	154.385
CONTRA COSTA, COUNTY OF	KYG655	PW/PF	154.385
CONTRA COSTA, COUNTY OF	KYS918	PF	154.385
CONTRA COSTA, COUNTY OF	KYS919	PW/PF	154.385
EL CERRITO, CITY OF	WPJH417	PW	154.385
CONTRA COSTA COMMUNITY COLLEGE DIST.	KUX587	IB	154.515
DIABLO VALLEY COLLEGE	KA9906	IB	154.57
CALIFORNIA, STATE OF	KMG445	PW	154.68
CALIFORNIA, STATE OF	WPAD599	PW	154.68
CALIFORNIA, STATE OF	KYE982	PW	154.71
CONTRA COSTA, COUNTY OF	KA2988	PW/PP	154.755
CONTRA COSTA, COUNTY OF	KMG264	PW/PP	154.755
CONTRA COSTA, COUNTY OF	KNCE507	PW/PP	154.755
CONTRA COSTA, COUNTY OF	WNZF354	PW/PP	154.755
CONTRA COSTA, COUNTY OF	WPKN371	PW/PP	154.755
CONTRA COSTA, COUNTY OF	WPKN372	PW/PP	154.755
CONTRA COSTA, COUNTY OF	WPKN373	PW/PP	154.755
CONTRA COSTA, COUNTY OF	WPKN374	PW/PP	154.755
CONTRA COSTA, COUNTY OF	WPKN375	PP	154.755
CONTRA COSTA, COUNTY OF	WPKN376	PW/PP	154.755
ANTIOCH, CITY OF	WNSB257	PW/PP	154.845
ANTIOCH, CITY OF	WPOX277	PW	154.845
CALIFORNIA STATE UNIVERSITY	KNNK407	PW	154.89
CALIFORNIA, STATE OF	KLU341	PW	154.92
CALIFORNIA, STATE OF	KNHU669	PW/PP	154.92
CALIFORNIA, STATE OF	KNHU670	PW	154.92
CALIFORNIA, STATE OF	KNHU671	PW	154.92
CALIFORNIA, STATE OF	KNHU672	PW	154.92
CALIFORNIA, STATE OF	KNHW257	PW	154.92
CALIFORNIA, STATE OF	KNHY376	PW	154.92
CALIFORNIA, STATE OF	KNHY377	PW	154.92
CALIFORNIA, STATE OF	KNHY378	PW	154.92
CALIFORNIA, STATE OF	KNHY379	PW	154.92
CALIFORNIA, STATE OF	KNHY380	PW	154.92
CALIFORNIA, STATE OF	KQR620	PW	154.92
CALIFORNIA, STATE OF	KRA565	PW	154.92

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CALIFORNIA, STATE OF	KRO411	PW	154.92
CALIFORNIA, STATE OF	KRZ240	PW	154.92
CALIFORNIA, STATE OF	WNUX719	PW	154.92
CALIFORNIA, STATE OF	WPBM353	PW/PP	154.92
CALIFORNIA, STATE OF	WPBM355	PW/PP	154.92
CALIFORNIA, STATE OF	WPBM356	PW/PP	154.92
CALIFORNIA, STATE OF	WYK436	PW	154.92
CONTRA COSTA, COUNTY OF	KA2988	PW/PP	154.95
CONTRA COSTA, COUNTY OF	KMG264	PW/PP	154.95
CONTRA COSTA, COUNTY OF	KNCE507	PW/PP	154.95
CONTRA COSTA, COUNTY OF	KNHP708	PW/PP	154.95
CONTRA COSTA, COUNTY OF	WNZF354	PW/PP	154.95
CONTRA COSTA, COUNTY OF	WPKN371	PW/PP	154.95
CONTRA COSTA, COUNTY OF	WPKN372	PW/PP	154.95
CONTRA COSTA, COUNTY OF	WPKN373	PW/PP	154.95
CONTRA COSTA, COUNTY OF	WPKN374	PW/PP	154.95
CONTRA COSTA, COUNTY OF	WPKN376	PW/PP	154.95
CALIFORNIA, STATE OF	KGR355	PW/PF	154.98
CONCORD, CITY OF	KMK772	PW	154.995
CONTRA COSTA, COUNTY OF	WPSP325	PW	154.995
SAN RAMON VALLEY FIRE PROTECTION DISTRICT	WPUC470	PW	154.995
CONTRA COSTA, COUNTY OF	KNCR633	PW/PL	155.04
CONTRA COSTA, COUNTY OF	KV2192	PL	155.04
CONTRA COSTA, COUNTY OF	KYD927	PW/PL	155.04
CONTRA COSTA, COUNTY OF	WNPM636	PW/PL	155.04
CONTRA COSTA, COUNTY OF	WNPM681	PW/PL	155.04
CONTRA COSTA, COUNTY OF	WPIR557	PW/PL	155.04
ANTIOCH, CITY OF	WNSB257	PW/PL	155.07
ANTIOCH, CITY OF	WPMZ453	PW	155.07
ANTIOCH, CITY OF	WPQX277	PW/PL	155.07
LAFAYETTE, CITY OF	KNJP768	PW/PL	155.115
ORINDA UNION SCHOOL DISTRICT	WNAD765	PW	155.16
PITTSBURG UNIFIED SCHOOL DISTRICT	WNJX883	PW	155.16
CONTRA COSTA, COUNTY OF	KA2988	PW/PP	155.19
CONTRA COSTA, COUNTY OF	KJC967	PP	155.19
CONTRA COSTA, COUNTY OF	KMA371	PW/PP	155.19
CONTRA COSTA, COUNTY OF	KMA499	PW/PP	155.19
CONTRA COSTA, COUNTY OF	KMG264	PW/PP	155.19
CONTRA COSTA, COUNTY OF	KNCE507	PW/PP	155.19
CONTRA COSTA, COUNTY OF	WNZF354	PW/PP	155.19
CONTRA COSTA, COUNTY OF	WPKN371	PW/PP	155.19
CONTRA COSTA, COUNTY OF	WPKN372	PW/PP	155.19
CONTRA COSTA, COUNTY OF	WPKN373	PW/PP	155.19
CONTRA COSTA, COUNTY OF	WPKN374	PW/PP	155.19
CONTRA COSTA, COUNTY OF	WPKN375	PP	155.19
CONTRA COSTA, COUNTY OF	WPKN376	PW/PP	155.19
KAISER FOUNDATION HEALTH PLAN INC	KXC738	PW	155.22
CONTRA COSTA, COUNTY OF	KA2988	PW/PP	155.25
CONTRA COSTA, COUNTY OF	KMA371	PW/PP	155.25
CONTRA COSTA, COUNTY OF	KMG264	PW/PP	155.25
CONTRA COSTA, COUNTY OF	KNCE507	PW/PP	155.25
CONTRA COSTA, COUNTY OF	WNZF354	PW/PP	155.25
CONTRA COSTA, COUNTY OF	WPKN371	PW/PP	155.25

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CONTRA COSTA, COUNTY OF	WPKN372	PW/PP	155.25
CONTRA COSTA, COUNTY OF	WPKN373	PW/PP	155.25
CONTRA COSTA, COUNTY OF	WPKN374	PW/PP	155.25
CONTRA COSTA, COUNTY OF	WPKN375	PP	155.25
CONTRA COSTA, COUNTY OF	WPKN376	PW/PP	155.25
CONTRA COSTA, COUNTY OF	WPNU981	PW	155.25
CONTRA COSTA, COUNTY OF	KB27868	PW/PS	155.28
JOHN MUIR MEDICAL CENTER	KSP200	PW	155.28
CONTRA COSTA, COUNTY OF	KA2988	PW/PP	155.31
CONTRA COSTA, COUNTY OF	KJC967	PP	155.31
CONTRA COSTA, COUNTY OF	KMA371	PW/PP	155.31
CONTRA COSTA, COUNTY OF	KMG264	PW/PP	155.31
CONTRA COSTA, COUNTY OF	KNCE507	PW/PP	155.31
CONTRA COSTA, COUNTY OF	KNGL587	PW/PP	155.31
WALNUT CREEK, CITY OF	KZE704	PW	155.31
CONTRA COSTA, COUNTY OF	WNZF354	PW/PP	155.31
CONTRA COSTA, COUNTY OF	WPKN371	PW/PP	155.31
CONTRA COSTA, COUNTY OF	WPKN372	PW/PP	155.31
CONTRA COSTA, COUNTY OF	WPKN373	PW/PP	155.31
CONTRA COSTA, COUNTY OF	WPKN374	PW/PP	155.31
CONTRA COSTA, COUNTY OF	WPKN375	PP	155.31
CONTRA COSTA, COUNTY OF	WPKN376	PW/PP	155.31
MEDIC AMBULANCE SERVICE	KD50347	PW	155.4
TENET HEALTH SYSTEM HOSPITALS INC	KQO219	PW	155.4
JOHN MUIR MEDICAL CENTER	KSP200	PW	155.4
MT DIABLO HOSPITAL	KWI758	PW	155.4
LOS MEDANOS COMMUNITY HOSPITAL	KWJ288	PW/PS	155.4
CONTRA COSTA, COUNTY OF	KWO571	PW/PS	155.4
COUNTY HOSPITAL	KWO573	PW/PS	155.4
CONTRA COSTA, COUNTY OF	KWO574	PW/PS	155.4
SAN RAMON REGIONAL MEDICAL CENTER	WNQW992	PW	155.4
MEDICAL CENTER	WSZ655	PW/PS	155.4
BRENTWOOD, CITY OF	KMA691	PW	155.55
ANTIOCH, CITY OF	WPMZ453	PW	155.55
ANTIOCH, CITY OF	WPOX277	PW	155.55
ANTIOCH, CITY OF	WNSB257	PW/PP	155.61
ANTIOCH, CITY OF	WPOX277	PW	155.61
CONTRA COSTA, COUNTY OF	KA2988	PW/PP	155.625
CONTRA COSTA, COUNTY OF	KMA499	PW/PP	155.625
CONTRA COSTA, COUNTY OF	WNQE218	PW	155.625
CONTRA COSTA, COUNTY OF	WRU892	PW/PP	155.625
CONTRA COSTA, COUNTY OF	KA2988	PW/PP	155.64
CONTRA COSTA, COUNTY OF	KJC967	PP	155.64
CONTRA COSTA, COUNTY OF	KMA499	PW/PP	155.64
CONTRA COSTA, COUNTY OF	KMG264	PW/PP	155.64
CONTRA COSTA, COUNTY OF	KNCE507	PW/PP	155.64
CONTRA COSTA, COUNTY OF	WNZF354	PW/PP	155.64
CONTRA COSTA, COUNTY OF	WPKN371	PW/PP	155.64
CONTRA COSTA, COUNTY OF	WPKN372	PW/PP	155.64
CONTRA COSTA, COUNTY OF	WPKN373	PW/PP	155.64
CONTRA COSTA, COUNTY OF	WPKN374	PW/PP	155.64
CONTRA COSTA, COUNTY OF	WPKN375	PP	155.64
CONTRA COSTA, COUNTY OF	WPKN376	PW/PP	155.64

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CONTRA COSTA, COUNTY OF	KJC967	PP	155.67
RICHMOND, CITY OF	KMA358	PW	155.67
PITTSBURG, CITY OF	KMA779	PW/PP	155.67
CONCORD, CITY OF	KMC308	PW	155.67
PINOLE, CITY OF	KMJ446	PW	155.67
CALIFORNIA, STATE OF	KYE982	PW	155.67
WALNUT CREEK, CITY OF	KZE704	PW	155.67
CONTRA COSTA, COUNTY OF	WCH762	PW/PP	155.67
CONTRA COSTA, COUNTY OF	WCL694	PP	155.67
DANVILLE, CITY OF	KNGN893	PW/PP	155.79
RICHMOND, CITY OF	KMM574	PW	155.82
EL CERRITO, CITY OF	KA48230	PL	155.88
ANTIOCH, CITY OF	KIZ211	PW/PL	155.88
CONCORD, CITY OF	KMK772	PW	155.88
MARTINEZ, CITY OF	KML203	PW	155.88
LAFAYETTE, CITY OF	KNJP768	PW/PL	155.88
PINOLE, CITY OF	KRM778	PW	155.88
PITTSBURG, CITY OF	KVJ754	PW/PL	155.88
EL CERRITO, CITY OF	KXA218	PW/PL	155.88
HERCULES, CITY OF	WNVX752	PW	155.88
ANTIOCH, CITY OF	WPNX326	PW	155.88
EL CERRITO, CITY OF	WYZ469	PW/PL	155.88
CONTRA COSTA, COUNTY OF	KA2988	PW/PP	155.955
CONTRA COSTA, COUNTY OF	KMG264	PW/PP	155.955
CONTRA COSTA, COUNTY OF	KNCE507	PW/PP	155.955
CONTRA COSTA, COUNTY OF	WNZF354	PW/PP	155.955
CONTRA COSTA, COUNTY OF	WPKN371	PW/PP	155.955
CONTRA COSTA, COUNTY OF	WPKN372	PW/PP	155.955
CONTRA COSTA, COUNTY OF	WPKN373	PW/PP	155.955
CONTRA COSTA, COUNTY OF	WPKN374	PW/PP	155.955
CONTRA COSTA, COUNTY OF	WPKN375	PP	155.955
CONTRA COSTA, COUNTY OF	WPKN376	PW/PP	155.955
CONTRA COSTA, COUNTY OF	KD8107	PW/PL	156
CONTRA COSTA, COUNTY OF	WO6421	Shp	156
CONTRA COSTA, COUNTY OF	WRQ4098	Shp	156
CONTRA COSTA, COUNTY OF	KD8107	PW/PL	156.015
CONTRA COSTA COUNTY FIRE PROTECTION DISTRICT	WNYM827	PW/PH	156.045
MORAGA, TOWN OF	WPAU780	PW/PH	156.06
WALNUT CREEK, CITY OF	WYK413	PW	156.165
CONTRA COSTA, COUNTY OF	KF4115	PW/PH	156.195
SAN RAMON, CITY OF	WNMG614	PW	156.225
ANTIOCH, CITY OF	WNUK908	PW/PH	156.225
ANTIOCH, CITY OF	WPNX326	PW	156.225
CONTRA COSTA, COUNTY OF	WHU432	MC	156.45
CONTRA COSTA, COUNTY OF	WHU432	MC	156.8
CONTRA COSTA, COUNTY OF	WHU432	MC	156.925
JOHN MUIR MEDICAL CENTER	KNFC871	PW	157.45
ANTIOCH, CITY OF	WPOX277	PW	158.76
MT VIEW SANITARY DISTRICT	WPFS279	PW	158.805
ANTIOCH, CITY OF	WNUK908	PW/PH	158.985
ANTIOCH, CITY OF	WPNX326	PW	158.985
WALNUT CREEK, CITY OF	WYK413	PW	159.12
CALIFORNIA, STATE OF	KZE65	PW	159.135

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CONTRA COSTA, COUNTY OF	WNQE218	PW/PP	159.15
SAN RAMON, CITY OF	WNMG614	PW	159.165
CALIFORNIA, STATE OF	KZE65	PW	159.195
CALIFORNIA, STATE OF	KIZ343	PW	159.24
CALIFORNIA, STATE OF	WPEM924	PW	159.24
EAST BAY REGIONAL PARK DISTRICT	KBB840	PW	159.255
CALIFORNIA, STATE OF	KIZ343	PW	159.255
CALIFORNIA, STATE OF	WPEM924	PW	159.255
CALIFORNIA, STATE OF	WNYS818	PW	159.285
CALIFORNIA, STATE OF	WVK23	PW	159.3
CALIFORNIA, STATE OF	WNYS818	PW	159.3
CALIFORNIA, STATE OF	WVK23	PW	159.345
CALIFORNIA, STATE OF	WNYS818	PW	159.345
CALIFORNIA, STATE OF	KNGG687	PW	159.435
CALIFORNIA, STATE OF	KIZ343	PW	159.465
CALIFORNIA, STATE OF	WPEM924	PW	159.465
CONTRA COSTA, COUNTY OF	WPLT748	PW	159.615
CONTRA COSTA, COUNTY OF	WPLT747	PW	159.735
CONTRA COSTA, COUNTY OF	WPLT749	PW/MO	160.11
METROCALL USA INC	WNAF392	PW	163.25
METROCALL USA INC	WNJG997	PW	163.25
METROCALL USA INC	WNJH205	PW	163.25
METROCALL USA INC	WNXU925	PW	163.25
METROCALL USA INC	WPQD743	PW	163.25
CALIFORNIA, STATE OF	WRV51	PW	169.575
CALIFORNIA, STATE OF	WRV52	PW	169.575
CALIFORNIA, STATE OF	WPDW790	PW	171.825
CALIFORNIA, STATE OF	WPJ1545	PW	171.825
CALIFORNIA, STATE OF	WPJM984	PW	171.825
LOS ANGELES, CITY OF	WPQG846	PW	173.075
CONTRA COSTA, COUNTY OF	WGI954	PWPL	173.39625

Notes:

Shared = Multiple Licensees or Call signs

Totals:

Entries = 290

Unique frequencies = 90

Shared frequencies = 43

Unique Licensees = 41

Appendix D. Channel Variety for Interoperability and Tactical Information

The following table contains a roster of channels as they are currently assigned and used by public safety agencies in the County. It does not contain all the individual VHF frequencies licensed in the County, which are presented in Appendix C.

Channel Number	Receive Frequency	Transmit Frequency	Channel Name	Channel Use
1	155.310	154.755	WEST P1	Countywide system dispatch channel
2	155.250	155.955	CENT P2	Countywide system dispatch channel
3	155.190	155.640	EAST P3	Countywide system dispatch channel
4	154.920	154.920	CLEMARS	California law enforcement interoperability
5	154.950	154.950	TAC W T1	County tactical channel
6	155.790	155.790	TAC C T2	County tactical channel
7	155.625	155.625	TAC E T3	County tactical channel
8	155.040	155.040	TAC CNTY	County tactical channel
9	155.280	155.280	SAR P22	Search and rescue channel
10	156.075	156.075	CALCORD	California coordination channel
11	154.935	154.935	CLEMARS2	California law enforcement interoperability
12	154.280	154.280	FIRE WT1	Fire protection "white" channel
13	154.265	154.265	FIRE WT2	Fire protection "white" channel
14	155.160	155.160	MRA	Mountain rescue association
15	153.755	153.755	OES SIMP	Office of emergency services channel
16	153.755	154.980	OES DIAB	Office of emergency services channel
17	153.755	154.980	OES TAM	Office of emergency services channel
18	153.755	154.980	OES LOMA	Office of emergency services channel
19	153.755	154.980	OES HELE	Office of emergency services channel
20	153.755	154.980	OES ZION	Office of emergency services channel
21	154.845	155.610	ANTIOCH	Antioch police dispatch channel
22	155.070	155.070	ANT TAC	Antioch police tactical channel
23	155.910	155.010	VALLEJO	Border area channel
24	155.775	154.815	BENICIA	Border area channel
25	155.490	158.790	SOLANO	Border area channel
26	151.580	158.190	CCWD	County water district channel
27	154.905	154.905	CHP EXT	California highway patrol channel
28	157.050	157.050	USCG 21	US coast guard channel
29	157.100	157.100	USCG22	US coast guard channel
30	157.150	157.150	USCG23	US coast guard channel
31	157.175	157.175	USCG 83	US coast guard channel
32	162.550		162.55WX	Weather frequency
33	162.400		162.40WX	Weather frequency

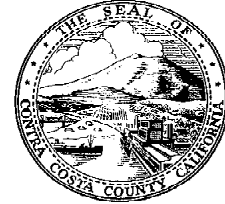
**Appendix E. Contra Costa County Public Safety Radio Needs
Assessment Report, Federal Engineering, April 2000
(Table of Contents only)**

This needs assessment report is the result of the first part of this Master Planning project. Contents of the report appear below. The entire report and its attachments are available in electronic form.

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Appendix F. Letter from Steve Overacker to Terry Betts, 8/27/2001

Contra Costa County
Department of Information Technology
 30 Douglas Drive
 Martinez, California 94553-4068
 V: 925-313-1200
 F: 925-313-1459



TeleCommunications
 2467 Waterbird Way
 Martinez, California 94553-1457
 V: 925-957-7700
 F: 925-646-2111

August 27, 2001

Mr. Terry Betts
 Communications Manager
 Contra Costa Sheriff's Office
 30 Glacier Drive
 Martinez, CA 94553

Dear Terry,

After further discussion we revised the frequencies for your project. Randy found that Lafayette no longer uses 155.115 MHz and there is a potential to pick up that frequency for the Sheriff's Office. Here are the results of our discussions:

CH	Hilltop Frequency		Transmit Sites	Coverage Area
	Transmit	Receive		
P1	155.310 (e)	155.625 (n)	Nichol, Cummings	West County
P2	155.115 (n)	159.150 (n)	Bald (directional antenna)	LaMorinda Area
P3	155.190 (e)	155.640 (e)	Kregor, Cummings, Highland	North Central to Bay Point
P4	155.250 (e)	155.955 (e)	Highland, Rocky, Kregor, Bald	Central County South
P5	154.755 (n)	159.150 (n)	Oakley	Far East County

(n) = new, (e) = existing

Some qualifications besides getting 155.115 MHz. Note we are receiving on adjacent channels 155.625 and 155.640 MHz. It may be best to receive P3 at Pine Street or 40 Glacier and not at Cummings to minimize self-interference. We suggest that jail frequencies be moved from 159.150 MHz to 154.95 MHz. 154.95 (TAC WEST, T1), 155.79 (TAC CENT, T2) and 155.04 (TAC CNTY, L5) would still be available as they are today. There is a potential of co-channel interference between P2 in and P5 in (even with different DPL). The solution may require all low level receive sites for P2. All of this is subject to coordination.

Please look over this information and see if it meets the Sheriff's needs. Please respond as quickly as possible so I can get design and licensing work started.

Sincerely,

Steve Overacker
 Telecommunication Manager

Appendix G. County-Owned Microwave Interconnect

Supplied in a separate electronic file are three diagrams that reflect the current County-owned microwave system.

- ◆ System Layout, Rev. 12/23/99. This is a network diagram showing the locations of loop sites, spur sites, dispatch locations, and T-carrier links.
- ◆ 19Loops Diagram, Rev. 7/18/00. This diagrams the multiplexed loops extending from the main hub at the Glacier site to the remaining repeater sites, and shows spurs from those points.
- ◆ T-1 Plan, Rev. 12/23/99. This diagram shows the landlines interconnecting the microwave sites.

Appendix H. Analysis of Sheriff’s Office Radio Traffic Statistics

Sheriff’s Office officials supplied statistical data in tabular form describing radio dispatch activity for the existing countywide system. Of particular interest is the count of dispatcher microphone key actions for 187 consecutive days from Saturday, October 14, 2001 through Wednesday, April 18, 2002. The collection of this data was recommended in the “Communications Study for 2001” paper presented by Alan Burton. Channels studied are designated P1, P2, P3, and P7, providing coverage as shown below:

- ◆ P1 = West County
- ◆ P2 = Central County
- ◆ P3 = East County
- ◆ P7 = City of Pittsburg

Source of the Data

The data represent each instance where the dispatcher activated the push-to-talk (PTT) switch to speak to a unit in the field. The duration of the transmission is unknown. Data was generated by electronic counters connected to the console positions for each channel. Data for Channels P1 and P2 were accepted as presented. Data for P3 was halved because of double counting by the electronic counter. Data for P7 was reduced by the halved P3 data because the electronic counter combines the two Channels when dispatched from the same console.

Interpretation of the Data

This data may be used to represent the relative volume of traffic dispatched on each channel and the total for the dispatch center. Channel loading cannot be estimated from this data, however, since the corresponding duration of speech is unknown. Also unknown is the quantity and duration of the field unit. Nor can any conclusions be drawn regarding the urgency or priority of the communications, the number of field units involved, the time to clear an incident, etc. Basic statistical analysis was performed on the corrected data as shown below:

	P1	P2	P3	P7	Total
Sum	439,437	523,692	538,178	409,126	1,910,433
Mean	2,350	2,800	2,878	2,188	10,216
Median	2,302	2,813	2,891	2,182	10,102
Mode	2,328	2,692	2,736	2,157	10,815
Std. Dev.	571	493	517	528	1,620
Low	0	1,723	882	329	6,749
High	7,797	5,916	6,321	5,153	22,063

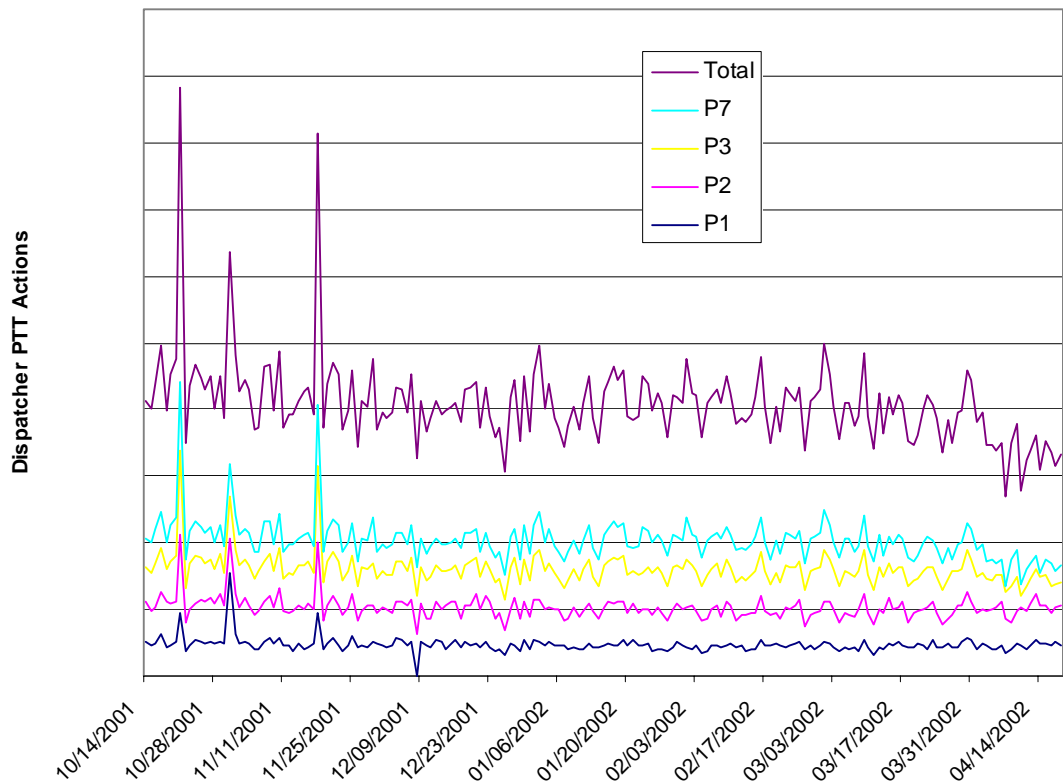
- ◆ The sum is the total dispatcher microphone key actions per channel for the 187-day period.
- ◆ Mean is the common average, a number that might not actually be present in the data.

Contra Costa County Public Safety Mobile Radio Master Plan

- ◆ Median is the most central number actually contained in the data table.
- ◆ Mode is the most frequently represented actual number.
- ◆ Standard Deviation is a measure of dispersion around the Mean value; approximately 2/3 of the data points occur within 1/2 of the Standard Deviation of the Mean. Larger standard deviation values relative to the mean imply the data is spread-out; smaller values imply the data is more tightly confined to the mean value.
- ◆ The lowest and highest occurring data points are also shown. The zero shown for P1 is probably an anomaly of the data.

Summary Conclusions

Channels P1, P2, and P3 provide communications for 32 Sheriff patrol beats as well as seven local police departments³⁵ including five contract municipalities. The shapes of the Sheriff patrol beats exhibit an amoeba-like appearance on the map, with several seriously fragmented throughout the County geography. Given these facts, the statistics for the four channels are remarkably similar to each other. The close statistical similarities suggest two conclusions: (1) message dispatch activity appears balanced channel-to-channel, and (3) similar levels of police activity appear to occur throughout the County



³⁵ Danville, Lafayette, Moraga, Oakley, Orinda, Pittsburg, and San Ramon
Federal Engineering, Inc.
June 18, 2002

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The graphical representation of the data shown on the above chart confirms the numerical statistics. Most of the data points do not appear to deviate significantly far above or below the average level of activity. Furthermore, the level of dispatch activity appears relatively constant day-to-day. The fall-off of total activity from the end of March of 2002 may be the result of separating P3 from P7 dispatch functions or an anomaly in the data. Reasons for the three peak activity spikes noted from October through November of last year are unknown.

Individual Channel Analysis

The top 20 peak and low daily figures are shown for each channel. The data points appear to be randomly distributed without apparent correlation to the date or day of the week.

Channel P1

Peak	PTT-1	Date	Day	Low	PTT-1	Date	Day
1	7797	10/31/01	Wed	1	0	12/08/01	Sat
2	4790	11/18/01	Sun	2	1633	12/26/01	Wed
3	4673	10/21/01	Sun	3	1633	03/11/02	Mon
4	3111	10/17/01	Wed	4	1775	02/04/02	Mon
5	3082	11/01/01	Thu	5	1780	04/07/02	Sun
6	2995	11/25/01	Sun	6	1856	12/24/01	Mon
7	2930	11/08/01	Thu	7	1866	01/28/02	Mon
8	2892	11/10/01	Sat	8	1875	02/05/02	Tue
9	2883	11/21/01	Wed	9	1877	11/13/01	Tue
10	2871	03/30/02	Sat	10	1886	03/08/02	Fri
11	2849	12/04/01	Tue	11	1897	01/25/02	Fri
12	2785	03/23/02	Sat	12	1897	03/04/02	Mon
13	2775	01/21/02	Mon	13	1909	10/22/01	Mon
14	2769	12/05/01	Wed	14	1911	12/29/01	Sat
15	2746	12/12/01	Wed	15	1926	11/23/01	Fri
16	2738	04/13/02	Sat	16	1926	02/13/02	Wed
17	2735	02/16/02	Sat	17	1943	12/14/01	Fri
18	2734	03/31/02	Sun	18	1943	01/27/02	Sun
19	2728	03/09/02	Sat	19	1952	03/13/02	Wed
20	2714	01/01/02	Tue	20	1955	04/08/02	Mon

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Channel P2

Peak	PTT-2	Date	Day
1	5916	10/21/01	Sun
2	5202	11/18/01	Sun
3	3749	12/20/01	Thu
4	3672	10/29/01	Mon
5	3631	11/10/01	Sat
6	3572	12/28/01	Fri
7	3485	10/18/01	Thu
8	3476	12/23/01	Sun
9	3450	03/14/02	Thu
10	3436	03/30/02	Sat
11	3434	12/22/01	Sat
12	3427	03/09/02	Sat
13	3403	01/18/02	Fri
14	3364	04/13/02	Sat
15	3362	11/16/01	Fri
16	3360	10/27/01	Sat
17	3358	04/06/02	Sat
18	3349	02/09/02	Sat
19	3329	03/17/02	Sun
20	3292	12/14/01	Fri

Low	PTT-2	Date	Day
1	1732	02/25/02	Mon
2	1766	12/26/01	Wed
3	1791	03/25/02	Mon
4	1861	03/18/02	Mon
5	1867	01/07/02	Mon
6	1972	02/11/02	Mon
7	1982	03/26/02	Tue
8	2048	11/19/01	Mon
9	2050	12/10/01	Mon
10	2055	03/04/02	Mon
11	2064	11/26/01	Mon
12	2066	10/22/01	Mon
13	2067	02/20/02	Wed
14	2116	04/08/02	Mon
15	2136	12/17/01	Mon
16	2162	12/11/01	Tue
17	2183	03/11/02	Mon
18	2184	01/14/02	Mon
19	2211	02/26/02	Tue
20	2217	01/08/02	Tue

Channel P3

Peak	PTT-3	Date	Day
1	6321	10/21/01	Sun
2	5816	11/18/01	Sun
3	3870	03/01/02	Fri
4	3676	01/02/02	Wed
5	3558	10/24/01	Wed
6	3555	02/01/02	Fri
7	3552	01/17/02	Thu
8	3435	10/23/01	Tue
9	3418	10/20/01	Sat
10	3389	03/27/02	Wed
11	3367	10/17/01	Wed
12	3365	02/16/02	Sat
13	3345	11/27/01	Tue
14	3343	11/22/01	Thu
15	3328	01/19/02	Sat
16	3328	03/09/02	Sat
17	3323	02/26/02	Tue
18	3306	02/28/02	Thu
19	3287	11/15/01	Thu
20	3272	02/27/02	Wed

Low	PTT-3	Date	Day
1	882	04/10/02	Wed
2	1707	04/18/02	Thu
3	1741	04/17/02	Wed
4	1801	04/11/02	Thu
5	1828	04/12/02	Fri
6	1921	04/07/02	Sun
7	1962	04/13/02	Sat
8	2040	04/06/02	Sat
9	2080	04/16/02	Tue
10	2141	04/14/02	Sun
11	2196	04/04/02	Thu
12	2279	02/18/02	Mon
13	2287	01/06/02	Sun
14	2323	04/05/02	Fri
15	2337	12/23/01	Sun
16	2369	10/18/01	Thu
17	2382	10/30/01	Tue
18	2383	04/15/02	Mon
19	2391	12/26/01	Wed
20	2396	04/03/02	Wed

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Channel P7

Peak	PTT-7	Date	Day
1	5153	10/21/01	Sun
2	4513	11/18/01	Sun
3	3493	01/23/02	Wed
4	3387	11/29/01	Thu
5	3105	02/01/02	Fri
6	3096	11/07/01	Wed
7	3025	03/01/02	Fri
8	2977	01/02/02	Wed
9	2868	10/20/01	Sat
10	2787	01/24/02	Thu
11	2763	10/19/01	Fri
12	2754	02/08/02	Fri
13	2732	10/17/01	Wed
14	2719	11/22/01	Thu
15	2690	10/24/01	Wed
16	2681	01/17/02	Thu
17	2620	02/16/02	Sat
18	2615	02/03/02	Sun
19	2615	03/09/02	Sat
20	2602	02/05/02	Tue

Low	PTT-7	Date	Day
1	329	04/14/02	Sun
2	466	04/07/02	Sun
3	797	03/27/02	Wed
4	867	04/10/02	Wed
5	927	04/05/02	Fri
6	974	04/13/02	Sat
7	996	04/17/02	Wed
8	1130	04/06/02	Sat
9	1149	04/15/02	Mon
10	1213	04/12/02	Fri
11	1240	04/18/02	Thu
12	1390	04/03/02	Wed
13	1402	04/11/02	Thu
14	1481	04/04/02	Thu
15	1484	11/06/01	Tue
16	1496	03/19/02	Tue
17	1618	03/13/02	Wed
18	1619	04/16/02	Tue
19	1645	03/20/02	Wed
20	1767	01/21/02	Mon

All Channels

Peak	Total	Date	Day
1	22063	10/21/01	Sun
2	20320	11/18/01	Sun
3	15888	10/31/01	Wed
4	12488	03/01/02	Fri
5	12378	01/02/02	Wed
6	12358	10/17/01	Wed
7	12188	11/10/01	Sat
8	12097	03/09/02	Sat
9	11999	11/01/01	Thu
10	11947	02/16/02	Sat
11	11874	02/01/02	Fri
12	11872	10/20/01	Sat
13	11865	11/29/01	Thu
14	11747	11/21/01	Wed
15	11674	10/24/01	Wed
16	11653	11/08/01	Thu
17	11632	11/07/01	Wed
18	11613	01/17/02	Thu
19	11459	11/25/01	Sun
20	11459	03/30/02	Sat

Low	Total	Date	Day
1	6749	04/07/02	Sun
2	6942	04/10/02	Wed
3	7664	12/26/01	Wed
4	7729	04/14/02	Sun
5	7906	04/17/02	Wed
6	8080	04/11/02	Thu
7	8175	12/08/01	Sat
8	8315	04/18/02	Thu
9	8385	03/25/02	Mon
10	8415	04/16/02	Tue
11	8448	04/12/02	Fri
12	8466	02/25/02	Mon
13	8479	04/05/02	Fri
14	8552	03/11/02	Mon
15	8606	11/26/01	Mon
16	8607	01/07/02	Mon
17	8642	03/19/02	Tue
18	8664	04/03/02	Wed
19	8696	04/04/02	Thu
20	8714	01/14/02	Mon