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CITY OF OAKLAND

AGENDA REPORT

TO: HENRY GARDNER
INTERIM CITY ADMINISTRATOR

FROM: Bryan M. Sastokas and
Jason Mitchell

SUBJECT: P25 Network Selection Project

DATE: June 23, 2014

City Administrator Approval

Date 6/26/14

COUNCIL DISTRICT: City-wide

RECOMMENDATION

Staff recommends that the City Council authorize the City Administrator or his designee to: (A) continue using the Oakland's P25 Network by adopting Resolution #1 set forth below; or alternatively, (B) join the East Bay Regional Communications Systems Authority ("EBRSCA") by adopting Resolution #2 that accompanies this Report:

Resolution #1 authorizing the City Administrator or his designee to:

1) Negotiate and award a two-year contract to Harris Public Safety Communications and other related vendors, in an amount not to exceed five-million nine hundred ninety-thousand dollars ($5,990,000) for the purchase of equipment, hardware, software and other professional services for the proposed Oakland P25 network and other technological upgrades; and
2) Negotiate and award a two-year agreement to Aviat networks in an amount not to exceed one million six hundred thirty-three thousand dollars ($1,633,000) for the purchase of network equipment, hardware, software and other professional services to enhance microwave backbone resiliency for the P25 Network; and
3) Waive advertising,competitive bidding , and the request for proposals/qualifications (RFP/RFQ) requirements, for the purchase of equipment, hardware, software and other professional services for the above-referenced contracts and service agreements; and,
4) Award contracts utilizing the City's competitive bidding requirements within the budget amount of nine hundred twenty thousand dollars ($920,000) to purchase mobile radios for the City's non-public safety departments and for additional upgrades to the City's outdoor public siren system project without return to council, provided that prior to expenditure of any funds staff will award contracts and establish contract amounts for the Controller's Bureau; and

5) Authorize additional appropriations to the Fiscal Year 2014-2015 operating budget for the Information Technology Department in an amount of three hundred seventy four thousand four hundred dollars ($374,400) for professional service contracts and other related service agreements to implement the proposed Oakland's P25 network radio system.

An alternative resolution #2 to join the EBRCSA network has been included with this Agenda report; however, the Administration does not recommend its adoption due to the following reasons:

- Over the next six years, the City would save over $7.32 million if Council adopts staff's recommendations;
- Lack of representation on the JPA;
- Lack of BART interoperability;
- Inability to opt-out of future financial obligations; and
- No additional network enhancement over existing network.

EXECUTIVE SUMMARY

At the June 25, 2013, the Finance and Management Committee meeting, the Information Technology Department (ITD) was directed to negotiate a professional services contract with RCC Consultants, Inc. to provide an independent side-by-side comparison of the East Bay Regional Communications System Authority (EBRCSA) P25 network against the Oakland P25 network and provide an addendum to their P25 Radio Systems Evaluation report, dated May 14, 2012.

On December 17, 2013, the Finance and Management Committee received the independent consultant report which found the problems that plagued Oakland's P25 network to have been addressed to a significant extent; resulting in measurable improvements in both real and perceived performance of the Oakland P25 network. Based upon independent tests, the two P25 networks, EBRCSA P25 and Oakland P25, are fairly similar in coverage, performance, and reliability. However, it was readily determined that the City should either commit to proceeding with operational improvements within ITD, or outsource these services entirely by joining EBRCSA. Further, based on independent evaluation, the consultant did not find any compelling technical or operational reason(s) to migrate to the EBRCSA P25 network based on the City's substantial progress to date, and said networks measured performance.

On January 21, 2014, the Administration recommended and the City Council authorized the City Administrator to negotiate a contract for service with the EBRCSA and to return to City Council in 90-120 days with proposed negotiation terms and a funding and transition plan; inclusive of a funding plan for the purchase and maintenance of radio units. The Administration made this recommendation in order to resolve the issues raised by the Administration, City Council and

Alameda County Grand Jury, since the inception of EBRCSA. (See Attachment H for the Grand Jury report.)

The major issues raised are as follows:

- Governance
- Cost
- Interoperability

On February 13, 2014, the City commenced negotiations with EBRCSA. The goal was to negotiate terms and conditions of potential contractual obligations should the City opt to join the EBRCSA P25 network. The City negotiation team, appointed by the City Administrator, was co-chaired by Jason Mitchell, Assistant Director for the Oakland Public Works Department, Bureau of Infrastructure and Operations, and Bryan Sastokas, Chief Information Officer for the Information Technology Department. The committee was also comprised of representatives from the Police Department, Fire Department and the Office of the City Attorney.

The negotiations process included engagement with the Oakland P25 network external users, including the Oakland Housing Authority, City of Piedmont and the Oakland Unified School District. Additionally, the Committee engaged other internal users of the P25 network to incorporate their issues and concerns into the negotiations and recommendation process.

This report summarizes the outcome of the negotiations with EBRCSA; a summary of the cost-benefit analysis between both respective P25 networks; the results of informal vendor negotiations that were held to establish the capital costs related to both options, as well as on-going costs and a final recommendation by the Information Technology Department.

OUTCOME

On February 13, 2014, the City commenced negotiations with the East Bay Regional Communications System Authority (EBRCSA). The goal was to negotiate terms and conditions of potential contractual obligations should the City choose to join the EBRCSA P25 network.

The following listing of critical issues was used as a starting point to begin said negotiating processes:

- Mutual-Aid Interoperability
- BART Interoperability
- Recording System
- Siren System: EBRCSA to interface its P25 System and Motorola radios with the City of Oakland Outdoor Siren System
- Subscriber Maintenance
- System-wide Coverage

- Committee Representation
- Joint Powers Authority Representation
- Future Projects

Our recommendation was developed as a result of the responses to these issues from EBRCSA as identified in Attachment A – EBRCSA responses to City Negotiation Team.

In addition to the above discussion points, staff reviewed EBRCSA's network coverage, system capacity and current financial conditions. Staff agrees with the independent third party consultant that both P25 networks are equivalent. Staff likewise agrees that the EBRCSA system has the capacity to absorb all of the current users of Oakland's P25 network. In reviewing EBRCSA's previous audit reports, bank statements, budgets and cash flow statements, we conclude that EBRCSA is in good financial condition at this particular point in time, and is expected to have a fund balance of $6.06 million at the end of FY 2013-14.

BACKGROUND/LEGISLATIVE HISTORY

Beginning in 1995, the City of Oakland operated a proprietary analog radio system known as Enhanced Digital Access Communications System (EDACS). Following the events of September 11, 2001, a national initiative to enable first responders to communicate during disasters was launched by the Federal Department of Homeland Security (DHS). This resulted in the adoption of P25 interoperability standards for public safety radio communications. In 2006, the Bay Area Urban Area Security Initiative (UASI) launched an initiative called "BayRICS" (Bay Area Regional Interoperable Communications System) to fund a "system of systems" across the Bay Area for regional interoperability. This initiative was designed to allow each jurisdiction operating on a P25 interoperable radio network to connect their radio system to each other in order to achieve interoperability between jurisdictions and potentially enhance radio coverage for first responders.

Beginning in 2006, the City of Oakland participated in the planning for BayRICS, which included holding discussions with EBRCSA as part of the City's initial examination and consideration of joining the EBRCSA jurisdictional consortium. Since 2006, the City has allocated more than $10 million in grant funds to EBRCSA for the construction of its network and several tower locations in the interest of regional interoperability. In 2010, Oakland's EDACS system was reaching the end of its useful life and was no longer supported by the manufacturer. At the same time, the EDACS system began to experience several high profile failures, which could not be easily corrected and therefore necessitated the City to take immediate corrective action and begin replacing the aging system components.

The City once again, engaged with EBRCSA to reexamine the potential for the City to join the future EBRCSA P25 network, and attempt to expedite the construction of EBRCSA to support a transition. At that time, EBRCSA was unable to meet the City's urgent need to abandon the EDACS system and therefore necessitated the City, with the recommendation of an independent

Consultant, (Attachment B, Informational Report - P25 Roadmap, Public Safety Committee December 1, 2009) to move forward with the P25 network upgrade. By leveraging the UASI grant funding, the City replaced a portion of the aging system components with P25 capable equipment and transitioned its public safety users to the P25 System in June of 2011. The EBRCSA P25 network finally went live eighteen months later in November of 2012.
The City has also implemented the first interoperable P25 link to a neighboring radio system belonging to the Bay Area Rapid Transit system (BART) to continue to fulfill the BayRICS "system of systems" vision by connecting the Oakland P25 System with the BART's underground radio system; thereby greatly enhancing our first responders' abilities to seamlessly communicate while responding to, and supporting public safety within, BART's jurisdictions. This P25 Inter-RF Sub System Interface (ISSI) network link was the first of several planned links to neighboring P25 radio systems, including a link to the future EBRCSA P25 network, which is designed to fulfill the regional vision for communications interoperability between various jurisdictions.

In January 2012, following frequent complaints from our first responders, including reports by users that the Oakland P25 system created additional "dead-spots" of radio coverage, the City Administrator commissioned an independent consultant, RCC Consultants Inc. (RCC), to evaluate the Oakland P25 network and its respective operations, and make recommendations to correct any deficiencies. In addition to contracting the independent consultant, in August 2012, the City hired a public safety systems expert to assist City staff in finding the root causes of, and recommending solutions to, user complaints, including the assessment of the EBRCSA system as an alternative. This detailed analysis of Oakland's radio communications uncovered numerous operational deficiencies, including, widespread cellular interference, a lack of user training, and maintenance procedures that contributed to the trouble reports. Since that time, the City and its manufacturer supplier, Harris Public Safety & Professional Communications, have initiated numerous corrective actions to resolve the issues mentioned above. The largest remaining issue is the replacement of the portable radio fleet, pending City Council approval, would be scheduled for deployment during 2015. The Oakland P25 network itself was not found to be the root cause of the trouble reports, and today, the network continues to meet public safety standards and exceed 99.999% network availability.

In November of 2012, the City executed an amendment to the contract with RCC to conduct independent in-building coverage surveys of 30 governments owned and operated buildings in order to compare the coverage between the Oakland P25 System and EBRCSA. The survey results concluded that there are minor differences between the in-building coverage offered by both respective systems.

In June of 2013, the Finance and Management Committee directed staff to negotiate an additional professional services contract with RCC Consultants, Inc. to provide an independent side-by-side comparison of the EBRCS P-25 network and the Oakland P25 network, as well as providing an addendum to their report dated March 2012.

In January of 2014, the City Council received the RCC report which found the problems that plagued Oakland to have been addressed to a significant extent; resulting in measurable improvements in both real and perceived performance of the Oakland P25 network. Further, based on its independent tests, the two P25 networks are fairly similar in coverage, performance, and reliability. RCC did point out, however that the City should either commit to moving forward with technological and operational improvements within ITD, or outsource these services entirely by joining EBRCSA. RCC pointed out that based on the current governance model and number of users, a fair and equitable representation for the City on the JPA would be equivalent to four standing seats. Staff agrees with the Consultant that this is an issue of considerable concern and that the City would be at risk of having no influence or ability to control its own radio needs or future budgeted costs without a dedicated, four-person vote on a system where it represents a significant portion of the EBRCSA system.

In January of 2014, the City Council authorized the City Administrator to negotiate with EBRCSA and to return to Council in 90-120 days with proposed negotiation terms; a funding and transition plan, and include a plan for the purchase and maintenance of radio units.

In February of 2014, the City Council passed the Resolution 84840 C.M.S. authorizing the City Administrator to negotiate and execute a Master Lease Agreement and necessary related documents to provide funding to replace the existing radio fleet and upgrade the aging communications equipment in an amount not to exceed twenty-seven million dollars ($27,000,000), with an interest rate not to exceed 4.5% - on a tax-exempt basis and 5.75% on a taxable basis for a term of not more than eight (8) years.

ANALYSIS

Over the past twenty-four months, the City has made considerable investments to improve and deliver a reliable P25 network that meets public safety standards. The City Council also commissioned an independent third-party consultant, RCC, to validate, verify, and compare both respective P25 networks. That report and analysis is available as Attachment C – RCC report and as presented, demonstrates that both P25 networks are comparable and provide quality service and reliability. Staff also included an additional comparison chart that lists and rates the various issues included in this decision that can be found in Attachment D, Staff Recommendation Comparison Chart.

As detailed in the analysis matrix, the differentiating factors between the two P25 networks are as follows:

- One-time and ongoing costs, including the potential for future unknown financial obligations and cost increases;
- Governance and representation of the participating City agencies;
- Interoperability with BART and network coverage in the underground tunnels; and,

- Management of a turn-key, full-service P25 network solution combined with subscriber radio support and maintenance.

The one-time and on-going costs for the City to join EBRCSA are substantially higher when compared to continuing to operate Oakland's current Oakland P25 network as a stand-alone entity. Further, as referenced within the context of the RCC report, EBRCSA has neither funded nor planned to fund the replacement of its microwave network, which is now past its useful life and must be replaced. The costs to replace this network will likely be borne by each of the EBRCSA member agencies by way of increased monthly subscriber fees, which have yet to be determined.

The current governance model of the East Bay Regional Communications System Authority (EBRCSA) is a primary factor that should be considered. EBRCSA is a JPA that is governed by a Board of Directors which consists of 23 members; comprised of elected officials, police chiefs, fire chiefs, and city managers/administrators. The members' distinctions among the various entities as follows:

(3) City Manager of Contra Costa County*
(3) City Manager of Alameda County*
(3) Elected Officials of Contra Costa County**
(3) Elected Officials of Alameda County**
(2) One member of each county jurisdiction's Board of Supervisors
(2) Members of the Police Chiefs Association***
(2) Members of the County Fire Chiefs Association***
(2) County Sheriffs***
(1) Contra Costa County (CAO)
(1) Alameda County (CAO)
(1) Special District

*selection determined by each County's City Managers Association
**selection to be determined by the Mayor's conference of each County
***one representative from Contra Costa and one from Alameda

One critical negotiation item discussed with EBRCSA was to ensure that the City's first responders maintain the same level of P25 network interoperability with BART as currently possessed by the Oakland P25 network. Oakland users are the only first responders that currently possess the capability to operate seamlessly in the underground BART stations and tunnels. This is currently accomplished by radio equipment compatibility with the legacy BART system, and is now transitioning to the newly deployed BART underground P25 network. As confirmed by BART personnel and by the City's independent consultant, EBRCSA users do not have the ability to communicate on the EBRCSA P25 network once they go into the underground tunnel system. Our request for EBRCSA to deploy the same level of interoperability and seamless network coverage as the Oakland P25 network was met with resistance and ultimately rejected. However, EBRCSA proposed an alternative, lower-grade solution to BART for future deployment. This is a critical factor to be considered given that BART is well represented in Oakland, and significantly more present than in other EBRCSA member cities.

In order to ensure a reliable and sustainable radio environment for City personnel, ITD recommends that the City Council consider use of a business model that employs a full service solution that includes P25 network access, as well as radio subscriber support and maintenance. ITD currently uses this model by operating and maintaining the Oakland P25 network, and is responsible for the maintenance of the radio subscriber units and operational user support. Information Technology Department does not believe that it would be in the City's best interests to act as an "integrator" or "middle person" with one entity responsible for the P25 network, while still holding responsibility of the radio subscriber fleet. As well demonstrated, there are no clear lines of demarcation between the network and the radios. As such, ITD strongly believes the City's radio users would be best served by a single entity that would be responsible for all radios. The negotiations team did engage EBRCSA to provide a turnkey full service solution and received the response that such an agreement would not be possible since EBRCSA does not provide subscriber radio maintenance. However, after signing with EBRCSA, the City could elect to negotiate with either the County of Alameda or the County of Contra Costa to provide these services. The negotiations team did confer with the Chief Technology Officer of Alameda County to request a proposal from their jurisdiction relative to providing these services. However, the Alameda County response stated that the County would not provide a proposal until after the City agrees to join the EBRCSA.

In addition to the above concerns, ITD also recommends that the Council consider the following as part of their decision: 1) project governance and change management. 2) FCC licensed spectrum assets, and 3) enhanced network coverage and limitations.

Project Governance

- Appropriate project governance and change management considerations such as funding the training of personnel, resource allocation and development of a realistic transition schedule should be given to staff and their respective operating departments who will be affected by any decision to transition to the EBRCSA P25 network.

FCC Licensed Spectrum Assets

- The FCC licensed spectrum currently used to operate the City's P25 network is an extremely valuable asset which should be considered. The City has invested a tremendous amount of human and financial resources to acquire, manage, license, and protect these spectrum assets. Over the past 24 months, the City has invested nearly $250,000 to mitigate cellular carrier interference in order to protect these spectrum assets and further enhance the reliability of the P25 network. If the Council makes a policy decision to migrate to an alternative P25 network, these spectrum assets will no longer be held by the City and therefore would represent a lost investment. Once these licenses are lost, the City will not have the ability to reacquire them, as this spectrum is an extremely limited commodity that is highly sought after within Northern California.

The City's current P25 network is comprised of three (3) individual tower locations spread across the City. As measured by the independent consultant, the existing P25 network provides mobile subscriber coverage across 99.59% of the City and portable subscriber coverage across 97.77%. Within the current environment and user defined governance, the City retains the ability to enhance coverage as it deems necessary based on user requests. If a transition to EBRCSA were to occur, the City would lose the autonomy and ability to make user requested upgrades and enhancements. Given the lack of representation on the EBRCSA Board of Directors, the City would be required to engage and solicit support from other member agencies to make upgrades and enhancements that may strictly benefit Oakland residents.

Policy and Governance Concerns

Within the last five years, there have been discussions to amend the JPA bylaws to include representation for the City. Thus far, no substantial changes have resulted from those discussions. In the event that Oakland joins the EBRCSA consortium, it would become the largest participating member of the JPA. However it would not be provided with equal representation on the voting body which governs the JPA. In fact, although the City of Oakland would not be provided with the ability to voice a single vote on the respective JPA Board, it would be responsible for one of the largest ongoing financial obligations based on the per user fee structure. Recently the Alameda County City Managers Association (ACCMA) has made the offer to allow the Oakland City Administrator to appoint one (1) member to its three (3) voting seats by way of executing a Memorandum of Understanding (MOU) between the City and the ACCMA. This voting seat, however, would remain controlled by the ACCMA, in keeping with the EBRCSA JPA bylaws. And, as stated in the ACCMA letter in Attachment E dated March 13, 2014 "it is understood that the representation on the EBRCSA Board will primarily be to represent the City of Oakland interests, but the City Administrator will also represent the cities within Alameda County". The Administration strongly believes that this type of agreement and form of representation has the potential to create a conflict of interest and render the City of Oakland and its respective representative unable to adequately perform their duties of fully representing the interests of the City of Oakland; inclusive of carrying out policy direction received by the City Council, as well as management direction received by the Administration.

Based on the Administrations review of the JPA Operating Agreement (See Attachment F) and Bylaws (See Attachment G), the issue of governance and ensuring equitable representation is an important factor given that the EBRCSA JPA, by its own Operating Agreement, has granted itself broad powers which may exceed the operations of a P25 network in the future. The Operating Agreement provides the opportunity for EBRCSA to embark on future projects related to public safety call taking and dispatch operations, as well as future communication projects including broadband data systems. With regard to this sample provision, and others, the City of Oakland would not have a voice, other than the one (1) vote via ACCMA in either the future projects or the debt obligations that the JPA may undertake. However, the City would become financially responsible to support such efforts regardless of the City's intent to participate in future projects. In addition to the lack of representation on the EBRCSA board, the City of Oakland should consider the following policy items which are included in the EBRCSA Operating Agreement:

- Section 1.01 – The Authority has the ability to issue Bonds "from time to time."
- Section 2.03 – Defines that bonds are to be "…issued, sold and delivered… as the authority deems necessary."
- Section 2.04 – Defines the term of this operating agreement as the date of execution and terminates when "there are no bonds outstanding."

Based upon the existing language in the EBRCSA Operating Agreement, there is no ceiling or expressed limitation(s) on the bond issuance authority of the JPA, or any clauses which would prevent the JPA from entering into another trust agreement to issue bonds. Further, based on the current governance structure, the City would become obligated to repay future debt obligations without being afforded the ability to participate in the governance vote, other than the 1 vote via ACCMA or withdrawing itself from the JPA until all of the current debt obligations are paid in full. The resultant circumstance is a perpetual funding obligation for the City and no voice on behalf of the residents which ultimately will bear the responsibility for one of the largest shares of any debt repayment. These issues were discussed with EBRCSA during the negotiations and resulted in no changes being accepted by EBRCSA to the Operating Agreement. In fact, EBRCSA did not propose any alternative language or make any compromises on these critical financial issues with regard to the proposed Operating Agreement.

PUBLIC OUTREACH/INTEREST

The Committee Co-Chairs have held discussions with the affected external entities including: the City of Piedmont Police Department; the City of Piedmont Fire Department; the Oakland Housing Authority; the Oakland Unified School District; the Port of Oakland; Local 55; Local 1021; Local 21 and the Oakland Police Officers Association.

COORDINATION

Information that is the basis of this report has been coordinated with the Treasury Division, Budget Office, and the Office of the City Attorney.

COST SUMMARY/IMPLICATIONS

As referenced within the context of the charts below, the Administration is recommending financing the acquisition of equipment, hardware, software and professional services for the Oakland P25 network and technology refresh. This financing transaction will provide fourteen million two-hundred nineteen thousand nine hundred forty-seven dollars ($14,219,947) in new equipment and establish approximately two million two hundred seventy three thousand and eight hundred dollars ($2,273,800) in professional service agreements to execute the upgrades. Financing payments will be acquired from the City's Radio and Telecommunications Fund (Fund 4200), which earns revenue from internal service rates/charges imposed upon all City departments. There is an existing appropriation of one million dollars ($1,000,000) that have been designated in the Fund 1010 per Resolution No. 84500 C.M.S. dated July 3, 2013 to cover the cost of the professional services.

Capital Investment

Through enactment of the proposed P25 Network Selection Project, the City will:

- Upgrade its P25 network
- Complete a technology refresh
- Replace radios within non-public safety City Departments with P25 compliant radios
- Upgrade the Outdoor Public Emergency Siren System to the P25 network

Staff is also recommending the purchase of a deployable emergency network to enhance the City's resilience and disaster response capabilities, make improvements to the microwave network and purchase new portable radios for our first responders. A savings of approximately $4.6 million is anticipated as a direct result of the initial capital investment.

OAKLAND P25 VS. EBRCSA P25 CAPITAL INVESTMENTS

Oakland Network Costs			
Cost Description	**Hardware**	**Professional Services**	**Total**
Project #1 - Replace Portable Radio Fleet	7,576,800	373,800	7,950,600
Project #2 - Microwave Improvement Project	1,083,040	550,000	1,633,040
Project #3 - ITD Technology Refresh	610,000	375,000	985,000
Project #4 - P25 Network Hardening	3,430,097	975,000	4,405,097
Project #5 - Migrate PWA & Siren System	920,010	-	920,010
Project #6 - Emergency Mobile Network	600,000	-	600,000
Total	**14,219,947**	**2,273,800**	**16,493,747**

EBRCSA Network Costs			
Cost Description	**Hardware**	**Professional Services**	**Total**
Project #1 - Replace Portable Radio Fleet	8,101,800	373,800	8,475,600
Project #2 - Replace Mobile Radio Fleet	6,130,950	1,108,800	7,239,750
Project #3 - Microwave Improvement Project	1,083,040	550,000	1,633,040
Project #4 - Migrate PWA & Siren System	3,446,100	970,200	4,416,300
Project #5 - Emergency Mobile Network	600,000	-	600,000
Total	**19,361,890**	**3,002,800**	**22,364,690**

Difference	**5,141,943**	**729,000**	**5,870,943**

Annual Maintenance Costs

The projected annual maintenance costs associated with the proposed P25 Network Selection Project are detailed in the chart(s) below; with an anticipated savings equating to $735,000 less than if the City were to transition to the EBRCSA network. Said savings would be realized as follows:

- The City would forego the one-time system access fee of $580,000
- Overall annual maintenance costs would be reduced by $31,000.

The chart below provides a five year forecast of maintenance costs:

Cost Comparison Between moving to EBRCSA or staying with the Oakland System:

COSTS - EBRCSA	FY 14-15	FY 15-16	FY 16-17	FY 17-18	FY 18-19	FY 19-20	Total
One-time System Access Fee	-	580,000	-	-	-	-	580,000
Ongoing O&M Cost	-	1,183,000	1,183,000	1,183,000	1,183,000	1,183,000	5,915,000
TOTAL	-	**1,763,000**	**1,183,000**	**1,183,000**	**1,183,000**	**1,183,000**	**6,495,000**

COSTS - OAKLAND	FY 14-15	FY 15-16	FY 16-17	FY 17-18	FY 18-19	FY 19-20	Total
One-time System Access Fee	-	-	-	-	-	-	-
Ongoing O&M Cost (Internal Services)	-	1,152,000	1,152,000	1,152,000	1,152,000	1,152,000	5,760,000
TOTAL	-	**1,152,000**	**1,152,000**	**1,152,000**	**1,152,000**	**1,152,000**	**5,760,000**

Difference	**735,000**

Debt Service Costs:

In February of 2014, City Council passed Authorizing Resolution No. 84840 C.M.S dated February 18, 2014, which authorized the City Administrator to negotiate and execute a Master Lease Agreement and necessary related documents to provide funding to replace the existing radio fleet and upgrade the aging communications equipment in an amount not to exceed twenty-seven million dollars ($27,000,000). Council further directed that financing for said Agreement should bear an interest rate in an amount not to exceed four and one-half percent (4.5%) on a tax-exempt basis or five and three-quarter percent (5.75%) on a taxable basis.

The chart below outlines the debt service cost over a five-year period. As noted above, the projected savings relating to the purchase of the hardware capital costs is $5.14 million; creating an annual savings of $1.12 million, equating to cumulative savings of $7.32 million over a five-year term.

Debt Service Cost Over a 5 Year Period Based on a 4.5% Interest Rate:

NETWORK	FY 14-15	FY 15-16	FY 16-17	FY 17-18	FY 18-19	FY 19-20	TOTAL	Interest
Debt Service Payment (Oakland)	-	3,239,185	3,239,185	3,239,185	3,239,185	3,239,185	16,195,925	1,975,978
Debt Service Payment (EBRCSA)	-	4,410,477	4,410,477	4,410,477	4,410,477	4,410,477	22,052,383	2,690,493
DIFFERENCE	-	**1,171,292**	**1,171,292**	**1,171,292**	**1,171,292**	**1,171,292**	**5,856,458**	**714,515**

FINANCIAL SUMMARY

Over the next six years, the City would save over $7.32 million if Council adopts staff's recommendations. Staff is requesting an adjustment and increased appropriation to the operating budget within Information Technology Department's Fiscal Year 2014-2015 operating budget in the amount of $374,400 for the one-time professional service contracts associated with the implementation of the proposed P25 Network Selection Project.

Staff is also proposing the use of undesignated fund balance revenue in the Radio and Telecommunications Fund (Fund 4200) to cover the remaining costs of these professional services. The resultant impact of the use of all referenced funds will NOT have an immediate impact to the General Purpose Fund. All other costs would be included in the FY 2015-17 Budget cycle. These costs will be included in the radio internal services rates calculation for the Radio and Telecommunications Fund (Fund 4200) in FY 2015-17.

The Radio Fund 4200 charges will be minimal due to the positive fund balance. The Internal Service Fund will continue to charge using departments amounts to cover the semi-annual principal and interest payments on the master lease-purchase agreement. These debt service amounts will be accounted for in the FY 2015-17 baseline budget.

WAIVER OF ADVERTISING, COMPETITIVE BIDDING, AND OF THE REQUEST FOR PROPOSALS/QUALIFICATIONS ("RFP/RFQ") SELECTION REQUIREMENTS

Section 2.040.050 of the Oakland Municipal Code ("OMC") requires the City Administrator to conduct advertising and bidding and award to the lowest responsible, responsive bidder for the purchase of products or goods, where the cost of services, supplies or combination required by the city exceeds fifty thousand dollars ($50,000). OMC section 2.04.050.I.5 allows Council to waive these requirements upon a finding by the Council that it is in the best interests of the the City to do so.

Additionally, OMC section 2.040.051 A requires the City Administrator to conduct a request for proposals/qualifications (RFP/Q) process for professional services contracts in excess of $25,000 and OMC section 2.04.051B allows Council to waive the RFP/Q process upon a finding by the Council that it is in the best interests of the City to do so. Staff is requesting Council to waive the advertising, competitive bidding and the RFP/Q process and authorize the City Administrator to negotiate and award contracts to Harris Public Safety Systems and to related vendors, and to also negotiate and award a contract to Aviat Networks. It is in the best interests of the City to waive advertising, bidding, and the RFP/Q requirements because of the following reasons.

The City's existing 800 MHz Radio Network system was manufactured by Harris Public Safety Communications and the company is the sole manufacturer of the parts and materials required for the radio system. Harris Public Safety Communications has been maintaining and supporting the City's radio system since it became operational and possesses deep technical knowledge of the Oakland network system.

The City's existing Microwave backbone supports the P25 network and is manufactured by Aviat Networks. Aviat Networks is the sole manufacturer of the parts and materials required for the microwave system and has been maintaining and supporting the City's Microwave backbone system since it became operational. Aviat Network also possesses deep technical knowledge of the Oakland network system.

Therefore, it is in the best interests of the City to waive advertising, bidding, and the RFP/Q requirements due to the City's urgent need to enhance the P25 network system. Given the necessity to maintain this critical public safety communications system, the City would benefit by expediting the execution of these professional services contracts.

SUSTAINABLE OPPORTUNITIES

Economic: There are no economic development opportunities related to this report at this time.

Environmental: There are no environmental opportunities related to this report.

Social Equity: The City of Oakland continues to ensure that its public safety personnel continually maintain their ability to readily communicate during emergencies with minimal disruptions; thereby providing first responders with the ability and capabilities of readily being able to respond during emergencies for the direct benefit of the citizens and communities of the City of Oakland.

For questions regarding this report, please contact Annie To, Administrative Services Manager, at (510) 238-7494.

Respectfully submitted,

Bryan Sastokas

Bryan M. Sastokas
Chief Information Officer
Information Technology Department

Jason Mitchell
Assistant Director
Public Works Bureau
Infrastructure and Operations

Attachments (8):

- **Attachment A – EBRCSA Responses to City Negotiation Team**
- **Attachment B – Info Report – P25 Roadmap**
- **Attachment C – RCC Report**
- **Attachment D – Staff Recommendation Comparison Chart**
- **Attachment E – EBRCSA ACCMA Letter**
- **Attachment F – EBRCSA Operation Agreement**
- **Attachment G –EBRCSA Bylaws**
- **Attachment H –Grand Jury Report**

Attachment A
EBRCSA Responses to City Negotiation Team

Attachment A -
Responses to City Negotiation Team

ALAMEDA COUNTY

East Bay Regional Communications System Authority

CONTRA COSTA COUNTY

Participating agencies include Alameda and Contra Costa Counties and the following cities and special districts: Alameda, Albany, Antioch, Berkeley, Brentwood, Clayton, Concord, Danville, Dublin, El Cerrito, Emeryville, Fremont, Hayward, Hercules, Lafayette, Livermore, Martinez, Moraga, Newark, Oakley, Pinole, Pittsburg, Pleasant Hill, Pleasanton, Richmond, San Leandro, San Pablo, San Ramon, Union City, Walnut Creek, East Bay Regional Park District, Kensington Police Community Services District, Livermore Amador Valley Transit Authority, Moraga-Orinda Fire District, Rodeo-Hercules Fire District, San Ramon Valley Fire District, California Department of Transportation, Ohlone Community College District, Contra Costa Community College District, Dublin-San Ramon Services District and University of California, Berkeley

May 22, 2014

Brian Sastokas, Chief Information Officer
City of Oakland
#150 Frank Ogawa Plaza
Oakland CA. 94612

Subject: East Bay Regional Communications System Authority (EBRCSA)

Dear Mr. Sastokas:

At our last meeting on April 22nd. we were presented a list of nine questions by your staff related to the EBRCSA system. I've attached our responses to the questions. At that meeting Engineers from Motorola presented you staff with system loading information for the EBRCSA Northwest Cell using existing EBRCSA user counts. While we strongly believe that the exercise shows that there is ample capacity to bring the City of Oakland users on to the EBRCSA system, we requested loading information from the City for your current system, to allow EBRCSA to accurately access the system load including the Oakland users. To date we have not received the information requested, and look forward to receiving the information to complete the loading analysis.

We also want to provide the City with a cost to join the EBRCSA system given the 2,900 radios the City plans to operate on the EBRCSA system. The costs for participation on the EBRCSA system is divided into two categories a onetime system access fee and the ongoing operations and maintenance costs that are billed on a yearly basis.

Onetime system Access Fee @ $200 per radio = $580,000
Yearly ongoing operations and maintenance fee = $1,183,000

It should be noted that the costs associated with the onetime system access fee and the ongoing operations and maintenance are calculated based on your user count. If the City changes the user count (2,900 radios) it will be reflected in the costs we've quoted.

If the city joins the EBRCSA system, EBRCSA will fund the replacement and maintain the 28 dispatch consoles in the cities Police, and Fire Departments dispatch centers and Emergency Operations Center.

We continue to look forward to the City of Oakland's participation in the EBRCSA system and will work with you and your staff to answer all questions that may arise.

Sincerely,

William J. McC

William J. McCammon
Executive Director
East Bay Regional Communications System Authority

Oakland Issues

The nine items below were presented to the EBRCSA team at the April 22nd. meeting with Oakland city staff:

Item #1: Mutual Aid Interoperability: EBRCSA to provide unrestricted radio system access to any and all entities approved by the City of Oakland without per user fees. Definition of no restrictions include the following: Unlimited radio user count, any and all talk groups accessed and approved for use by the City of Oakland including system-wide talk Mutual-Aid talk groups and, no restrictions on types of users (commercial, city/state/fed government, or any other external mutual-aid support)

EBRCSA will work with the City as we do with all member agencies to promote interoperability with surrounding jurisdictions. EBRCSA does not charge for access to the system for interoperability talk groups.

Item #2: BART Interoperability: EBRCSA to provide a level 3 ISSI interface to BART P25 System within 12 months.

EBRCSA has been working with BART to develop a connection between the BART underground and the EBRCSA system that will not require ISSI. The ISSI products offered today have not been fully tested as per the P25 Standard, and has limitations, that we believe place public safety first responders at undue risk in a confined space.

Item #3: NICE Recording System: EBRCSA to interface at the P25 Network level with the Oakland NICE recording system at its own cost. All technical hardware, licensing, integration, deployment and project management costs to be paid by the EBRCS A with projection completion within 12 months.

EBRCSA will work the City to determine the best way to obtain a connection to the ERCSA logging recorder to download recordings.

Item #4: Siren System: EBRCSA to interface its P25 System and Motorola radios with the city of Oakland Siren System. (29 Site, 2 control Points, manufactured by Federal Signal) All technical hardware, licensing, integration, deployment and project management costs to be paid by the EBRCSA with project completion within 12 months.

The siren system is beyond the scope of the EBRCSA system, and will not be addressed by EBRCSA. If the City develops a solution that uses radios programmed on the EBRCSA system, they will be included in the City's user count.

Item #5: Subscriber Maintenance: EBRCSA to provide all subscriber radio maintenance for the entire City of Oakland fleet (2900 radios) including annual calibration/maintenance/alignment. EBRCSA to provide a draft SLA within 15 days.

EBRCSA is not in a position to offer the City the type of services requested. If the City is interested in obtaining radio maintenance services, Alameda and Contra Costa counties have technical staffs and shops that can provide support for the City's radios.

Item #6: System-wide Coverage: EBRCSA to provide unrestricted system-wide coverage (2 County) for all 180 City of Oakland talk groups, and all 2900 users.

EBRCSA will work with the City to develop an appropriate fleet map as we have done with all agencies that use the EBRCSA system, providing interoperability, and access throughout the system for those users that need it.

Item #7: Committee Representation: EBRCSA to provide the City of Oakland with one (1) permanent seat on any and all ad-hoc, operational and technical committees for the duration of the Project Operating Agreement. The City seat shall be appointed by the City Administrator of the City of Oakland.

EBRCSA has three committees the Finance, Operations and Technical Advisory Committee. The Finance and Operations Committees are assigned representation through the bylaws. If the City joins EBRCSA the Board can consider a change to the bylaws to provide the City a seat on each committee. The Technical Advisory Committee has openings now that the City can fill.

Item #8: JPA Representation: EBRCSA to provide the City of Oakland with four (4) permanent seats on the JPA Board for the duration of the Project Operating Agreement. The City seats shall be appointed by the City Administrator of the City of Oakland.

The cities in Alameda County control 8 seats on the EBRCSA Board of Directors. Three seats are selected by the City Manager's association, three by the Mayor's conference, and one each by the Alameda County Police and Fire Chiefs Association. The City Manager's association has offered the City one of their seats permanently through the execution of an MOU between the *cities within the County, if the City joins EBRCSA. If the City would like more seats it will be up to the City to approach the Mayors' Conference, and/or the Police and Fire Chiefs associations to obtain additional seats.*

Item #9: Future Projects: EBRCSA to provide the City of Oakland with the ability to opt-out of, and be free from all debts related to any future projects taken on by the JPA. Any and all future projects may include P25 system or radio upgrades and enhancements, or replacement, any and all backhaul or service provider contracts or replacements, and any further projects relates to PSAP operations and maintenance. In the event the City of Oakland opts-out of a project which incurs debt on the part of the JPA, the JPA shall be required to establish a new series of debt without contribution by the City of Oakland and shall free the City from any and all liabilities in relation to the new debt.

The City will be required to execute the Project Operating Agreement as have all 43 member agencies. The City will be required to meet the terms in the agreement.

Attachment B
Info Report – P25 Roadmap

AECOM

CITY OF OAKLAND

City of Oakland, California

Interoperability Study

PUBLIC REPORT

November 6, 2009

CTA Communications
20715 Timberlake Road, Suite 106
Lynchburg, Virginia, 24502

All content that constitutes a breach of security or that would comprise the Public Safety Radio system has been removed from this report. Please contact the City of Oakland Department of Information Technology for access to the entire document. No pages that contain significant findings or critical decision criteria have been removed.

Table of Contents

Executive Summary

This Executive Summary provides a high level overview of the Interoperability Study report developed for the City of Oakland by CTA Communications (CTA). This project was focused on providing the City of Oakland with a technical roadmap for improved operability within the City and increased interoperability with those agencies in the Bay Area Super Urban Area Security Initiative (UASI).

The Interoperability Report describes the process CTA used to arrive at a jointly developed plan for wireless voice and supporting interconnect systems. The report considers the existing public safety communications system design and presents design alternatives based on available technology, frequency spectrum availability and operational feasibility. This project had 5 main goals or objectives:

1. Review and evaluate existing technology owned and operated by the City.
2. Establish a technical roadmap for full and seamless interoperability with BayRICS.
3. Provide a cost benefit analysis of the EBRCS JPA proposal.
4. Review the City's spectrum efficiencies (simulcast) and the leveraging of the City's equipment and investments as part of the EBRCS.
5. Provide recommendations for an interim solution for an Oakland EBRCS MOU.

CTA completed 14 tasks to achieve the goals outlined above. The report provides a detailed overview of each of the following 14 tasks:

TASK 1 SYSTEM COVERAGE - This Task includes an analysis of the existing two-site 800 MHz voice radio communications system. In addition, this Task includes an opinion of probable cost analysis that analyzes the costs associated with the City building their own P25 Phase 2 System.

TASK 2 SPECTRUM EFFICIENCY – This Task provides an overview of the current multi-site system including the advantages and disadvantages, and provides recommendations for improved system operation and utilization.

TASK 3 COVERAGE REDUNDANCY - This Task analyzes the coverage overlap between the City's radio system and the proposed EBRCS coverage area.

TASK 4 SIMULCAST TECHNOLOGY - This Task provides an overview of simulcast technology and evaluates the use of simulcast technology for the City of Oakland.

TASK 5 IN-BUILDING COVERAGE - This Task provides an analysis of the portable radio in-building coverage requirements and makes recommendations to improve in-building radio coverage within the City.

TASK 6 P25 MIGRATION - This Task provides an overview of P25 and evaluates the City's migration from its existing M/A-COM EDACS 800 MHz radio system to a Harris P25 Phase 2 standards based system.

TASK 7 SUBSCRIBER EVALUATION - This Task provides an evaluation of the backward compatibility of the City's newly purchased P25 subscriber radios with the BART's EDACS radio system and includes a comparison of feature/function sets.

TASK 8 INTEROPERABILITY WITH BART - This Task evaluates the City's upgrade and migration to a P25 radio system and the affect this will have on interoperability with BART.

TASK 9 This task has been purposely omitted from the report.

TASK 10 CHANNEL CAPACITY - This Task provides an analysis of the channel capacity of the existing radio system and addresses current and future channel capacity needs.

TASK 11 RETURN ON INVESTMENT (ROI) EVALUATION - This Task contains a review of the City's investments in communications and provides recommendations on the ROI analysis.

TASK 12 MAINTENANCE COSTS - This Task provides an analysis of maintenance / replacement costs for the City of Oakland. The analysis includes a comparison of the City's maintenance costs of its current radio communications system versus the buy-in, maintenance and ongoing system/equipment costs (monthly subscriber fees) of joining the EBRCSA.

TASK 13 CONTINUITY OF OPERATIONS - This Task provides an overview of the Oakland Radio Shop and an assessment of the radio shop's ability to provide the level of maintenance required to maintain the continuity of operations needed to support public safety communication.

TASK 14 GOVERNANCE - This Task outlines CTA's findings concerning the current EBRCSA JPA that are related to the technical, financial and implementation (timeline) aspects of the regional agreement and researches any cost savings to the City if it were to join the EBRCSA.

CTA has focused on providing an accurate assessment of the existing City of Oakland Radio System and has provided a detailed overview of the immediate concerns expressed by users and managers of the existing system. Based on this current system overview, CTA has made recommendations on how to improve the current system. These changes are areas that CTA has identified which will provide low cost, non-intrusive modifications to the existing system that will provide great benefits for all radio users. We also documented our recommended next steps that the City of Oakland should consider as they look toward the radio system that will support their needs 15 years into the future.

Summary of Completed Objectives

Because, the City of Oakland is part of the Bay Area Super Urban Area Security Initiative (UASI), the goals and vision of the UASI must be incorporated into the technical roadmap that is developed for the City. CTA's assessment and recommendation keeps the vision of BayRICS and the UASI in view, namely "the ability for any public safety radio in the region to communicate with any other public safety radio regardless of location, radio system, or frequency band and to seamlessly roam throughout all 10 Counties in the Bay Area." In addition, our recommendation also addresses the critical needs of the emergency responders in the City of Oakland. The summary and recommendations provided here are substantiated by the analysis and documentation provided in the report. Below, each objective of the project is summarized along with CTA's recommendations.

Objective 1: Review and evaluate existing technology owned and operated by the City.

CTA conducted interviews, radio site and dispatch surveys, additional meetings with the City of Oakland, and used an online surveyor tool, CTA Surveyor^{SM} to the gather the data needed to complete this task. Our research revealed that the City of Oakland's radio system meets the needs of the users and no significant channel sizing or coverage issues were reported. There are several areas where increased coverage is desired, and the system is nearing capacity limits, but meets the current needs of the users. However, as additional users are added, or if a major incident occurs, the system would likely exceed capacity limitations. Furthermore, current interoperability solutions are not robust and do not meet the goals stated by BayRICS. Our assessment of the radio shop, and the site surveys conducted revealed that your current system is well maintained and the radio shop is doing an excellent job in meeting the maintenance needs of the users in the City.

In order to meet the near term needs, our recommendations include:

1. Install low noise tower top amplifiers on APL and Seneca for use on the existing EDACS system.
2. After completion of the rebanding project, relicense the frequencies on APL for at least 100 Watts and conduct a thorough diagnosis of the APL site to ensure that the transmit and receive power are correct.
3. Issue one portable radio for each police officer, which would mean purchasing about 500 additional portable radios.
4. Research the cost of upgrading the existing EADS system to a simulcast system. This research will be used to determine if current system needs exceed capacity, this might be a viable short term solution as the City of Oakland decides if they should build out their own system, or join EBRCSA.
5. The existing Microwave upgrades should continue. Even if the City of Oakland joins EBRCS, the existing microwave loop could be incorporated into the EBRCS design. If the City builds its own system, the existing microwave system will need to be upgraded as planned.

Objective 2: Establish a technical roadmap for full and seamless interoperability with BayRICS.

This objective can be accomplished in two ways. The City of Oakland can build their own Harris P25 Phase 2 standards based system (Option 1) or they can join the EBRCS P25 Radio system (Option 2). Each choice has advantages and disadvantages as summarized in each of the categories below:

Operability:	Both options provide the same level of operability. The needs of the radio users on the City of Oakland System could be met by both options. It is possible, that due to the additional tower sites in Option 2, that better in-building coverage would be achieved with Option 2.
Interoperability:	Both options meet the interoperability goals outlined by the Bay Area UASI and by the California SCIP. If the City chooses Option 1, then EBRCS would need to define Interoperability Talkgroups that can be used on the EBRCS by City of Oakland Users.
Initial Cost:	The City of Oakland would have to find a funding source to fund the build out of the $5.67M dollar system for Option 1. At this time there is no initial cost with joining EBRCSA.
Maintenance Costs:	The clear advantage is Option 1. Option 1 is about $740K less per year than Option 2. If the annual replacement costs are removed, then this difference is even greater. Option 2 can make up some of this difference if the City of Oakland is able to provide maintenance support to the users in the ALCO Northwest cell as described above.
Coverage:	Option 2 provides the best coverage, provided the current ALCO Northwest design with sites at UC Berkeley, APL, Seneca and Skyline is installed. In addition, in-building coverage should be better with Option 2. Option 1 will provide increased coverage over the current system and will meet the needs of the City of Oakland users.
Redundancy and Reliability:	Option 1 provides increased redundancy and reliability over Option 2. Option 1 provides an additional layer of coverage and is a completely separate radio system from EBRCSA. Provided interoperability talkgroups are defined on each system, Option 1 can provide redundancy for users on EBRCSA and EBRCSA can provide redundancy for City of Oakland Users.
System Capacity:	Both options provide adequate capacity for the City of Oakland. However, it should be noted that if the multi-cell users (those that place calls from ALCO Northwest to other cells) significantly increases, then Option 2 could begin to see in increase in traffic. If Option 1 is chosen, this would not be an issue.

Governance:	Option 1 is much less complicated from a governance perspective. The challenges with Option 2 are not significant, but will require more effort than Option 1.
Interoperability with BART:	Option 1 provides an advantage in this category. If Option 2 is chosen, then BART users cannot talk on the system unless they purchase P25 Phase II radios and they are defined on the Motorola system that is being built out for Option 2.

In order to determine which option will best meet the needs of the City of Oakland we recommend the following steps:

1. Aggressively look for grant funding opportunities to pay for a City of Oakland P25 radio system. If these grant funding sources can be found, then the City should move in this direction.
2. Aggressively work with EBRCSA to ensure the current site selections are those that are used in the final design for the EBRCSA ALCO Northwest Cell. Work closely with EBRCSA and negotiate site sharing details for Seneca and APL.
3. Work with EBRCSA to determine if a maintenance agreement can be put in place for the City of Oakland to provide all maintenance infrastructure and subscriber support for the agencies in the ALCO Northwest Cell. If an agreement can be made, it may be possible for the City of Oakland to defer most of the costs of using the EBRCS.
4. The final decision will depend on the answers to the steps listed above, since either solution is equally viable from an operational and interoperability perspective.

Objective 3: Provide a cost benefit analysis of the EBRCS JPA proposal.

The complete details of the maintenance costs for the EBRCS JPA were not finalized at the time of this report; however the major cost items needed for an accurate comparison were available. Our evaluation included the following comparison:

CTA estimate of the City of Oakland annual maintenance costs for their own P25 Phase 2 radio system:

City of Oakland Annual Maintenance Fee	$172,800
Software Support Services	$100,000
City of Oakland Annual Replacement Fee	$495,760
Additional City of Oakland Radio Shop Budget	$1,027,200
Annual Total	$1,795,760

CTA estimate of annual EBRCSA costs that the City of Oakland will have to pay based on 4,191 subscriber units on EBRCS:

EBRCSA Monthly Maintenance Fee	4191 times $15.25 = $63,912.60
EBRCSA Monthly Replacement Fee	4191 times $14.75 = $61,817.30

EBRCSA Annual Maintenance Fee	$766,953
EBRCSA Annual Replacement Fee	$741,807
Estimated City of Oakland Radio Shop Budget	$1,027,200
Annual Total	$2,535,960

One other significant cost comparison is the fact that if the City of Oakland decides to build their own P25 radio system, they will have to find a funding source for the cost of the new system shown below:

OPINION OF PROBABLE COST
CITY OF OAKLAND
P25 PHASE II SIMULCAST UPGRADE

	LIST COST			NEGOTIATED ESTIMATE		
RADIO INFRASTRUCTURE	100%	$	4,777,600	85%	$	4,061,000
MICROWAVE	100%	$	-	90%	$	-
PHYSICAL FACILITIES	100%	$	440,100	90%	$	396,100
VENDOR SERVICES	100%	$	861,000	85%	$	731,900
SPARES - FIXED	100%	$	47,800	100%	$	47,800
CONTINGENCY	100%	$	478,300	90%	$	430,500
TOTAL		**$**	**6,604,800**		**$**	**5,667,300**

Objective 4: Review the City's spectrum efficiencies (simulcast) and the leveraging of the City's equipment and investments as part of the EBRCS.

CTA evaluated the existing frequencies owned by the City of Oakland. Provided the City moves toward a P25 Phase 2 solution, which has the advantage of using 1 channel for 2 voice talkpaths, then the City will be able to meet the future radio system needs. Simulcast is another important step the City must take. Currently 60% of the City's radio traffic is using resources at both APL and Seneca due to the current system design. CTA recommends that the City move in the direction of a P25 Phase 2 simulcast radio system in order to meet current and future radio system capacity needs.

Objective 5: Provide recommendations for an interim solution for an Oakland EBRCSA MOU.

CTA recommends the following steps that will provide an interim solution for an Oakland EBRCSA MOU. Many of these steps were discussed above:

1. Work with EBRCSA to ensure the current site selections are those that are used in the final design for the EBRCSA ALCO Northwest Cell, which includes UC Berkeley, Seneca, APL, Skyline and Gwin. Work closely with EBRCSA and negotiate site sharing details for Seneca and APL. Any other site selections will not provide the level of coverage needed by the City of Oakland. These site selections should be agreed upon and included as part of the MOU.
2. The City of Oakland should work with EBRCSA and outline a maintenance agreement for the City of Oakland to provide all maintenance infrastructure and subscriber support for the agencies in the ALCO Northwest Cell. This agreement would provide the City of Oakland with an opportunity to defer most of the costs of using the EBRCS.
3. The City of Oakland has valuable frequency resources that may be needed by EBRCS. CTA recommends that the use of these frequencies by agencies in the ALCO Northwest Cell be included as part of the MOU.
4. Since the City of Oakland would be a major contributor, in maintenance support, frequency assets and number of users, CTA recommends that the City work out an agreement with EBRCSA for inclusion in the Board of Directors for EBRCSA.

Introduction

The City of Oakland is located east of San Francisco in northern Alameda County. The City has a population of over 420,000 people and encompasses a land area of 56 square miles. Oakland is located in the heart of the East Bay section of the San Francisco Bay area. The City of Oakland is a major west coast international sea port and manufacturing center and the Port of Oakland is one of the five largest container ports in North America.

The City has contracted with CTA Communications (CTA) to conduct an interoperability Study that focuses on five objectives outlined in the Scope of work. CTA will:

1. Review and evaluate existing technology owned and operated by the City.
2. Establish a technical roadmap for full and seamless interoperability with BayRICS.
3. Provide a cost benefit analysis of the EBRCS JPA proposal.
4. Review the City's spectrum efficiencies (simulcast) and the leveraging of the City's equipment and investments as part of the EBRCS.
5. Provide recommendations for an interim solution for an Oakland EBRCS MOU.

The City of Oakland is part of the Bay Area Super Urban Area Security Initiative (UASI). This study has been completed while keeping the vision of BayRICS and the UASI in view, namely "the ability for any public safety radio in the region to communicate with any other public safety radio regardless of location, radio system, or frequency band and to seamlessly roam throughout all 10 Counties in the Bay Area."

CTA has focused on providing an accurate assessment of the existing City of Oakland Radio System and has provided a detailed overview of the immediate concerns expressed by users and managers of the existing system. Based on this current system overview, CTA has made recommendations on how to improve the current system. These changes are areas that CTA has identified which will provide low cost, non-intrusive modifications to the existing system that will provide great benefits for all radio users.

CTA will then explore the next steps that the City of Oakland should consider as they look toward the radio system that will support their needs 15 years into the future.

Report Outline

CTA developed this needs assessment report using information obtained during interviews, radio site and dispatch surveys, additional meetings with the City of Oakland, and an online surveyor tool, CTA Surveyor^{SM}. The report is organized into sections that align with the fourteen tasks specified in the City's Interoperability Statement of Work:

INTRODUCTION – This section introduces the study.

SECTION 1 SYSTEM COVERAGE - This section includes an analysis of the existing two-site 800 MHz voice radio communications system. In addition this section includes an opinion of probable cost analysis that will analyze costs associated with the addition of City sites to the EBRCS.

SECTION 2 SPECTRUM EFFICIENCY – This section provides an overview of the current multi-site system including the advantages and disadvantages, and provides recommendations for improved system operation and utilization.

SECTION 3 COVERAGE REDUNDANCY - This section analyzes the coverage overlap between the City's radio system and the proposed EBRCS coverage area.

SECTION 4 SIMULCAST TECHNOLOGY - This section provides an overview of simulcast technology and evaluates the use of simulcast technology for the City of Oakland.

SECTION 5 IN-BUILDING COVERAGE - This section provides an analysis of the portable radio in-building coverage requirements and makes recommendations to improve in-building radio coverage within the City.

SECTION 6 P25 MIGRATION - This section provides an overview of P25 and evaluates the City's migration from its existing M/A-COM EDACS 800 MHz radio system to a P25 standards based system.

SECTION 7 SUBSCRIBER EVALUATION - This section provides an evaluation of the backward compatibility of the City's newly purchased P25 subscriber radios with the BART's EDACS radio system and includes a comparison of feature/function sets.

SECTION 8 INTEROPERABILITY WITH BART - This section evaluates the City's upgrade and migration to a P25 radio system and the affect this will have on interoperability with BART.

SECTION 9 This section has been purposely omitted from this report.

SECTION 10 CHANNEL CAPACITY - This section provides an analysis of the channel capacity of the existing radio system and addresses current and future channel capacity needs.

SECTION 11 RETURN ON INVESTMENT (ROI) EVALUATION - This section contains a review of the City's investments in communications and provides recommendations on the ROI analysis.

SECTION 12 MAINTENANCE COSTS - This section provides an analysis of maintenance / replacement costs for the City of Oakland. The analysis includes a comparison of the City's maintenance costs of its current radio communications system versus the buy-in, maintenance and ongoing system/equipment costs (monthly subscriber fees) of joining the EBRCSA.

SECTION 13 CONTINUITY OF OPERATIONS - This section provides an overview of the Oakland Radio Shop and an assessment of the radio shop's ability to provide the level of maintenance required to maintain the continuity of operations needed to support public safety communication.

SECTION 14 GOVERNANCE - This section outlines CTA's findings concerning the current EBRCSA JPA that are related to the technical, financial and implementation (timeline) aspects of the regional agreement and researches any cost savings to the City if it were to join the EBRCSA.

SECTION 15 RECOMMENDATIONS – This section makes recommendations on a technical roadmap for a radio system that will meet the needs of the City of Oakland and that will provide seamless interoperability with BayRICS.

This appendix has been purposely omitted from this report.
This appendix has been purposely omitted from this report.
APPENDIX C – CTA SURVEYOR RESULTS – This section provides the survey results based on the online survey completed by individual agency users.

Appreciation

We wish to thank all of the departments and agencies who participated in this study for their cooperation and support. We especially wish to express our thanks and appreciation to Orval Badger and Gregg Tanner of the City of Oakland Department of Information Technology. All of the participants that assisted CTA with the preparation of this reported helped us provide accurate information that we have used to provide a technical roadmap for the future that meets the needs of the users.

1.0 System Coverage

1.1 Introduction

This section provides an analysis of existing radio coverage and opinion of probable cost in support of SOW Task #1. The assumption is that most readers of this report will begin here, so CTA begins to look at the available choices the City of Oakland faces as they develop a technical radio communications roadmap that best suits the needs of the City of Oakland radio users. CTA has considered and evaluated several options based on technical, operational, and cost factors. In this first section, we will refer to other sections of this document that provide the basis for some of the options discussed in this section.

The City of Oakland currently has an EDACS trunked radio system, originally supplied by Ericsson GE. Since the system was first installed, the vendor has gone through several acquisitions and subsequent name changes (Con Net, M/A-COM, Tyco Electronics, and as of June 1, 2009, Harris). However, throughout this report, the vendor will be referred to as "M/A-COM", which is the most familiar name to the City of Oakland.

As part of the analysis, CTA has evaluated the existing radio coverage of the three sites (APL, Gwin and Seneca) that provide coverage for the City of Oakland using CTA's Propagation, Coverage, and Loading Analyst (P-CALA^{SM}) software. In addition, we have compared existing City radio coverage with the proposed EBRCS radio coverage and identified leveraging opportunities for the City of Oakland.

CTA has also provided an opinion of probable cost analysis using our proprietary Cost Budgeting Analyst software. The analysis includes an opinion of probable cost for the viable options that are available to Oakland.

1.1.1 Presenting the Technical Solutions

Because this interoperability project focuses on developing a technical roadmap for full and seamless interoperability with the San Francisco Bay Area Regional Interoperable Communications System (BayRICS), CTA has considered several options that the City of Oakland can choose as it moves forward. These options are presented below and each of the 14 sections of this report is used to support CTA's final recommendation, which is presented in Section 15.

CTA considered several choices for the City of Oakland's future radio system:
1. Continue to maintain the current EDACS system.
2. Migrate to a true Multi-site EDACS system that supports automatic roaming.
3. Migrate to an EDACS simulcast system.
4. Migrate to a M/A-COM (Harris) P25 system.
5. Migrate to a M/A-COM (Harris) P25 simulcast system.
6. Join the EBRCS P25 simulcast system.

Options 1 through 5 all assume that the City of Oakland will continue to use its existing radio system in some form, while option 6 is unique in that it explores the possibility of moving entirely to the EBRCS. As a first step, CTA looked for opportunities to reduce the number of choices from 6 down to a manageable number so that the detailed analysis could be completed.

1.1.2 Reducing the Number of Technical Solutions

After completing the analysis contained in Section 2: Spectrum Efficiency and Section 4: Simulcast Analysis and reviewing the information provided to CTA during interviews and during the online survey, it is clear that the advantages of a simulcast system far outweigh the advantages of a pure multi-site system. A simulcast system is the clear choice based on user needs, technical feasibility, spectral efficiency, interoperability needs, operational effectiveness and cost benefits.

The choice of a simulcast system effectively reduces the choices to three: migrate to an EDACS simulcast system, migrate to a M/A-COM P25 Simulcast system or join the EBRCS P25 Simulcast System. Furthermore, because of the desire to provide "seamless interoperability" with BayRICS, these three choices can be reduced to two. If the City of Oakland decides to upgrade its existing EDACS radio system to a simulcast EDACS system, the main goal of achieving "seamless interoperability" with BayRICS will not be achieved. As the agencies, counties and municipalities throughout the Bay Area move toward P25 standards based systems, the City of Oakland must also move in this direction if they are to achieve truly interoperable communications with these surrounding agencies. If the City of Oakland stays with EDACS technology it will not be able to directly communicate with surrounding agencies as they implement P25 systems.

CTA recognizes that several temporary or functionally limited technical solutions are available to connect P25 networks with non-P25 networks; however these solutions do not meet the requirement to provide "seamless interoperability". Although several "workarounds" exist that will enable some level of interoperability between an EDACS system and P25 standards based systems, they do not provide the level of interoperability required by the City of Oakland radio users. These needs are summarized in Section 7: Subscriber Analysis. In addition, the Appendices contain information gathered during interviews and from the online surveys that clearly indicate something more than a "workaround" is needed for interoperability.

If we eliminate the EDACS simulcast technology choice the number has effectively been reduced to down to 2:

1. Migrate to a M/A-COM (Harris) P25 simulcast system.
2. Join the EBRCS P25 simulcast system.

Choosing between these two options becomes increasingly difficult as the operational, technical, governance and costing considerations are evaluated. The remainder of this report will be used to further refine the details of implementing either of these two options. Another consideration is that as the City of Oakland migrates to a P25 system, several components, including the recently acquired EDACS rebanding equipment, will likely remain in place until a complete migration to a P25 standards based system is implemented.

As we begin to look at the needs of the radio users, it is clear that we must begin with coverage. The online survey as well as the interviews indicated that improved radio coverage was the number one concern of the radio users, which can be clearly seen in Table 7-4 and in Section 7. CTA began its analysis of radio coverage by first looking at existing radio coverage.

1.2 Existing Radio Coverage Analysis

CTA began to analyze system coverage by looking at existing radio coverage within the City of Oakland's operational area. The City of Oakland's coverage area includes the City of Oakland, City of Piedmont and the City of Emeryville. The coverage maps shown at the end of this section reflect portable Talk-In (the communication path from the portable to the tower) and mobile Talk-In coverage. In a properly designed system, Talk-In and Talk-out should be balanced, but users in the City of Oakland consistently described being able to hear dispatch, but not being able to be heard by dispatch. Since the existing City of Oakland system is not balanced for Talk-In and Talk-Out using low noise tower top amplifiers, Talk-In diagrams were selected due to the concern users consistently expressed during interviews about not being able to talk back to dispatch from their portable radio. User-reported coverage difficulties with portable radios far exceeded those indicated for mobile radios. As a result, CTA has chosen to reflect Talk-In coverage. .

Figures 1-1 and 1-2 reflect the existing portable and mobile Talk-In coverage for the APL site, Figures 1-3 and 1-4 for Seneca and Figures 1-5 and 1-6 for the new site at Gwin. The three sites in the Oakland system operate independently and automatic roaming between the sites is not supported at this time. If a user from the northern portion of the City wants to move to the southern portion, they must manually change from a talkgroup on APL to a talkgroup on Seneca. As a result, users typically have a primary site that they use for all communication. The coverage diagrams reflect the coverage that users are accustomed to as they operate from a **single** site. Simulcast coverage predictions are provided in Section 4.

The source of these coverage estimates is an RF coverage prediction program that is part of CTA's proprietary Propagation, Coverage, and Loading Analyst (P-CALA^SM) software. These predictions are based on knowledge of radio signal propagation, and the factors which affect the signal as it travels through the air, over different terrain types, through different vegetation types, into and around buildings and other obstacles. Parameters, which affect the predictions, include:

- Transmitter power
- Line losses
- Combiner losses
- Connector losses and other expected losses
- Antenna Gain(s), beam width and directional orientation
- Antenna/Tower Height(s) - AGL
- Receiver Sensitivity, Receive height (head or hip)
- Terrain gradients
- Tree or foliage type, density and clutter height above ground (Morphology)
- RF Noise

Coverage predictions are based on the Longley-Rice point-to-point model as implemented in the Terrain Analysis Package (TAP™) by SoftWright, LLC. This implementation is based on version 1.2.2 of the Longley-Rice model. CTA participated in the early development of this implementation and continues to refine the accuracy of the model through our P-CALA™ suite of engineering tools and through actual field testing accomplished in our Radio Coverage Evaluator (RaCE^[PATENTED]) mobile testing solution.

1.2.1 Potential Problem at APL site.

These coverage diagrams were compared to the coverage problems reported to CTA by the radio users during our interviews. CTA normally observes a close correlation between what the users are experiencing in the field and the coverage diagrams generated using P-CALA^SM, however that was not the case in Oakland. For the APL site in particular, CTA observed that the expected Portable Talk-In coverage was about 10 dB more optimistic than what users were reporting. The coverage reported by the users during interviews closely matched the user-adjusted coverage we show in Figure 1-7 for the APL Site. Many of the coverage gaps reported by the users are clearly seen in Figure 1-7 but they cannot be seen in the theoretical coverage prediction of Figure 1-1 for the APL site. Most notably are the coverage gaps in and around the City of Piedmont and in the City of Emeryville. Portable coverage in these areas is essential and many of the areas where officers and firefighters frequently respond do not have adequate coverage in Figure 1-7. These coverage problems were consistently mentioned during interviews, especially with the City of Emeryville.

Several factors could contribute to the difference in user-adjusted (Figure 1-7) versus predicted (Figure 1-1) coverage. Everything from connectors to equipment settings at the site could contribute to signal loss. Another factor, often overlooked, is the fact that the 800 MHz noise environment is dramatically different today than it was 10-15 years ago when Oakland's system was first operational. None of the sites in the Oakland system are utilizing low noise tower top amplifiers, which will reduce the system noise floor and improve Talk-In reception. Tower top amplifiers will significantly help the users in the City of Oakland by balancing Talk-in and Talk-out reception. Furthermore, the power output levels at the APL site should be verified.

Regardless of the cause, CTA recommends that further testing and evaluation are required to confirm the apparent 10 dB difference and identify the source of this difference. The testing should include gathering Talk-out RSSI data around the APL site and comparing this data with the expected signal levels based on ERP and Power Output. In addition, the site validation should include verification of transmitter settings and an electronic performance sweep of the RF transmission lines to ensure the return loss is within specification.

CTA is able to perform this testing upon request and will, at a minimum, discuss the details of the testing that is needed to isolate the source of the coverage differences. It should also be noted that if there is a problem that is causing a 10 dB difference, correcting the problem will dramatically improve radio coverage for all users affiliated with the APL site.

1.2.2 Low Power Level at APL site.

Another concern that CTA discovered was the low licensed power output level at the APL site. The APL site has a licensed ERP of 19 Watts. This power output is significantly lower than any of the surrounding sites, which typically have an ERP of 300 Watts. CTA verified this licensed low power output level with the City of Oakland radio technicians and with the FCC license for that site. We then began to research why the power level was set to 19 Watts.

We conducted a frequency search for the 16 channels that are licensed for APL, Gwin and Seneca. During this search we found three channels that could have been the reason for the lower power output level at APL. The first potential limiting power contributor was with Oakland Channel 868.5625 MHz, which has an adjacent channel interference with an Alameda County channel 868.5750 MHz. The Alameda channel is licensed as a county-wide mobile channel (talk-around) and there is no fixed equipment for this site. The second potential limiting power contributor was with Oakland Channel 867.0500 MHz, which has an adjacent channel interference with a Statewide temporary use channel of 867.0375 MHz. The third potential limiting power contributor is with Oakland Channel 866.4000 MHz, which has an adjacent channel interference with 866.3875 MHz licensed as a fixed site to Santa Clara Water. This third channel is likely the main cause of the lower ERP requirement by the FCC at the Oakland APL site.

CTA has identified some potential ways to obtain an FCC license with an increased power level for the APL site. First, the City of Oakland can move the three channels above to the Gwin site and license them at the lower ERP setting, which is not expected to have any FCC licensing difficulties. The remaining channels at APL could then operate at a higher transmit power under the existing license. Second, the City of Oakland can work with the 800 MHz regional coordinator and discuss licensing the remaining Oakland channels as an 800 MHz simulcast system at the higher ERP level (100 W or 300 W). Our preliminary research did not reveal anything that would prohibit this licensing process, however; we were unable to look at the effect rebanding would have on these channels since the Bay Area 800 MHz channels were repacked for rebanding.

One other licensing note is that the frequency 867.5750 MHz is licensed under a separate City of Oakland License (Call Sign WQGN458). This frequency is not currently assigned a channel, and the current license will expired on March 14th, 2009, but the FCC granted the City of Oakland a STA.

1.2.3 CTA Recommendations for APL site.

CTA recommends the following steps be taken to increase the coverage from APL.

1. Install low noise tower top amplifiers. This should be done at the Gwin and Seneca sites as well.
2. Relicense the frequencies at APL for 200 – 300 Watts, as described in Section 1.2.2. If the City of Oakland is unable to relicense these frequencies at a higher power level, then additional frequency resources should be sought after so that the APL can license all frequencies at that site at a higher power level.
3. Even after the installation of the new MASTR III repeaters that were received as a result of rebanding, APL still might not perform as expected. CTA recommends that the problem be thoroughly diagnosed to be sure that there is not a problem between the transmit and receive sides of the repeater. The diagnosis should include checking all connections between the repeater and the antenna. Upon request, CTA is able to perform this level of diagnostics.

1.2.4 Comparison between Existing Coverage and Proposed EBRCS

The requirement for the City of Oakland radio users is that they have 95% Portable Talk-In radio coverage. Often times radio coverage maps are provided that reflect the more optimistic Portable or Mobile Talk-Out path, which indicates that you can receive the signal from the repeater, but gives no indication that the repeater can receive your incoming portable radio signal. In a balanced system with low noise tower top amplifiers Talk-In and Talk-Out coverage is essentially the same. Since the City of Oakland is not using tower top amplifiers, CTA has provided portable talk-in maps, which is a more realistic coverage prediction for the existing system.

CTA compared existing and predicted simulcast City radio coverage with the coverage that could be expected within the City after **all** of the EBRCS sites are constructed and **operational in the Northwest Cell**. The City of Oakland is part of the Alameda County Northwest Cell (ALCO Northwest). The coverage provided for the City of Oakland is primarily provided by the 4 sites in the ALCO Northwest Cell. CTA has used our P-CALA^{SM} propagation tool to predict the EBRCS coverage provided for the City of Oakland's coverage area. The 4 sites in the ALCO Northwest Cell are configured as a P25 simulcast cell. Table 1-2 at the end of this section, provides the information used for coverage predictions, which includes: latitude, longitude, elevation, transmit antenna height and effective radiated power (ERP). The values in Table 1-2 were verified with data available from the Motorola design as of August 21, 2009.

Figure 1-8 shows the **portable talk-in / talk-out** EBRCS coverage for the City of Oakland that could be expected in the City of Oakland after the ALCO Northwest Cell is operational. In order to provide a better comparison, CTA has created a portable talk-in / talk-out coverage map for the proposed City of Oakland radio simulcast system (Figure 1-9) using APL and Seneca as the primary sites with the Gwin site used in a multisite configuration. The reasons for the selection of this simulcast system design are described in Section 4. Keep in mind that these maps provide coverage predictions and actual coverage may differ from what is reflected in these figures.

It should be noted that during the course of the City of Oakland project, EBRCSA has made several adjustments to their system design, many of which have been of great value to the City of Oakland. These changes included separating the ALCO West cell into the Northwest and the Southwest. In addition, the ALCO Northwest cell has been sized to include all the Oakland users and sites in the that cell have been relocated to co-locate with existing City of Oakland Sites. At the time of this report the assumption is that the ALCO Northwest cell will have sites at APL, Seneca, UC Berkeley and Skyline. Gwin will be used in the Northwest cell as a fill-in site in the same what that Oakland is using it today.

A careful comparison between the coverage shown in the EBRCS ALCO Northwest Cell map (Figure 1-8) and that shown in the Oakland Sites map (Figure 1-9) shows similar coverage between the two coverage maps. Figures 1-10 and 1-11 show mobile coverage. Because of the additional sites of UC Berkeley, and Skyline, the coverage offered by EBRCS is superior to that of what Oakland would expect from a simulcast system that only consisted of APL and Seneca. The City of Oakland should make every effort to keep the site selections as indicated in Table 1-2 for the ALCO Northwest Cell, any other site selection will likely mean degraded coverage for the City.

1.2.5 Leveraging "Not Yet Constructed" EBRCS Sites

Construction on most of the sites used in the EBRCS coverage described in Section 1.2 is not complete. At the time of this report none of the EBRCS sites are operational; however, construction has begun on some sites. As the EBRCSA continues to move forward in the construction of radio sites, the City of Oakland has several important leveraging opportunities. Most of the leveraging or sharing opportunities listed below have a relatively short lead time. The short lead time means that coordination is required as soon as possible with EBRCSA to ensure that the leveraging opportunities that exist today are not missed as the project moves forward.

One important difference between the two coverage areas shown in Figure 1-8 and Figure 1-9 is the additional coverage that the EBRCS sites provide outside the City's area of operation. During interviews, many users expressed the need for improved interoperability coverage outside the City. In some cases this interoperability coverage was needed to support vehicle pursuits and other incidents that require mutual aid. In other cases, coverage was needed so that officers and firefighters who live outside the City have the ability to use their radios while in route to and from incidents from their place of residence. Regardless of the need, the additional interoperability coverage provided outside the City by the EBRCS sites in the ALCO West and the surrounding EBRCS cells can be used to dramatically improve interoperability for those users responding outside the City.

Three of the EBRCS sites in the original design (Glen Dyer Jail, Lawrence Berkeley Lab and Skyline Reservoir) are either in, or on the border of the City of Oakland and are in close proximity to some of the existing City of Oakland sites. The Glen Dyer Jail EBRCS site in particular, is within ¼ mile of the City of Oakland APL site. In conversations with EBRCSA, CTA and EBRCSA have agreed that the APL site is superior to the Glen Dyer Jail site due to reduction in number of microwave links, cost savings based on using the APL existing infrastructure and the superior coverage due to the height of APL. In addition, the Skyline Reservoir site provides additional coverage over the APL / Seneca design used by the City of Oakland. Originally EBRCSA planned to use a site at the Lawrence Berkeley Lab but this site has been moved to UC Berkeley. The UC Berkeley site is in close proximity to the Gwin Site, but does provide additional coverage that the Gwin site does not provide, especially in the Northeast corner of the city.

As the City of Oakland continues to examine the two long term communication solutions, either installing their own P25 standards based M/A-COM system or joining the EBRCS P25 simulcast system, additional leveraging opportunities exist for sharing sites between the two systems. Regardless of the long term solution chosen, collocating sites or sharing sites provides sufficient cost savings. If Oakland decides not to join EBRCS, the following factors should be considered for site sharing opportunities between EBRCS and the City of Oakland.

Because of the close proximity of the sites discussed above, they were selected as potential candidates for collocating EBRCS and City of Oakland sites. A collocated site indicates that the site may share a shelter, tower, power, backup power, grounding or other physical components, but the two radio systems remain separate. In the event Oakland joins EBRCS, these sites would be considered EBRCS sites. The details of how to "share" these sites would have to be determined by each of the governing authorities. As part of this evaluation, CTA has included several technical factors that must be considered if any of the sites is selected as a collocated site.

These factors include:

1. Existing LMR Site - Is the site an existing LMR site? A significant cost savings can be realized if an existing LMR site is already in place.
2. Shelter – Does the Shelter have physical room for additional equipment? If the shelter does not have physical room, is there room at the site for an additional shelter?
3. Rack Space – Is their sufficient rack space in the shelter for additional equipment?
4. Power – Is the power at the site sufficient to support additional equipment?
5. Backup Power - Is the backup power at the site sufficient to support additional equipment?
6. Tower Condition – Is the existing tower able to support additional antennas and equipment?
7. Coverage – If the sites are collocated, will the resulting coverage be essentially the same as when the sites remain separate?
8. Microwave – Can the existing microwave connectivity and capacity support additional equipment and traffic? Each of the sites must be linked together in a microwave network, or at a minimum have some type of high capacity backbone connectivity in place. In the case where an established microwave connection is in place, the connection can be considered a "known good" path. For any new sites a microwave path analysis and capacity study should be completed to verify that the connectivity network can support the additional sites. A thorough analysis of the City of Oakland microwave connectivity is contained in Section 9.
9. Cost Savings – What is the anticipated cost savings for both the City of Oakland and EBRCSA if the sites were collocated?

CTA used the above factors to determine which of the three combinations of sites provides the best opportunity for collocating sites. The comparison of the EBRCS sites is based on information available from EBRCSA and Motorola as of January 21, 2009 and subsequent design modifications up through August 21, 2009. Each of the three possible site combinations was evaluated based on the above criteria. The nine factors above are summarized for each site in Table 1-3 at the end of section 1. CTA did not conduct a site survey for the EBRCS sites, and additional research should be completed prior to making a final decision to collocate EBRCS and City of Oakland sites. The factors in Table 1-3 are included with this report so that a comparison of EBRCS sites and Oakland sites can be documented for future reference. At the time of this report the EBRCS ALCO Northwest design had chosen the following sites: APL, Seneca, Skyline, and UC Berkeley. CTA believes these are the best sites for the ALCO Northwest Cell from the City of Oakland's perspective. Gwin is included as a four channel stand alone site.

1.2.6 Potential Leveraging Benefits

If the City of Oakland were to build their own P25 system and they are able to reach a "sharing" or collocation agreement with the EBRCSA they would have a location that houses both EBRCS equipment and City of Oakland equipment. A collocated site of this type offers many advantages. One important advantage of a co-located site will be the fact that physical equipment from two separate radio systems will have a common location which will better facilitate further system integration. This collocated site would be a significant advantage if the City of Oakland decides to move toward a M/A-COM P25 simulcast system.

If the M/A-COM P25 simulcast option is chosen, both the EBRCSA and the City of Oakland would be moving toward P25 standards based systems and a collocated site would help facilitate the implementation of an interface between the two systems. The P25 interface known as the Inter RF Subsystem Interface, or ISSI, is an IP-based Ethernet interconnection that allows users from different P25 radio systems the ability to roam across multiple radio systems. **The ISSI is an**

interface standard, not an actual device. System interfaces that are ISSI compliant are being developed and will be available on P25 systems in the near future. Once ISSI interfaces are developed, they will need a physical connection between adjacent radio systems and utilizing a shared site easily facilitates this shared path. It should be noted, however, that an ISSI interface is not absolutely critical. Since the City of Oakland and EBRCSA are both P25 systems, it is possible to define talkgroups on each system that can facilitate interoperability without the use of an ISSI interface provided proper planning and coordination is completed.

Another important leveraging activity will be the interoperable use of EBRCS sites through the ISSI. It would be cost prohibitive for Oakland to build additional sites that could provide significant coverage outside the City. The City of Oakland should begin work developing MOU's with the EBRCSA now in order to coordinate the shared use of any EBRCS P25 standards based sites that will provide coverage in and around the Oakland area. This EBRCS coverage will facilitate most of the interoperability needs in the areas that surround the City of Oakland and throughout Contra Costa and Alameda County.

It is also important to realize that some of the same challenges the City of Oakland faced when implementing the Stargate with BART and the City of Richmond will exist when implementing a P25 standards based interoperability solution with EBRCSA through an ISSI. These challenges include identifying users, talkgroups and physical radios that will be allowed to roam between the two systems. Essentially, an active ISSI will require coordinating users, talkgroups and system databases between the EBRCSA and City of Oakland radio systems.

However, if these efforts are coordinated now, before either P25 system is completely built out, it will be easier to overcome these difficulties. Additionally, coordination now will help each agency understand the amount and level of interoperability that must be planned into each system as it is developed so that traffic loading, site development and other activities can be coordinated. It is also important to note that if these planning activities occur now, the ISSI interoperability between the two systems is not expected to have an adverse affect on either existing system. This potential exists if proper planning is not done in advance.

1.2.7 FCC Site License Modifications

The statement of work requires CTA to analyze the FCC site license modifications required to leverage City equipment associated with applicable EBRCS sites. Furthermore, CTA is required to analyze license issues associated with applicable EBRCS sites.

First, it is important to understand the rules and regulations that mandate a change to an FCC license. FCC licenses include administrative details of the licensee and technical details such as antenna location and elevation, frequency, emissions, effective radiated power (ERP), mobile area of operation and other information. The FCC requires a new license (or a license modification) for the addition or modification of any combination of antenna location and frequency. This includes, but is not limited to, (1) adding a new frequency at a new antenna location, (2) moving an existing antenna more than one arc minute, (3) adding a new frequency to an existing antenna location or (4) adding a new antenna location to an existing frequency.

If the City chooses to expand its radio system to an EBRCS site, it must obtain a license for new antennas and frequencies at that site. Likewise if the EBRCSA expands its radio system to a City of Oakland site, it must obtain a license.

If the City of Oakland enters an agreement with the EBRCSA to use the EBRCS, a new FCC license is not required as long as there are no new antennas or frequencies added. In fact, no modifications to the EBRCSA's FCC license would be needed, unless the number of mobile units exceeds the number on the license or the area of operation is expanded.

Although an FCC license modification may not be required, a memorandum of understanding (MOU) between the City of Oakland and the EBRCSA is recommended. The MOU will outline the specific frequencies that the City of Oakland is allowed to use and will outline the conditions for use. A similar agreement would be needed for any of the EBRCS users that need to use City of Oakland frequencies. The MOU is the first step in the critical coordination process that must be put in place to support interoperability.

1.3 Opinion of Probable Cost

Estimates were developed for the major categories of equipment as they apply to the options currently available to the City of Oakland. The costing information is obtained from historical CTA cost files and vendor pricing of comparable projects. The various costs are compared and weighted in order to derive an average "list price" type of estimate. Although CTA cannot guarantee bid price levels, successful competitive bidding typically results in savings on the list price costs. The Opinion of Probable Cost includes the following options:
1. Cost associated with upgrading to M/A-COM P25 Simulcast system.
2. Cost associated with joining the EBRCS P25 Simulcast system.

Option 2 is discussed in detail in later sections of the report and the costs for Option 1 are provided below. The Opinion of Probable Costs calculated here will be used to develop a technical roadmap for the City of Oakland that incorporates cost considerations, available technology and the ability to support operational needs as identified by the radio users.

Several tables are included in this section reflecting our opinion of the probable costs of the project. These display tables contain elements and categories that drive the reflected cost estimate numbers.

Cost Element
Cost Elements are categories of equipment that make up the system design and costs. Each of these cost elements are discussed in section 1.4 of this document.

List Estimate
Items and categories of equipment are applied to the List Costs database that CTA has created. This database is created by our compilation of all known costs converted to this list costs status, creating a common basis of estimation. List Costs figures are the inputs for all of our calculations and all estimates begin with a List Cost level.

Negotiated Estimate
We have adjusted the List Costs for the effect of negotiating with a sole source vendor or system integrator. The Lists Costs are reduced by the percentages that we have typically seen in this type procurement. Each cost element is affected in differing ratios based on the experience in previous procurements.

Competitive Estimate
Estimates are further reduced to reflect the cost reduction we have seen in highly competitive areas, and the cost elements are reduced in differing ratios to account for the impact of competition on purchasing.

1.4 Cost Elements

1.4.1 Radio Infrastructure

The estimate display for Voice Infrastructure contains several cost elements. These are generally the fixed equipment contained at the transmission and control sites. This includes transmitters, receivers, repeaters, antennas, multicouplers and combiners, voters, and site control equipment. The following assumptions and elements are included:

The system and site control and support equipment and facilities installed are sized for the overall system. The number of transmitters and other equipment is based on the number of channels expected to be in use initially when the system is activated.

For the basic system, additional, specialized equipment that is included within the Infrastructure categories are:

A. Dispatch Equipment
Consoles are required to allow functionality for the dispatch operations. Based on our assessment all the existing consoles will need to be replaced when the City upgrades to a P25 standards based system.

B. System Management Equipment
The system management subsystem provides the means of infrastructure programming and daily radio operation. This includes the subscriber permissions database, key management for encrypted operation, and the radio programming equipment. One system management terminal is included in the design at each dispatch location.

C. Alarm and Diagnostic System
A network typically requires alarm and diagnostic equipment. Such subsystems are included to significantly ease the task of critical maintenance. One alarm monitoring terminal is included in the design at each dispatch location. Typical alarms are:
- Voice network diagnostics, management and monitoring
- Mobile data network maintenance system
- Connectivity network maintenance system
- Tower site facilities monitoring - power, temperature, fire, intrusion, etc.

1.4.2 Microwave

This opinion of probable cost does not include any costing for microwave connectivity as indicated in the scope of work for this project; however it is expected that the current microwave connectivity upgrades will be completed. Since the microwave connectivity is currently being upgraded, CTA did not want to duplicate those costs in this cost estimate.

1.4.3 Physical Facilities

This category is perhaps the most difficult to identify. Contained here are tower upgrades, foundations, tower analysis surveys, site clearing, security fencing, shelters, generators, UPS power supplies, HVAC, solar power, utilities connections, and grounding.

The existing facilities at all of the tower site locations have been evaluated. The different sites are in various levels of readiness. The sites will require some additional development before they are ready to support a simulcast system. Much of the system's reliability will rely on the sites' condition.

1.4.4 Vendor Services

Purchasing a communications system is a complex and detailed process. Some of the effort on the part of a major radio retailer and/or a systems integrator would be outsourcing those efforts not part of their core business.

As expected in the outsourcing, the price for the service is escalated with pass through fees and administrative add-ons, as well as risk factors for unanticipated activities.

In the cost estimate there is a category for Vendor Services. This accounts for the expenses experienced for the Vendor to perform procedures for professional engineering, design, project management, user train the trainer sessions, and their own verification of performance for these elements to match your requirements. This category's cost information is obtained from historical CTA cost files and vendor pricing for comparable projects.

1.4.5 Spares Infrastructure

This cost element is a simple 2% factor of the value of the Fixed Infrastructure costs; including consoles.

1.4.6 Subscriber Radio Equipment

The Opinion of Probable Cost does not include any subscriber or non-fixed equipment costs since the City has already procured non-fixed equipment needed through a combination of rebanding requirements and recent subscriber purchases. This non-fixed equipment is P25 Phase I capable, but will likely need a software upgrade to P25 Phase II.

1.4.7 Contingency

In any radio project, unexpected occurrences and expenditures will be required. All of the estimates and all of the proposals will be predicated on such terms as "normal soils conditions", that there will be no zoning appeals and/or delays, suitable access will be available, and other such codicils. While successful and detailed negotiations can assist in protecting the project; there will be the unexpected. In our experience a viable cost element for contingencies should be set aside at 10% of the project without the non-fixed element.

Often this cost element is identified early on as a place for cost reduction. CTA strongly encourages the project to leave the Contingency funds in place until the end of the project.

1.5 Radio System Cost Summaries

The costs of a modern radio communication system includes a number of interrelated factors:

- Present and future requirements
- Coverage
- Interoperability
- Performance
- Capacity
- System reliability
- Maintainability
- Features

The voice system design will be based on the cost associated with upgrading to M/A-COM P25 Phase II Simulcast system. Although the sites currently have M/A-COM Master III repeaters, they will need to be updated to repeaters that support P25 Phase II. We have not included the cost of upgrading the microwave in the costs below because the assumption is that the current microwave and connectivity network upgrades will support the new system.

The costs in Table 1-4 are based on 8 Phase II Voice channels and one control channel. This would provide 16 P25 talkpaths and one control channel at APL and Seneca. In addition two additional Phase II voice channels (4 talkpaths) and one control channel on Gwin for a total of three transmitters on Gwin. From a costing perspective this means there are 9 transmitters at APL and Seneca.

Table 1-1 has purposely been omitted from this report.

Table 1-2
Potential EBRCS ALCO Northwest Coverage in the City of Oakland

SITE NAME	LATITUDE	LONGITUDE	Transmit Antenna Height (feet)	ERP (Watts)
APL (See Note 2)	37 48 09.78	122 16 22.86	366	19.0
UC Berkeley	37 52 39.64	122 14 48.36	60	309.0
Skyline Reservoir	37 49 13.1	122 11 5.1	90	147.9
Seneca	37 45 22.02	122 09 26.34	60	173.8
Gwin	37 51 45.66	122 13 21.24	60	173.8

Note1: The antenna type, directional azimuth and tilt were factored into the coverage prediction
Note2: The Transmit Antenna height for APL includes the building that the 20 foot tower sits on.

Table 1-3
EBRCS / City of Oakland Collocation Factors

Factor	EBRCS Sites		City of Oakland Sites		
	Skyline Reservoir	UC Berkeley	APL	Seneca	Gwin
Existing LMR Site	Usable	New	Good	Good	Good
Shelter	New	New	Good	Usable	Good
Rack Space	New	New	Good	Usable	Poor
Power	Good	Good	Good	Good	Good
Backup Power	New	New	Good	Poor	Poor
Tower Condition	Good	New	Good	Good	Poor
Coverage	Figure 1-8	Figure 1-8	Figure 1-9	Figure 1-9	Figure 1-9
Microwave	Planned	Planned	Good	Good	Good

Unknown	**Requires a Site Survey to Determine Condition**
New	**Requires a new site construction or is planned for a complete replacement**
Poor	**Requires complete replacement or significant upgrade**
Usable	**Possible to reuse, but will cost at least 50% of complete replacement**
Good	**Reusable, but may need slight refurbishment with only minor expenditure**

TABLE 1-4
OPINION OF PROBABLE COST
CITY OF OAKLAND
P25 PHASE II SIMULCAST UPGRADE

	LIST COST			NEGOTIATED ESTIMATE		
RADIO INFRASTRUCTURE	100%	$	4,777,600	85%	$	4,061,000
MICROWAVE	100%	$	-	90%	$	-
PHYSICAL FACILITIES	100%	$	440,100	90%	$	396,100
VENDOR SERVICES	100%	$	861,000	85%	$	731,900
SPARES - FIXED	100%	$	47,800	100%	$	47,800
CONTINGENCY	100%	$	478,300	90%	$	430,500
TOTAL		**$**	**6,604,800**		**$**	**5,667,300**
INFRASTURE & SOFTWARE MAINTENANCE	2nd Year	$	272,800	2nd Year	$	272,800
	3rd Year	$	279,600	3rd Year	$	279,600
	4th Year	$	286,600	4th Year	$	286,600
	5th Year	$	293,800	5th Year	$	293,800

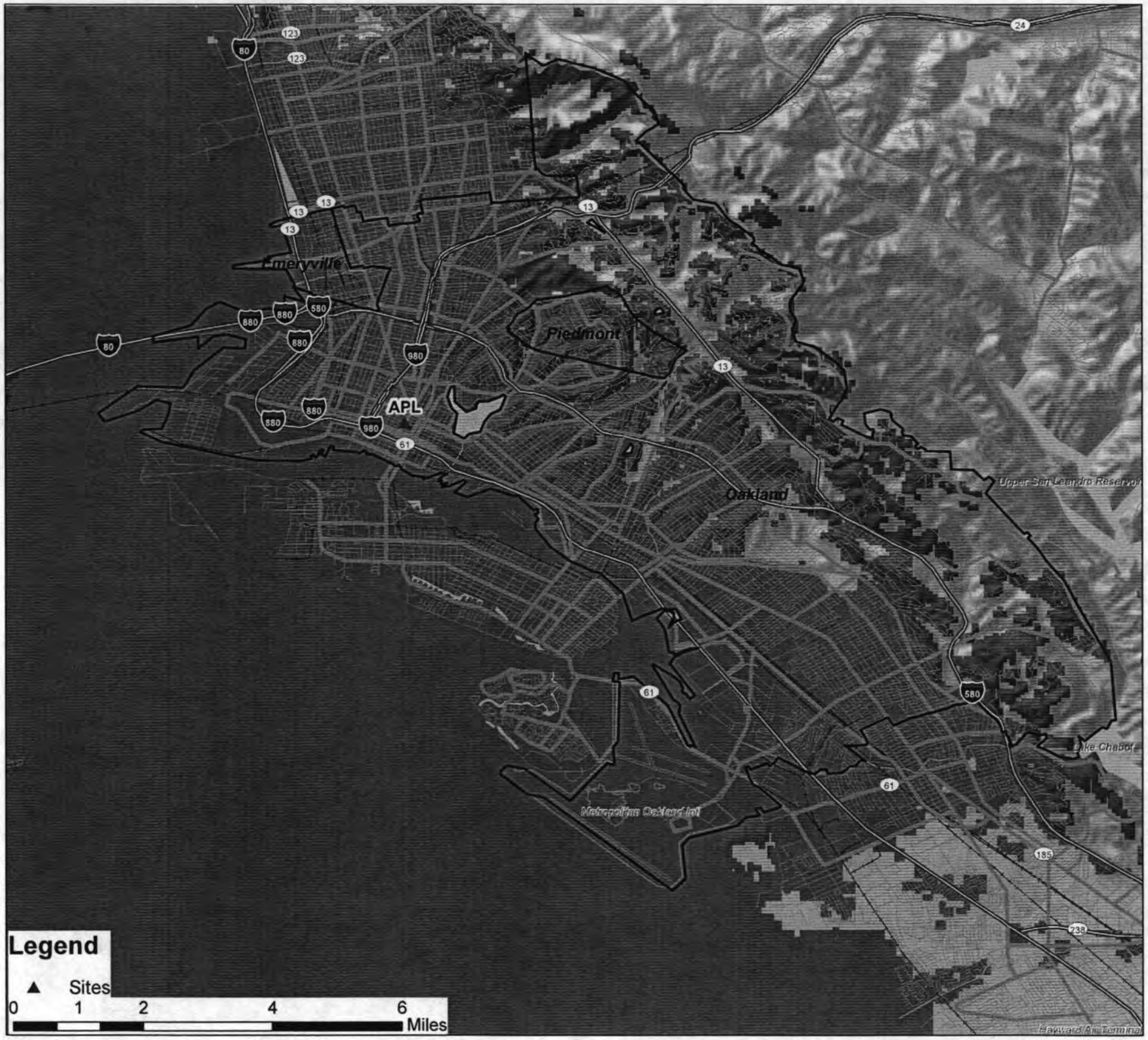

Figure 1-1 Existing APL Talkin Portable Outdoors 800MHz Coverage

Client: City of Oakland

Commission No. 20177A

Existing System Portable Outdoors Coverage Prediction Talkin (Portable to Base) 800MHz Prediction Based on FCC License

Site: APL

Longely-Rice 90/90 with Land Clutter/Land Use

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File Name: M:\Projects\Radio Projects\20177 City of Oakland, CA\Phase A Needs Analysis\Job Files\Technical Data\CTA P-CALA\Arcview Maps\Figure 1-1 Existing APL Talkin Portable Outdoors 800MHz Coverage rev1.pdf
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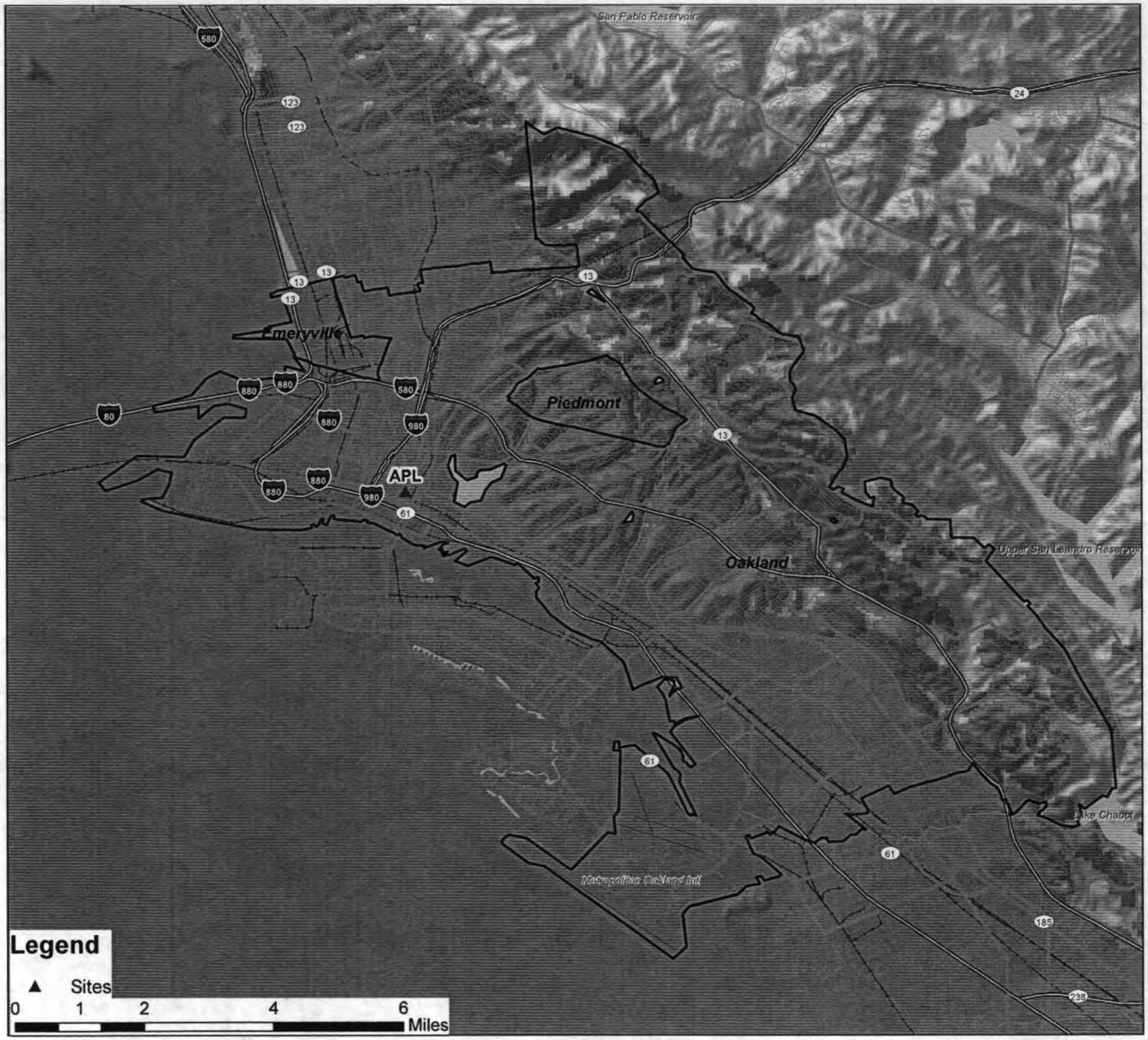

Figure 1-2
Existing APL Talkin Mobile 800MHz Coverage

Client: City of Oakland

Commission No. 20177A

Existing System Mobile Coverage Prediction Talkin (Mobile to Base) 800MHz Prediction Based on FCC License

Site: APL

Longely-Rice 90/90 with Land Clutter/Land Use

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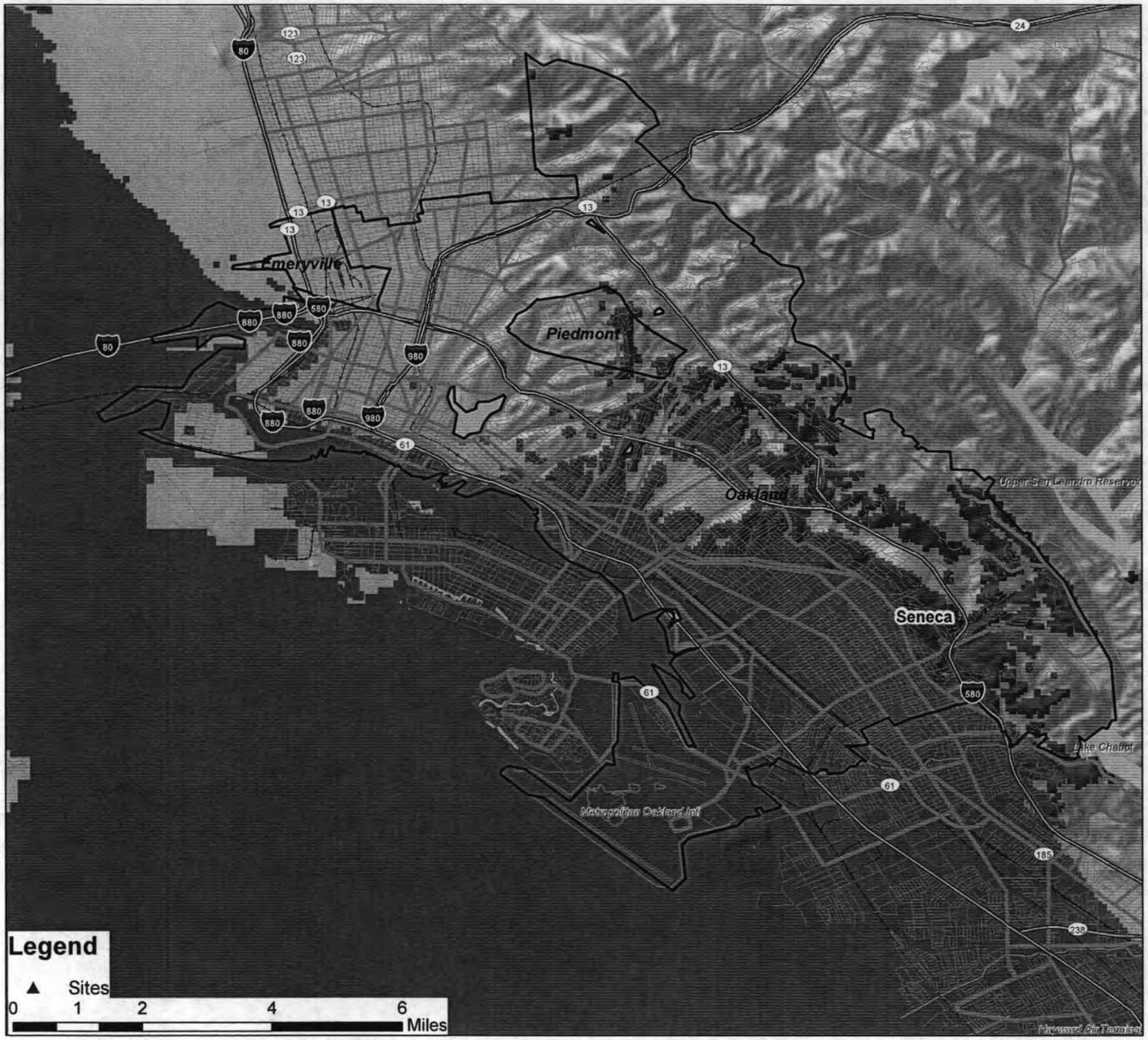

Figure 1-3 Existing Seneca Talkin Portable Outdoors 800MHz Coverage

Client: City of Oakland

Commission No. 20177A

Existing System Portable Outdoors Coverage Prediction Talkin (Portable to Base) 800MHz Prediction Based on FCC License

Site: Seneca

Longely-Rice 90/90 with Land Clutter/Land Use

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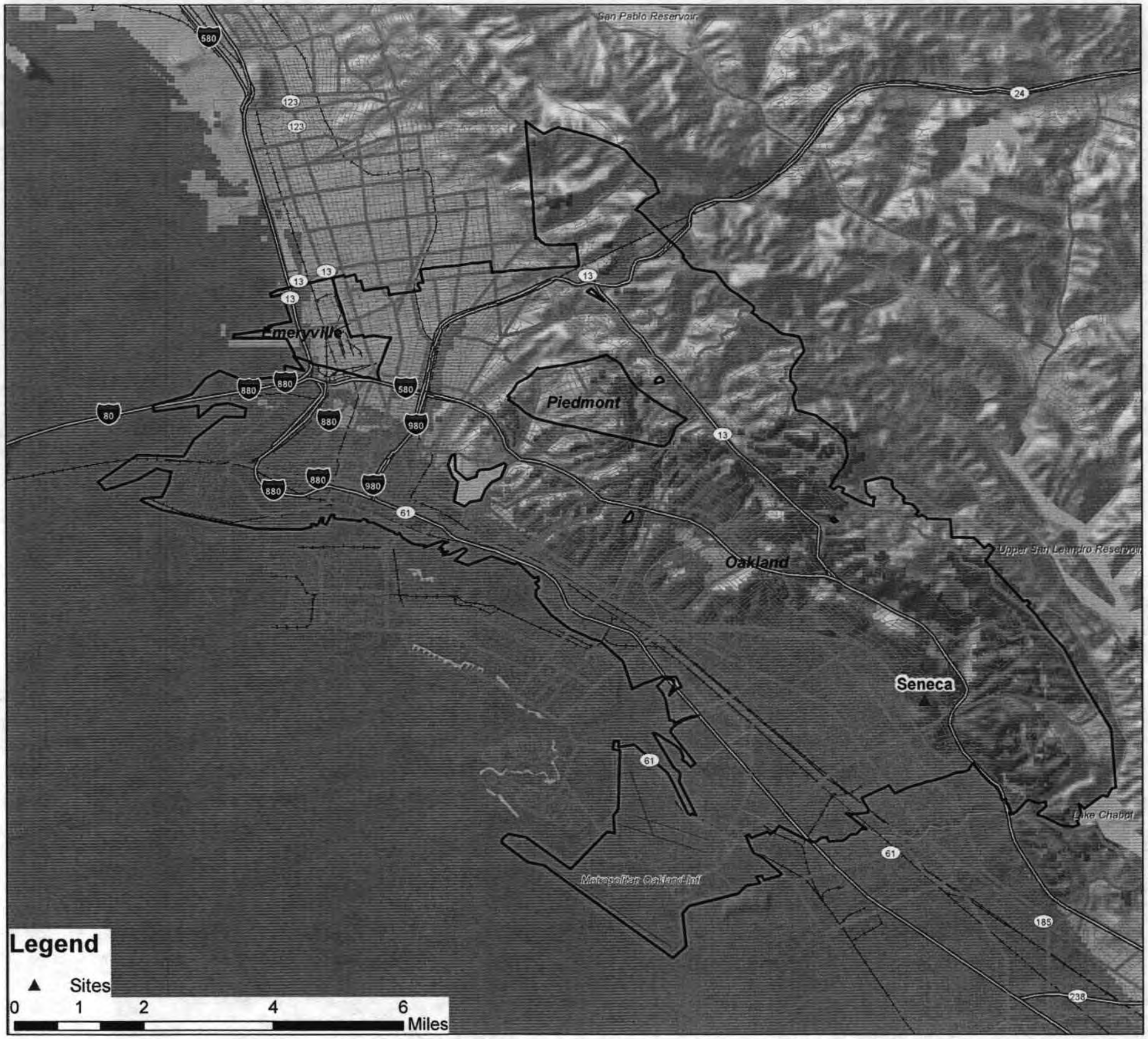

Figure 1-4 Existing Seneca Talkin Mobile 800MHz Coverage

Client: City of Oakland

Commission No. 20177A

Existing System Mobile Coverage Prediction Talkin (Mobile to Base) 800MHz Prediction Based on FCC License

Site: Seneca

Longely-Rice 90/90 with Land Clutter/Land Use

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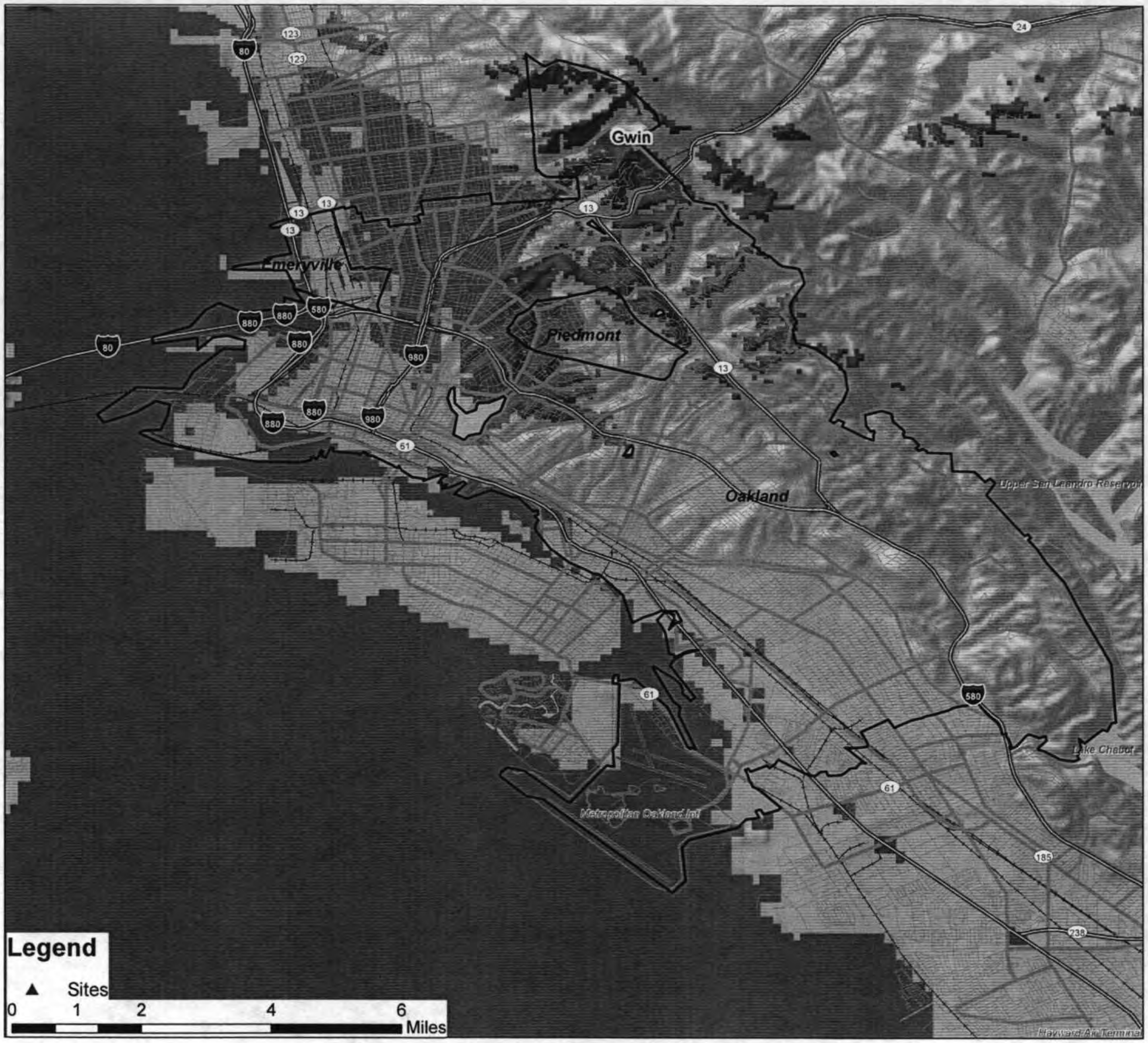

Figure 1-5 Existing GWIN Talkin Portable Outdoors 800MHz Coverage

Client: City of Oakland

Commission No. 20177A

Existing System Portable Outdoors Coverage Prediction Talkin (Portable to Base) 800MHz Prediction Based on FCC License

Site: GWIN

Longely-Rice 90/90 with Land Clutter/Land Use

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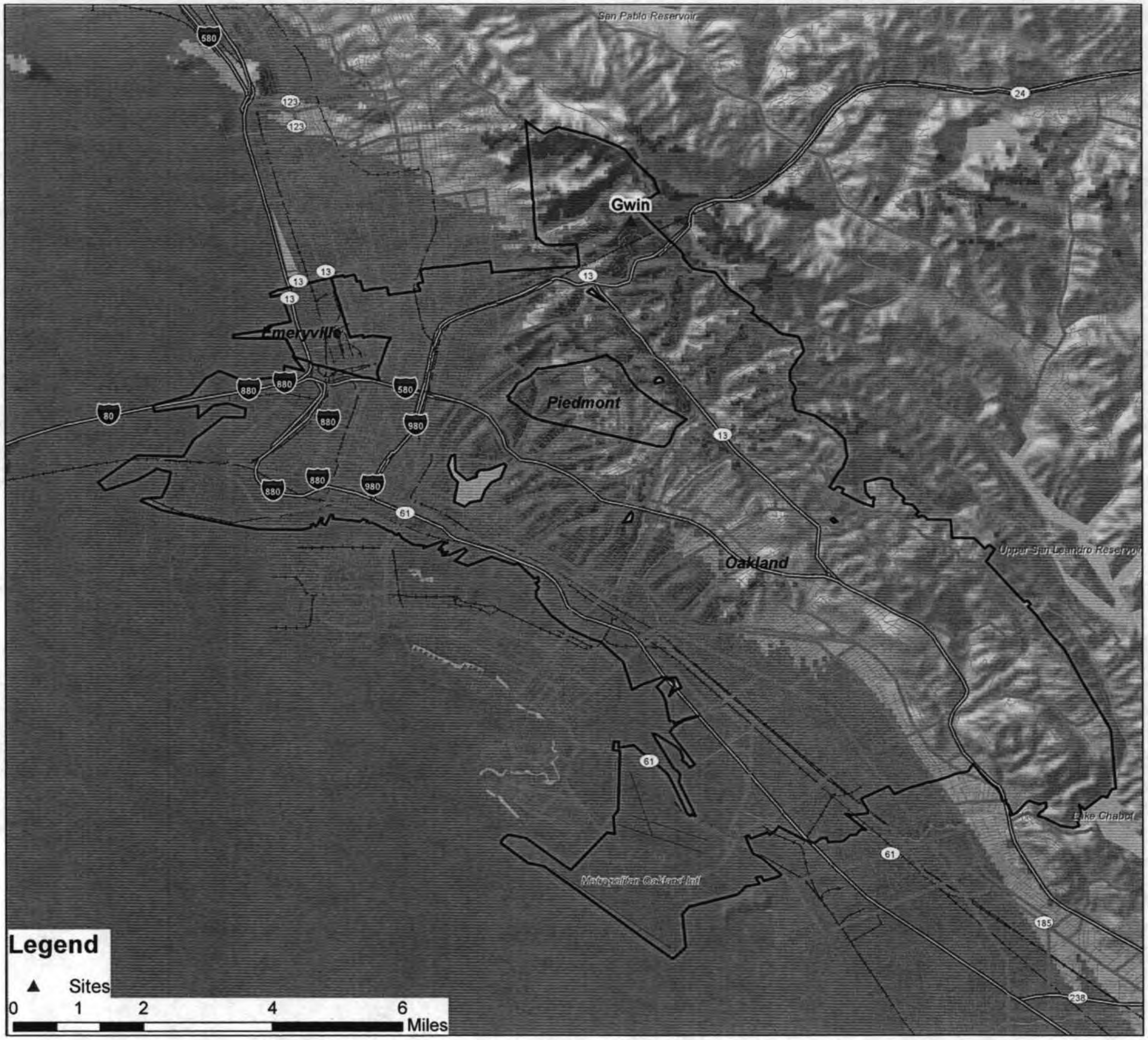

Figure 1-6 Existing Gwin Talkin Mobile 800MHz Coverage

Client: City of Oakland

Commission No. 20177A

Existing System Mobile Coverage Prediction Talkin (Mobile to Base) 800MHz Prediction Based on FCC License

Site: Gwin

Longely-Rice 90/90 with Land Clutter/Land Use

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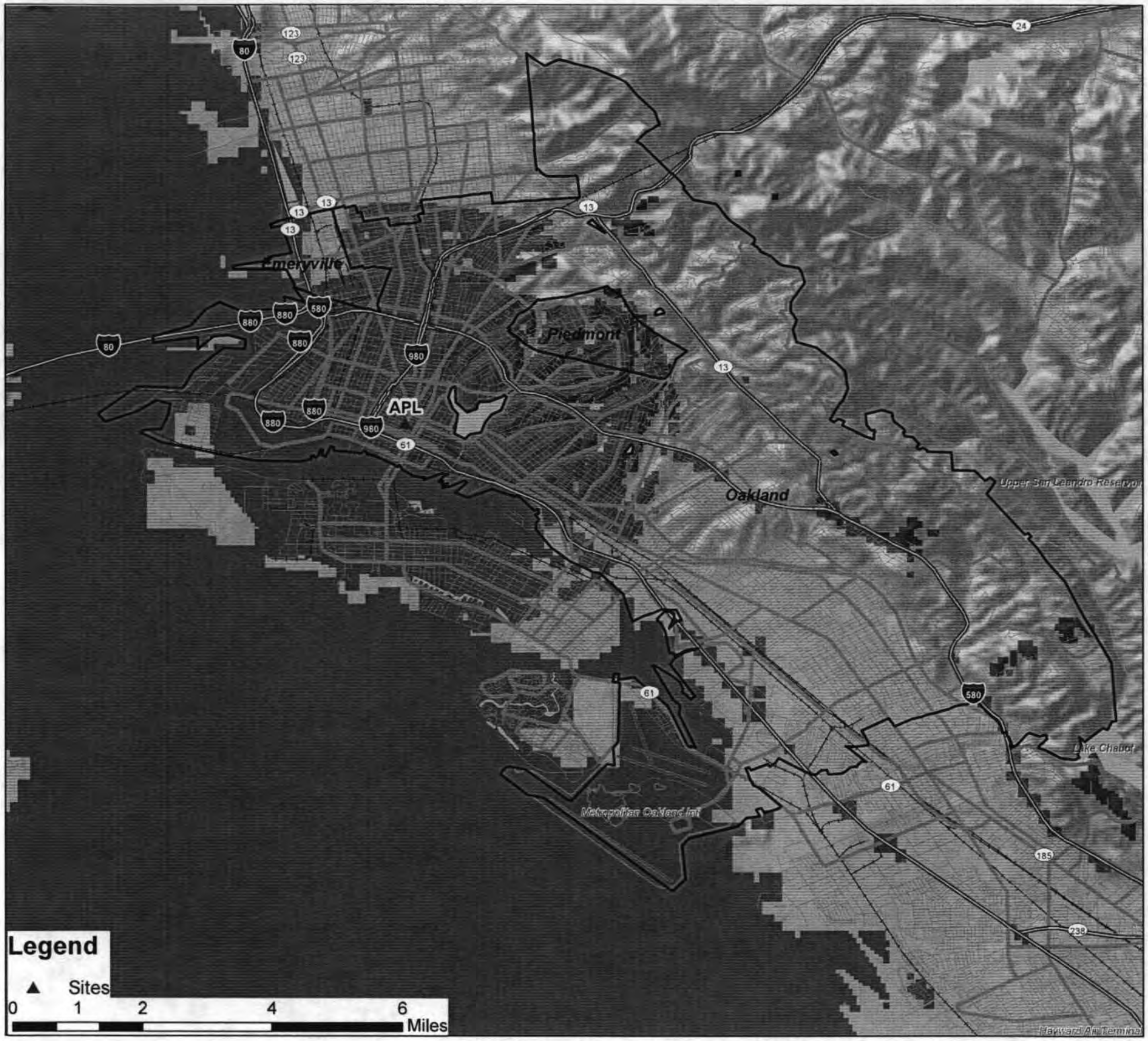

Figure 1-7
APL User Reported Coverage

Client: City of Oakland

Commission No. 20177A

Existing System Portable Outdoors Coverage Prediction Talkin (Portable to Base) 800MHz Prediction Based on FCC License

Site: APL

Longely-Rice 90/90 with Land Clutter/Land Use

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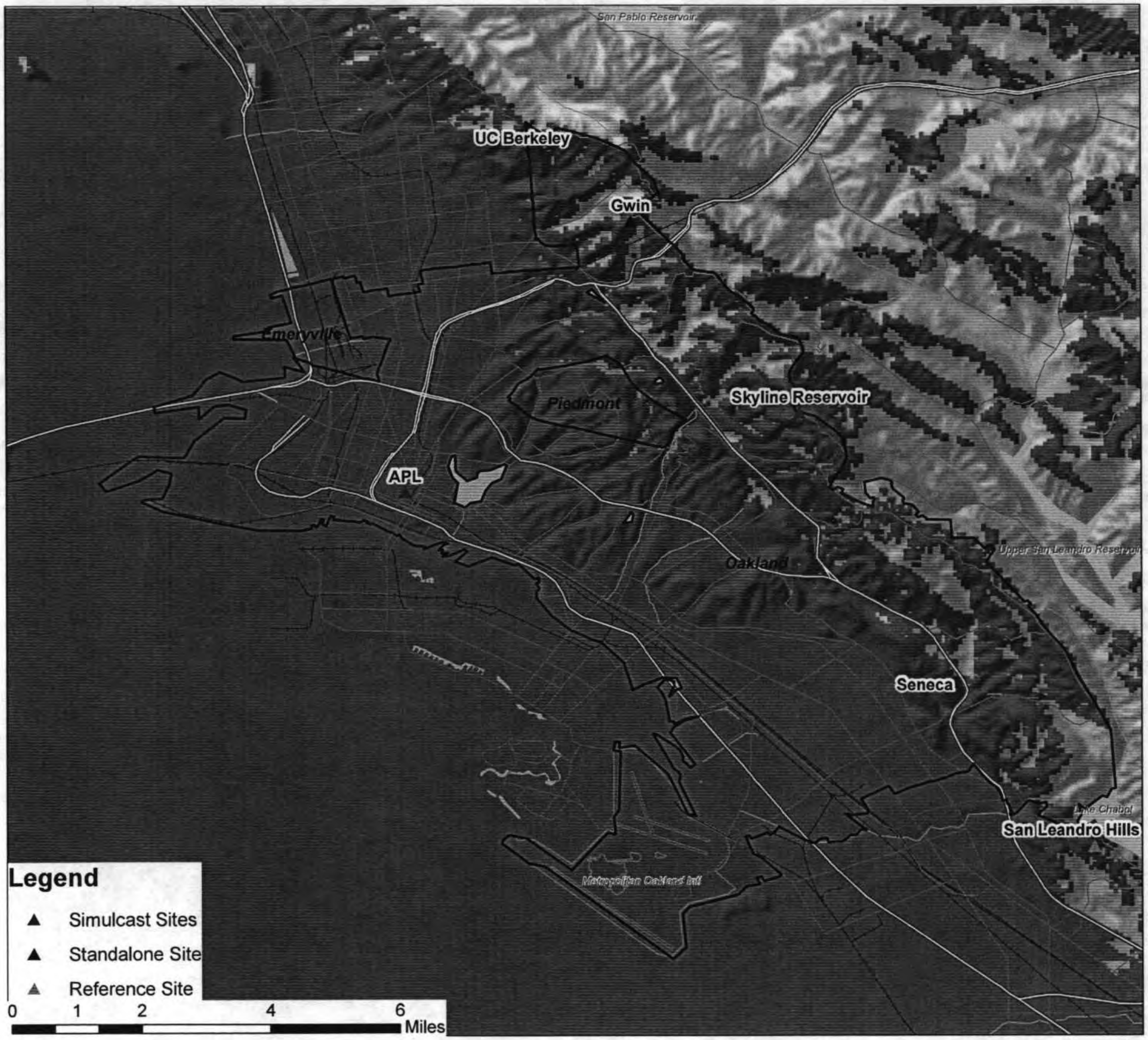

Figure 1-8
Proposed EBRCS Interoperability Coverage

Client: City of Oakland

Commission No. 20177A

Proposed System Portable Outdoors Coverage Prediction
(Base to Portable) 800MHz Prediction
Based on FCC License

Simulcast Sites: APL
Seneca
Skyline Reservoir
UC Berkeley

Standalone Site: GWIN

Design: TRM 15 December 2008
Drawn: TRM 14 September 2009
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Approved: WNC 15 September 2009

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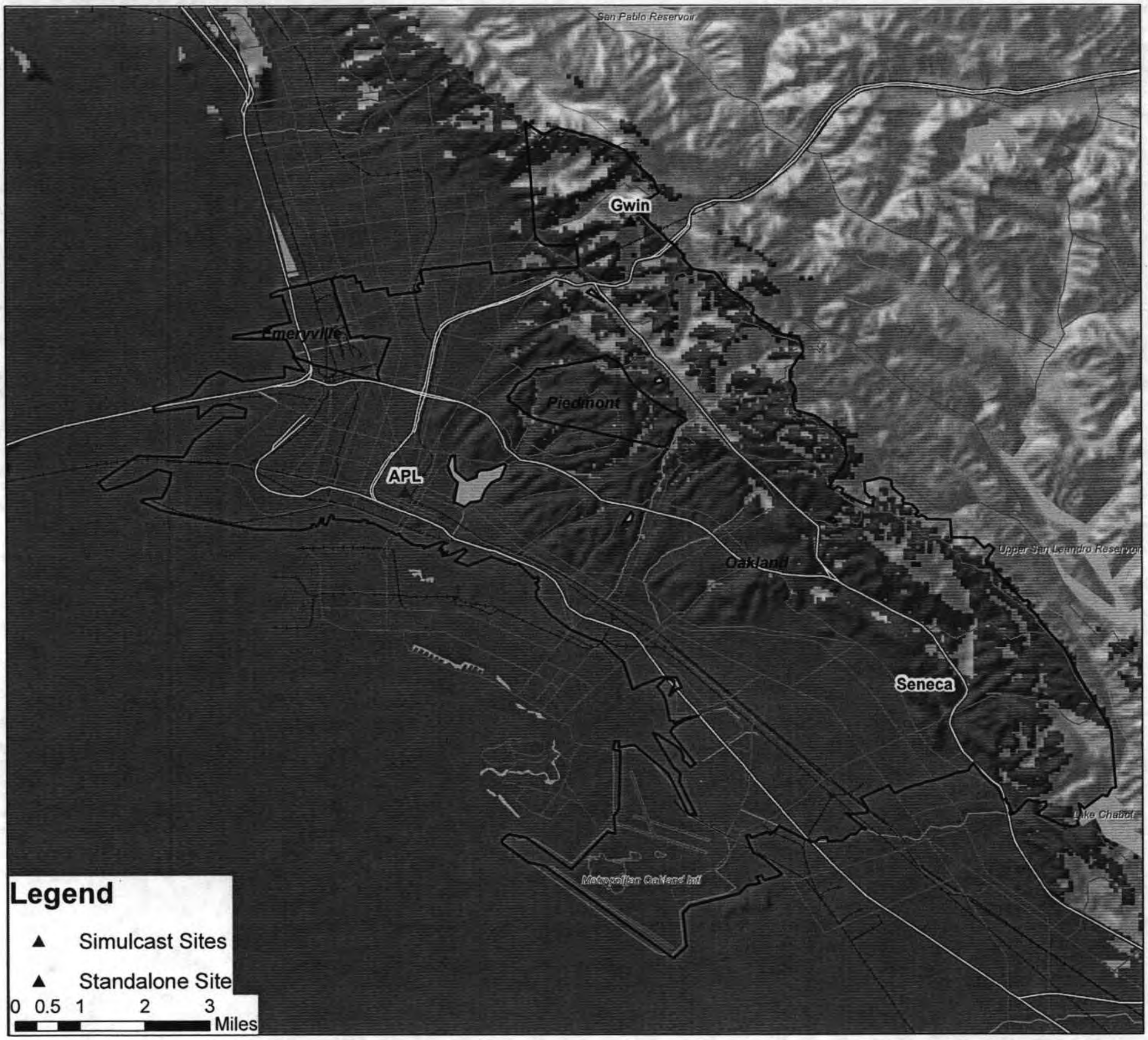

Figure 1-9 Predicted Oakland Simulcast Portable Outdoors 800MHz Coverage

Client: City of Oakland

Commission No. 20177A

Predicted Oakland Simulcast System Portable Outdoors Coverage (Base to Portable) 800MHz Prediction Based on FCC License

Simulcast Sites: APL
Seneca

Standalone Site: GWIN

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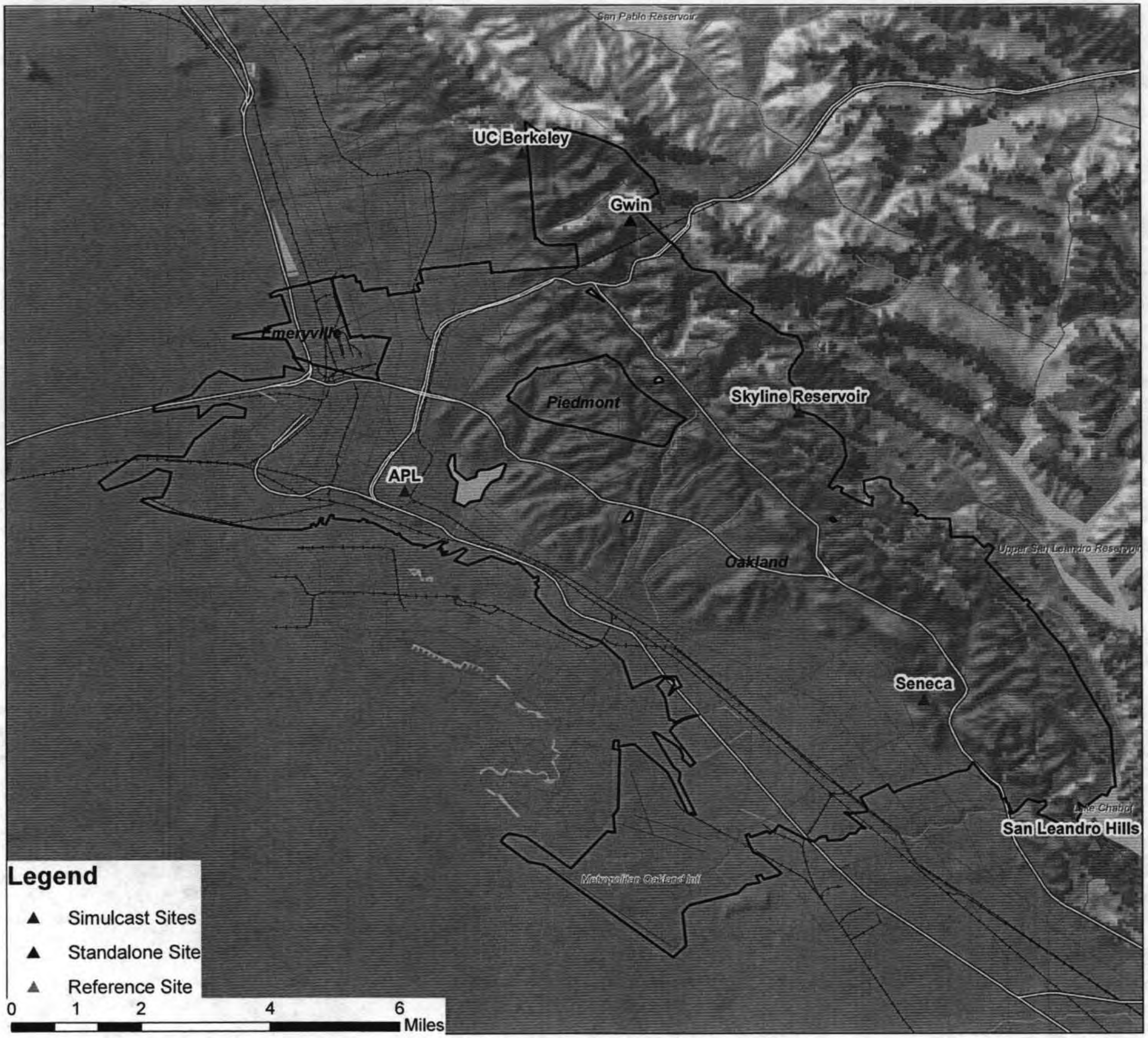

Figure 1-10 Proposed EBRCS Interoperability Coverage

Client: City of Oakland

Commission No. 20177A

Proposed System Mobile
Coverage Prediction
(Base to Portable) 800MHz Prediction
Based on FCC License

Simulcast Sites: APL
Seneca
Skyline Reservoir
UC Berkeley

Standalone Site: GWIN

Design: TRM 15 December 2008

Drawn: TRM 14 September 2009

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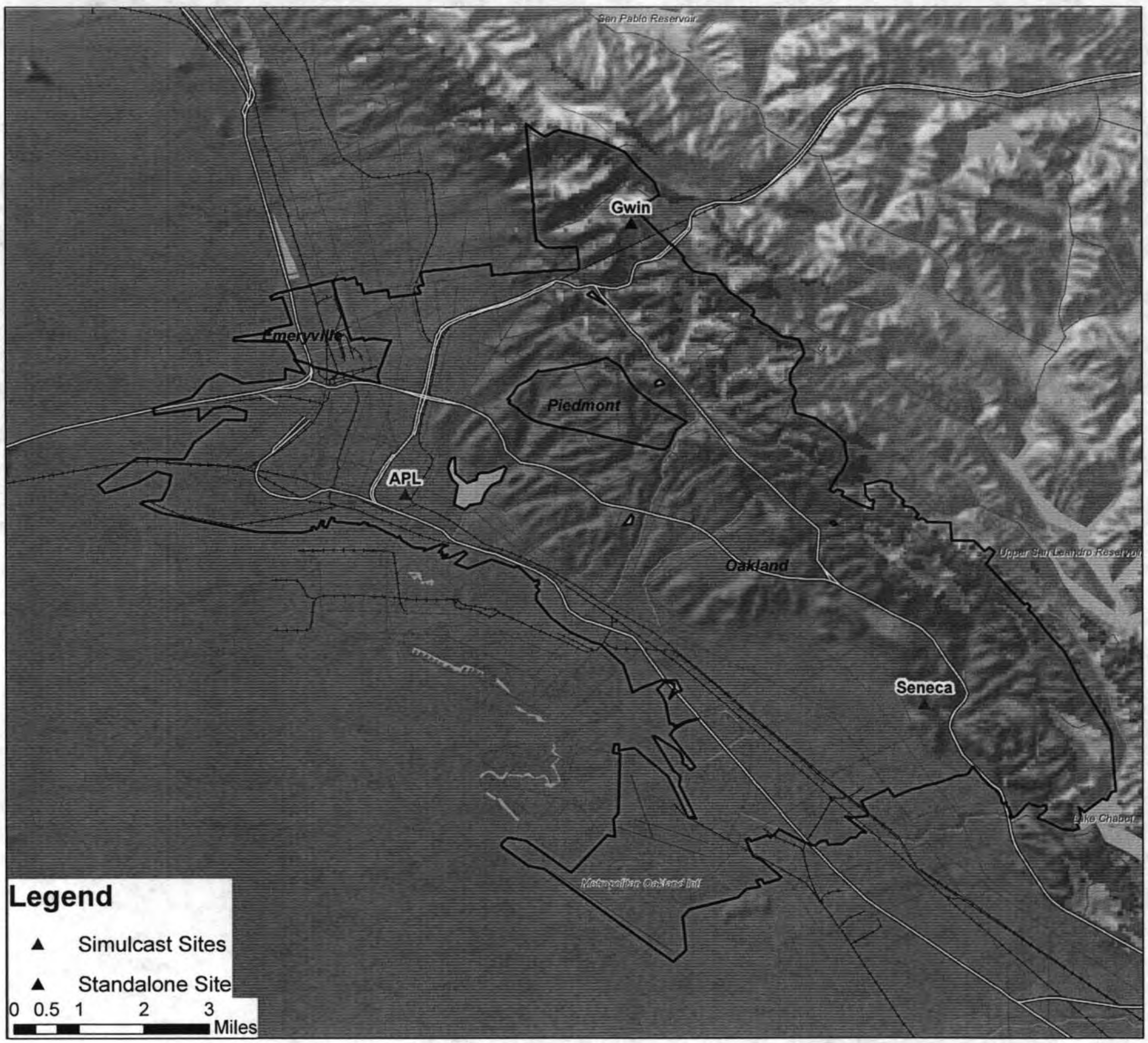

Figure 1-11
Predicted Oakland Simulcast Mobile 800MHz Coverage

Client: City of Oakland

Commission No. 20177A

Predicted Oakland Simulcast System Mobile Coverage
(Base to Portable) 800MHz Prediction Based on FCC License

Simulcast Sites: APL
Seneca

Standalone Site: GWIN

Coverage displayed on this document is the result of predictive statistical modeling based upon client provided parameters, USGS geographical data. Actual coverage, as experienced by users in the field, may vary due to interference, multi-path fading, and other random effects.

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2.0 Spectrum Efficiency

2.1 Introduction

This section provides information and data pertaining to system operation that was gathered from the interview meetings, the site and dispatch facility surveys and the online survey. CTA used this system data to analyze the City's current communication system operation. This section also documents the advantages and disadvantage of a multi-site system configuration and provides recommendations for improved system operation and utilization.

The analysis in this section meets the requirements for SOW #2, Spectrum Efficiency. Although the SOW describes this task as Spectrum Efficiency, the description given for task #2 indicates that it could be called Multi-Site Operational Analysis. The results of this section will be included in the Final Study Report.

2.2 Multi-Site System

The City of Oakland Radio System is a two site EDACS 800 MHz radio system with transmit/receive sites at APL and Seneca. Oakland has installed an 800 MHz P25 site at Gwin that will eventually be used to fill in coverage for the Oakland Hills. The sites are tied together via microwave using a console switch at the dispatch center so that the dispatch operators can monitor radio traffic at all sites.

Each site in the Oakland system operates independently and automatic roaming between the sites is not supported at this time. The operational impact is that if a user from the northern portion of the City wants to communicate in the southern portion, they must manually change from an APL talkgroup to a Seneca talkgroup. This also holds true for users who need to use the Gwin site for coverage. The existing system consists of multiple repeater sites that are manually accessed by the radio user as **the user decides** which site will provide the best coverage for their location, and then the user must manually change the radio channel to that site.

The existing City of Oakland system is not a true "multi-site" system. In a true multi-site system, separate channels are assigned to each site, which presently is being done in the existing Oakland system. However, the major difference between the City of Oakland's system and a true multi-site system is that a true multi-site system supports roaming between the sites.

If the Oakland system was a true multi-site system, then as a user from APL's coverage area moved into an area with dual overlapping coverage (APL and Seneca), the subscriber unit would automatically recognize the additional control channel now also available from the Seneca site. The **radio would then decide** which site to affiliate with based on received signal strength. If the users from APL moved to an area where the Seneca site had superior signal strength, the radio would affiliate with the Seneca site. This process is called "hand-off" and is a major feature of cellular telephone networks. Hand-off gives the user the appearance of "seamless" operation when in fact multiple hand-offs are occurring as the user "roams" between different coverage areas.

The true Multi-Site system has the added benefit of automatic roaming over the existing system, but there is one important disadvantage. Because the coverage areas of each of the sites have significant overlap, many users from the same talkgroup could be affiliated to each of the two sites. It is not unlikely that half of the users on a talkgroup could be on one site, and the other half on another site, based on the location of each user. This would cause a significant increase in the number of channels needed to support the talkgroup and could cause a strain on radio capacity because channels are dedicated to the call from each site. CTA has analyzed the radio traffic for Oakland's current system and has found that many users (as many as 60%) are manually selecting sites that require a multi-site connection. In other words about

60% of the calls made must go through the IMC to make a connection between APL and Seneca. A large majority of these could be Dispatch initiated calls, but the numbers do indicate that additional strain is being placed on the system due to the current APL / Seneca configuration.

2.2.1 Multi-Site Advantages compared to Simulcast

This section also compares a true-multi site system with its counterpart, the simulcast system.

This comparison is provided in the next two sections:

- The primary advantage is cost.
  - Multi-Site systems require fewer repeaters. For example, a typical two-site simulcast system supporting 1000 users may require 7 shared channels total, while a two-site, multi-site system supporting the same 1000 users may require 5 channels per site—a total of 10 channels. The two-site simulcast system with the same 7 channels at each site would require 14 repeaters total—while the multi-site system with only 5 channels at each site would only require 10 repeaters total.
  - A multi-site system does not require the precise timing and equalization equipment, or the voters that a simulcast system needs. This translates to a reduction in cost.
- Ease of Implementation. Since each site operates independently on separate channels, each site can be configured individually without the need to account for the voters or signal comparators that are needed in simulcast systems.

2.2.2 Multi-Site Disadvantages compared to Simulcast

Despite the advantages offered by the Multi-Site system, there are several disadvantages when compared to its counterpart, the simulcast system.

These disadvantages are described below.

- Spectral efficiency is a disadvantage. In a multi-site system, different frequencies are required at each site, however, in a simulcast system, the same channels are reused at all sites. This requires additional frequencies for a multi-site system. For example, a typical two-site simulcast system supporting 1000 users may require 7 channels total, while a two-site multi-site system supporting the same 1000 users may require 5 channels per site—a total of 10 channels. Simulcast systems yield a higher capacity with an equivalent amount of spectrum, or an equivalent capacity with less spectrum.
- Network efficiency is also a disadvantage. If too many talk groups are operating on multiple sites, the system may require additional channels at each site to avoid the system becoming overloaded during the busy hour.
- Wide-area calls (calls between users on multiple sites but within the same talkgroup) can create the potential for lost or delayed communications. Wide-area call handling in a multi-site system can be programmed in one of two ways, but neither of these approaches is entirely satisfactory.
  1. The system can require that a channel be assigned to all sites associated with the talk group before the channel is granted (causing delays before communications can proceed); or
  2. The system can allow a call to proceed as soon as a channel is available on the site of the calling unit and units on other sites receive the call when channels are available at their sites (causing some units to miss part or all of the call).
- Roaming between multiple sites presents special problems to the programming and operation of the subscriber units in a multi-site system. As a unit travels through the coverage areas of multiple sites, it has to decide with which site to affiliate. This is done by periodically measuring the signal of all sites that it can receive and selecting what it considers to be the best one based on a predetermined algorithm. Terrain and other factors can cause

significant signal fades; signal levels can change by 20 or 30 dB within a distance of a couple feet. Because of these rapid fluctuations, the decision-making process is subject to potential error; a unit may not always affiliate with the best site and a user may not have communications when needed. In a Simulcast System, the all RF sites appear as one "site" to the mobile or portable. The voters in a simulcast system determine which RF site received the best signal, and provides this signal to the transmitters.

2.3 Improved System Operation

The real advantage to a true multisite system is the ability for users to roam between multiple sites without the need to make manual changes on the radio. In addition, the cost savings over a simulcast system can be significant depending on the number of channels. During the interview process, CTA was advised that the City of Oakland had purchased the equipment necessary to move from their current system to a true multisite system. Although the equipment is purchased, it has not been installed. Installation of the multisite system will provide the roaming feature many of the users requested during interviews.

A thorough study of the microwave back-haul capacity will also have to be conducted to ensure that the additional load placed on the backbone will not affect communications. In addition, traffic monitoring statistics available for the existing EDACS system can be used to verify that roaming will not add an additional burden on channel availability. After these studies are complete, the migration to a true roaming system can begin. In addition the installation of the roaming equipment can be coordinated with the current reprogramming that is occurring as a result of the 800 MHz rebanding effort. A final decision on the technical roadmap will be discussed after expressing the advantages and disadvantages of a simulcast system.

3.0 Coverage Redundancy

3.1 Introduction

This section analyzes the coverage overlap between the City's current 800 MHz radio system and the proposed EBRCS. The analysis in this section meets the requirements for SOW #3, Coverage Redundancy. The results of this section will be included in the Final Study Report.

3.2 Predicted Coverage Overlap

A preliminary look at the EBRCS and City of Oakland coverage overlap was presented in Section 1.2 of this report. The coverage maps presented in Section 1.2 will be used for the purpose of the comparison in this section. In Figure 1-8, the coverage provided in the City of Oakland's operational area by the EBRCS ALCO Northwest Cell is displayed. The coverage overlap for the City of Oakland is significant.

In the system design from Motorola in January 2009, the current ALCO Northwest and Southwest cells were merged into one cell. The cell was undersized for the city of Oakland, did not provide adequate coverage and did not meet the needs of the City of Oakland. Since the cell was split into a Northwest and Southwest and the sites were moved, the existing system design provides very good coverage for the City of Oakland. Even if the City does not decide to join EBRCSA, they should aggressively pursue keeping the sites in the existing Northwest Cell in order to provide very good coverage overlap for the entire City. A comparison of the coverage overlap can be clearly seen by comparing Figure 1-8 with Figure 1-9.

3.3 Site Consolidation Opportunities

In section 1.2.2, we summarized some of the site consolidation opportunities for EBRCS and the City of Oakland.

We examined three possible site consolidation opportunities:
1. Gwin and Lawrence Berkeley Lab
2. APL and Glen Dyer Jail
3. Seneca and Skyline Reservoir

The Gwin / Lawrence Berkeley site consolidation was determined not feasible for two reasons. First, the coverage provided by the Lawrence Berkeley site was not sufficient. Second, if EBRCS desired to move the Lawrence Berkeley Lab site to Gwin, there is not enough physical space to support additional equipment. Based on our evaluation of the Gwin site, the existing conditions of the site including grounding and maintenance all meet or exceed LMR standards. However, an additional tower and shelter would be needed to support additional channels for EBRCS. Due to the location of the Gwin site, there is not physical room for the new tower and larger shelter that would be needed to support a simulcast site. Because of the coverage differences and the lack of physical space, CTA recommends that these two sites remain separate.

The APL and Glen Dyer site combination provides a significant opportunity to consolidate two separate sites. In section 1.2, we provided an overview of several technical factors that should be considered if the two sites are to be consolidated. This analysis did not reveal any technical limitations that would prevent EBRCS from co-locating equipment at the APL site. A similar analysis was conducted for the Seneca and Skyline Reservoir site combination and again, nothing was revealed that would prevent EBRCS from collocating equipment at the Seneca site.

Even though a site consolidation may be technically feasible, it must also be cost effective and administratively achievable. A discussion of the various governance and administrative concerns is deferred to Section 14 of this report. The discussion of the cost savings of collocating equipment was discussed in Section 1.4. The costs included in Section 1.4 provide a guideline for making site consolidation decisions based on cost.

The major cost advantage is the fact that both APL and Seneca are existing LMR sites in excellent condition and both facilities have the physical space to accommodate additional equipment, towers and shelters.

4.0 Simulcast Technology

4.1 Introduction

This section evaluates the use of simulcast technology for use within the City of Oakland's radio system and provides an overview of the advantages and disadvantages of implementing a wide area simulcast radio system. In addition, CTA will include the information presented in this section to develop a potential technical roadmap if the City decides to implement a simulcast system.

The analysis in this section meets the requirements for SOW #4, Simulcast Technology. The results of this section will be included in the Final Study Report.

4.2 Simulcast Systems

The discussion of Simulcast Systems presented here assumes that the reader is familiar with trunked radio systems and that the multi-site description presented in Section 2 has been read. In a simulcast trunked radio system, all sites share the same set of frequencies. To avoid interference, timing among all transmitters must be precisely controlled to within fractions of a second and output power levels must be adjusted to avoid self interference. When a call is made, the best audio from the receivers is selected and routed to all transmitters. A Simulcast System enables users to roam anywhere in the system coverage area and continue to talk on their radio without making any adjustments based on location.

4.2.1 Simulcast Disadvantages compared to a Multi-site System

Overview of the disadvantages of simulcast compared to a multi-site system.

- The primary disadvantage is cost.
  - A simulcast system requires precise transmitter timing and equalization equipment. Receive systems must include voters (or signal comparators) to select the strongest receive signal and direct it to the console or repeater transmitters.
  - A simulcast system also requires additional repeaters compared to a multi-site system. For example, a typical two-site simulcast system supporting 1000 users may require 7 channels, while a two-site multi-site system supporting the same 1000 users may require 5 channels per site for a total of 10 channels. The two-site simulcast system with 7 channels at each site would require 14 repeaters total, while the multi-site system with only 5 channels at each site would only require 10 repeaters total.
- In a simulcast system, there is the potential for signal distortion in overlap areas between the simulcast sites. This can be minimized through proper system design and accurate system timing. Due to the technology used in P25 simulcast systems this problem is no longer of great concern.
- Current Simulcast P25 Technology limits the number of channels per system to 24 channels per controller for a Tyco Electronics system and 28 channels for a Motorola system. Other vendors may have similar channel limitations. Although this limitation does not affect the City of Oakland at this time (17 channels are currently used) it may have an impact on future upgrades or may affect channel limitations for EBRCS.
- Additional requirements are placed on the back-haul network that inter-connects the sites. Since additional traffic will likely occur between sites as a result of automatically routing all received signals to voter equipment and sending the best received signal out to all transmit sites, the back-haul network that connects the sites must be analyzed to ensure that it can support any additional traffic.

- Reduced coverage area is another disadvantage. In a simulcast system there is a limit to the number of sites, which effectively limits the coverage area. In the City of Oakland, this limitation will have no affect because the existing three sites are sufficient to cover the entire City.

4.2.2 Simulcast Advantages compared to multi-site system

Overview of the advantages of simulcast compared to multi-site system.

- The primary advantage of a simulcast radio system is spectral efficiency. Far fewer frequencies are needed for the same user capacity.
  - In a simulcast system, the same channels are reused at all sites; in a multi-site system, different frequencies are required at each site. For example, a typical two-site simulcast system supporting 1000 users may require 7 shared channels total, while a two-site multi-site system supporting the same 1000 users may require 5 channels per site—a total of 10 channels.
  - Another advantage is the reduction in the number of control channels from one per site, to one per system. In a multi-site system, one control channel is needed per site, while a simulcast system uses one control channel for the entire coverage area. The result is reduced equipment allocation for control channels, which results in more channels available for voice traffic.
- Simplicity of use is another advantage. All units are communicating on the same set of frequencies. No special procedures are required for wide-area calls among users on multiple sites.
  - Users do not have to "manually" select the site based on their location within the City of Oakland. With simulcast coverage, users can operate anywhere in the simulcast system's coverage area without adjusting radio settings. In the City of Oakland this would enable seamless operation throughout the coverage area, including the cities of Oakland, Piedmont and Emeryville.
- The last advantage worth noting is improved redundancy. If one site totally fails, the remaining sites at least partially fill the gap. This is because of the existing coverage overlaps.

4.2.3 Simulcast in Oakland

Currently, with only 8 operational channels on the APL site and 5 channels on the Seneca site, the City has 11 channels available (7 on APL and 4 on Seneca) for voice traffic. If the City of Oakland should go simulcast, they would have 14 channels total, with 13 channels available for voice traffic.

Due to the spectrum efficiencies provided by Simulcast systems, as well as ease of use, CTA recommends that the City of Oakland begin to migrate to a Simulcast system. CTA completed an analysis of the radio traffic for the existing radio system and noted that about 60% of the calls were considered "multi-site" or wide area calls. Each of these calls ties up frequency resources on both sites. In some cases, these wide area calls have increased the queue time and have likely been the cause of degraded service. Despite the increased cost, the simulcast system is the best solution for the City of Oakland.

5.0 In-Building Coverage

5.1 Introduction

In this section, CTA provides an overview and analysis of the existing In-Building Coverage. CTA noted several problems that were reported during interviews and via the responses to CTASurveyorSM, the online survey tool, which are addressed in this section. An overview of possible solutions is provided and the section concludes with a recommended course of action to improve the City's in-building radio coverage.

The analysis in this section meets the requirements for SOW #5, In-Building Coverage. A brief excerpt from the Code of Federal Regulations, Title 47, Part 90 (47 CFR 90), which discusses the deployment of BDAs, is also included for the City of Oakland's convenience. The results of this section will be included in the Final Study Report.

5.2 Existing In-Building Coverage

Analysis of in-building system coverage began by first looking at existing radio in-building coverage within the City of Oakland's operational area. The in-building coverage maps shown at the end of this section reflect portable talk-In (the communication path from the portable to the tower) coverage for light, medium, and heavy buildings. Talk-in diagrams were selected due to the concern users consistently mentioned during interviews about not being able to talk back to dispatch.

The source of these in-building coverage estimates is a coverage prediction program that is part of CTA's proprietary Propagation, Coverage, and Loading Analyst (P-CALA^{SM}) software. These in-building predictions are based on knowledge of radio signal propagation, and the factors which affect the signal as it travels through the air, over different terrain types, through different vegetation types, and into buildings. In-building coverage predictions are based on the version 1.2.2 Longley-Rice point-to-point model as implemented in the Terrain Analysis Package (TAP™) by SoftWright, LLC.

The three sites in the Oakland system operate independently, and automatic roaming between the sites is not supported at this time. If a user from the northern portion of the City travels to the southern portion, they must manually change from an APL talkgroup to a Seneca talkgroup. As a result, users typically have a primary site that they use for all communications. The in-building coverage diagrams reflect the in-building coverage that users are accustomed to as they operate from a single site.

5.2.1 Identified Problem areas

In-building problem areas were identified by the City of Oakland, Piedmont, and Emeryville users during initial interviews conducted by CTA. The specific buildings identified with poor in-building coverage during the interview process included 250 Frank H Ogawa Plaza (in the middle of the building), inside the Caldecott Tunnel, which connects Oakland with Contra Costa County, and inside the Highland General Hospital.

All three locations identified by the radio users are considered heavy buildings. GWIN talk-in portable radio coverage, show lack of coverage in and around the Caldecott Tunnel. The tunnel is blocked by terrain, and Hwy 24 leading into the tunnel from the west is located in a valley. The APL talk-in portable coverage for heavy buildings, it is clear that the Highland Hospital does not have coverage. It is well outside the heavy building coverage provided by the closest site. When reviewing the other heavy building coverage, it is clear they do not provide coverage at the hospital.

The "250 Frank Ogawa Plaza" location is actually a cluster of buildings. It was not clear during the interview process which building did not have coverage, though the City Hall building was discussed. The plaza is located just down the street from the APL site. Due to the close proximity to the APL site, it is expected that in-building coverage in the Frank Ogawa buildings would be achieved. In the middle of the building, where the problem was reported, the penetration loss through several walls of heavy construction can easily reach 50 dB or higher. CTA Communications calculates their heavy building coverage predictions at a 20 dB building penetration loss (i.e. one wall). It is typical to generate coverage predictions using a "one wall in" design approach. This would explain the discrepancy between the in-building coverage, and the radio user reported lack of coverage in the middle of the building. Table 5-1 shows typical attenuation values by construction material type measured in dB.

Table 5-1
UHF (300 MHz–3 Gigahertz) Building Materials Loss Measurements

Material	Attenuation (dB)
Ceiling duct	1–8
Small metal pole (6" in diameter)	3
Foil Insulation	3.9
Metal stairs	5
Concrete wall	8–15
Loss from one floor	13–33
Loss from two floors	18–50
Aluminum siding	20.4

*Rappaport, Theodore S., Wireless Communications Principles and Practice, Prentice-Hall, Inc., 1996

Older concrete construction, like that of the Frank Ogawa Plaza buildings, is notorious for causing in-building coverage issues. Sample link budgets showing street level, heavy building, and heavy building cluster signal levels are included in Table 5-3. The link budget shows the ability of a repeater site with a hypothetical receive sensitivity of -119 dB to receive a street level signal with a large margin available for further attenuation. This "fade margin" is calculated by subtracting the receiver sensitivity threshold from the received signal level. A negative value for fade margin indicates the repeater site would not be able to successfully receive the signal transmitted by the portable radio.

The values shown in the last column of the table, Heavy Cluster In-Building Talk-In, indicate increased losses through several walls of heavy construction, and illustrate why wireless networks that are able to provide adequate street level coverage often encounter difficulties operating inside buildings through multiple walls. This is an excellent example of why it is cost prohibitive to build a network that is specified to provide 100% in-building coverage due to the additional equipment required to achieve that goal.

In addition to the in-building coverage problems listed above, problems would likely exist in and around areas that lack outdoor coverage. Though relatively few in-building problems were reported, it is suspected that they could also be found near the areas where outdoor coverage problems were reported such as, Glen Alpine, La Salle Ave, Piedmont Ave, near the intersection of Oakland and Grand Ave, and so on.

5.2.2 Overview of Possible Solutions

Several options exist to improved in-building coverage. The following solutions can be used either as standalone solutions or together in various combinations as components of a system. They including simple bi-directional amplifier (BDA) installations, passive antennas, in-building repeaters paired with more complex distributed antenna systems, radiating cable, installation of new repeater sites, and mobile and portable coverage solutions.

5.2.2.1 Simple Bi-Directional Amplifier Installation

A simple BDA installation consists of a donor antenna usually located high on the exterior of the building to attain increased isolation and signal reception, feeding into the building (often through plenum rated coaxial cable) to a BDA. The amplifier then feeds the subscriber antenna, also called the coverage antenna, through a similar coaxial transmission line. The donor antenna receives the signal from the repeater site, routes the signal over the cable to the BDA which amplifies and retransmits over the coverage antennas located inside the building.

A BDA operates over a range of frequencies in a pass band and at lower power levels when compared with a repeater, and will not work on a simplex system. There are two types of Federal Communications Commission (FCC) accepted BDAs. Class A boosters amplify discrete, narrowband frequencies, while Class B boosters amplify a pass band of broadband frequencies. Typical donor antennas used in implementing in-building systems include Yagi antennas, corner reflectors, panels, and parabolics, while conventional antennas or radiating cable are used as coverage antennas inside the building.[1]

Typical BDA applications include underground parking structures, tunnels, sports stadiums, shopping malls, schools, casinos, convention centers, airports, museums, office buildings, factories, utility plants, hospitals, hotels, apartment complexes, government centers, courthouses, detention facilities, and other large buildings. The safety of first responders, tenants, and patrons of the facility being covered is the major benefit of a BDA. Common features of a BDA include isolation control, automatic gain control (AGC), and overload shutdown. More advanced features of a BDA are oscillation detection and suppression control feature to prevent network interference, dual band operation using two controllers which allows users to operate all functional capabilities independently, and local alarm contact closure points and interface for remote shutdown.

5.2.2.2 Passive Antennas

Passive antennas can also be installed externally and internally to a building to improve coverage. In order for this solution to be effective, very strong signals from the donor site are necessary, along with short coaxial cable runs when connecting the antennas. Also, the highest practical gain antennas should be used. The installation consists of a donor antenna and a coverage antenna connected via coaxial cable, and can be very cost effective under the right circumstances.

5.2.2.3 Distributed Antenna Systems (DAS)

For larger buildings, a distributed antenna system (DAS) can be used along with a repeater or BDA to radiate the signal throughout the building. A DAS consists of small antennas that are strategically located throughout a building where the coverage is limited. A DAS allows the

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[1] Stoll, George R., Bi-Directional Amplifiers—Enhancing Radio Coverage in Shadowed Areas and Inside Buildings. February 11, 2002 (Stoll), Slide 8.

desired signal to be captured over the air from an external antenna, typically located on the roof, and then retransmitted through a network of small low power antennas inside the building. The antennas are usually small and inexpensive, and the factor limiting their deployment in a building is the cable required to connect them back to the main antenna on the roof. Fiber optic cables can carry the communications information over much greater distances than coaxial cable. For very large buildings, it may be necessary to use fiber optic cables to distribute signals rather than coaxial cables.

5.2.2.4 Radiating Cable

Radiating cable or "leaky coax" is a passive device that can be used to improve wireless communications coverage in confined areas. The cable functions like a continuous antenna. It is outfitted with controlled slots in the outer conductor that allow RF signals to be coupled between the coax cable and its surrounding environment uniformly along the entire length of cable. Furthermore, radiating cable helps to evenly distribute the power throughout a coverage area. Radiating cable is a viable option for communicating in buildings where the potential for RF blockage of point-source antennas due to obstructions is high and where public safety and emergency communications is essential.

5.2.2.5 New Repeater Sites

A new repeater site is another possible solution to resolving in building coverage. If a large number of buildings clustered together in a particular area do not have in-building coverage, and in-building coverage is deemed imperative, a new repeater site could be constructed. A careful cost-benefit analysis should be considered before making the decision to build a new repeater site versus covering each building with stand alone solution.

5.2.2.6 Mobile and Portable Coverage Solutions

While long term in-building solutions may be viable for heavily utilized buildings, such as the Highland Hospital, it is often more cost effective to implement a more portable solution. Mobile and portable repeaters provide portable grade coverage by acting as a coverage extender or by providing local coverage for disaster recovery operations. The primary distinction between the two is that a mobile repeater is usually mounted to a vehicle in a permanent installation, and the portable repeater is designed to be brought into a building or other enclosed areas away from the vehicle. Some mobile repeaters are designed for an in-vehicle installation but have quick release tabs for portable use.

There are several modes of operation to consider when investigating mobile and portable solutions. When mounted on a vehicle and integrated into the system, mobile repeaters extend system coverage for personnel operating with portable or mobile radios. Most repeaters can operate as a base repeater for localized operations and support operations in either trunked or conventional systems. Some portable repeaters operate in full duplex and are fully synthesized, field programmable, and flash upgradeable.

A mobile repeater configured in "system repeat mode" as a coverage extender allows portable radio use in areas with mobile coverage only. Installed on a car, fire apparatus, off-road vehicle or ATV the mobile repeater provides radio coverage when the user is away from the vehicle or in a nearby building. In full duplex mode a mobile repeater is configured as a true full duplex repeater, where it allows users at an incident to communicate with one another and also back to dispatch. End to end encryption and portable radio ID pass through between the companion portables and system users is normally supported.

In "local repeat mode" a mobile or portable repeater provides local coverage for companion portables working in analog or digital mode. Communication between local and portable radio users and mobile radio users is possible. The dispatcher and other system users are disconnected. This mode is designed for local radio use when the system-wide communications is not available or not desired. Typical applications include disaster recovery, fire ground communication, security detail operations or any remote-out of network coverage application.

A portable repeater configured as a "transportable tactical repeater" usually works as a portable base station. No mobile radio or vehicle is required. This configuration is ideal for ad hoc coverage where a single channel repeater is sufficient. Multiple portable repeaters can be added to the scene for additional capacity in most cases.

Some mobile or portable repeaters are flexible enough in their design to also be installed on the roof of a building to provide in-building and local area coverage for portable radio users with marginal or no system coverage.

Common features of mobile and portable repeaters to consider are as follows. Output power varies, typically from 1-10 Watts. Input power is normally provided by either plugging the repeater into an AC power outlet or by an external battery pack for portable units, or if it's a mobile unit, it is likely designed to run off of a vehicles 12v battery. It is a good idea to check accessibility of the connectors when considering the purchase of a mobile or portable repeater. Another feature to evaluate is whether or not the repeater allows for an Off Mode which disables the repeater for system communications while all other radio operational features remain. Some repeaters can be quickly activated either through the vehicle or remotely via a portable unit. Rugged, self contained, and water proof packaging is important.

It is also important to consider if the mobile, portable or vehicular repeater can support P25 features. Some key P25 features to consider are: group call (clear and encrypted), private call (clear and encrypted), emergency call (clear and encrypted), portable PTT ID pass-through, call alert paging, call back, "failsoft", out-of-range, site trunking, and talk permit/prohibit tone. Sometimes vehicular repeater modes can be selected from a mobile radio control head or from a portable when the mode is programmed as a talk group attribute. When some P25 vehicular repeaters work with a compatible P25 companion portable, the P25 trunking features are available to the portable radio user. In particular, a companion portable radio ID is passed across the system for group, private and emergency calls. End-to-end encryption is sometimes supported in all formats supported by the mobile radio. If programmed in a mixed mode, some P25 vehicular repeaters support both digital P25 and analog conventional portables operating on the same channel, providing a higher level of interoperability with legacy systems. Some vehicular repeaters use sophisticated algorithms that prevent multiple repeaters at the scene from transmitting on top of each other. In most cases, the algorithm can be fully transparent to the user or can be user controlled if deterministic selection of the master repeater is required.

5.2.3 Excerpt from FCC Title 47

The FCC rules address the deployment of BDAs. These rules rely primarily on the licensee to authorize and police any BDA use.

Following are the rules from 47 CFR, sections 90.7 and 90.219 that apply to public safety use of signal boosters:

Sec. 90.7 Definitions
Signal booster. A device at a fixed location which automatically receives, amplifies, and retransmits on a one-way or two-way basis, the signals received from base, fixed, mobile, and

portable stations, with no change in frequency or authorized bandwidth. A signal booster may be either narrowband (Class A), in which case the booster amplifies only those discrete frequencies intended to be retransmitted, or broadband (Class B), in which case all signals within the passband of the signal booster filter are amplified.

Sec. 90.219 Use of signal boosters
Licensees authorized to operate radio systems in the frequency bands above 150 MHz may employ signal boosters at fixed locations in accordance with the following criteria:

A. The amplified signal is retransmitted only on the exact frequency(ies) of the originating base, fixed, mobile, or portable station(s). The booster will fill in only weak signal areas and cannot extend the system's normal signal coverage area.
B. Class A narrowband signal boosters must be equipped with automatic gain control circuitry which will limit the total effective radiated power (ERP) of the unit to a maximum of 5 watts under all conditions. Class B broadband signal boosters are limited to 5 watts ERP for each authorized frequency that the booster is designed to amplify.
C. Class A narrowband boosters must meet the out-of-band emission limits of Sec. 90.209 for each narrowband channel that the booster is designed to amplify. Class B broadband signal boosters must meet the emission limits of Sec. 90.209 for frequencies outside of the booster's design passband.
D. Class B broadband signal boosters are permitted to be used only in confined or indoor areas such as buildings, tunnels, underground areas, etc., or in remote areas, i.e., areas where there is little or no risk of interference to other users.
E. The licensee is given authority to operate signal boosters without separate authorization from the Commission. Certificated equipment must be employed and the licensee must ensure that all applicable rule requirements are met.
F. Licensees employing either Class A narrowband or Class B broadband signal boosters as defined in Sec. 90.7 are responsible for correcting any harmful interference that the equipment may cause to other systems. Normal co-channel transmissions will not be considered as harmful interference. Licensees will be required to resolve interference problems pursuant to Sec. 90.173(b).

5.3 Recommended Solution

A detailed cost benefit study should be conducted prior to installing any in-building coverage solution. There are often several technical solutions to the same problem, but only one will prove to be the most cost effective. Radio user demand at the hospital is high. A permanent in-building repeater solution is recommended to improve in-building coverage at Highland General Hospital. For the Caldecott tunnel, a radiating coaxial cable installation would work well, but other solutions should also be considered. For the Frank Ogawa Plaza, the solution will depend on whether or not in-building coverage is required in all of the buildings or just one. An outdoor repeater on a rooftop is probably not the best option since outdoor coverage in this area is already strong and in-building coverage does not exist deep inside the buildings. A distributed antenna system or a simple BDA deployment would work best for a single building. Multiple building solutions become expensive and "cost-benefit" becomes a critical parameter to evaluate.

Portable and mobile solutions are recommended for buildings where in-building coverage is not needed on a frequent basis. Portable and Mobile solutions offer the advantage of being able to be used on a case-by-case basis as the incident dictates. Since coverage throughout the City of Oakland is provided for most heavy buildings, the portable and mobile solutions would be the most cost effective solution to cover any buildings that do not need frequent in-building coverage. These flexible solutions allow relatively small investments to be leveraged through repeaters that can be deployed when and where they are most needed. Recommended solutions for the City of Oakland are discussed further in the final report.

Table 5-2 has been omitted from this report.

Table 5-3
Heavy Building Link Budget

Parameter	Typical Street Level Talk-In Power Level (dBm)	CTA Heavy In-Building Talk-In Power Level (dBm)	Heavy Cluster In-Building Talk-In Power Level (dBm)
Portable Tx Power	34.8	34.8	34.8
Human Body Loss	-4	-4	-4
Antenna Gain	-2.2	-2.2	-2.2
ERP of Portable	30.8	30.8	30.8
Two Floor Penetration Loss	0	0	-30
Concrete Wall Penetration Loss	0	-10	-10
Other Losses (see Table 5-2)	0	-10	-10
Path Loss*	-108.6	-108.6	-108.6
Rx sensitivity**	-110	-110	-110
Rx Power at Radio Site	-77.8	-97.8	-127.8
Fade Margin***	32.2	12.2	-17.8

*Path Loss was calculated over 5 miles at 800 MHz

**This is a hypothetical minimum received signal level. Actual level may vary by manufacturer and other variables.

***A negative fade margin indicates the repeater site would not be able to successfully receive the signal.

6.0 P25 Migration

6.1 Introduction

This section provides an evaluation of the process of migrating to an APCO Project 25 (P25) standards based digital radio communications network. The evaluation takes a close look at the technical, operational and cost factors involved in implementing a P25 system.

The analysis in this section meets the requirements for SOW #6, P25 Migration. The results of this section will be included in the Final Study Report.

6.2 P25 Overview

As users throughout the City of Oakland consider the best technical and operational solutions to meet their current and future communications needs, they need to fully understand the advantages of a P25 standards based communication system.

The Association of Public-Safety Communications Officials International (APCO), in conjunction with the Telecommunications Industry Association (TIA) and others, initiated APCO Project 25 (P25) to promote a single non-proprietary set of standards for digital radio communications. The purpose of the standards was two-fold:

- To improve interoperability between public safety agencies; and
- To provide greater vendor competition and resultant cost savings in the procurement of radio equipment.

The TIA is responsible for overseeing and coordinating the ongoing development of the P25 standards. The P25 Standard is supported by a number of organizations, some of which are listed below, indicating widespread acceptance and a willingness for agencies throughout the nation to move toward P25:

- APCO
- Department of Homeland Security
- International Association of Chiefs of Police
- International Association of Fire Chiefs
- Department of Defense
- Department of Interior

The first phase of P25 implementation focused on providing a common air interface (CAI). The CAI defined a standard to provide one voice channel in a 12.5-kHz channel at a bit rate of 9.6 kbps using compatible four-level FM (C4FM) modulation. The CAI supports conventional and trunked operation. P25 also supports 9.6 kbps data with defined IP packets that are integrated with voice and control. P25 supports voice, data and control encryption and also supports over-the-air rekeying (OTAR).

Another advantage of P25 is backwards compatibility, which enables new digital P25 radios to communicate in analog mode with legacy analog radios and either digital or analog mode with current Project 25 radios. For the City of Oakland this means that the Harris P7200 portables received through rebanding have the ability to communicate with EDACS radio systems (BART for example), with Harris P25 radio systems, and with Motorola P25 radio systems. Connectivity to Motorola P25 systems may be limited without the use of an ISSI connection.

Impact of P25 Phase 2

P25 Phase 2 has several goals. One goal is to define technology standards that will provide one voice channel per 6.25 kHz of spectrum, doubling the spectral efficiency of Phase 1. The P25 committee is