# City of Oakland
# Wireless Broadband Feasibility Study

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# 1. Executive Summary

## 1.1. Findings

The Oakland Wireless Broadband Feasibility Study finds:

- A point-to-point wireless broadband system serving specific community and institutional needs is financially and technically sustainable for the City of Oakland.
- The cost of building and operating such a system can be met through identifiable cost savings, efficiency gains and budgetary choices based on the economic value of benefits.
- Public Internet access by way of community anchor institutions is financially and technically feasible, and universally supported by a diverse range of Oakland residents, organizations, agencies and businesses if it is implemented in a fiscally sound manner.
- Enabling entrepreneurial opportunities for local businesses on a pay-as-you-go, public-private partnership basis is likewise backed by Oakland stakeholders and supported by the financial and technical analysis conducted for this study.
- Providing wireless Internet service to residences or individual consumers is not financially sustainable or technically feasible for the City of Oakland, and is opposed by nearly all stakeholders, who cite the widespread technical and financial failure of such systems in other cities.

## 1.2. Community Priorities

A comprehensive stakeholder assessment process gathered extensive comment from members of the public, local businesses and non-profits, City staff and other government agencies. This research included district-based focus groups, a town hall meeting, workshops, meetings, written staff surveys, and inbound and outbound telephone and email contact.

The top strategic goals identified by Oakland residents and other stakeholders are:

**Stakeholder Assessment Strategic Goals**

| Priority | Strategic Goal |
|---|---|
| 1 | Sound financial planning |
| 2 | Free school access |
| 3 | Free public access at libraries, community centers, parks, etc. |
| 4 | Affordable access for the public |
| 5 | System facilitates improved productivity |
| 6 | Public project awareness |

Oakland residents, City staff and representatives from local businesses, non-profits, government agencies believe that a wireless broadband system must, to the extent financially and technically possible, meet five design criteria:

**Stakeholder Assessment Design Criteria**

| Priority | Strategic Goal |
|---|---|
| 1 | Flexible and interoperable |
| 2 | Reliable network |
| 3 | High level of security |
| 4 | Full city coverage |
| 5 | Mobile and real time data access |

In the context of the stakeholder discussions, "full city coverage" means that any proposed wireless service or facility should be available equally and evenly throughout Oakland, within the limits of technology and finances. For example, if wireless broadband service is provided to City libraries, it should be provided to all libraries to the extent practical.

On the other hand, stakeholders strongly believed the City should not spend money on blanket wireless coverage based on inappropriate technology or unsustainable economics. Failed municipal wireless networks in other cities were frequently and emphatically offered as examples of what the City of Oakland should not do.

## 1.3. Current Opportunity

The American Recovery and Investment Act of 2009 (ARRA) includes $7.2 billion in funding for broadband development. The bulk of that funding will come through Broadband Technology Opportunities Program (BTOP) grants administered by the National Telecommunications and Information Administration (NTIA).

Consistent with the BTOP grant criteria released by NTIA on 1 July 2009, this feasibility study presents a conceptual point-to-point system that will:

- Provide broadband access to community anchor institutions such as schools, libraries and organizations and agencies serving vulnerable populations, as well as job-creating strategic facilities in Oakland.
- Provide improved access to broadband service to consumers living in underserved areas of Oakland through community anchor institutions and proven middle-mile solutions.
- Improve access to, and use of, broadband service by public safety agencies that serve Oakland.
- Stimulate the demand for broadband, economic growth and job creation for all members of the Oakland community.

The reference architecture developed during this study is not intended as a final design, however it is a financial and technical proof-of-concept that will support a BTOP grant application by the City, and provide an objective basis for the system and performance requirements in subsequent requests for proposals (RFP).

## 1.4. System Design

This study uses a modular implementation approach, and develops a reference architecture that employs a variety of spectrum, technology and applications to meet the diversity of stakeholder needs in the City of Oakland:

| Reference Architecture | |
|---|---|
| **Segment** | **Primary Users** |
| Backbone | Central infrastructure for all users |
| Public Safety | Police, fire, health, public works |
| Government | All City departments, City staff in field |
| BayRICS | Police and fire |
| Public | Community anchor institutions |
| Business | Underserved commercial properties |

In this conceptual design, the backbone segment provides the underlying broadband infrastructure necessary for supporting all users of the system. Once it is built, the system can be extended to serve any or all user groups, depending on policy priorities and funding availability.

For analytical purposes, the reference architecture is based on specific technologies, because concrete examples are necessary to developing benchmark specifications and costs. However, prospective vendors will not be asked to build the reference design or use any specific technologies. They will be free to propose any solution that meets the financial and technical requirements contained in the RFP.

The prospective budget for the system includes equipment costs for connecting to community anchor institutions and other public facilities. Funds for more than 600 such connections are included in the budget and are supported by the financial analysis.

## 1.5. Financial Analysis

Funding for construction and operation of the core system will come from five primary sources:

- Offsetting current expenditures by replacing some existing leased lines with faster and more survivable wireless links.
- Broadband Technology Opportunity Program grants.
- Federal and state public safety grants.
- Use of existing City facilities such as towers and telecommunications sites.
- Providing service to underserved commercial properties for a fee on a public-private partnership basis.

The system has the potential for reducing City expenditures, enhancing revenues and improving public services through increased efficiency. This productivity gain primarily comes from allowing staff to work from the field without having to return to their offices to access information technology resources.

The business case analysis also shows that the market value of the new services provided is greater than the cost of building and operating the system, even when discounted rates are available to government and nonprofit organizations. The cost offsets and other value created by the system pay its full costs over time, including capital financing costs.

## 1.6. Next Steps

To meet BTOP grant application requirements and deadlines, five steps should be taken in the next four weeks:

- Develop an implementation plan that meets BTOP schedule requirements and ARRA criteria for "shovel-ready" projects.
- Identify complementary ARRA-funded projects and potential partners, per BTOP guidelines.
- Determine the source for the 20% matching funds required by BTOP, including making any necessary applications to State agencies.
- Prepare and submit grant applications covering as those BTOP categories for which the City of Oakland qualifies.
- Release an RFP to support the BTOP grant application as soon as possible.

The NTIA schedule and qualification criteria will be difficult to meet. However, because of it, the ideal time to move forward with a wireless broadband system in the City of Oakland is now.

# 2. Findings and Recommendations

## 2.1. Introduction

The goal of the Wireless Broadband Feasibility Study is to determine if a wireless broadband system can be deployed, either comprehensively or modularly, in the City of Oakland to achieve key objectives:

- Enhance economic development.
- Improve public safety.
- Increase the effectiveness of public, private, and nonprofit organizations through improved access to state of the art broadband wireless technology.
- Help overcome the digital divide.
- Improve quality of life for all Oaklanders.

Tellus Venture Associates was engaged in September 2007 to conduct a thorough evaluation of this question through a process that included staff and community participation, and technical and financial analysis.

## 2.2. Needs and Requirements

The study began with an extensive assessment, consultation and research effort that included goal setting and technical meetings, and an assessment process with Department of Information Technology (DIT) staff. Workshops for staff from all City departments, and for representatives from local non-profits, businesses and other government agencies followed. Finally, a town hall meeting and a series of citywide, council district-based focus groups were held to gather comments from as broad a cross section of the public as possible.

The information collected was analyzed, and priorities, needs and design criteria were developed. The top strategic goals identified during the research were:

1. Sound financial planning.
2. Free school access.
3. Free public access at libraries, community centers, parks, etc.
4. Affordable access for the public.
5. System facilitates improved productivity.
6. Public project awareness.

From these strategic goals and after deeper discussions on needed capabilities, a set of top level system design requirements were established. According to the research, any wireless broadband system deployed for the City of Oakland should, to the extent financially possible, meet five criteria:

1. Flexible & interoperable.
2. Reliable network.
3. High level of security.
4. Full city coverage.
5. Mobile & real time data access.

Operational requirements identified by all potential users and beneficiaries of the system were then evaluated against these design criteria and against the available technological options. Finally, seven prioritized operational requirements were established:

1. Extensible network backbone
2. Point to point networking
3. Citywide data access
4. Video: incidents and events
5. Video: surveillance and monitoring
6. Video: routine operations
7. Mobile communications

To ensure that any system deployed can address these requirements and priorities within tight budget constraints, a modular approach was used, so individual segments could be deployed separately, in any order, over a flexible time frame.

## 2.3. Reference Architecture

An initial reference architecture for a citywide wireless broadband system was developed to meet these operational requirements, and the financial cost and benefits of each alternative were evaluated. Prime consideration was given to finding immediate offsets of existing costs, such as leased data lines, and the potential for grant funding.

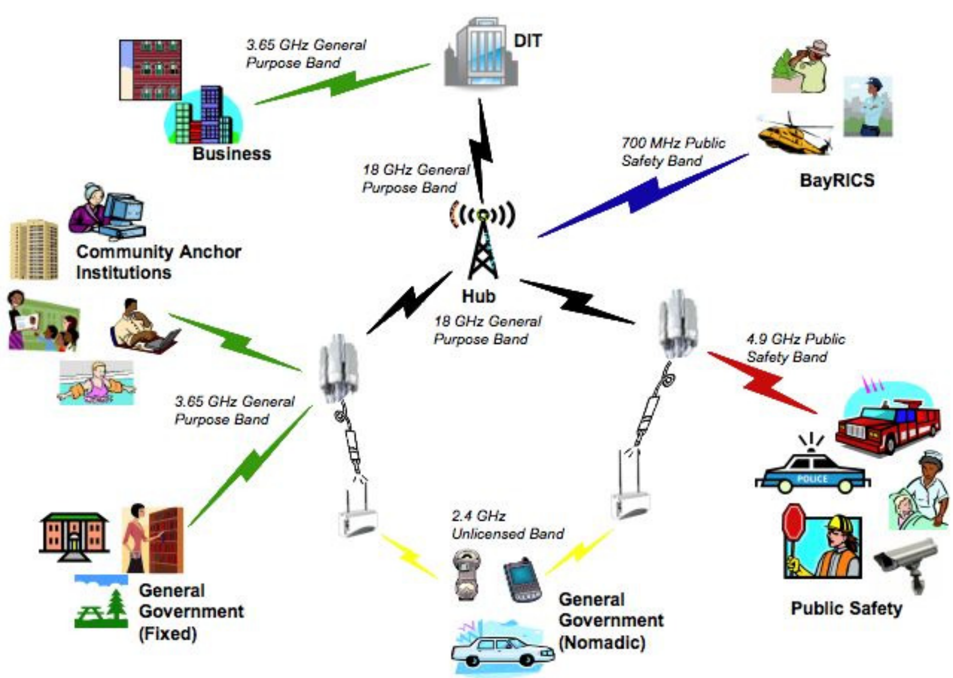
Several iterations of this design/financial analysis cycle were performed, resulting in a conceptual system design that meets these operational requirements to the greatest extent possible given the limits of current technology, regulations and funding.

Public safety agencies require robust and redundant systems able to survive and perform under emergency conditions, and the federal government has set aside both valuable spectrum and grant funding for this purpose. General purpose grant funding, such as the American Recovery and Reinvestment Act of 2009 (ARRA) program, may also be used for public safety applications. This variety of possible sources greatly increases the chances of successfully funding the project. Consequently, the reference architecture focuses on maximizing these resources.

Scenarios and alternatives for extending broadband capabilities to other City departments build on this core system. Other point-to-point links would serve other government agencies, businesses and the general public through community anchor institutions. As noted above, there is virtually no public support or financial case or technologically viable method for providing a ubiquitous citywide "cloud" of Internet access coverage by the City of Oakland.

The reference architecture provides an extensible backbone that minimizes the cost of adding these capabilities, and demonstrates that wireless broadband technology is deployable and effective in the City of Oakland.

**Figure 2.1 – Oakland Wireless Broadband System Conceptual View**

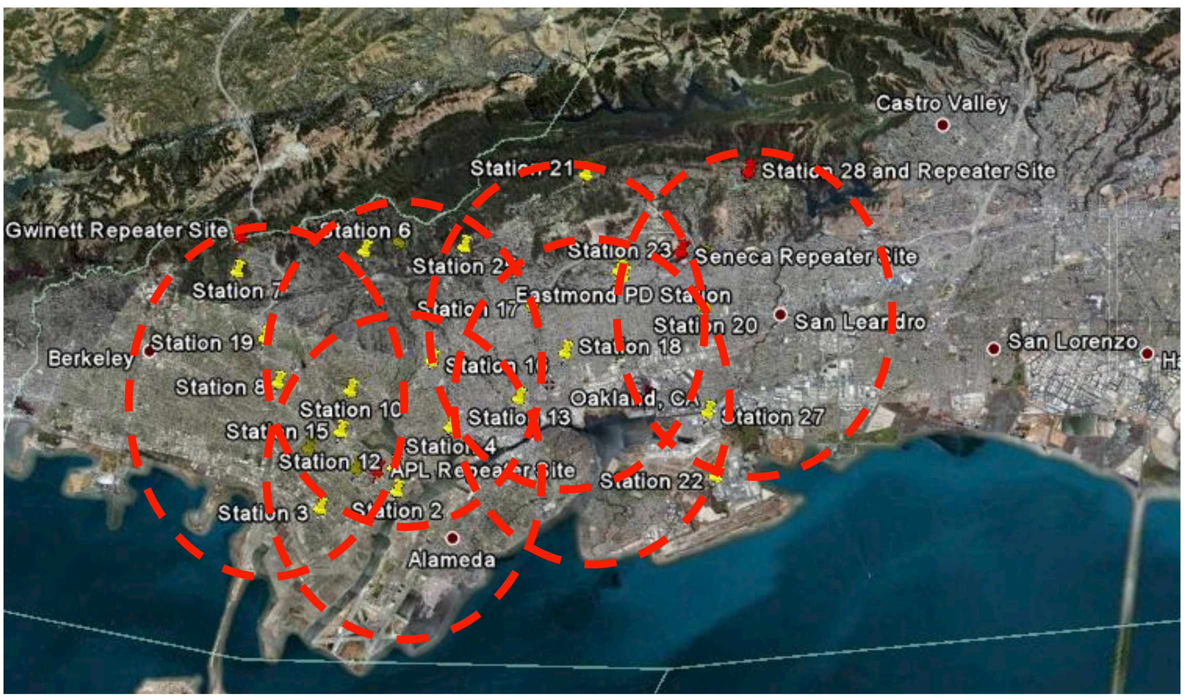



The backbone of the system is a wireless broadband system operating on licensed frequencies in the 18 GHz band. The backbone is built around six hubs, centering on the DIT facility at Frank Ogawa Plaza, and then extending first to fire stations and police department facilities, and then potentially to other city-owned locations. These links will operate at speeds up to 600 Mbps. There are no regulatory restrictions on the type of applications or users that may be supported.

Two types of connectivity are provided at each backbone location, or "node". First, high speed city network access is provided directly to the location itself. Second, wireless access points operating on the unlicensed 2.4 GHz band are installed at each node, providing convenient information technology network access at or near the backbone location for city employees, and potentially offering fixed IT network connectivity to nearby City facilities.

The second half of the core system described by the reference architecture is a public safety wireless broadband segment that radiates out from each of these backbone nodes. This segment takes advantage of the 4.9 GHz band that the federal government has set aside exclusively for public safety purposes. This segment will support fixed uses, such as surveillance cameras, and what are referred to as "nomadic" applications.

**Figure 2.2 – Core System**




Nomadic applications are midway between fixed uses, such as permanent cameras or links between buildings, and truly mobile applications such as video from moving vehicles or handheld devices that people use while walking around. Examples of nomadic applications include using a laptop computer in a parked car, or streaming video from the scene of a fire.

## 2.4. Alternatives and Scenarios

Beyond the reference architecture, and building upon it, additional system segments provide some level of wireless broadband service to every corner of the community. These segments include:

- Fixed links for general government purposes on the 3.65 GHz semi-licensed band.
- 802.11 standard hotspots on the unlicensed 2.4 GHz band for general government nomadic purposes.
- A 700 MHz system for mobile public safety applications that is being developed separately by a coalition of Bay Area cities, initiated by Oakland Mayor Ron Dellums.
- Public Internet access offered at community anchor institutions such as community centers, non profit organizations and public housing.
- Business grade Internet service to unserved and underserved commercial buildings.

Each of these alternatives and scenarios can be implemented independently. In some cases costs are offset by replacing existing leased lines or by improvements in efficiency and productivity. In other cases, costs are offset by users or through programs such as the ARRA package.

## 2.5. Business Case Evaluation

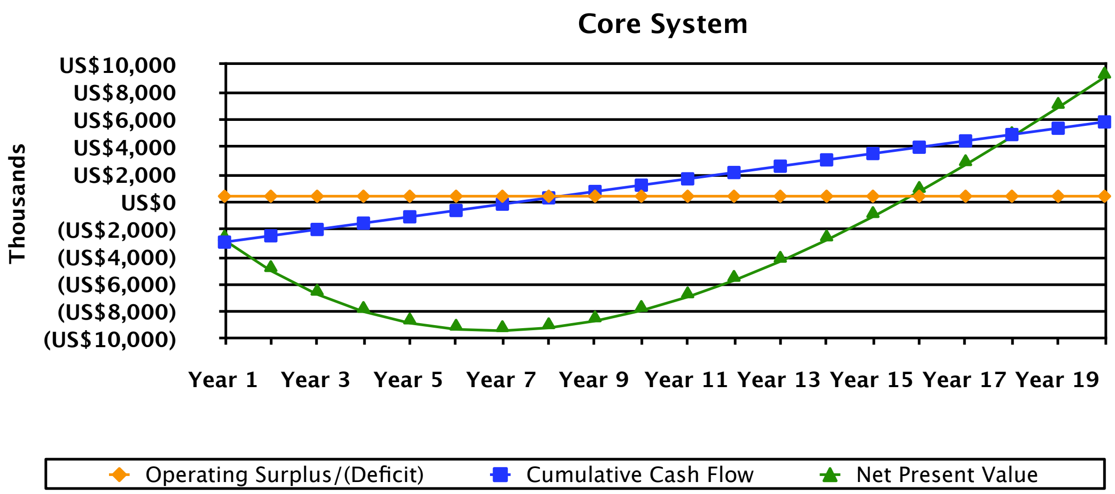
Financial analysis of the reference architecture's core system and the alternatives and scenarios is based on:

- The annual out of pocket cost of operations versus cost offsets and other funding
- The ability of the system to repay construction costs over time
- The long term capital value of the system

The core system pays for itself on an operating basis, based on the hard cost savings provided by replacing a few, redundant leased circuits. The system also pays for its full cost over time, even if no public safety grant funding is available. Enough cost savings are generated to support the ongoing operations of the 700 MHz public safety mobile system as well.

Various cost savings and efficiency gains, potentially including improved tax revenue collection, provide both an operating cost and long term capital cost justification for extending City network access to all employees and departments. Business-oriented services are designed to be self-supporting, and to provide an opportunity for local entrepreneurs to be part of an innovative public-private partnership with the City.

**Figure 2.3 – Oakland Wireless Broadband Core System Financial Analysis**




There is no immediate funding source for public Internet access via community anchor institutions, however the financial analysis clearly shows that the value of these services more than outweighs the cost of building and operating the necessary facilities. These facilities will provide essential digital inclusion services to unserved and underserved segments of the community, and are intended to meet the ARRA grant funding criteria.

## 2.6. Conclusion

This study demonstrates that a citywide broadband system based on wireless technology is both technically and financially feasible. This system can extend and enhance connectivity to the City's existing information technology network, providing new capabilities and enhanced efficiencies to City departments and employees. It can also provide sustainable Internet access to unserved and underserved communities in Oakland.

The ARRA program offers a unique window of opportunity to fund and operate this system, and significantly enhance the quality of life and public services available to Oakland residents. This study offers a solid basis for policy makers to evaluate the alternatives and decide how to move forward. Once those decisions are made, this study provides the tools needed to implement those decisions and support the quest for grant funding, including a shovel-ready request for proposal document.

# 3. Needs Assessment

## 3.1. Overview

Extensive primary research was conducted to facilitate the establishment of a sound vision for the deployment (or not) of an achievable and sustainable wireless broadband network in the City of Oakland. Under the direction of the City of Oakland's Department of Information Technology, several specific objectives were to be evaluated:

- Enhance economic development.
- Improve public safety.
- Increase the effectiveness of public, private, and nonprofit organizations through improved access to state of the art wireless broadband technology.
- Help overcome the digital divide.
- Improve the quality of life for all Oaklanders.

A total of 15 assessment sessions were conducted to obtain comments from and ascertain the needs and priorities of:

- Members of the public
- City of Oakland staff
- Businesses
- Nonprofit organization
- Educational institutions
- Other government agencies

In December 2007, a meeting was held with communications and information technology personnel from key City departments. Then, in July 2008, a series of workshops were conducted, three for city staff, and one each for the business community, nonprofit organizations, and educational institutions and other local government agencies.

Seven public focus groups were held in September 2008, one in each council district, along with a citywide town hall meeting at Oakland City Hall. Throughout this process, additional public comment was gathered in person and by phone and email.

Many concerns, issues and ideas were put forth during the course of this research. However this study is limited to the assessment of how the City of Oakland's needs might be met by wireless broadband technology, and a comprehensive examination of all related concerns is outside its scope. Key concerns that are noted and treated as potential limiting factors for a wireless broadband deployment include:

1. Web-based communications and service delivery by government agencies.
2. Interoperability between City departments, and with outside agencies.
3. General information technology and telecommunications infrastructure and policy.
4. Provision of computer hardware, software, training and technical support to under-served communities and individuals.

A summary of scope, methodology and findings is in Appendix A below, and complete minutes and research documents from all events are contained in Volume 2 of this study.

## 3.2. Analytical Framework

The results of this research are broken down into two categories: strategic goals and design criteria. Strategic goals encompass top level concerns voiced by study participants, and are broad concepts that might be applied to any major project. These goals can help guide policy makers and managers as implementation progresses, and inform the recommendations made by this study.

Design criteria, on the other hand, are specific attributes that study participants believe a wireless broadband system should meet. Any wireless broadband system that might result from this study should meet these criteria to the greatest extent possible.

## 3.3. Strategic Goals

Although each public session and community workshop was made up of different participants drawn from broad cross sections of Oakland's very diverse community, the groups were remarkably consistent in identifying and prioritizing strategic goals. Figure 3.1 provides a breakdown of these goals.

The top three goals identified during the focus groups, town hall meeting, and workshops for nonprofit organizations and local government agencies were free school access, free public access at community anchor institutions, and affordable access for the public.

The endorsement of these goals, however, was not unconditional. Nearly all the participants assessed these goals within the context of what were perceived to be greater needs of the Oakland community and with an explicit awareness of the fiscal constraints facing the City. Participants made a distinction between "free" and "affordable" service, and overwhelmingly chose not to endorse the provision of free Internet access to businesses and residences. Providing public access, free or otherwise, at public facilities, such as libraries and community centers, or high traffic areas, such as bus shelters, the convention center or the downtown area, was generally seen as a much higher priority than providing residential Internet service of any kind.

The city staff and business community workshops were similarly consistent, although the focus was on different goals and priorities. The top concerns were insuring that any system facilitates improved productivity and the public is aware and in support of any wireless broadband project. Both these goals received further endorsement from various public, nonprofit and local agency groups.

**Figure 3.1 – Strategic Goals**

| | Free school access | Free access at public facilities | Affordable access | System facilitates improved productivity | Public project awareness | Employs local vendors | Facilitates community outreach |
|---|---|---|---|---|---|---|---|
| **City Workshops** | | | | | | | |
| Police, Fire, Admin | | | | X | X | | |
| Pub Wks, CEDA, Finance | | | | X | X | | |
| Library, Museum, Parks | | | | X | X | | X |
| | | | | | | | |
| **Community Workshops** | | | | | | | |
| Businesses | | | | X | | X | |
| Non-profits | X | X | X | | X | | X |
| Agencies & Education | X | X | X | | | | |
| | | | | | | | |
| **Focus Groups** | | | | | | | |
| Focus group 1 | X | | X | | X | | |
| Focus group 2 | X | X | X | | X | X | |
| Focus group 3 | X | X | X | X | | | |
| Focus group 4 | X | X | | | | | |
| Focus group 5 | X | X | X | X | X | | |
| Focus group 6 | X | X | | | | X | |
| Focus group 7 | X | X | X | | | | |
| **Town Hall Meeting** | X | X | X | X | | X | |

Two other goals – using local vendors to build and operate a system and facilitating community outreach – were mentioned in a handful of groups, but overall received significantly lower support.

Although the groups did not specifically identify financial goals, such as lowering City operating costs or meeting specific budget requirements, a consistently high level of concern was expressed for the financial and managerial aspects of any broadband initiative. All of the various goals were explicitly discussed within this context. For this reason, an additional goal of sound financial planning and fiscal responsibility is included as a top priority.

Consequently, the six strategic goals identified by this research for a wireless broadband initiative by the City of Oakland are:

1. Sound financial planning.
2. Free school access.
3. Free public access at libraries, community centers, parks, etc.
4. Affordable access for the public.
5. System facilitates improved productivity.
6. Public project awareness.

These goals are further addressed in the final study recommendations.

## 3.4. Design Criteria

The fourteen groups discussed six design criteria that were seen as relevant to any wireless broadband network that the City might procure.

**Figure 3.2 – Design Criteria**

| | Flexible & inter-operable | Reliable network | High level of security | Full City coverage | Mobile & real time data access | Revenue stream for City |
|---|---|---|---|---|---|---|
| **City Workshops** | | | | | | |
| Police, Fire, Admin | X | X | X | X | X | |
| Pub Wks, CEDA, Finance | X | X | X | X | X | |
| Library, Museum, Parks | | | X | | X | X |
| | | | | | | |
| **Community Workshops** | | | | | | |
| Businesses | X | | | | | X |
| Non-profits | | | | | | |
| Agencies & Education | X | | X | X | | |
| | | | | | | |
| **Focus Groups** | | | | | | |
| Focus group 1 | X | | | | | |
| Focus group 2 | X | | | | | |
| Focus group 3 | X | X | | | | |
| Focus group 4 | | X | | X | | |
| Focus group 5 | X | | | | | |
| Focus group 6 | X | X | X | | | |
| Focus group 7 | X | | | | | X |
| **Town Hall Meeting** | | X | X | | | |

The top concern, identified by city staff, businesses, local agencies and six out of seven focus groups, was that any system be flexible and interoperable. In other words, that it can be used by all city departments (although every department wouldn't necessarily need access to all the features and capabilities), that it serve as a means of communications with other public agencies, and that the public can use and benefit directly from it, as appropriate. System reliability (including disaster survivability for emergency systems) and security were also perceived as being necessary by most participants.

Complete coverage of the City and mobile access to real-time data was not seen as a necessary technical requirement by most groups, however both were particular priorities of City staff. Both requirements will have to be met if City of Oakland departments are assumed to be regular users of any citywide wireless broadband system. Additionally, there was a general concern expressed during most focus groups, the town hall meeting and some workshops that all areas of the City be served equally, if not fully.

There was some discussion of whether a wireless broadband system should be a source of revenue for the City, however only three groups identified it as a requirement. Instead, as noted above, when the focus of discussion turned to financial and managerial issues, the emphasis was on cost savings and greater efficiency rather than revenue generation.

Consequently, the research identified five attributes which can be described as necessary for a citywide wireless broadband system:

1. Flexible & interoperable.
2. Reliable network.
3. High level of security.
4. Full city coverage.
5. Mobile & real time data access.

It should be noted that "full city coverage" refers to providing a given service or facility equally and evenly throughout Oakland, within the limits of technology and finances. For example, if wireless broadband service is provided to City libraries, it should be provided to all libraries to the extent practical. It does not mean blanketing the City with wireless Internet access, in fact that approach was generally opposed by nearly all stakeholders.

These design criteria are taken into account in the assessment of functional system requirements and the design of the reference architecture below. In addition, the business case analysis looks at the costs involved in meeting these criteria to the fullest extent practical.

# 4. Operational Requirements

Strategic priorities and operational needs must drive the overall design, deployment and management of any citywide wireless broadband system in the City of Oakland, but ultimately prospective users of the system will individually decide whether the system meets their particular needs and whether or not they want to pay for it. Those needs are defined by the applications and information they use, and by the circumstances in which they use it. If a network does not meet the requirements imposed by these operational considerations on a given user, then that user will not be served by it.

**Figure 4.1 – Operational Requirements by User Group**

| Operational Requirement | Public Safety | Emergency Services | Public Works | Finance & Admin | CEDA | Human Services | Parks & Recreation | Other Agencies | Business | Non-Profits | Public |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Citywide data access | X | X | X | X | | X | X | X | | | |
| Mobile communication | X | X | X | | | | | | | | |
| Video: routine operations | X | X | X | X | | | | | | | |
| Video: incidents & events | X | X | X | | | | X | X | | | |
| Video: surveillance & monitoring | X | | X | | | | X | | X | | |
| Point to point networking | | | | | X | | X | X | X | X | |
| Extensible network backbone | | | | | X | | X | X | X | X | X |

Seven operational requirements were identified. The applications that drove these requirements are described below, followed by a technical summary. At a top level, though, no single type of user needs a network that meets all of these criteria. There is overlap between these requirements. Meeting one, for example providing citywide data access, might support another, such as transmitting live video from emergencies or planned events.

Three of these requirements concern video transmission. Video was singled out because it is the most bandwidth intensive application currently in common use. A network that supports the sustained, high bandwidth requirements of video transmission today, should support other types of applications well into the future. The three different video modes are:

- Planned transmissions to support routine operations at specific locations.
- Unplanned transmissions from as wide a range of City locations as possible.
- Surveillance and monitoring.

Other operational requirements are the ability to access data throughout the City, either through the City's IT infrastructure or the Internet, mobile communications, point to point networking and an extensible network backbone.

## 4.1. Citywide Data Access

Provided that any system deployed meets the basic security and other design criteria of the various City departments, there was a nearly universal belief expressed throughout the research process that citywide data access would boost the efficiency, productivity and public accessibility of City operations and services. In particular, representatives from the police, fire, public works and emergency services departments indicated that wireless technology in the field would allow them to better communicate and access vital information where they need it most.

On a general basis, two-way data communication from the field can provide City departments with increased awareness of ongoing incidents and improve communications between and amongst supervisors and field personnel, as well as the emergency operations center. A citywide network could also enhance survivability of the City's communications system during a disaster by providing a redundant pathway. Another potential benefit is the ability to communicate with other government agencies, on a routine basis as well as in emergencies.

Emergency and routine communications priorities for the police department include high data rates, scalability, reliability and no dead spots. In addition, the fire department needs access above and below ground, for example in basements and tunnels.

Another potential application for citywide data access is improving communication to and from neighborhood service coordinators, and citizens groups such as neighborhood watch or CORE (Citizens of Oakland Respond to Emergencies).

City departments have a variety of needs. For example, simply having a nearby hotspot available would allow a human services caseworker to access current client information before making a site visit. Building inspectors stated that they spent considerable time in the field checking building sites and performing code compliance inspections, but then had to return to an office to complete their reports. Access to plans and documents for real time submission, approval and confirmation was identified as a potential benefit by both City staff and representatives from the business community.

Having remote access to information could allow the finance department to increase tax revenue by conducting more, and more thorough, field audits. Police officers would like better access to resources such as Department of Justice databases.

The City's human services department has a multipurpose senior services program (MSSP). Having access to a citywide wireless network could be helpful to the registered nurses (RNs) who go into the field to check on clients. Currently, they are using commercial wireless service to access the Internet, but not City IT resources. Such a network could also be used for remote health monitoring, and to deliver other services to the elderly, on a routine basis and in emergencies.

Another possible use of a citywide data network is to create the Internet equivalent of a traditional bookmobile. Computers and supporting technology can be brought directly into neighborhoods on a periodic basis (along with the necessary training and technical support) and connected to the Internet from wherever is most advantageous. Similarly mobile facilities could be used to deliver health care to under served communities, either at central locations or in homes.

The Oakland Unified School District and the Port of Oakland are two government agencies that could be primary users of the system. The jurisdictions of both agencies are essentially within the city limits, and therefor might be well served by a citywide network. Both agencies also have their own wireless broadband programs, and could be good partners in any City project. Other government agencies that have a presence in Oakland could also make use of a citywide network, but this use would be supplemental to whatever network strategy they may adopt to cover their entire jurisdictions.

## 4.2. Mobile Communication

Mobile communication is a specific kind of citywide data access need that is necessarily met wirelessly. Mobile users need to be able to communicate to and from moving vehicles, including boats and aircraft. In addition to adequate radio frequency signal strength, maintaining this sort of connectivity for data networking requires the use of appropriate protocols, modulation techniques and other network design elements.

The City of Oakland already has an extensive radio communications system designed to support public safety, public works and other City departments, particularly for voice communications. In other cases, City workers use commercially available facilities, for example data service provided by cellular telephone carriers.

Location-based services for vehicles and other assets is one mobile data application that was discussed by workshop participants which the City does not currently have. It was also identified as a need by business representatives.

Other mobile services might be, in effect, extensions of existing networks. For example, real-time information about transit bus locations and status could be gathered wirelessly, and delivered to members of the public through their mobile phones.

Achieving truly mobile communications is not an easy, or inexpensive, challenge. Options for creating a mobile data infrastructure, and the associated costs, are explored below.

## 4.3. Video Transmission

Three types of video transmission needs were identified:

1. *Live, high quality video from incident sites and organized events.* Live video from the scene, for example, of a major fire would allow field personnel who were staging or were not yet involved to gain situational awareness and to better prepare before deploying. Fire department representatives, in particular, identified visual information as being particularly valuable for deployment to and management of incidents, as well as for coordination with police and public works personnel. Command staff and communication center personnel would also gain increased awareness and be better equipped to make decisions, manage assets and communicate with field personnel. A technically similar application would be to transmit live coverage of a soccer match from a park via the City's KTOP cable access station.

2. *Video to support routine operations.* Video could be used to reduce the time and expense associated with transporting personnel to handle course-of-business operations at varying locations. Examples would be the use of video lineups at the Eastmont police substation or performing sewer inspections. Another would be to offer video-based training, either live from a central location to remote sites, such as fire stations, or on an on-demand basis. In the long run, wired connections are faster, more reliable and cheaper for fixed, point to point communications than wireless. However, wireless facilities could be used to test applications, rapidly deploy or extend connectivity to new or seldom used locations, and support operations until an economic case exists to install hardwired connections.

3. *Surveillance and monitoring.* The same economic and technical tradeoffs apply to these sorts of applications. Where a need is more or less permanent, such as watching high-traffic areas or a frequently flooded underpass, fixed wireline facilities would generally be preferred. However, those facilities are not available or

economically feasible at every location, or might be too expensive to acquire if the need had not yet been proven. Wireless technology can be used to reach problematic locations, test the effectiveness of video monitoring in a specific location, and quickly adjust coverage as needs change or as private sector participants join the system. For ad hoc surveillance, for example from an area experiencing a sudden increase in crime or of traffic congestion caused by a freeway closure, wireless technology would almost always be the means of choice.

## 4.4. Point to Point Networking

Wireless technology is well suited to providing quick connectivity to, say, a someone who is using a laptop computer on a city street to connect to an access point. However, depending on location and the availability of wired connections, wireless technology could also connect a fixed location to the City's IT infrastructure or the Internet. In this sort of application, both ends of the connection would be wired (for example, a desktop computer connecting to a central server) but part of the intermediate transmission chain would be wireless.

City workers at some locations, such as park offices, lack wired connectivity to the City's information technology infrastructure. A wireless system could be used to quickly extend network access to such locations, or to test the effectiveness of a particular application at a particular location. The economic and technical case for extending hard wired facilities can then be properly evaluated.

In many respects, the requirement for point to point networking is the same as the requirement for video support of ongoing operations. The major difference is in the capacity and quality of service requirements involved. Live video requires continuous access to a large amount of bandwidth, with little tolerance for network congestion or capacity sharing, and little ability to make momentary use of empty bandwidth. Standard data networking, on the other hand, is more amenable to sharing facilities, can make good use of bandwidth that varies in capacity, and usually requires less capacity.

Point to point capability could also be used to extend Internet service to community groups and public facilities, where it can be made available to anyone at little or no cost. This approach has advantages over attempting to deliver wireless Internet service directly into homes.

First, the laws of physics make it very difficult, and very expensive, to achieve reliable two-way wireless data transmission from inside a building to an outside access point using consumer grade equipment or untrained personnel. Mobile phone companies have spent years and billions of dollars trying to solve this problem and have yet to deploy sufficient assets to comprehensively do so. Municipalities that have attempted it have either failed or, at best, have achieved partial success at significant cost.

Second, raw bandwidth can be combined with properly configured and maintained equipment, neighborhood-specific training and ongoing technical support. Where cities have been able to provide some level of residential wireless Internet service to communities in need, usage of this service has been lower than anticipated. In some cases, usage has been unacceptably low because people lack the basic technological prerequisites to make use of it.

Point to point networking can also be used to enhance other programs, for example health care and education, that can make onsite use of Internet resources. These programs (or the facilities themselves) might be operated by non-profits or other government agencies who in turn might be able to help offset costs.

## 4.5. Extensible Network Backbone

Wireless network services, such as citywide data access, mobile communication, video transmission and point to point networking, would be supported by a shared network backbone that would connect these facilities back to the City's IT infrastructure and, possibly, the Internet. This backbone would likely include both wireless and wired facilities.

This backbone can be designed so that it can be expanded and extended to support additional services as desired. For example, the City could sell access to its network backbone to building owners that needed to upgrade Internet connectivity, or to groups – public and private sector alike – that wanted to install public wireless hotspots.

A few research participants thought that it would be a good idea for the City to provide utility-like Internet service to the general public, either on a subsidized basis to targeted communities, or on a general market basis. Most participants did not support the idea, and in many cases expressed emphatic opposition. For technical and economic reasons, the municipal wireless Internet utility model has generally failed. As also noted below, there are a handful of cities where this model is still being pursuing, usually with significant public subsidies, but these exceptions have little in common with Oakland.

For these reasons, this study will not recommend the adoption of the municipal wireless Internet utility model by the City of Oakland. Nevertheless, an extensible network backbone would support such an endeavor, should circumstances change.

Other government agencies that have a significant presence in Oakland, such as BART or the County of Alameda, but that have operations that extend well beyond Oakland's borders, could use this backbone to supplement and extend their existing network architecture where they have a specific need. Likewise, the City of Oakland may be able to share wireless or other broadband facilities owned by other agencies. For example, BART has a broadband system with wireless capabilities throughout its right of way, and offers some level of access to City departments.

# 5. Network Design Priorities

## 5.1. Methodology

The network design attributes needed to support these operational requirements are assessed according to five criteria that measure resource intensity – bandwidth, quality of service (QoS), ubiquity, simultaneous users of a given network segment, and mobility – and are rated as low, medium and high. At this stage in the analysis, resource intensity also provides a rough proxy for cost: higher resource intensity generally equates to higher cost.

**Figure 5.1 – Ratings Scale for Operational Requirements**

| | Low | Medium | High |
|---|---|---|---|
| Bandwidth | 2 Mbps or less per session | 2 to 20 Mbps | More than 20 Mbps |
| Quality of Service | Variable & bursty (web browsing, database queries) | Fault tolerant (file transfer) | Uninterrupted streaming |
| Ubiquity | Specific points | Designated areas | Citywide |
| Simultaneous Users | One | Few | Many |
| Mobility | Fixed | Portable | Mobile |

When resource intensity is plotted against the relative number of user groups identified as likely beneficiaries of a given operational requirement, a rough picture emerges that helps to clarify design priorities. In this analysis, the simultaneous users criterion is given double weight because being able to support many users at once, across a wide range of applications and departments, is a critical requirement for a cost-effective network.

**Figure 5.2 – Prioritization of Categories**

| Category | Priority |
|---|---|
| High demand, low cost | High |
| Low demand, low cost | Medium |
| High demand, high cost | Medium |
| Low demand, high cost | Low |

Using these categories, operational requirements can then be assigned a rough, provisional priority. This prioritization has a very limited purpose. It is used to guide the initial development of the reference architecture and business model, and provide a starting point for further analysis of the technical feasibility and constraints of, and the economic case for deploying a network that can support these operational requirements. This prioritization is also relative: it compares the demand for and the cost of any given requirement against the other requirements. It is an intermediate step used in determining the total cost and the ability or willingness of potential users to defray those costs, which is the central focus of the business case analysis below.

Operational requirements that have a high demand and low cost relative to other requirements are assigned a high priority. The applications supported by these requirements should provide the biggest bang for the buck. Requirements that have costs commensurate with demand – low demand/low cost, high demand/high cost – are assigned a medium priority. Lowest priority are requirements that have a relatively low demand and high cost.

## 5.2. Prioritization

This provisional analysis first assesses the resource intensity of the seven operational requirements identified by the research conducted in the City of Oakland.

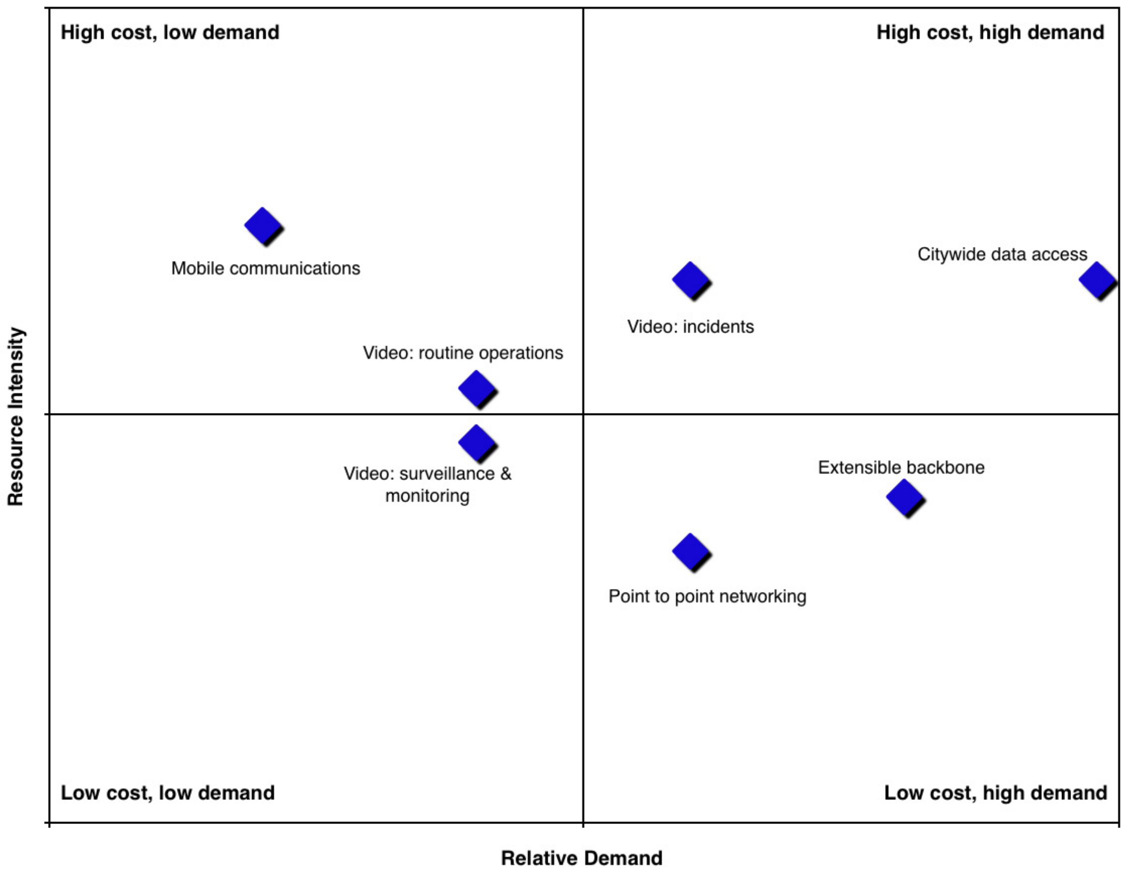
**Figure 5.3 – Operational Requirements by Resource Intensity**

| | Bandwidth | QoS | Ubiquity | Simultaneous users | Mobility |
|---|---|---|---|---|---|
| Citywide data access | Low | Low | High | High | Medium |
| Mobile communication | Low | Low | High | High | High |
| Video: routine operations | Medium | High | Low | Medium | Low |
| Video: incidents & events | High | High | High | Low | Medium |
| Video: surveillance & monitoring | Medium | Medium | Low | Medium | Low |
| Point to point networking | Medium | Medium | Low | Low | Low |
| Extensible network backbone | Medium | Medium | Medium | Low | Low |

Figure 5.4 then shows how these operational requirements sort into the four prioritization categories described above.

By this analysis, an extensible network backbone and point to point networking are the operational requirements with the highest priority, in that order. Although an extensible backbone is somewhat more costly than point to point networking, the potential demand is significantly greater. Citywide data access has the third highest priority, despite its relatively higher cost, because of its potential to serve a greater number of users than any other requirement.

**Figure 5.4 – Relative Demand versus Resource Intensity of Operational Requirements**




Video from incidents and events is fourth on the list, showing a cost generally in line with demand.

**Figure 5.5 – Provisional Operational Requirement Priority**

| Priority | Operational Requirement |
|---|---|
| 1 | Extensible network backbone |
| 2 | Point to point networking |
| 3 | Citywide data access |
| 4 | Video: incidents & events |
| 5 | Video: surveillance & monitoring |
| 6 | Video: routine operations |
| 7 | Mobile communication |

Next, in order of priority, are video for surveillance and monitoring, and video to support routine operations. Both have midlevel demand and cost, with surveillance and monitoring showing a marginally better balance between the two factors. Last priority is mobile communications, which has the lowest relative demand and highest relative resource intensity of the seven operational requirements.

It is important to note that all of these operational requirements were identified as being both desirable and beneficial by the research process. The fact that one requirement is low on the list does not necessarily mean that it shouldn't be supported by the reference architecture, or by any eventual network that the City deploys. Conversely, a high provisional priority does not guarantee implementation.

Nor are these seven requirements mutually exclusive. Implementing one can create basic infrastructure that lowers the cost of another, or can attract additional users, which in turn could raise demand. One example given above is video to support routine operations, which might be added to a point to point network facility for a low marginal cost. Another example is mobile communications, which might be supported by a citywide data access network to a degree that is sufficient for certain applications. Finally, creating a wireless broadband network with an extensible network backbone will ensure that operational requirements that are not supported in an initial deployment can be accommodated in later phases.

The next step in the process is to create a reference architecture and a business model that support these operational requirements, while meeting the strategic goals and design criteria identified by this study.

# 6. Reference Architecture

## 6.1. System Overview

Public safety and other departments in the City of Oakland have requirements for fixed and nomadic broadband communications that can be met by a wireless Ethernet system.

This system can also serve other government agencies, private businesses, community based organizations and non-profits, and the community at large.

**Figure 6.1 – Operational Requirement Matrix**

| Priority | Operational Requirement | Comment |
|---|---|---|
| **1** | Extensible network backbone | Phase one design can be expanded for additional bandwidth, and infrastructure can support phase 2 scenario for citywide Internet access. |
| **2** | Point to point networking | Design supports bidirectional point to point links up to 15 Mbps, throughout the city. |
| **3** | Citywide data access | Basic design covers entire city limits, and budget allows for supplementation in difficult areas. User terminal options range from USB-enabled data modems to vehicle or building-mounted subscriber units) |
| **4** | Video: incidents & events | Ad hoc, high bandwidth coverage (up to 15 Mbps) is available throughout the city. Field units are available to support needs. |
| **5** | Video: surveillance & monitoring | Scalable bandwidth (up to 15 Mbps in theory) is available throughout the city. |
| **6** | Video: routine operations | Point to point bandwidth (up to 15 Mbps) is available throughout the city. |
| **7** | Mobile communications | Network not optimized for mobile use, but can support up to a point. Network is designed to be upgradable when mobile protocols are finalized. |

A reference system plan using a hub/spoke/cloud architecture has been designed using:

- Antenna towers, space and power at existing public safety radio repeater sites which are owned and operated by the City of Oakland and provide city wide coverage at radio frequencies.
- Point-to-point (PTP) FCC licensed 18 GHz radio links from these existing repeater sites.
- Point to multipoint (PMP) FCC licensed 4.9 GHz radios installed at city fire department stations and police department sub stations to support fixed and transportable broadband Ethernet links from city agencies.
- Point-to-point (PTP) 4.9 GHz subscriber units (SU) that can be fixed or nomadic to support video camera links, voice over Internet protocol (VoIP) links and high speed internet data.

- A second phase scenario which allows the system to be expanded to include provision of Internet service to the community, either directly or indirectly via City facilities such as community centers.

This design provides wireless Ethernet connectivity throughout the city limits of Oakland. The traffic generated, from units in the field and from police or fire stations, is aggregated into five major hubs, located at existing City of Oakland communication facilities, and from there to a sixth hub at the Oakland City Hall complex. There are three options for connecting these hubs into the City of Oakland's existing information technology network:

- Use existing data links, either upgraded for the purpose or used as is.
- Install high capacity wireless PTP links.
- Multi-Point Label Switching (MPLS) IP Virtual Private Network (VPN) links from the five hub sites to a central location.

For the purposes of this study we have used the second option, the high capacity wireless PTP links, to connect five hubs into the central aggregation point (and sixth hub) at the City Hall complex. This option is the middle-case alternative, providing cost-effective connectivity with minimal impact on the City's existing IT infrastructure.

In some of the scenarios, some or all of the hubs are connected to the public Internet by DS3 grade (45 Mbps) MPLS lines. These lines can be used to route traffic directly onto the public Internet and to connect the hubs to the City Hall complex.

## 6.2. System Plan Description

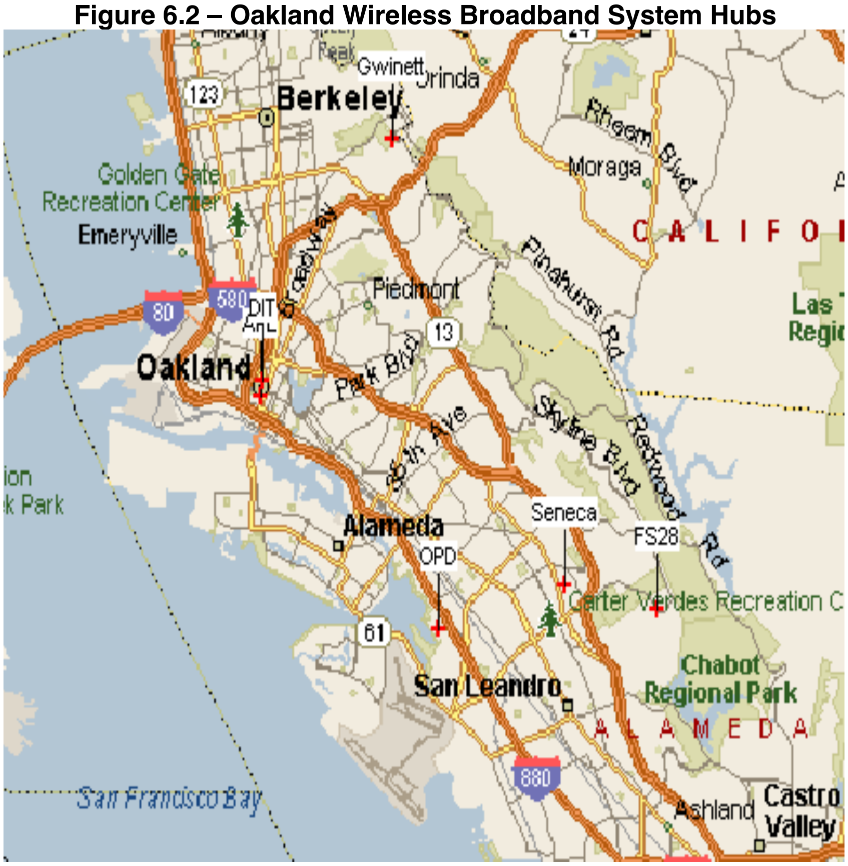
This reference architecture for a citywide wireless broadband system has been designed to take advantage of existing City of Oakland facilities. The system relies on a star network architecture consisting of the six hub sites, twenty-six spokes and thirty-two wireless local area network (WLAN) clouds to service subscriber radios in the field, and provide the means to establish fixed links as needed, either permanently or temporarily.

In the some scenarios, additional "spoke" links are added to the hub sites. These additional spokes could terminate, for example, at community centers, schools, businesses or nonprofit organizations. From these sites, Internet access could be further extended into the community. At the hubs, these spokes would connect directly to the public Internet and could be physically separate from the City's IT infrastructure, sharing only logistical facilities such as towers and power supplies, and management and maintenance resources. Alternatively, this added capacity could be fully integrated into the initial system, with public traffic securely and logically separated from City traffic.

## 6.3. System Hubs

Four existing radio repeater sites (which include a fire station) that currently support 800 MHz public safety radio services to the City's police and fire departments, a police department site at 7101 Edgewater Drive, and the Department of Information Technology in City Hall were selected to be hub sites for the wireless system. Each of the hubs would be equipped with PTP 18 GHz radios installed on repeater site towers linking to a corresponding 18 GHz radio installed at twenty-five fire stations (the City's twenty-sixth fire station is a hub location) and one police substation. Each of the hub sites would then be connected back to the central aggregation point at the City Hall complex via additional 18 GHz PTP radio links.

**Figure 6.2 – Oakland Wireless Broadband System Hubs**




For some scenarios, radios used for public Internet access (or the entire system, if desirable) would be interfaced to DS3 leased lines provided by a local telecommunication carrier. These lines would utilize Multi-Point Label Switching (MPLS) technology to provide public Internet access and to create an Internet Protocol (IP) Virtual Private Network (VPN), exclusively for City use if desired

## Figure 6.3 – System Plan

| Site Base Statio | Address Oakland, California | Latitude | Longitude | AMSL Feet | Tower Height (ft) | Hub Location | RF Path Length | Ch. BW |
|---|---|---|---|---|---|---|---|---|
| Station 1 | 1605 Martin Luther Way | 37°48'27.55"N | 122°16'30.30"W | 28 | TBD | APL | 0.45 | 15 |
| Station 2 | 100 Jack London Squa | 37°47'41.79"N | 122°16'31.86"W | 12 | TBD | APL | 0.49 | 15 |
| Station 3 | 1445 14th Street | 37°48'39.91"N | 122°17'34.29"W | 14 | TBD | APL | 1.27 | 15 |
| Station 4 | 1235 E. 14th Street | 37°47'24.60"N | 122°14'51.25"W | 32 | TBD | APL | 1.57 | 15 |
| Station 5 | 934 34th Street | 37°49'17.44"N | 122°16'35.40"W | 33 | TBD | APL | 1.29 | 15 |
| Station 6 | 6080 Colton Blvd. | 37°49'56.97"N | 122°12'28.35"W | 918 | TBD | Gwinett | 2.30 | 15 |
| Station 7 | 1006 Amito Dr. | 37°51'37.38"N | 122°14'3.41"W | 912 | TBD | Gwinett | 0.62 | 15 |
| Station 8 | 463 %1st Street | 37°50'13.32"N | 122°15'41.21"W | 119 | TBD | Gwinett | 2.76 | 15 |
| Station 10 | 172 Santa Clara Ave. | 37°49'7.37"N | 122°15'8.52"W | 115 | TBD | Gwinett | 3.49 | 15 |
| Station 12 | 822 Alice Street | 37°47'55.28"N | 122°16'7.62"W | 23 | TBD | APL | 0.27 | 15 |
| Station 13 | 1225 Derby Ave. | 37°46'38.86"N | 122°13'40.63"W | 45 | TBD | Seneca | 4.12 | 15 |
| Station 15 | 455 27th St | 37°48'57.26"N | 122°15'59.43"W | 38 | TBD | APL | 1.00 | 15 |
| Station 16 | 3600 13th Ave. | 37°48'10.36"N | 122°13'49.29"W | 197 | TBD | APL | 2.26 | 15 |
| Station 17 | 3344 High Street | 37°47'9.60"N | 122°11'50.37"W | 185 | TBD | Seneca | 2.97 | 15 |
| Station 18 | 1700 50th Ave. | 37°46'19.30"N | 122°12'23.53"W | 50 | TBD | Seneca | 2.82 | 15 |
| Station 19 | 5766 Miles Ave. | 37°50'44.47"N | 122°15'0.19"W | 236 | TBD | Gwinett | 1.89 | 15 |
| Station 20 | 1401 98th Ave. | 37°44'39.88"N | 122°10'13.56"W | 34 | TBD | Seneca | 1.04 | 15 |
| Station 21 | 13150 Skyline Blvd. | 37°47'21.28"N | 122° 8'59.07"W | 1140 | TBD | FS-28 | 3.00 | 15 |
| Station 22 | 751 Air Cargo Way | 37°43'13.50"N | 122°13'12.11"W | 5 | TBD | Seneca | 4.18 | 15 |
| Station 23 | 7100 Foothill Blvd. | 37°46'10.18"N | 122°10'24.01"W | 104 | TBD | Seneca | 1.20 | 15 |
| Station 24 | 5900 Shepard Canyon | 37°49'31.66"N | 122°11'57.71"W | 781 | TBD | Gwinett | 2.89 | 15 |
| Station 25 | 2795 Buters Drive | 37°48'33.36"N | 122°11'27.25"W | 836 | TBD | Gwinett | 4.07 | 15 |
| Station 26 | 2611 98th Ave. | 37°45'4.54"N | 122° 9'20.66"W | 185 | TBD | FS-28 | 1.76 | 15 |
| Station 27 | 8501 Pardee Drive | 37°43'49.53"N | 122°12'6.97"W | 9 | TBD | FS-28 | 4.51 | 15 |
| Station 28 | 4615 Grass Valley | 37°45'3.52"N | 122° 7'22.86"W | 485 | TBD | Hub | 0 | 15 |
| Station 29 | 1061 66th Ave. | 37°45'33.21"N | 122°11'51.91"W | 245 | TBD | FS-28 | 4.06 | 15 |
| Eastmont PD | 2651 73rd Ave. | 37°46'4.33"N | 122°10'27.41"W | 94 | TBD | OPD | 2.33 | 15 |
| APL | 1100 Broadway | 37°48'8.09"N | 122°16'20.63"W | 13 | 450 | Hub | 0 | 15 |
| Gwinett | 7185 Marlborough Terra | 37°51'50.09"N | 122°13'22.94"W | 637 | 45 | Hub | 0 | 15 |
| Seneca | 9000 Seneca | 37°45'25.36"N | 122° 9'27.88"W | 220 | 60 | Hub | 0 | 15 |
| OPD | 7101 Edgewater Dr. | 37°44'49.23"N | 122°12'18.91"W | 7 | 250 | Hub | 0 | 15 |
| DIT | 150 Frank Ogawa Plaza | 37°48'18.19"N | 122°16'16.07"W | 39 | TBD | Hub | 0 | 15 |
| **RF Hub** | **Address** | **Latitude** | **Longitude** | **AMSL** | **Tower Hgt** | **FCC ULS** | **# Radios** | **BW** |
| APL | 1100 Broadway | 37°48'8.09"N | 122°16'20.63"W | 13 | 450 | yes | 8 | 113 |
| Gwinett | 7185 Marlborough Terra | 37°51'50.09"N | 122°13'22.94"W | 637 | 45 | yes | 7 | 105 |
| Seneca | 9000 Seneca | 37°45'25.36"N | 122° 9'27.88"W | 220 | 60 | yes | 6 | 90 |
| FS-28 | 4615 Grass Valley | 37°45'3.52"N | 122° 7'22.86"W | 468 | 12 | yes | 4 | 60 |
| OPD | 7101 Edgewater Dr. | 37°44'49.23"N | 122°12'18.91"W | 7 | 250 | yes | 1 | 15 |
| DIT | 150 Frank Ogawa Plaza | 37°48'18.19"N | 122°16'16.07"W | 39 | TBD | yes | 5 | 75 |

Notes:
1. Tower height in feet. Fire station towers average 50' to 75' -TBD
2. RF Path lengths in miles.
3. Channel bandwidth in Mbps.
4. PTP Backhaul channel frequency at 18.0 GHz (licensed). Bandwidth per link is 15 GHz.
5. PMP WiMAX radio frequency at 4.9 GHz.(licensed).
6. WiMAX radio can be sectored for 360 degree coverage in six sectors (6 radios).
7. All Radios have SMNP and vendor supplied M&C for network management.
8. Network Operations Center located at DIT.

If implemented, the wireline Layer 3 MPLS VPN (L3VPN) facility in some scenarios provides enhanced border gateway protocol (BGP) signaling, MPLS traffic isolation and router support for VRF's (virtual routing/forwarding) to create an IP based VPN. A Layer 3 MPLS VPN also provides Quality of Service (QoS) facilities which rely on resource reservation control mechanisms rather than achieved service quality methods.

Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow. For example, a required bit rate, delay, jitter, packet dropping probability and/or bit error rate may be guaranteed. Quality of service guarantees are important if the system capacity is insufficient, especially for real-time streaming multimedia applications such as VoIP and video (since these often require fixed bit rates and are delay sensitive) and in networks where the capacity is a limited resource. In the absence of network congestion, QoS mechanisms are not required.

## 6.4. System Spokes

Each of the PTP radio hops supports data channels up to 108 Mbps in bandwidth operating in the 18 GHz radio frequency band and would require FCC licensing. The radio path lengths are all less than 5 miles line of sight (LOS). The financial analysis below evaluates 15 Mbps and 108 Mbps alternatives, and even higher speeds are possible through software upgrades.

### WLAN Base Stations

The hubs, fire stations and the police substation would be equipped with 50 to 75 foot towers to support the PTP radio and the PMP radios that create the Internet "clouds" around each of those sites. Each of the six hub sites will also be equipped with 4.9 GHz radios and function as base stations as well as hubs.

These locations will function as a WLAN base station. Each antenna tower will be equipped with three (3) PMP radios using 802.16 (WiMAX) standards that operate in the 4.9 GHz band and require FCC licensing.

Additionally, 802.11 standard outdoor access points operating in the unlicensed 2.4 GHz band would be installed at each spoke and hub location, to provide additional connectivity to City workers wishing to access the City's information technology network. In some cases, these access points could also be used to provide fixed links to nearby City facilities. There are no significant regulatory restrictions on the type of traffic or applications that can be used on these access points.

However, the available frequencies in the 4.9 GHz band are designated for public safety use, which "must be related to the protection of life, health or property." This definition is fairly broad, and does not necessarily limit usage to police, fire and emergency services agencies. It would include, for example, supporting most public works field operations, or enhancing security at City facilities, through such things as surveillance equipment or through increased onsite availability of trained personnel. It would not include supplying public Internet access or providing television coverage of sporting events.

On the other hand, there is no significant usage restriction on the 18 GHz spoke links, or on the 3.65 GHz cloud radios designated for the second phase scenario. This reference architecture provides sufficient flexibility to deploy additional 18 GHz spokes (or remote units for applications such as public video coverage) or 3.65 GHz point-to-point links on an as-needed basis in the event a specific City application is deemed unacceptable for use at 4.9 GHz.

Each of the radios will be tower mounted and interfaced to 120º sector antennas to create 360º radio coverage of the local area. Coverage at 4.9 GHz is in the 3 to 5 mile range. Overlapping "clouds" in some parts of the city center will create very intense coverage and could support mobile interconnection from subscriber units as 802.16 technology is improved. All the radios used in the system are software upgradable and care must be taken to ensure forward compatibility with upcoming mobile 802.16 standards to the greatest extent possible.

There are several options for connecting City users or equipment to the cloud, including:

- Fixed 802.16 protocol user terminals, such as might be connected to a surveillance camera or installed in a park office to provide LAN facilities.
- Portable 802.16 protocol user terminals that could be installed, for example, on a truck used for remote video production.
- Hybrid 802.16/802.11 terminals that could be installed on a vehicle, such as a fire engine, or at an office or worksite.
- USB-compatible 802.16 modems which could be connected directly to laptop computers.

This public safety cloud coverage would be available outdoors. Not every type of public safety user terminal will be able to directly access the cloud from every point in the City, so consideration will have to be given to matching terminals to user needs in order to provide the appropriate range of coverage.

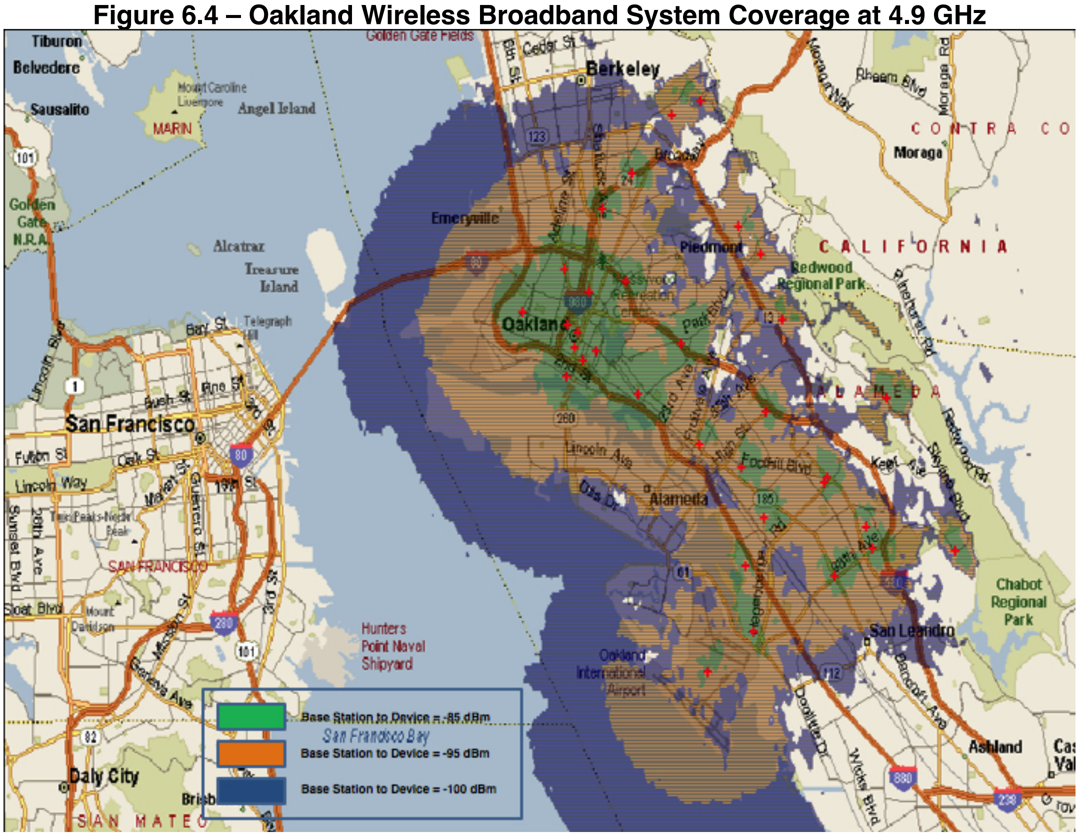
Indoor coverage will depend on building location, type, size and construction. Cost effective solutions are available for extending fixed access from the cloud to the interior of structures, however the use of portable equipment, such as USB modems, will be restricted.

For the second phase scenario, similar radios operating preferably in the 3.65 GHz band (assuming successful frequency coordination with existing users) or at alternative frequencies could be used to extend Internet access to community anchor institutions.

## 6.5. System Coverage

The geographic coverage of the 4.9 GHz reference architecture was modeled by RCC Consultants, Inc. using their proprietary Comsite tool. A complete set of maps can be found in Appendix B.

**Figure 6.4 – Oakland Wireless Broadband System Coverage at 4.9 GHz**




These maps show the expected reach of the 4.9 GHz base stations to users in the field. The parameters used assume maximum allowable effective radiated power, tower height of 75 feet (except for three hubs which were modeled using 25 foot towers) and QAM modulation. General assumptions were made for all locations. No effort was made to shape or optimize coverage for specific sites.

Three different contours were mapped: -85 dBm, -95 dBm and -100 dBm, which roughly correspond to connection speeds of 24 Mbps, 6 Mbps and 1 Mbps respectively. Nearly all of Oakland west of the SR13/I-580 line is covered by the 6 Mbps contour, and the 1 Mbps contour covers most of what remains in that area. Site-specific engineering can mitigate the small white areas and further extend the 6 Mbps contour. Given the generalized parameters of the reference architecture, the modeling shows that full coverage is feasible at 4.9 GHz west of the SR13/I-580 line.

Coverage east of the SR13/I-580 line, in the Oakland hills area, is more problematic. It is difficult to fully cover that sort of terrain and vegetation using the 4.9 GHz band. There are two options: build an extensive 4.9 GHz repeater network or look at other frequencies. As more fully described below, the City of Oakland is part of an effort to create a Bay Area-wide 700 MHz public safety network.

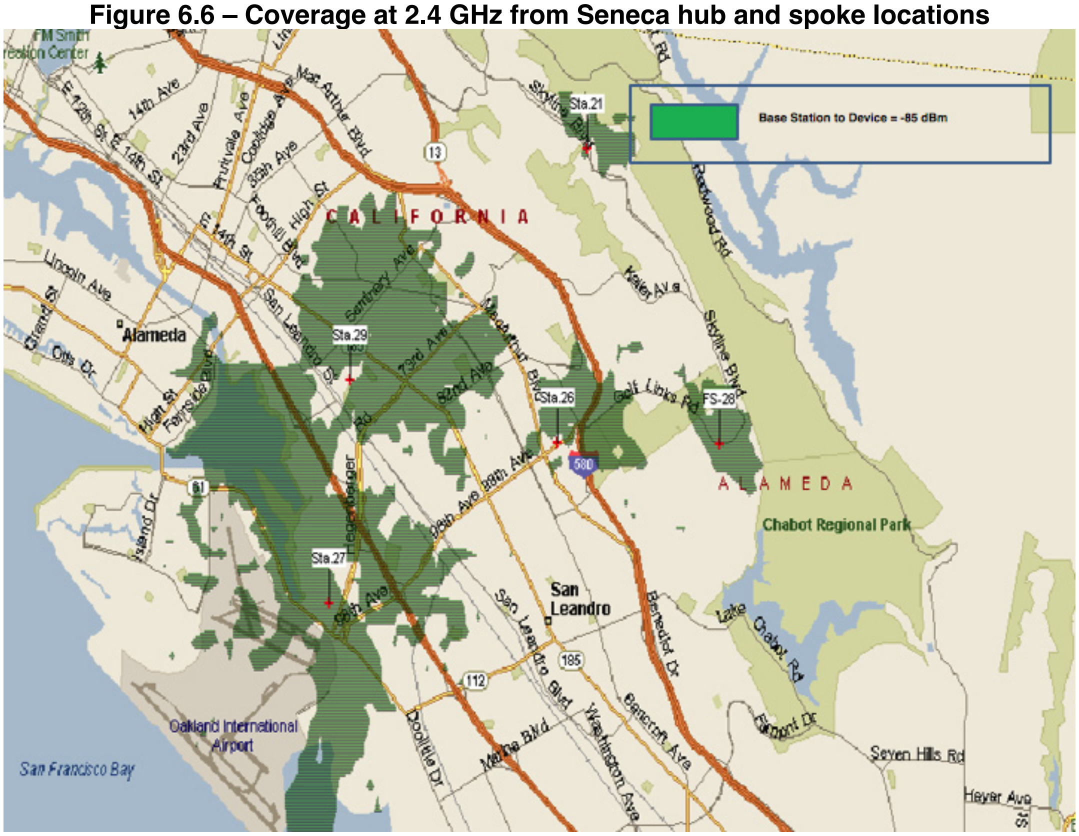
**Figure 6.5 – Comparative Coverage at 700 MHz**


For comparison purposes, coverage of a mobile network operating at 700 MHz was modeled. No effort was made to optimize coverage or transmitter sites. The six hub locations used for the reference architecture were also used for the 700 MHz sites. With only these six locations, a 700 MHz system covers nearly the entire Oakland hills area. A frequency-specific network design and use of advantageous locations in neighboring jurisdictions should provide as close to 100% coverage as is physically possible.

Although the 4.9 GHz reference architecture can provide very useful service in the Oakland hills, further optimizing coverage there will quickly reach the point of diminishing returns. This system will provide excellent service throughout the balance of the City, and because licensing requirements are well established and equipment is widely available, it can truly be regarded as "shovel-ready." Once the core system is constructed and actual coverage is evaluated, a decision can be made whether to attempt to enhance 4.9 GHz coverage in the hills, or to rely on a 700 MHz solution.

Finally, the coverage of 802.11-standard access points at 2.4 GHz was mapped. The result shows that placing access points at hub and spoke locations will provide ample laptop-grade connectivity for City workers who drive to those locations.

**Figure 6.6 – Coverage at 2.4 GHz from Seneca hub and spoke locations**




The maps show the -85 dBm contour line, which is the practical limit for reliable fixed connectivity using specialized, higher powered bridges (which cost about $200). City facilities which lie within that limit have an excellent chance of establishing a 1 Mbps or better connection to the system. It should be noted, however, that the 2.4 GHz spectrum is unlicensed and subject to interference and competition from other users. These maps should be used as guides for field testing fixed 2.4 GHz links, rather than as firm predictions of results.

## 6.6. System Flexibility, Interoperability and Security

A system which supports Ethernet traffic throughout is more flexible, interoperable and secure than one which relies on Internet protocol alone. Extending Ethernet connectivity all the way to the end points of the system allows data to be transmitted seamlessly between this wireless broadband system and the City of Oakland's existing information technology network, in the process extending existing network protocols and security measures.

Broadband networks are commonly described in terms of "layers". Layer 1 is the physical equipment used to construct the network. In a wireline network, this layer might consist of fiber optic cables or copper wire, along with the other devices, such as routers and switches, which connect and manage the traffic. In a wireless network, radio waves or, sometimes, beams of light replace copper and fiber optic connections.

Layer 2 is called the data link layer. This layer is where the "ones and zeros" of digital communication are formed and transmitted. Ethernet, which is specified in the reference architecture, is a robust and commonly used Layer 2 protocol.

The next step up is the network layer, or Layer 3, which chops up the stream of ones and zeros into manageable packets and routes those packets from the beginning, through what might be a maze of connections, to the final destination. Internet protocol (IP) is the most familiar Layer 3 standard.

In effect Layer 3 rides on top of Layer 2, and Layer 2 rides on top of Layer 1. There are several more layers to consider when designing a complete system which might include computers, applications and data structures. But the first three layers are collectively referred to as the media layers and form the fundamental structure of a broadband network.

Each layer has its own security considerations and methodology. At Layer 1, security is a physical issue. For an outdoor wireline network, Layer 1 security is provided by locking up equipment and either burying a line or stringing it high and out of reach. Because lines can cross great distances, Layer 1 security is problematic. For a wireless network, the problems are multiplied because radio transmissions can be intercepted. The radios can be physically locked up, but the actual transmissions are easily accessible to anyone.

The solution, for wireline and wireless networks alike, is to build encryption and other security technology into Layers 2 and 3. All traffic going through the radios specified in the reference architecture can be encrypted using 256-bit Advanced Encryption Standard (AES) security, which meets the latest Federal Information Processing Standard 197 for data security.

However, because the reference architecture allows for a seamless extension of the City's existing IT network, additional security levels and methods can be used as needed. For example, a secure "tunnel" – a virtual private network – can be formed inside the encrypted data stream going from a police car to a relay point on a fire station and then on to a central hub. The data flowing through that tunnel can be further encrypted, providing several layers of security that will continue uninterrupted as the information from the wireless system to the City's existing IT network and finally to a secure database at Police Department headquarters.

Likewise, outside agencies or public users can access the system using common Layer 2 and 3 protocols that are already implemented on their own networks or individual equipment. At its basic level, this reference architecture is interoperable with the standard data transmission protocols used for nearly every purpose. Any given department, agency or other authorized user can access the system and run their existing data communications through it.

Interoperability between different users would be determined by those users on a case by case basis. There are factors which limit interoperability between different users and data networks, however this network design should not provide additional obstacles or limits. In that sense, it is neutral ground.

Another interoperability consideration is forward compatibility with other potential wireless broadband systems. One such system is the region-wide proposal to establish a 700 MHz wireless broadband system for public safety purposes. This network would be more specialized than the system defined in this reference architecture and would encompass a 10-county region. Although the proposed 700 MHz system could not be accessed by the equipment described in this report, using a common, widely used Layer 2 protocol such as Ethernet should make it easier to integrate data traffic if desired. Layer 1 forward compatibility issues to be considered include selecting equipment that is not likely to cause radio frequency interference and making sure that physical assets, such as tower sites, can support the larger antennas and/or power requirements that a 700 MHz system might require.

This architecture allows public Internet traffic to be transported on the same system as public safety or other sensitive and confidential data, and for one agency's data to be completely separate from another's. Although wired networks provide an extra measure of security over wireless systems, both are vulnerable to tapping. True and effective protection comes from thorough, end to end network design and rigorous application of security principles. The reference architecture adopted by this study allows each City department, outside agency or other user to adopt and implement the most appropriate data networking and security methods for its individual needs.

## 6.7. Expandability, Mobile Access and Citywide Coverage

"Citywide" coverage, in the context of this report, does not mean ubiquitous, cloud-type availability for all users, at all times, within the boundaries of the City of Oakland. Even the 4.9 GHz "cloud" intended for public safety users will have spotty coverage in parts of the Oakland hills. The anticipated 700 MHz BayRICS system will have effectively ubiquitous coverage, and within the limits of its capacity can fill those gaps for public safety users.

Other segments of the reference architecture are intended either as limited reach hotspots, for example for City employees working in the field, or as point to point links serving specific locations such as a community center or library. For a number of reasons, including a near total lack of public support, expense and technical issues, the reference architecture does not attempt to provide ubiquitous public Internet access.

However, to insure that these point to point links are available throughout the City, this reference architecture can be expanded to include additional fixed lines of communication, for example by placing additional PTP "spoke" radios at locations which require high bandwidth connectivity such as a computer education lab at a community center.

Each hub location can support up to 10 spoke sites, and if necessary additional back haul capacity out of each hub can be acquired. To carry this example to the extreme limit, more hub radios could be installed at each hub location, and additional hub locations could be established, without having to do a fundamental redesign of the network or replacing any significant components.

It is likewise possible to increase the number of public safety "cloud" radios, and to extend the system into moving vehicles and hard to reach canyons. If additional spoke locations, such as libraries, are added to the system, those sites could also be used to add more capacity to the cloud. This reference architecture is designed to be scalable. Hub locations will be able to support additional spokes, which could be either integrated into the existing system or kept physically separate, depending on security considerations and other operational needs. Backhaul capacity from the hubs to City Hall could be increased by adding additional wireless links, or even by installing land lines if the demand for capacity grows sufficiently.

Although it is possible for users to connect to the system while moving, it would not always be with the highest degree of reliability. In particular, as a user moved from the area covered by one cloud radio to another, there is a chance the connection would be dropped, and there would be a momentary interruption in connectivity while the link was being reestablished. More robust mobile protocols are being developed for this technology and this reference architecture is designed to support it when it becomes available, largely through software upgrades.

## 6.8. Reliability

All equipment and other system infrastructure and design features selected for this reference architecture meet 99.99% availability standards. All hub and initial phase spoke locations are already hardened to public safety standards. Overlapping coverage of hub, spoke and cloud radios provides redundancy if there is a failure, and the modular design of the system allows for rapid replacement of faulty or damaged equipment.

In addition, in the event of an emergency, equipment intended for routine portable applications, such as event video transmission, could be repurposed to fill in sudden gaps. Subscriber terminals mounted on public safety apparatus could also be used for emergency coverage.

## 6.9. Case Studies

The technology presented in this reference architecture has been deployed by cities and other public agencies, and its effectiveness has been field proven. The Federal Communications Commission set aside the 4.9 GHz band specifically for public safety purposes, and local agencies have made extensive use of it for many years. Examples include:

> Galveston County, Texas is using 4.9 GHz point to point links, deployed using a hub and spoke topology very similar to the reference architecture developed for this report. The system links the county's central 911 dispatch center with seven local emergency communications facilities. It has already fulfilled its role as back up capacity to the primary landline network, supporting all operations for a week in 2008 when the wired network went down completely.
>
> The U.S. Coast Guard is using a point to point 4.9 GHz broadband network as the primary path for its coastal surveillance system based at the Port of Miami. This particular network is optimized for high reliability over long distances (up to 13 miles), but still supports a minimum throughput rate of 10 Mbps and meets all military security standards.

> The Phoenix police department deployed a 4.9 GHz network in 2006, primarily for surveillance purposes. The objective, which they met, was to create a system that allowed cameras to be installed and moved quickly, to respond to day to day changes in crime patterns and investigative needs. The video is monitored by officers in a central location, and relayed wirelessly to police cars as needed.
>
> The Cities of Lewiston and Auburn, and the Auburn schools in Maine are using 4.9 GHz point to point links over distances as far as 10 miles to serve an extensive network of surveillance cameras, and to provide connectivity to government IT networks. The network has been operating since 2006. Some links are primary connections, others are used to provide redundancy to critical locations.
>
> In 2005, Beaverton, Oregon installed a hybrid 4.9 GHz WiMAX and WiFi network very similar to this reference architecture. The usage case is very similar as well. Police cars have been fitted with nomadic radios, and officers access the public safety network from the field. In addition, the system supports point to point links for surveillance purposes.

The general government alternative described above relies on the semi-licensed 3.65 GHz band, rather than the 4.9 GHz public safety spectrum. The same kind of equipment used for 4.9 GHz public safety networks is available for the 3.65 GHz band, as well as unlicensed frequencies in the 5 GHz range.

System roll outs are just beginning in the 3.65 GHz band, but early adopters, such as business Internet service providers Rapid Link and VoiceNetworks, have successfully built commercial operations using that spectrum in Southern California and other large urban markets. Internationally, the 2.5 and 3.5 GHz bands are used extensively for Internet service, and enterprise and government data networks. Taiwan has been using WiMAX-based 2.5 GHz technology for networking since 2005. 3.5 GHz networks are common in Asia and Europe.

In the U.S., Clearwire is providing Internet service by way of 2.5 GHz facilities in Baltimore and Portland, Oregon, and plans a nationwide roll out. In California, the City of Santa Barbara uses unlicensed 5 GHz spectrum for public safety communications.

Likewise, WiFi (802.11) based networks and hotspots are very common, and are used for both public Internet access and secure municipal networking. The City of Milpitas was one of the first cities to adopt WiFi for city networking purposes in 2004. Tucson, Arizona uses WiFi to transmit video from ambulances to hospital emergency rooms.

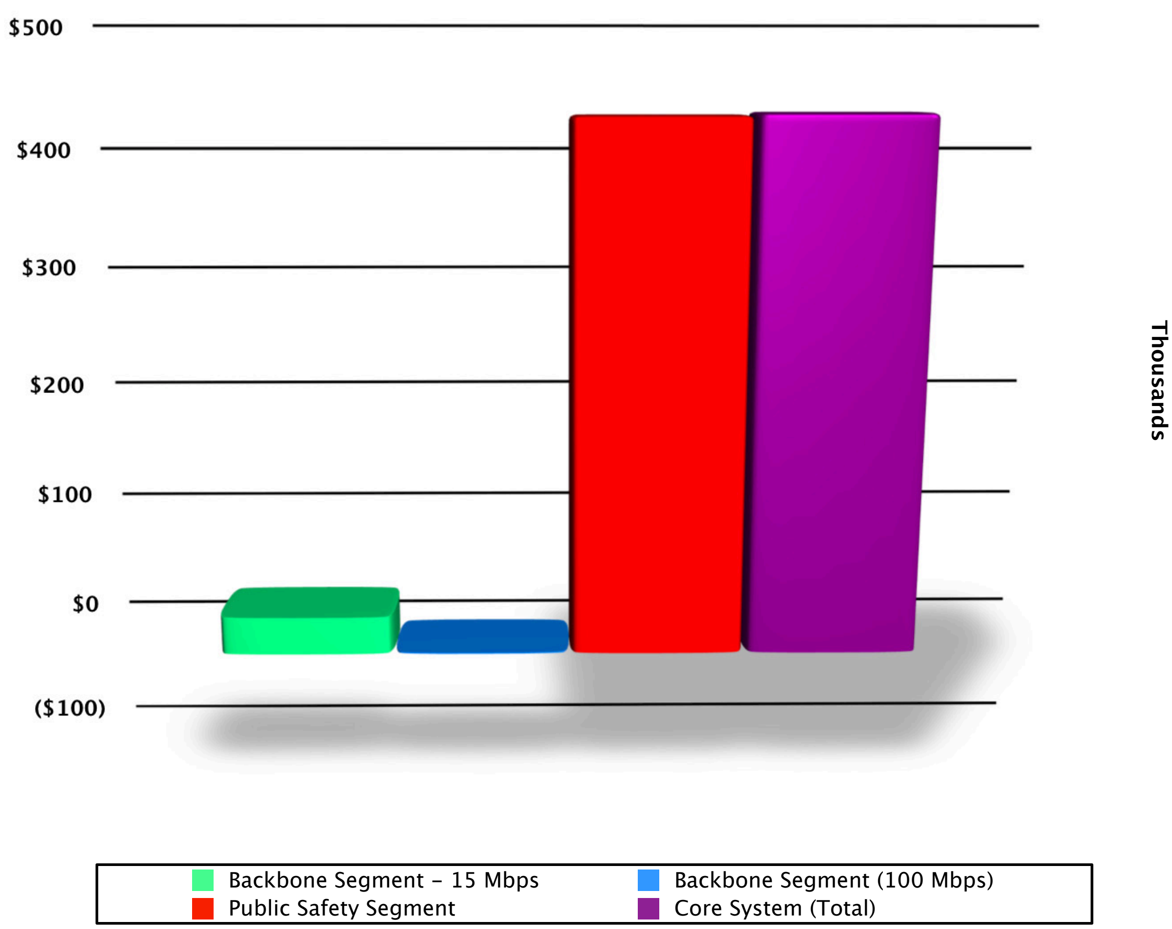
One of the most dramatic examples of WiFi suitability for public safety applications occurred in 2007, when emergency responders used a partially completed municipal WiFi network to support rescue operations following a bridge collapse in Minneapolis. Cellular phone and data facilities near the incident were overwhelmed by the public, but responders were able to use standard, consumer-grade WiFi equipment to securely carry emergency communications.

The 18 GHz system used for backbone connectivity in the reference architecture is an engineered, point to point wireless network. Rather than rely on wide area coverage to reach nomadic or randomly located fixed locations, this system would be designed location by location and link by link. These sorts of engineered wireless networks have been in operation for decades by many organizations, including the City of Oakland.

# 7. Business Case and Financial Analysis

## 7.1. Modeling Framework

**Figure 7.1 – Core System Operating Surplus/Deficit)**




The business model analysis is broken into five segments:

- Core system, which includes:
    a. Common backbone infrastructure with a minimum link bandwidth of 15 Mbps,
    b. Expanded common backbone, with a minimum link bandwidth of 100 Mbps,

   c. Public safety facilities
- General City of Oakland IT support alternatives, which include:
   a. Fixed wireless broadband links
   b. City IT network access by field workers (also referred to as nomadic or portable applications).
- Mobile video scenario
- Business and entrepreneurship opportunities scenario
- "Drinking fountain" model public access scenario

The core system is described by the reference architecture and evaluated by the primary business model. In addition, alternatives and scenarios have been developed and analyzed. Taken together, these segments support the requirements identified in Chapter 4 above. To evaluate these system elements...

- Specific cost offsets, value propositions, revenue enhancements and operating efficiencies have been identified as sources of and justification for funding each segment of the project.
- Cost estimates have been developed for construction and operation.
- Each segment is evaluated on the basis of surplus/deficit, cumulative cost and net present value calculations.

**Figure 7.2 – Business Model Assumptions**

**Expenses**

Site installation costs are averaged, with an expectation that some existing facilities will be available
Cost estimates do not include additional IT infrastructure beyond boundaries of wireless broadband facilities
Project management, design, furnishing & commissioning is estimated at 25% of total base capital expenditure
DOIT wireless network security cost is estimated at 10% of total base capital expenditure
DOIT acceptance, testing & documentation cost is estimated at 12.5% of hardware related capital expenditure
Cost of capital is benchmarked at 5%
Base operating costs are annual rates per node and per site
DOIT overhead is estimated at 15% of base operating cost
Annual software upgrades and licensing are estimated at 20% of software capex
Annual hardware replacement is estimated at 5% of hardware capex
Internet bandwidth costs are included only in public service provisioning scenarios
Public service provisioning scenarios include a 5% franchise & facilities fee payable to the City

**Funding**

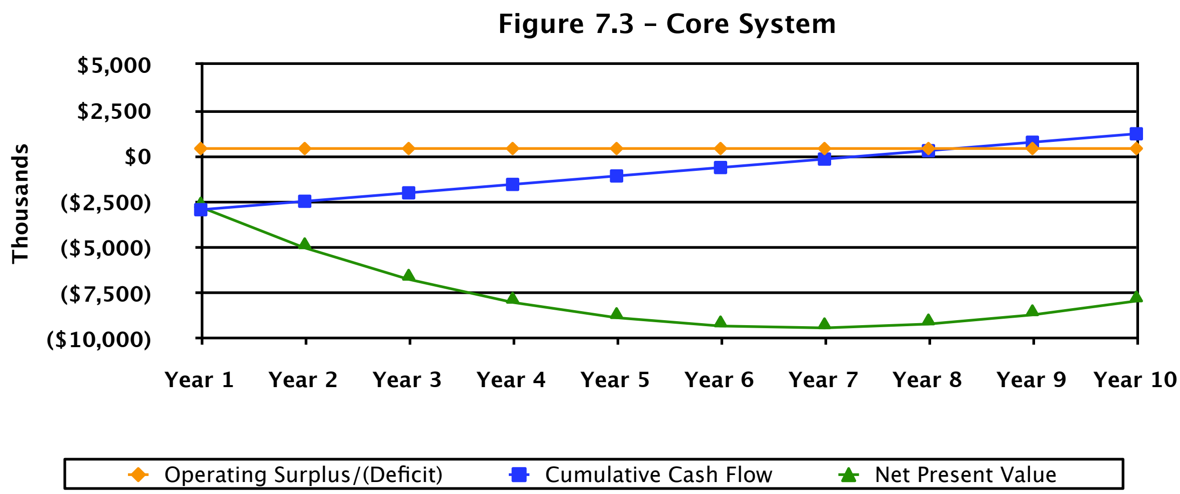
Commercial carrier cost offsets & new facility market values are based on actual City landline circuit costs
Efficiency gains are based on FTE costs and performance measures in the 2007-2009 City budget
Tax revenue gains are based on efficiency gains and City Auditor revenue/cost ratio

**Modeling**

All cost and revenue figures are expressed in constant 2009 dollars
No intra-system charge backs are included

A number of assumptions have been made in creating this business model. These assumptions are based on nominal City of Oakland cost estimates and management accounting practices where applicable, on research conducted specifically for this study and on standard industry experience and practice.

The public safety segment is assumed to be the base case deployment option and as such provides the capital cost justification for the overall backbone infrastructure. The backbone segment is self-supporting on an operating basis, but does not pay off its full capital cost without factoring in the additional public safety benefits.




This backbone infrastructure will also support all other segments and sub-segments. The general government IT alternative is broken into two sub-segments: fixed and nomadic (also referred to as portable).

A mobile video solution for public safety applications is presented as an alternative scenario, using a 700 MHz broadband system proposal (BayRICS) developed by a Bay Area-wide public safety consortium, of which the City of Oakland is a member.

Two other potential options for high speed mobile video are the prospective deployments of a 2.5 GHz mobile WiMAX service by Clearwire and various LTE systems by incumbent mobile telecom carriers. Any RFP requirements developed as a part of the Oakland Wireless Initiative will, to the extent possible, allow commercial carriers to respond as they deem appropriate.

Business and entrepreneurship opportunities and drinking fountain model public access are also presented as alternative scenarios within the business model. The core backbone of the system, developed to support governmental uses, is integral to these two segments. The business model will also outline the cost of additional equipment and operating costs to support these two segments.

## 7.2. Methodology

The complete business model, including detailed breakouts and alternate scenarios, can be found in Appendix C. The information in this chapter is summary only, and most figures have been rounded for the purpose of clarity.

All cost and funding figures are expressed in constant dollars. In other words, inflation is not figured into the model. A piece of equipment or a service that sells for a dollar today is assumed to sell for a dollar ten years from now. The constant dollar method is a clearer and simpler analytical method for comparing cost and funding projections over time.

For example, a quick glance at a graph of constant dollar surplus/deficit projections over ten years tells whether the trend is up, down or flat. If an inflation adjustment was included in the model, then the slope of such a graph would have to be calculated and the inflation adjustment backed out before meaningful year to year comparisons could be made.

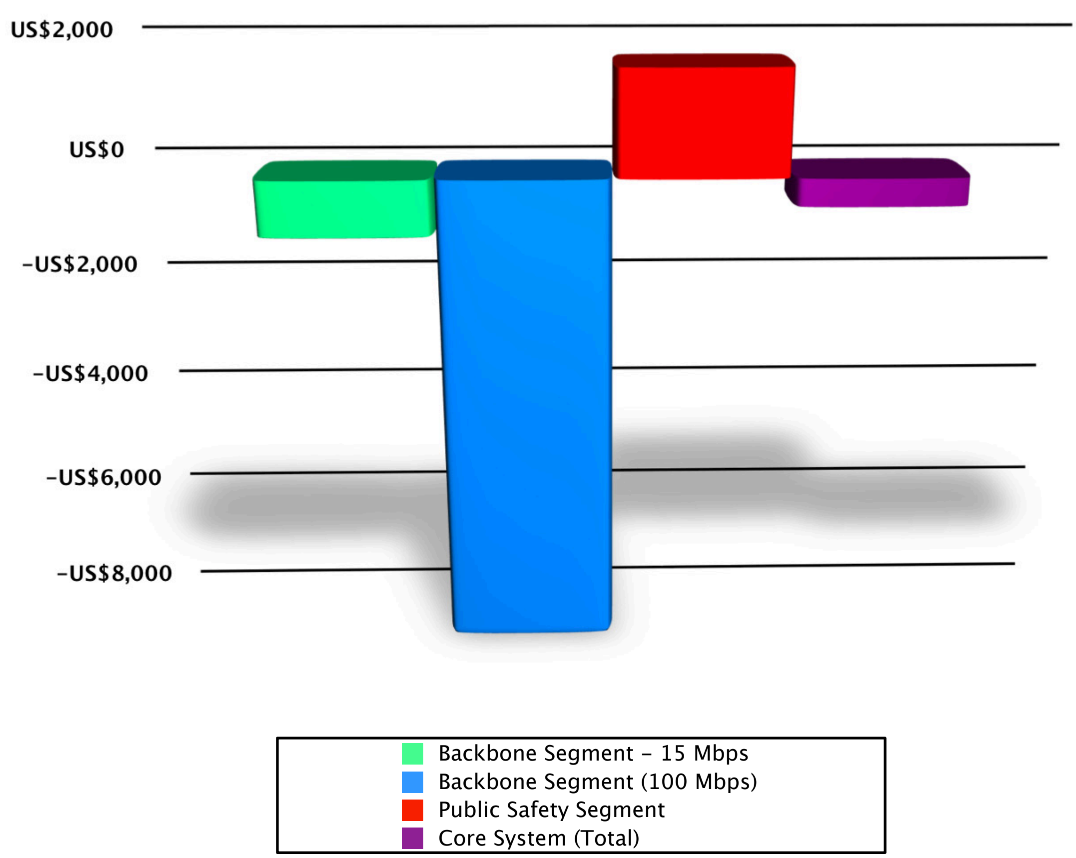
Although inflation adjustments are useful for budgeting purposes, adding a constant inflation figure unnecessarily complicates trend analysis and other long term comparisons. The constant dollar method allows for rapid and meaningful analysis of the value of the project over time, including the cost of funding.

A three step process is used for bottom line analysis of any given segment or scenario:

1. Annual operating surplus or deficit. Without considering the construction cost, which is treated as a capital expense, the annual cost to operate a given segment is subtracted from the associated funding source. This step shows whether funding is sufficient to support ongoing operations from year to year.
2. Cumulative cash flow. The capital costs incurred in each year are subtracted from the operating results, and then carried forward to show whether operating deficits and capital expenditures are eventually covered by the funding sources.
3. Net present value. Finally, the net present value technique is used to factor in the time value of money. A dollar received today is worth more than a dollar promised today and received in ten years, because the dollar received today could be earning interest during that time. By assuming that the City would have to pay interest on any money it borrows (5% is used for the purposes of calculation) and calculating the net present value on that basis, a clearer picture emerges of the long term financial cost of the project.

These three metrics show to what extent the cost of building and operating the system is offset by the cost savings, new value creation, efficiencies and increased revenue it generates.

**Figure 7.4 - Core Network Year 10 Net Present Value (000)**




This information can be applied in two different ways. First, it can be looked at as a pro forma business plan for construction and operation of the system by the City itself. Second, it can be used to evaluate the feasibility and market value of a public/private partnership, such as a build/lease arrangement, or a simple purchase of services from a telecommunications vendor.

## 7.3. Cost Estimates

### Capital Expense

Construction cost estimates are based on suggested retail prices from a variety of digital radio, tower and network equipment manufacturers. Installation and licensing estimates are based on standard costs. Furnishing and commissioning is estimated at five percent of hardware cost, engineering and design is estimated at 10% of hardware cost, and project management is estimated at ten percent of hardware and installation cost.

**Figure 7.5 – Capital Expense**

| Core Segments | Nodes | Licensing | Towers | Network | Installation | Total |
|---|---|---|---|---|---|---|
| Backbone (15 Mbps Base) | US$613,267 | US$74,400 | US$77,438 | US$208,713 | US$35,700 | US$1,198,697 |
| Backbone (100 Mbps Increment) | US$367,685 | US$0 | US$0 | US$90,713 | US$24,600 | US$482,998 |
| 4.9 GHz Public Safety Segment | US$1,175,988 | US$235,200 | US$0 | US$0 | US$0 | US$1,693,428 |
| **Sub Total** | US$2,156,940 | US$309,600 | US$77,438 | US$299,426 | US$60,300 | US$3,375,123 |
| | | | | | | |
| **Scenarios & Alternatives** | | | | | | |
| General Government Fixed | US$682,294 | US$190,800 | US$245,588 | US$245,588 | US$66,600 | US$1,966,369 |
| General Government Nomadic | US$627,273 | US$0 | US$0 | US$0 | US$0 | US$751,113 |
| BayRICS 700 MHz Scenario | US$885,000 | US$14,400 | US$0 | US$13,275 | US$3,600 | US$934,275 |
| Business and Entrepreneurship | US$83,084 | US$0 | US$0 | US$0 | US$0 | US$129,164 |
| Drinking Fountain Model | US$927,130 | US$0 | US$44,250 | US$44,250 | US$12,000 | US$1,977,310 |
| **Sub Total** | US$3,204,781 | US$205,200 | US$289,838 | US$303,113 | US$82,200 | US$5,758,231 |
| | | | | | | |
| **Total** | US$5,361,721 | US$514,800 | US$367,276 | US$602,539 | US$142,500 | US$9,133,354 |

Department of Information Technology expenses are estimated at 10% of base capital expenditure for network security and 12.5% for testing, acceptance and documentation. Costs do not include information technology or network facilities beyond the boundaries of the reference wireless broadband system architecture.

The capital cost of each segment is calculated individually and in isolation, for the purpose of analytical clarity. Adding in a charge back for the cost of constructing the backbone segment, for example, would result in money being shifted back and forth through the model. The bottom line result would remain the same, but the model would be more complicated and harder to understand. However, as with inflation adjustments, such charge backs would be appropriate in a budgetary document.

### Operating Expense

In the model, most annual operating costs vary according to the number of nodes and sites. A node is a radio, which is the essential active data transmission hardware. Switches, routers and network interfaces associated with a given radio are considered to be integral to the node. A site is a physical location which contains one or more nodes.

As an example, take the backbone infrastructure proposed for a typical fire station. A single tower would be installed, which would support one 18 GHz radio link back to a central hub and a WiFi radio for local network access. The station would count as a single site with two nodes. Adding the proposed public safety capability would involve installing three 4.9 GHz radios at the fire station. In that case, there would be a total of five nodes at the location, but it would still count as a single site.

**Figure 7.6 – Operating Expense**

| **Core Segments** | **Annual** |
|---|---|
| Backbone (15 Mbps Base) | US$85,145 |
| Backbone (100 Mbps Increment) | US$29,175 |
| 4.9 GHz Public Safety Segment | US$178,065 |
| **Sub Total** | US$292,385 |
| | |
| **Scenarios & Alternatives** | |
| General Government Fixed | US$222,967 |
| General Government Nomadic | US$84,529 |
| BayRICS 700 MHz Scenario | US$55,032 |
| Business and Entrepreneurship | US$94,209 |
| Drinking Fountain Model | US$788,059 |
| **Sub Total** | US$1,244,796 |
| | |
| **Total** | US$1,537,181 |

Ongoing equipment replacement and software upgrades and licensing are calculated as a percentage of original purchase price, 5% and 20% respectively.

For services provided to the private sector, including non-profits, a 5% franchise and facilities fee is included to account for the value of City resources such as antenna mounting locations, rack space and indirect IT support.

Finally, a 15% overhead charge is applied to all operating costs (except the franchise and facilities fee, which is in effect an overhead cost itself) to account for the value of administrative and support services provided by the City. As with capital costs, each segment is treated separately, without considering charge backs or cross-subsidies.

Except for this general overhead charge, only direct system expenses are included in the model. For example, where providing Internet access is integral to a segment, such as the Business and Entrepreneurship Opportunities scenario, the cost of outside bandwidth is included. But when a segment is primarily intended for internal City IT network use, the potential cost of incidental Internet usage is not considered.

## 7.4. Grant Funding Considerations

The American Recovery and Reinvestment Act of 2009 (ARRA), commonly referred to as the stimulus package, has a total of $4.7 billion allocated for the Broadband Technologies Opportunities Program (BTOP) administered by the National Telecommunications and Information Administration (NTIA).

**Figure 7.7 – National Telecommunications and Information Administration Broadband Technologies Opportunity Program (millions)**

| | |
|---|---|
| Broadband deployment | US$3,900 |
| Expand public computer center capacity | US$200 |
| Innovative programs to encourage sustainable adoption of broadband service | US$250 |
| State-level broadband mapping | US$350 |
| **Total** | US$4,700 |

NTIA has released specific grant request specifications, and evaluation and scoring methods. Goals and specifications include:

- Provide access to broadband service to consumers living in unserved areas.
- Provide improved access to broadband service to consumers residing in underserved areas, which can include urban neighborhoods.
- Provide broadband education, awareness, training, access, equipment and support to community anchor institutions, which include:
    a. Schools, libraries, medical and healthcare providers, community colleges and other organizations that facilitate greater broadband use by these organizations.
    b. Organizations that provide outreach, access, equipment and support services to facilitate greater use of broadband service by low-income, unemployed, ages and otherwise vulnerable populations.
- Job-producing strategic facilities located within state-designated economic zones.
- Improve access to, and use of, broadband service by public safety agencies.
- Stimulate the demand for broadband, economic growth and new jobs.
- No less than one grant in each state.
- Increase the affordability and take up of service, and the greatest broadband speed possible to the greatest population of users in the area.
- Enhance service for health care delivery, education or children to the greatest population of users in the area.

A similar program administered by the U.S. Department of Agriculture allocates $2.5 billion for broadband development in rural areas, however Oakland is not eligible for that funding.

In general terms, NTIA funding is available for cities such as Oakland. However, to qualify for grants to build infrastructure, cities have to meet stringent qualification criteria. At this time, Oakland does not appear to qualify for first round infrastructure funding, but criteria might change in later rounds.

There is a requirement for matching funds, usually 20%, from a non-federal source. The requirements follow typical Federal telecommunications grant guidelines, which can allow in-kind services to be counted towards matching funds. This business model identifies and puts a value on potential in-kind services which could fill the gap.

Another potential source of grant funding is the U.S. Department of Homeland Security (DHS). Most DHS grants focus on public safety and security needs. Consequently, the business model divides the proposed system into public safety and non-public safety segments to facilitate DHS grant applications.

Although the business model is intended to support grant funding efforts, it does not include any grant funds in the analysis. Each segment is evaluated on the basis of its direct benefits to the City of Oakland. Insofar as grant funding is available to offset capital and operating costs, the financial case for building the system is only improved.

## 7.5. Core System Analysis

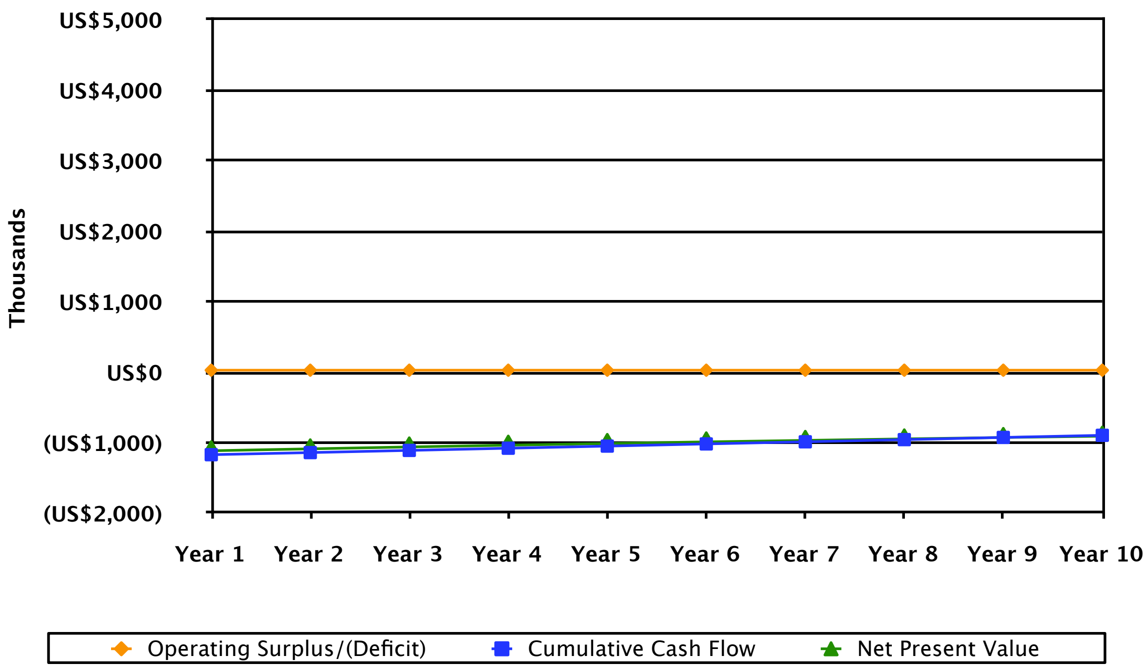
### Backbone Segment

The backbone segment is analyzed in two steps: first, a base facility with a minimum link bandwidth of 15 Mbps is evaluated. Then, the cost of an incremental upgrade to 100 Mbps is considered. The working assumption is that the higher bandwidth option is preferred, however a two-part analysis provides flexibility for future budgetary evaluations.

One-time construction costs for the 15 Mbps base total $1.2 million, which includes the cost of radios, towers, licenses, network connectivity equipment, installation, design and project management. Segment facilities include:

- High speed (100 Mbps) links between the Department of Information Technology (DIT) and all five hub locations (Edgewater 911 center, Fire Station 28, and the APL, Gwinett and Seneca sites), plus Fire Station 1/EOC and the Eastmont police substation.
- Multiple T1 grade (15 Mbps) links between DIT and the remaining fire stations.
- Secure network access via WiFi (802.11n at 2.4 GHz) at the above locations.
- Network Operations Center (NOC), including test equipment, at DIT.

**Figure 7.8 – Backbone – 15 Mbps Base**

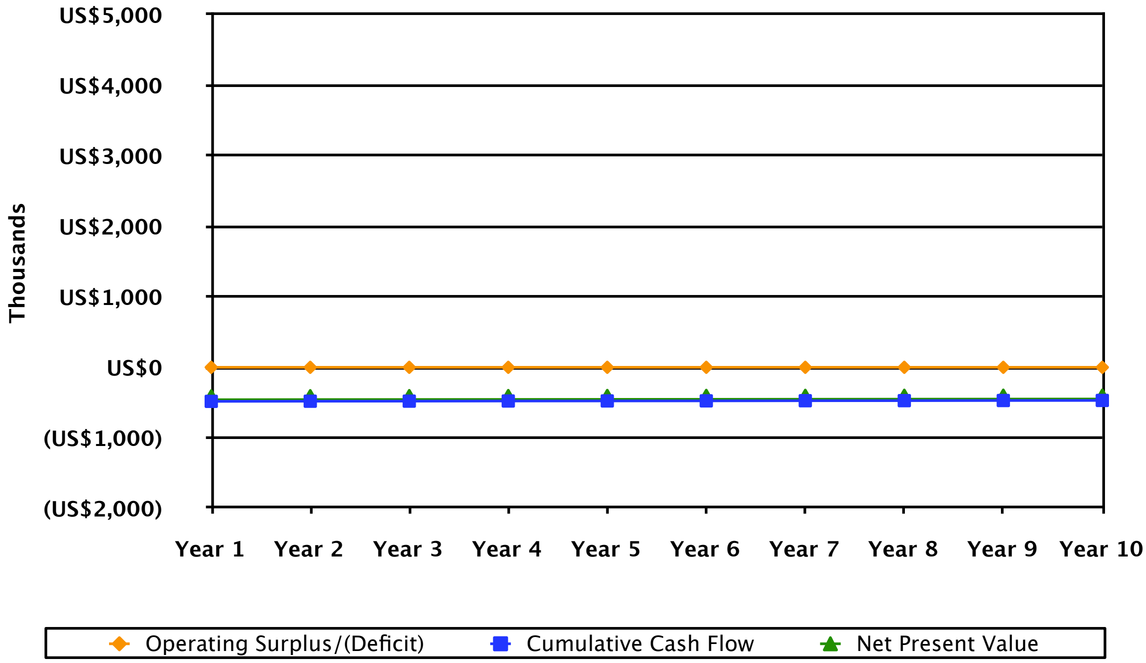



Annual operating expense for the base 15 Mbps segment is estimated to be $85,000 per year, with maintenance, replacements and upgrades accounting for $50,000 of that cost.

Upgrading the backbone to a minimum link bandwidth of 100 Mbps adds $483,000 to the capital cost for a total of $1.7 million. Annual operating cost increases by $29,000. Additional facilities include:

- 108 Mbps bi-directional, upgradable radios used for all 18 GHz nodes.
- All links between hubs and DIT are upgraded to 622 Mbps bi-directional via software upgrades and additional radios.
- The links to Fire Station 1/EOC and the Eastmont police substation are upgraded to 311 Mbps bi-directional via software upgrades.

Figure 7.9 Backbone – 100 Mbps Upgrade



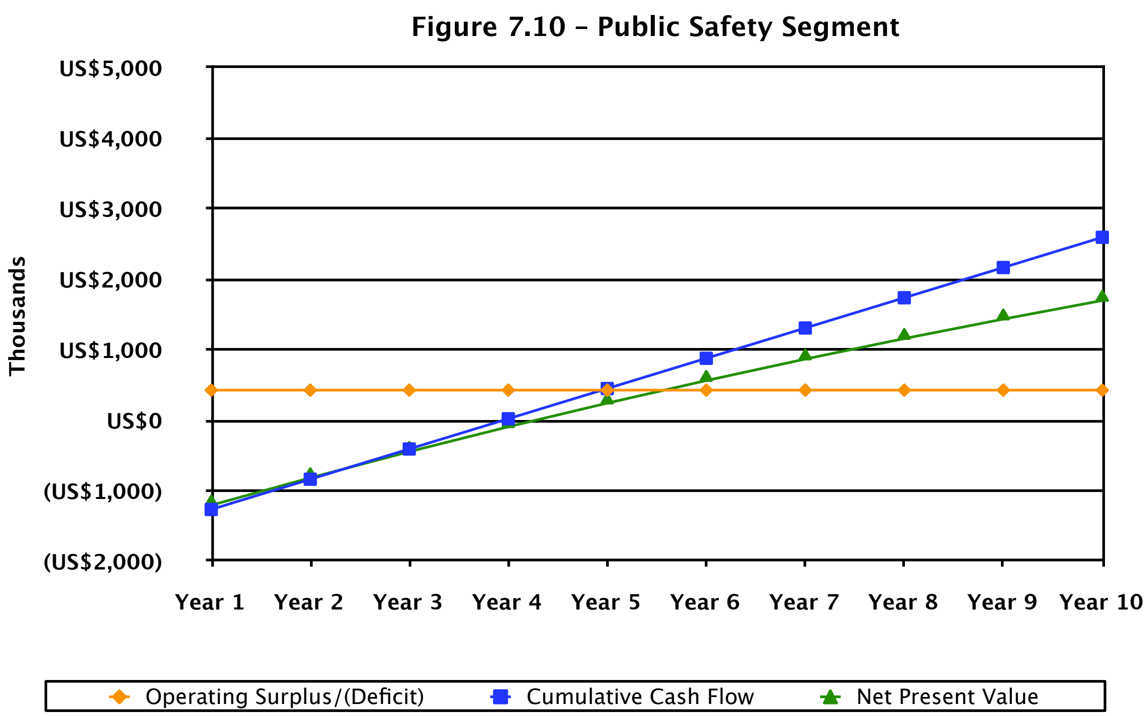

Several high speed data links used by public safety agencies have been identified as replaceable by this segment. Annual out of pocket costs for these links are approximately $116,000.

The backbone segment would provide better than T-1 grade circuits to all fire stations, replace two T-1 circuits serving the Police Department, and replace three DS-3 circuits serving the EOC, the Eastmont substation and the Edgewater 911 center. These three circuits represent a fraction of the total landline bandwidth leased by the City to serve these locations, and would enhance overall survivability and reliability by providing independent alternate pathways.

## Public Safety Segment (Fixed and Nomadic)

The public safety segment of the reference architecture provides high speed broadband connectivity, sufficient for video applications, to fixed locations and vehicles. However, the technology is not designed to work while vehicles are moving. In other words, it is intended for fixed and nomadic (or portable) applications, and not for mobile use.

The capital cost to build this segment is estimated at approximately $1.7 million. Operating costs are pegged at $178,000 annually, with maintenance and equipment replacement accounting for about half of that figure.




The bandwidth provided by this segment can be used by public safety personnel to access either the City's IT infrastructure or the Internet from the field. Some manufacturers claim to offer USB-enabled devices that can be plugged into personal computers and used in the same way as a cellular data card. However, these devices have not been field proven at this time, and should be assumed to have a limited range and/or high power consumption requirements.

An alternative is to mount more robust devices into vehicles. For the purposes of evaluation, the business model assumes 100 of these vehicle mounted devices would be bought, however the infrastructure and the operating cost offsets can support many times that figure, if non-reimbursable funding sources can be found for additional vehicle mounted units. These units can be used to provide connectivity to laptops and handheld devices through WiFi or other technology.

Cost offsets for the public safety segment include the cost of providing commercial cellular data service to laptop and handheld computers that have been acquired or are already in the purchasing pipeline. The Police Department has identified 842 such nomadic devices, the Fire Department 50 and the Public Works Agency 120. The estimated annual cost for providing commercial data service to these units is $607,000.

A comprehensive, integrated wireless broadband infrastructure will provide Oakland's public safety agencies with more options and greater capabilities than simple Internet access through commercial carriers. However, the Police and Fire Departments have already committed to widespread deployment of laptop and handheld computers and, to some extent, commercial data services. Both agencies already make use of extensive fixed data lines from commercial carriers as well. Additionally, quantifying the efficiency and performance measures used by these two agencies is difficult to do in ways that are directly relevant to their true mission. Taking all these factors together, it would be speculative to try to value the gains in efficiency and performance measures that the Police and Fire Departments could realize through a wireless broadband system.

Similar considerations apply to the Public Works Agency, particularly where public safety issues are concerned. However, routine operations are more quantifiable and more easily enhanced by information technology. The public works agency has purchased an advanced management information system for that purpose, and it is reasonable to assume that integration of that system into the City's IT infrastructure and extending it to workers in the field will result in efficiency gains. Consequently, efficiency and performance measure gains for public works activities are included with other departments under the general government nomadic segment below.

### General Government Alternatives: Fixed and Nomadic Segments

Deploying fixed wireless broadband capacity that can be used for non-public safety purposes will allow replacement of landline circuits that are currently costing the City $89,000 per year. As with the public safety segment, this figure only includes a fraction of the circuits being leased by the City.

More than sixty locations operated by the Parks and Recreation and Human Services Departments do not currently have this sort of high speed service, and the market value of extending the City's information technology infrastructure to these locations is estimated to be $87,000 annually. Because there is no regulatory restriction on the use of these segments, these new wireless links can also support public Internet access and other programs at recreation centers, swimming pools, rental facilities, Head Start/Early Head Start locations, shelters and senior centers.

Community gardens and open spaces have not been included in this calculation. To the extent such locations are included in this segment, the business case for deployment will be improved.

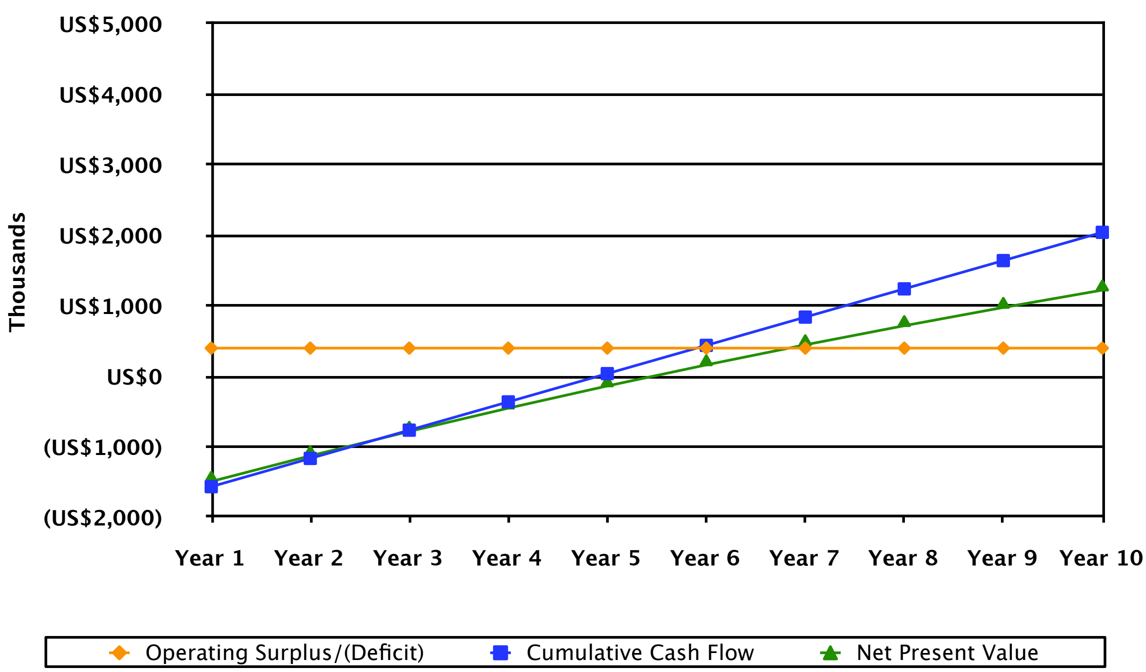
The Public Works Agency manages more than 300 separate locations for the City. This study identifies approximately half of these locations as being suitable for high speed wireless data links. The other half could also benefit from wireless connectivity. We have based the value of connecting these locations on the cost of providing a minimal data link for security purposes. To the extent these facilities could make use of greater bandwidth, the business case for the system is only enhanced. The estimated market value of these security links is $143,000 per year.

Adding remote monitoring capability should result in fewer routine trips and improved emergency response to these 157 sites. We estimate the value of the annual efficiency gain at $84,000, which is approximately equal to the average cost of one full time equivalent (FTE) for the Public Works Agency's facilities and management program.

Allowing non-public safety workers to access the system from the field is also an identified need with quantifiable benefits to virtually every department. Besides the Public Works Agency, major beneficiaries include the Finance and Management Agency, the Human Services Department and the Community and Economic Development Agency (CEDA). Parking enforcement personnel, tax auditors, tax officers, case workers and field inspectors can all make use of the system on a daily basis. The market value of providing remote data access to these workers is estimated to be $53,000 annually.

Allowing these workers to access their departments' IT resources and file reports from the field will result in greater operating efficiencies, estimated to be an average of one hour saved per day by eliminating repetitive trips and speeding up access to information.

**Figure 7.11 – General Government Fixed Alternative**



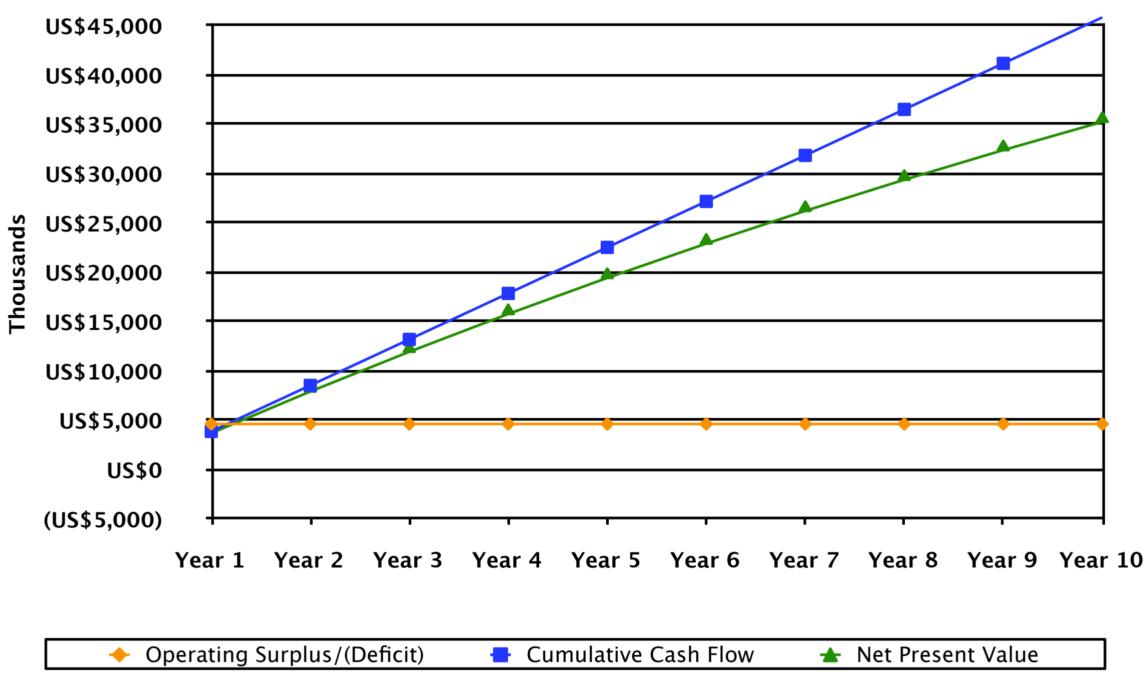
Performance improvement measures adopted by the Finance and Management Agency directly relate to enhanced tax revenue flowing to the City. Using the City Auditor's performance standard of a 4 to 1 dollar return on direct, specific auditing activities (as opposed to overall agency activities), the resulting annual revenue enhancement is estimated to be $2.5 million.

For Public Works, CEDA and Human Services field workers, the estimated yearly gain in FTE value is $2.2 million annually. Likewise, extending fixed wireless link capability to non-public safety locations will improve operating efficiencies. For example, supervisors will be able to securely access and report personnel data from their primary work locations. The value of these gains in efficiency and performance measures is estimated to be $221,000 annually.

In total, $624,000 in recurring funding offsets have been identified for fixed general government applications, such as providing broadband access to recreation centers, and $4.7 million for nomadic applications.

To support the fixed applications, an additional 18 GHz link has been budgeted to serve the main library, 33 additional access points would be installed at existing backbone sites, and 120 non-public safety locations would receive lower cost subscriber devices. The construction cost for this segment is estimated at $2 million.

Figure 7.12 – General Government Nomadic Alternative



To support nomadic user by providing widespread access by way of common WiFi devices, 86 WiFi access points would be added to the 32 budgeted for the backbone segment. Together, these 118 access points would not provide ubiquitous coverage, but would ensure that city employees are never very far – walking distance or a short drive at most – from access to the City's IT infrastructure or the Internet. The capital cost of extending this kind of nomadic connectivity is $751,000.

Annual operating cost is $223,000 for the fixed general government segment and $85,000 for the nomadic segment.

## 7.6. Additional Scenarios

### BayRICS 700 MHz Mobile Segment

One option for providing mobile, or near-mobile, broadband coverage throughout the City – of the sort contemplated for public safety video applications – is to blanket the city limits with outdoor WiFi coverage. This level of coverage would not be sufficient to provide Internet connectivity to homes or businesses, but it would effectively cover streets and open spaces.

The construction cost would be approximately $10 million, with an annual operating expense of nearly $1 million. The surplus generated by the public safety segment above does not come close to covering this additional expense.

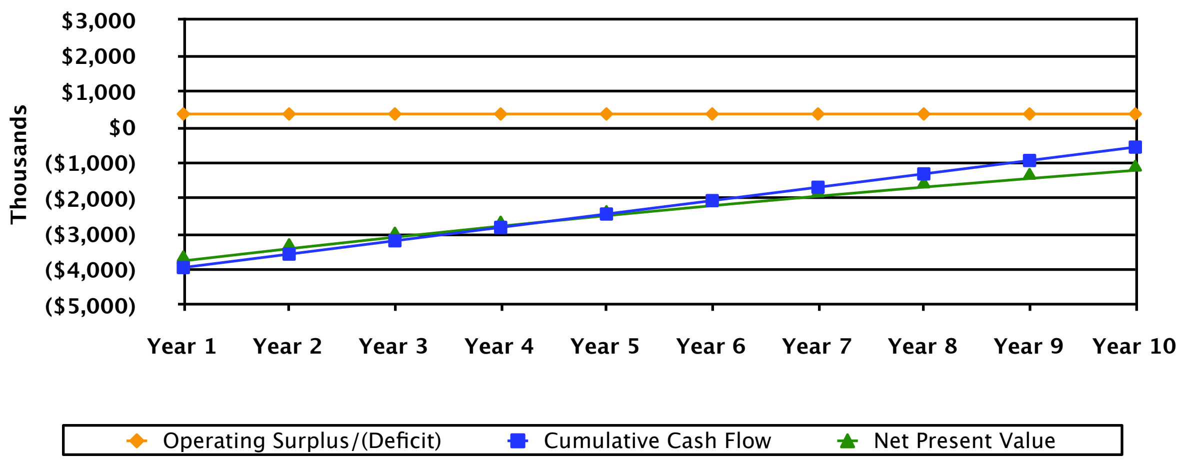
Although it is likely that such a system would support most mobile video applications, it is not at all certain. The technology employed is not specifically designed to support mobile applications, and the spectrum used can be problematic. The high cost and unknown reliability of a WiFi-based mobile video system eliminate this option from further consideration. Its only advantage is that it could be deployed immediately.

A cheaper and more reliable option is the 700 MHz BayRICS (Bay Area Region-wide Voice and Data Interoperable Communications System) system proposed by Oakland Mayor Ron Dellums, San Francisco Mayor Gavin Newsom and San Jose Mayor Chuck Reed on 11 September 2007. City of Oakland staff have been participating in the consortium, and have ensured that it will take into account the unique characteristics and needs of Oakland.

No additional funding sources have been identified to support this segment, however in the core business model, the core system shows a significant operating surplus and pays back the entire capital cost within eight years.

At this point, the details of the BayRICS system have not been fully defined. For comparison purposes, we assumed that six BayRICS sites would be built in Oakland and used the cost estimates generated by the Major Cities Chiefs' Workshop. The operating surplus is more than sufficient to meet the added operating expense of this conceptual segment, and the additional capital expense delays full positive cash flow by only four years. This analysis assume a worst case funding situation: no grant money would be available and the entire cost would have to be self-funded by the City of Oakland.

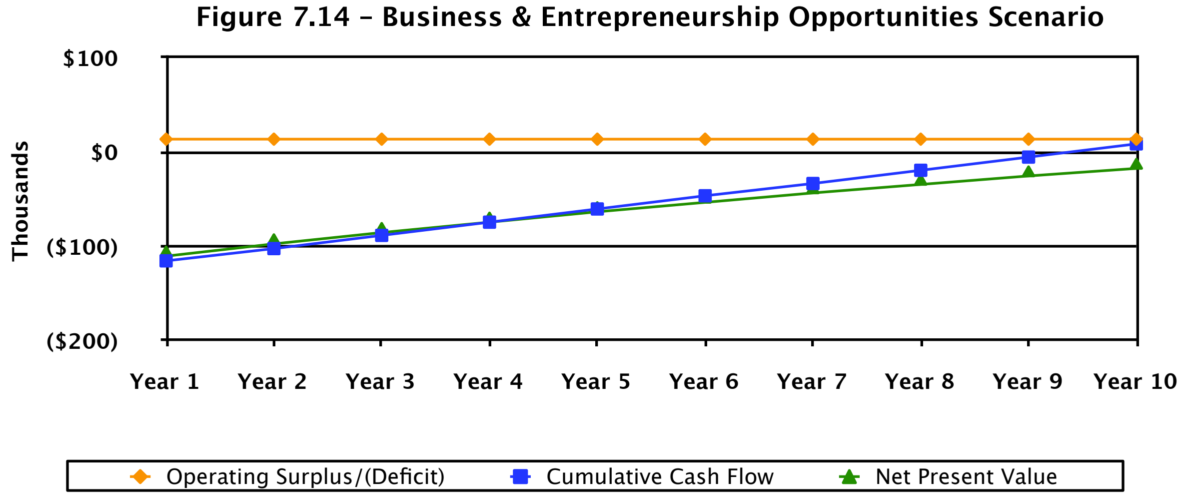
Figure 7.13 – BayRICS 700 MHz Scenario




## Business and Entrepreneurship Opportunities

Some commercial properties in Oakland are unable to obtain affordable high-speed broadband service from existing carriers. This lack restricts business and employment growth in Oakland, particularly in areas where it is needed most. The reference architecture developed for this study, in particular the core system, can be used to enable delivery of T-1 grade or better service to problematic locations.

It might not be appropriate for the City to directly compete with incumbent telecoms carriers. However, it is appropriate for the City to enable opportunities for new and/or small businesses, particularly in areas or locations where services are lacking. The City can help the business community overcome challenges by making facilities and technical resources available on a wholesale basis to qualified small businesses and business groups.




This scenario assumes that independent, commercial DS-3 grade Internet bandwidth, selected portions of the backbone system and standardized customer premise equipment (CPE) will be combined to create a facility that can support multiple T-1 grade circuits and lower bandwidth hotspots. Building this infrastructure would require a capital investment of $129,000, with annual operating expenses of $94,000.

Revenue would be derived from selling this capacity to local resellers or associations at the monthly wholesale rate of $300 per T-1 equivalent and $200 per hotspot. Providing standardized CPE and core maintenance service would generate additional revenue.

A pro forma estimate puts annual wholesale revenue to the City at $108,000, allowing for pay-as-you-go funding of the program.

## Drinking Fountain Model Public Access

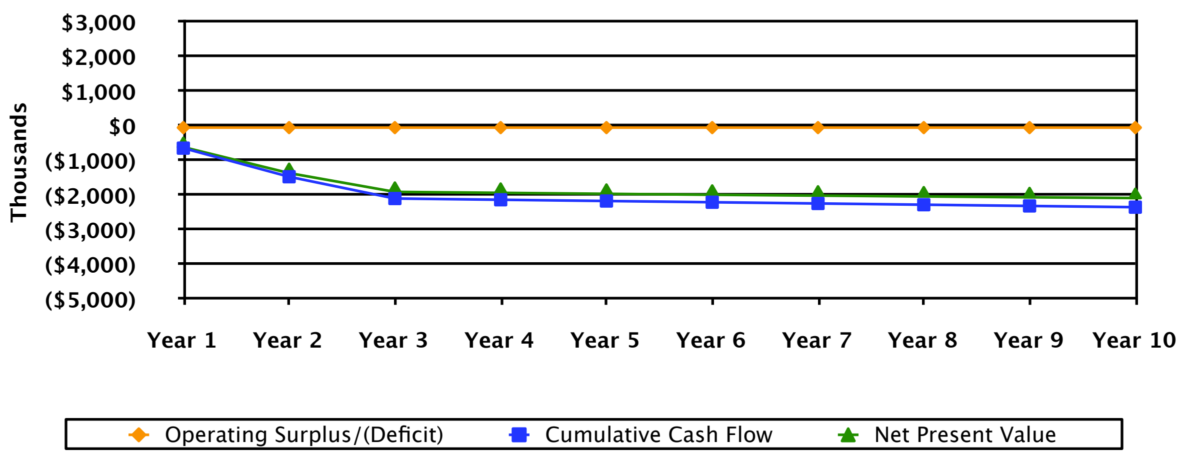
The backbone infrastructure and technical resources created through the Oakland Wireless Initiative can also be used to extend Internet access into the community, providing free or low cost access at community anchor institutions. This access also provides an enabling element for educational, economic development, employment, social, health and other programs. This increased service to the community would be in addition to any Internet access or related programs provided at city-owned community anchor institutions such as recreational centers, senior centers, libraries and the Oakland Museum.

One of the top priorities identified by Oakland residents during the stakeholder analysis process was ensuring that schools had sufficient Internet access. During the workshop process, it was determined that the Oakland Unified School District and other educational institutions already have access to adequate bandwidth through existing programs.

However, those programs place restrictions on the usage of that bandwidth. Offering alternative Internet resources to these institutions could expand their policy and programmatic options.

Community organizations and neighborhood institutions also support programs that could be enhanced by access to high speed Internet bandwidth. For example, the Oakland Housing Authority operates 267 sites where common area Internet access might be offered to residents. In total, the business model assumes that 627 such sites could be supported, including providing each site the necessary equipment to connect to the system.

Figure 7.15 – Drinking Fountain Model Public Access Scenario




Assuming a discounted T-1 equivalent rate of $100 per month, the yearly value of providing high speed bandwidth to these community anchor institutions is estimated to be $752,000, against a capital cost of $2 million and an annual operating budget of $788,000. Although the value proposition justifies the operating expense, accounting for the capital cost is more problematic.

No specific funding source has been identified for this program. However it would be a viable candidate for ARRA funding as well as other broadband funding initiatives currently in the pipeline. The job creation, digital inclusion, educational and public safety benefits are significant, and are directly in line with the BTOP goals and priorities set by Congress.

It is also possible to find funding sources on a case-by-case basis for individual sites. Because this program relies on unrestricted segments of the overall system, it can be built out as needs are prioritized and funds become available.

# 8. Appendix A: Summary of Research

## 8.1. Scope

While the scope of this feasibility study is restricted to the assessment of wireless broadband technology, applications and economics, and the needs that might be served directly by such technology, the scope of the assessment sessions was necessarily much broader.

Participants were not expected to immediately make distinctions between needs that might be met by the deployment of wireless broadband facilities, and needs that were either general in nature or for which wireless technology is not an appropriate solution. Conversations with and among participants were far ranging, and covered a wide variety of topics, concerns and needs. Volume 2 of this report contains detailed minutes of these sessions, along with other public comments, and could be very useful for a number of purposes unrelated to this study.

Topics discussed that are either outside the scope of this study or are too general to be comprehensively addressed by it include:

1. *Web-based communications and service delivery by government agencies, including the City of Oakland, to the public.* From an information technology perspective, general purpose content and applications are a key service government agencies provide to the public, a fact which was emphasized throughout the research process. Examples included the City of Oakland web site, an online permit process and a number of educational opportunities and applications. Although increased demand for online resources would tend to support a case for wireless broadband deployment, the same could be said of wired access. It is important to ensure that any public wireless Internet access deployed is able to support online services, but this study does not encompass determining the type, extent and need for such services.

2. *Interoperability between City departments, and between City departments and outside agencies.* As detailed below, to the greatest extent possible, any wireless broadband system deployed by the City of Oakland should be usable by all appropriate parties, and should facilitate rather than hinder cooperation. However, full interoperability is also a function of policy, management and other factors, which extend into areas that this study is not intended to address. Interoperability also depends on existing technology, which this study assesses in the specific context of wireless broadband feasibility, rather than in terms of general interoperability.

3. *General information technology and telecommunications infrastructure and policy.* Any wireless broadband system that might be deployed is necessarily an extension of the City's existing information technology network, and must support and adapt to the policies, standards and network architecture already in place. Where appropriate, this report will make recommendations concerning changes in this infrastructure insofar as it concerns integrating wireless resources, but it does not address general information technology strategy or implementation.

4. *Provision of computer hardware, software, training and technical support to under served communities and individuals.* As noted below, in order for under served communities and individuals to make use of broadband access of any sort, they must also have access to computer resources, including training. This consideration is a limiting factor for some aspects of a wireless broadband system, and must be assessed during any implementation process. Wireless technology, and the policy adopted to deploy it, can also create opportunities to increase the availability of these resources. However, a full assessment of this need and the means to fill it are outside the scope of this study.

## 8.2. Methodology

Examples of the agenda, discussion guides and other material used in this research can be found in Volume 2 of this study. The primary research program consisted of a series of targeted workshops and public focus groups, as well as a town hall meeting.

The six workshops were structured as semiformal meetings in a business setting. Three workshops were for city personnel, with participants invited from all city departments. One workshop was held for the local business community, one for local non-profits, and one for educational organizations and other government agencies. Department of information technology personnel were present at all workshops, and contributed information and observations as appropriate. However, since DIT is the department that is responsible for this study, they were not primary participants.

The workshops opened with introductions, and then moved to a presentation of background information about the study and on wireless broadband initiatives elsewhere. Participants then discussed their particular needs and concerns. This information was gathered on flip charts, which were then used to facilitate a brainstorming session. The workshops closed with participants prioritizing needs and solutions.

One focus group was held in each of the seven Oakland City Council districts, and participants were recruited from people who live and work in the respective district. An effort was made to recruit people from all demographic categories in each district, and although every focus group did not include participants from all possible demographic categories, taken as a whole the groups did encompass nearly every segment of the greater Oakland community. Focus group participants were assured of anonymity.

Each group was led through the same discussion guide, with the goal of sparking a wide ranging discussion of needs that could then be channeled into topics specific to wireless broadband. To set the stage, participants introduced themselves and were given a brief presentation of various examples of municipal broadband deployments. They were then asked open ended questions about their perceptions of needs and existing City services, which led to interactive discussion of relevant topics. Each session closed with a summary of the points raised in the discussion and a brief prioritization exercise.

The town hall meeting was designed as an open and unstructured public discussion, with no screening or targeted recruitment of participants. It began with a presentation about various municipal wireless broadband projects and an overview of the study process. Members of the audience then asked questions and presented their own views about what they thought were the important needs and service priorities for the City of Oakland, and their opinions and suggestions concerning wireless broadband specifically. All public comment was taken as presented, with no effort made to channel the discussion or produce a group consensus or identify common conclusions.

## 8.3. Technical Kickoff Meeting

On 7 December 2007, City of Oakland personnel responsible for networking and telecommunications met with prime study contractor Stephen Blum and technical lead Stuart Browne to discuss information needs, and to be briefed on the planned course of the study. Blum and Browne presented background information on the technology and economics of municipal wireless broadband and discussed technical information needs.

All participants agreed to help collect the technical data and later did so, using a guide and questionnaire prepared by Browne.

## 8.4. Workshops

### Workshop 1: Police and Fire Departments, Mayor's Office, Administrator's Office, KTOP

This workshop focused on public safety and emergency services. Participants brainstormed and discussed potential applications that could increase response time, improve service efficiency and increase interoperability between agencies in times of emergency. A representative from the Human Services Department attended, and provided ideas on how wireless technology could be used to serve the elderly.

Police department representatives discussed a current effort to provide all police officers with laptop computers, and the need to provide those computers with data access in the field. Fire department representatives stated that they are not currently accessing data from the field and that personnel, for example fire inspectors, are recording information on paper in the field and returning to their offices to manually enter it into computers.

Police and fire representatives believed that better visual information from the scene of incidents would lead to improved coordination between their departments, and would enhance their ability to respond to those incidents.

Network independence and cost savings were two key potential benefits identified. Using commercial networks for public safety can be problematic, primarily due to security concerns. There was a belief that costs could possibly be reduced if a Citywide network was in place. Increases in efficiency and productivity also could be possible. Participants identified an opportunity to make field workers more efficient by providing remote access to records, and to file reports and record other information without having to return to the station. The result could be better service and faster response, as well as an increase in the amount of time field workers could spend in the field.

Security and privacy were key concerns. Participants agreed that, in general, any wireless technology used must be secure and able to support Federal standards, including encryption and segmentation for law enforcement communications. Privacy standards, for medical records for example, must also be met.

Coverage must be adequate to support intended users and should represent an upgrade in capability, according to participants. They observed that police and fire personnel already have to contend with radio dead spots because of hilly terrain, and ideally any wireless network deployed would help alleviate that problem. Another challenge is the need to communicate with aircraft and boats.

Another concern of participants was system survivability during a disaster, such as an earthquake, and ensuring that the system is adaptable to meet the rapidly shifting needs and circumstances that major emergencies present. Participants believed that any system must have a high degree of reliability, with adequate emergency power, backup equipment and spare capacity to function at all times, during emergencies as well as routine operations.

## Workshop 2: Public Works, Facilities Management, Risk Management, Human Services, Community Economic Development Agency (CEDA)

In this workshop, the focus was cost savings, productivity, and driving new revenue opportunities for the City. Some of the same issues mentioned in Workshop 1, such as gaining efficiency in work management systems, were also raised. Location-based tracking was identified as a way to manage City assets. Ideas for emergency and disaster management applications were also offered.

Participants discussed ways wireless technology might improve efficiency and productivity, echoing comments in the earlier workshop about the benefits of being able to access information and file reports from the field. Potential cost savings were identified as well. For example, the public works department is acquiring 150 new laptop computers. Purchasing commercial wireless data service would cost approximately $50 per month for each computer, for a total budget of $90,000. An independent City wireless network might be able to provide comparable service for less money.

Specific applications that could enhance productivity were discussed, such as remote reporting and two-way access to the City's geographical information system (GIS). City tree crews would like to be able to access right of way and property line information while in the field. The traffic division is currently looking at wireless technology as a way of managing radar feedback signs. Currently, they are transferring data by swapping out physical media on individual units. Managing and monitoring traffic signals was also mentioned as a potential application.

Other uses for wireless technology mentioned included filling in dead spots in current City radio and commercial carrier data network coverage, providing remote access to desktop computers and enabling telecommuting. One observation made about telecommuting was that in addition to being a potential productivity enhancer, it is also useful in preparing for emergencies. According to one of the participants, the federal department of homeland security requires some employees to work from home one day per week, to ensure they can do their jobs if they are unable to report to their primary offices during an emergency.

Wireless technology was also mentioned as a potential economic development tool, which could boost the value of some properties by enabling state-of-art broadband facilities. In other cases, it could provide a back-up service for businesses that rely on wired connections or as an extension of wired networks for businesses with significant numbers of field workers within the city limits. Another potential economic development opportunity identified by participants was providing wireless public Internet access in high traffic areas, which could be of particular benefit to mobile workers and the travel industry.

Participants also thought that wireless technology could aid in increasing the trust of the general public and promoting transparency. The rationale was that when field workers were interacting with the public, for example during an inspection, wireless data access would allow them to show processes and results in real time, rather than having to wait days, or longer, to provide feedback. Another need identified was the lack of affordable Internet access in some neighborhoods, and wireless technology was discussed as one element of a potential solution.

### Workshop 3: Finance Department, Office of Emergency Services, Oakland Museum, Parks and Recreation Department

The discussion in this workshop centered on ways that wireless technology could plug holes in current networking capabilities, extend information technology resources into the field and enhance existing City services.

Participants came from a diverse group of departments, with a variety of institutional needs. Both the finance and parks and recreation department representatives saw value in being able to access their existing information technology assets directly from the field. For example, being able to access information remotely would allow the finance department to conduct more and better field audits, potentially leading to increased tax revenue flowing to the City.

Adding geographic information to existing databases, and accessing that information automatically through location-based services, was seen as a way to enhance tax code compliance, as well as compliance with other City requirements. Location-based services were identified as a way of improving City operations and services, such as emergency response management.

Some parks and recreation offices do not yet have wired access to the City's information technology infrastructure, and wireless technology was mentioned as a potential means of providing connectivity. Currently, supervisors have to go to a central office to file routine reports, such as personnel-related records. This situation was seen by the group as being inefficient and a specific application where wireless technology could improve productivity. As with previous groups, participants believed that being able to access and file information from the field would increase productivity by reducing the need to travel back and forth to an office.

Security was a central concern. Participants noted that the two examples above involve confidential information that has to be carefully controlled, both while it is being transmitted and on any devices that are used in the field. The City's current IT infrastructure already has extensive safeguards, such as virtual private networks (VPNs) built into it. Any wireless extensions to the existing network would have to support those safeguards.

The representative from the office of emergency services echoed comments made by police and fire department personnel during the first workshop. Wireless facilities could improve communication with emergency responders on a routine basis as well as during major incidents, and provide a back-up to existing systems.

Finally, improving communications with and service delivery to the public was seen as a significant potential benefit of wireless technology. For example, it could enhance interactive tours of the Oakland museum, provide better public access to the museum's collection, and aid in volunteer recruitment and management.

### Workshop 4: Oakland Businesses

Participants discussed gaps in services and facilities, both public and private, and ways wireless technology might plug those gaps. Much of the discussion focused on the economic case for extending networking resources and capabilities, including ways that the City might pay for the facilities needed, and on opportunities for private businesses and individuals to participate in such a project.

Business representatives generally believed that adding wireless connectivity to the City's IT facilities could increase the productivity of field workers, potentially reduce crime by improving surveillance, and improve service delivery to business, such as expediting building inspections permit processes.

A couple of specific business opportunities were identified and discussed. First, downtown Oakland has a number of "Class B" buildings that lack commercial-grade Internet access. A wireless network could be a way to bring connectivity to those buildings, and the use of wireless technology internally could be a way of quickly distributing access throughout a property. Second, adding wireless hotspots in key locations, such as bus shelters, the downtown area and Jack London Square, could help increase tourism and convention business.

Several suggestions for financing wireless facilities were offered. One idea was to allow business owners to buy in to a video surveillance network, making it possible for them to add supplemental coverage of their own locations, and to assist with monitoring and reporting. Another was to maximize advertising and sponsorship opportunities.

One suggestion made was to integrate public transit information and dial-a-ride service with mobile phone networks, offering both a way to deliver information to the public and a means of billing. Transportation-related applications were seen as potentially fundable through grants.

Participants generally believed that any wireless system deployed should be financially sustainable, and the costs of the system should fall primarily on those who benefit from it. They also emphasized that the value of any system should be determined before decisions are made, and that costs be in line with the value added.

A City wireless system could also encourage other wireless-related businesses to develop, according to participants. For example, access to wireless facilities might make it possible to offer new voice communication or Internet access services, or extend the reach of current, commercially available services to new places and new customers. Businesses might also be able to use a citywide system to track employees and assets.

### Workshop 5: Oakland Non-profits

Participants were concerned about providing access to Internet resources and services to those who don't yet have it, particularly youth and the economically disadvantaged. They generally believed these individuals would be left behind, academically and technologically, if efforts were not made to educate them with the basics of technology. The discussion focused on the benefits of Internet access, regardless of whether it was provided wirelessly or otherwise.

One of the key points of the discussion was that the inability to access Internet resources and services is due to several factors, including access to the necessary hardware and software, basic technology skills, computer-specific skills and professional technical support, as well as an inability to obtain Internet access service, either because it is not available or it is not affordable.

Two ways of overcoming Internet access issues were discussed. One was to deliver alternate Internet service into homes for free or at a reduced rate. Another was to provide it to community groups and at public facilities, making it easier to combine it with hardware, software, training, technical support and other necessary resources, and to create programs that serve the specific needs of different parts of the community. A variation on this idea, which favors the use of wireless technology, is to create mobile centers, similar to bookmobiles, that take these programs directly into neighborhoods.

One of the participants was from Kaiser Foundation Health Plan, Inc. He described a mobile medical clinic that Kaiser is currently testing in Hawaii. Its immediate purpose is to provide health care to under served communities, but ultimately it could be a platform for providing care directly to people in their homes. Other Oakland area hospitals are also expanding online services, and City infrastructure, wireless or otherwise, could help link these efforts.

Internet access, wireless or otherwise, was seen as a means to help achieve goals, rather than as a goal itself. Those goals included improving educational levels, teaching skills, encouraging the pursuit of higher education, improving delivery of health care, increasing access to social services, and community building. Participants generally had a sense of urgency about reaching these goals, and saw needs as being immediate and pressing.

Workshop participants generally favored business models, network architectures and technology that was non-exclusive and available to all. Creating competition for incumbent Internet service providers was seen a beneficial. Job training opportunities were also identified, for example training local residents to become network technicians.

### Workshop 6: Education and other Government Agencies

Participants in this workshop were primarily management level information technology and telecommunications staff from local government agencies. As a result, the discussion focused on common technical challenges, and interagency cooperation and the means to foster it. There was considerable willingness amongst all participants to discuss sharing resources and cooperating where possible.

Several of these agencies, for example the Oakland Unified School District (OUSD), BART, the Metropolitan Transportation Commission and the Port of Oakland, have existing broadband networks within the Oakland city limits, including wireless facilities. In addition, BART is extending public wireless access, through mobile phone carriers and other means, throughout its system. OUSD and the Port operate more or less completely within the city limits, and face some of the same networking challenges as the City. In some cases, participants said, the City could share existing facilities. In other cases, agency representatives said they would be interested in making use of City resources.

One example of project congruency is the Port's current program to install public wireless Internet access in high traffic areas that it controls, such as the airport and Jack London Square. Another example is OUSD’s program to create a wireless overlay of its existing information technology network within all its buildings. This network is not intended to provide public Internet access, however one suggestion made was for the City and OUSD to cooperate in providing public access in common areas, such as auditoriums, after school hours, if legal and security concerns could be addressed.

OUSD and Peralta Community College District representatives expressed other security concerns. Rogue wireless access points – personal wireless routers that are attached to a secure network – are an issue, and in some instances have shut down networks.

Emergency planning is another area of potential interagency cooperation. For example, some OUSD schools are designated as emergency evacuation shelters. If activated, those sites would have communication needs that are radically different from normal day to day operations, and could benefit from wireless broadband facilities that could be quickly adapted to satisfy those needs.

Ongoing technical coordination, from the planning process on through to deployment and operations, was seen by participants as essential to any partnership. Security was one area of particular concern. Individually, agencies have to meet security requirements that are unique to their jurisdiction. Consequently, any common broadband facilities have to be able to meet all the security requirements of all the partners.

One suggestion that was generally endorsed by all participants was that interagency planning and coordination should extend beyond the workshop, as a group or one-on-one as appropriate. One existing group that was mentioned as an example, and potentially as a forum, is the recently formed Bay Area transportation CIO roundtable.

Participants also believed that policy-level coordination is an important element in creating any ongoing cooperative effort. The governing authorities of each agency have concerns and priorities that might or might not be consistent with City policies and, according to participants, advance coordination would be necessary to ensure a smooth process.

## 8.5. Focus Groups

### Focus Group 1 - District 6

The majority of the participants either lived or worked in East Oakland. This focus group had the highest youth participation of all the focus groups, with young people comprising more than half of the participants. Council member Desley Brooks, who represents this district, made opening remarks to the participants.

#### Top priorities

- Overcome economic and educational hurdles to hardware and access, ensuring that everyone who wanted access could afford it, and who needed hardware could get it.
- Equip all schools.
- Secure post-disaster resources.

(Prioritization of topics was done by participants themselves as part of the concluding process of each focus group.)

### Focus Group 2 - District 5

This focus group was the smallest. The participants either live or work in this predominantly Latino area of Oakland. Perhaps because of its smaller size, this group engaged in a very lively discussion. Participants ranged in age from high school students to senior citizens.

#### Top priorities

- Access for all, "not just free access, but having the tools – the hardware and the software – to even endeavor taking advantage of the access".
- Service providers ought to be a part of Oakland.
- Make sure any public services are multilingual.

### Focus Group 3 - District 4

This session was very interactive. The focus group took place in the Dimond library, one of the few libraries that offer free wireless access to the Internet. While the focus group was taking place, members of the public parked outside the closed library, just to make use of this access. This group seemed well versed on innovative technologies. Council member Jean Quan and members of her staff participated in this focus group.

#### Top priorities

- Easy and inexpensive access for all, the more people on the network, the more valuable it becomes.
- Bandwidth and strong infrastructure to support use
- Public access should start in public areas.

### Focus Group 4 - District 1

Senior citizens were well represented at this focus group and it was held at a senior center. The group seemed very engaged with the city, in terms of volunteerism and other roles, and very educated about the status of Oakland politics. Overall this group focused more on city issues than on issues relating to their personal needs.

#### Top priorities

- Better real time communication in emergencies.
- Public safety and emergency response.
- Education.
- Technology and software.
- Accessibility across Oakland.

### Focus Group 5 - District 2

This focus group had the most culturally diverse group of participants, who spoke a remarkable variety of languages. Language issues might have led some to engage in discussion less than others, but even so a broad range of issues, some unique to the district, were put forth.

Top priorities

- Leadership necessary to effectively implement.
- “Public face” on this initiative.
- Public utility-type service.
- Training.
- Access.

### Focus Group 6 - District 3

This focus group was one of the most balanced in terms of male/female ratio and above/below 40 age range. The majority of participants in this focus group lived or worked in West Oakland.

Top priorities

- Infrastructure.
- Public access.
- Content, in terms of what is accessible over the system.

### Focus Group 7 - District 7

The participants of this focus group lived or worked in East Oakland. Just under half of the participants were young people. Perhaps as a result, the discussion was free flowing and covered topics and ideas that had not yet been considered.

Top priorities

- More WiFi at community centers, schools, libraries, etc.
- If the city wants to create more revenue, focus on WiFi on buses so people will use them more.
- Have WiFi available as a public service.

## 8.6. Town Hall Meeting

The Town Hall meeting was well attended. Participants focused on the City’s plans and what should be considered during the assessment process. A good portion were technology-oriented and seemed to have a good understanding of what would be involved in designing and deploying wireless broadband solutions for the City of Oakland.

Top priorities

- Access for unserved areas is important, but needs to be combined with other necessary resources such as equipment, training and support.
- Some solutions are easier to implement than other, and can be deployed quickly, such as offering free WiFi access at all City libraries.
- Costs have to carefully considered.
- Wireless broadband facilities created for City staff should address genuine needs.
- Wireless technology can help provide public as well as infrastructure support in emergencies.

## 8.7. Samples of Public Comment

As noted above, detail notes and other documentation from all the sessions, as well as other public comment received during the study, is contained in Volume 2 of this study. Typical comments include

"The Diamond Library has WiFi, but the Eastmont Branch doesn't. All the libraries need it."

"Residents could use Internet to report incidents to the City, or the police department. With wireless reporting police could see whether there are clusters of incidents happening repeatedly in an area, and send a cruiser to that area."

"Need to know what benefits the taxpayers are getting from the wireless service as well as what benefits the vendor is getting."

"Will development of this infrastructure produce the kinds of jobs we need in Oakland?"

"Security is important for privacy."

"Let's not spend all this money to hire brand new people to recreate stuff that already exists. See what already exists… and leverage existing resources."

Train teenagers to be technicians to support access and hardware. " The point is to train people in the community, not bringing folks from outside."

"Wireless access is only good if you have the equipment. Consider lending programs such as Berkeley's tools program for home improvements, for video cameras, digital cameras, computer equipment."

“Provide WiFi access in bus shelters as well as on buses. “[While riding the bus] people spend a lot of time sitting around doing nothing; it would be much more enjoyable and productive for people with WiFi access. In Japan they provide all the messaging in different languages.”

“It’s fairly common throughout the country that most libraries have WiFi, so we are a little bit behind the times now. The main library does not have it. We get asked for it easily five times per week. In terms of the digital divide, patrons who come in to use equipment at the library don’t have computers or printers at home, so providing WiFi in some neighborhoods might not actually provide access.”

“I have a concern that commercial implementation of WiMAX or a 4G system by a major corporation could easily render something that we put up ourselves obsolete.”

“Must be careful not to underestimate the cost associated with broad-scale wireless access. This makes me think pragmatically about the drinking fountain model, where you focus first on services that can piggyback on existing wired connections at schools, recreation centers, and public buildings as a nexus for people to come together that might otherwise have difficulty accessing the Internet.”

“I love technology – wireless everywhere would be wonderful. However, given other cities' problems with wireless, Oakland's current resource problems, and frankly track record – please don’t do it.”

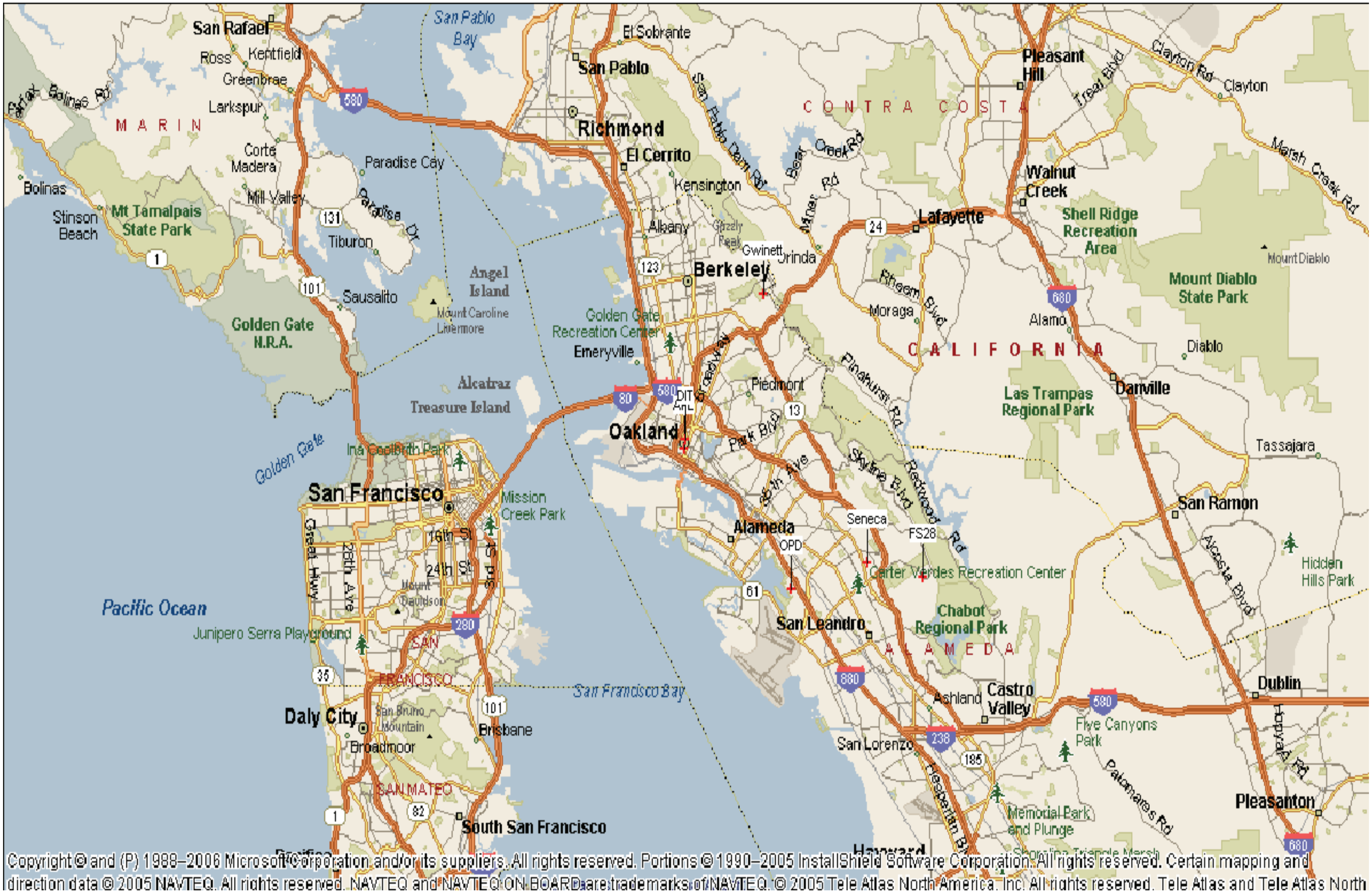
# 9. Appendix B: Frequency Mapping

# Oakland Reference Architecture

## Coverage Maps

4.9 GHz
2.4 GHz
700 MHz

# RF Hub Locations



# Oakland Reference Architecture

## Coverage Maps

## 4.9 GHz
## 2.4 GHz

# 4.9 GHz and 2.4 GHz Assumptions

- Maps are for informational purposes only.
- Do not assume a particular system design, other than frequency band.
- Maps do not account for subscriber density or multi channel access points.
- Maps are based on Talk Out– Base Station to Subscriber
- All maps are based upon a reliability of approximately 95% Area Reliability.
- 2.4 GHz Maps are based on an ERP of 36 dBm – Maximum allowable per FCC.
- 4.9 GHz Maps are based on an ERP of 29 dBm – Maximum allowable per FCC.
- Gwinnett, Seneca, and FS 28 location on tower adjusted to 25 ft.

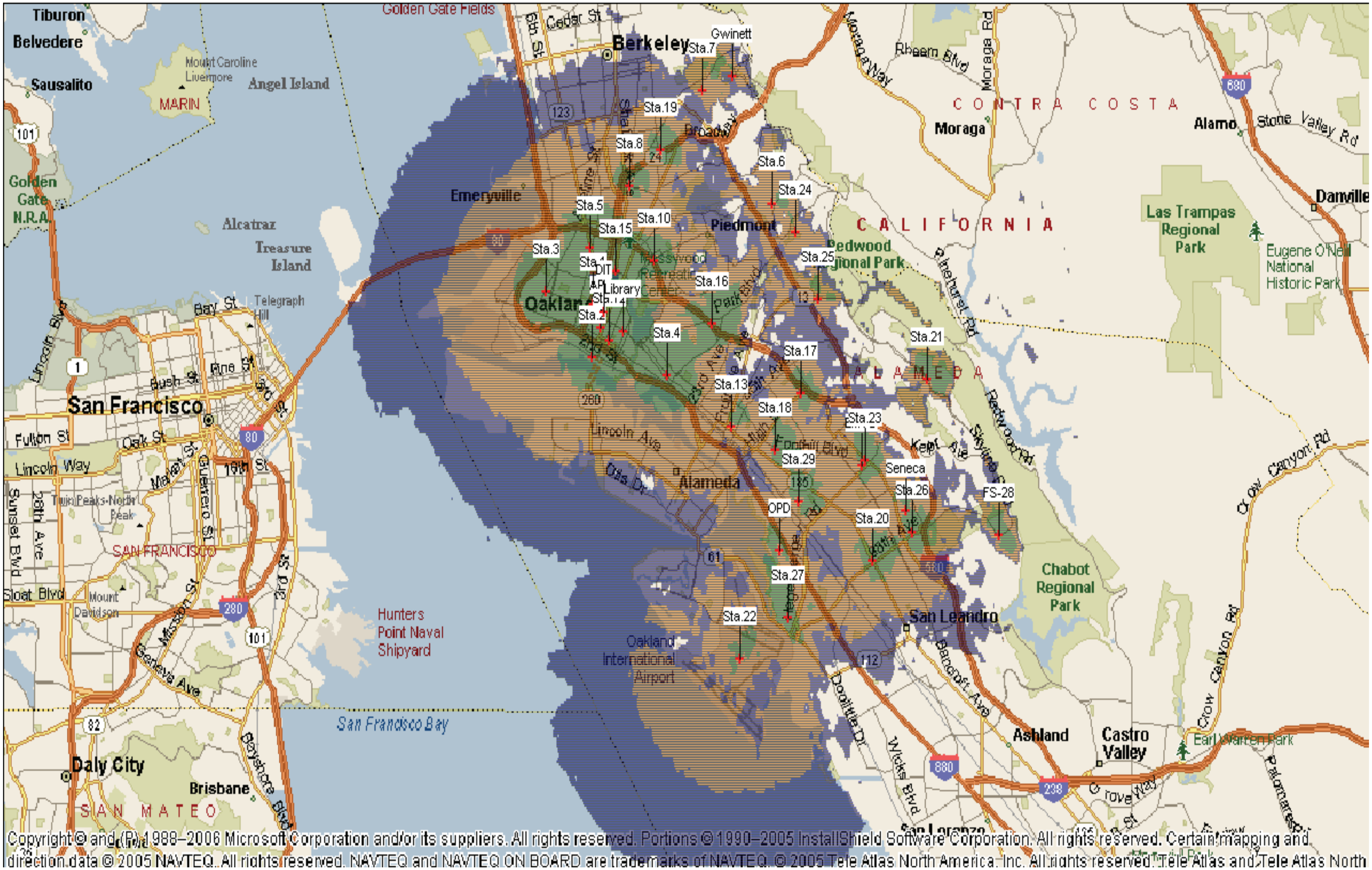
# Map Legend – 4.9 GHz and 2.4 GHz

Base Station to Device = -85 dBm

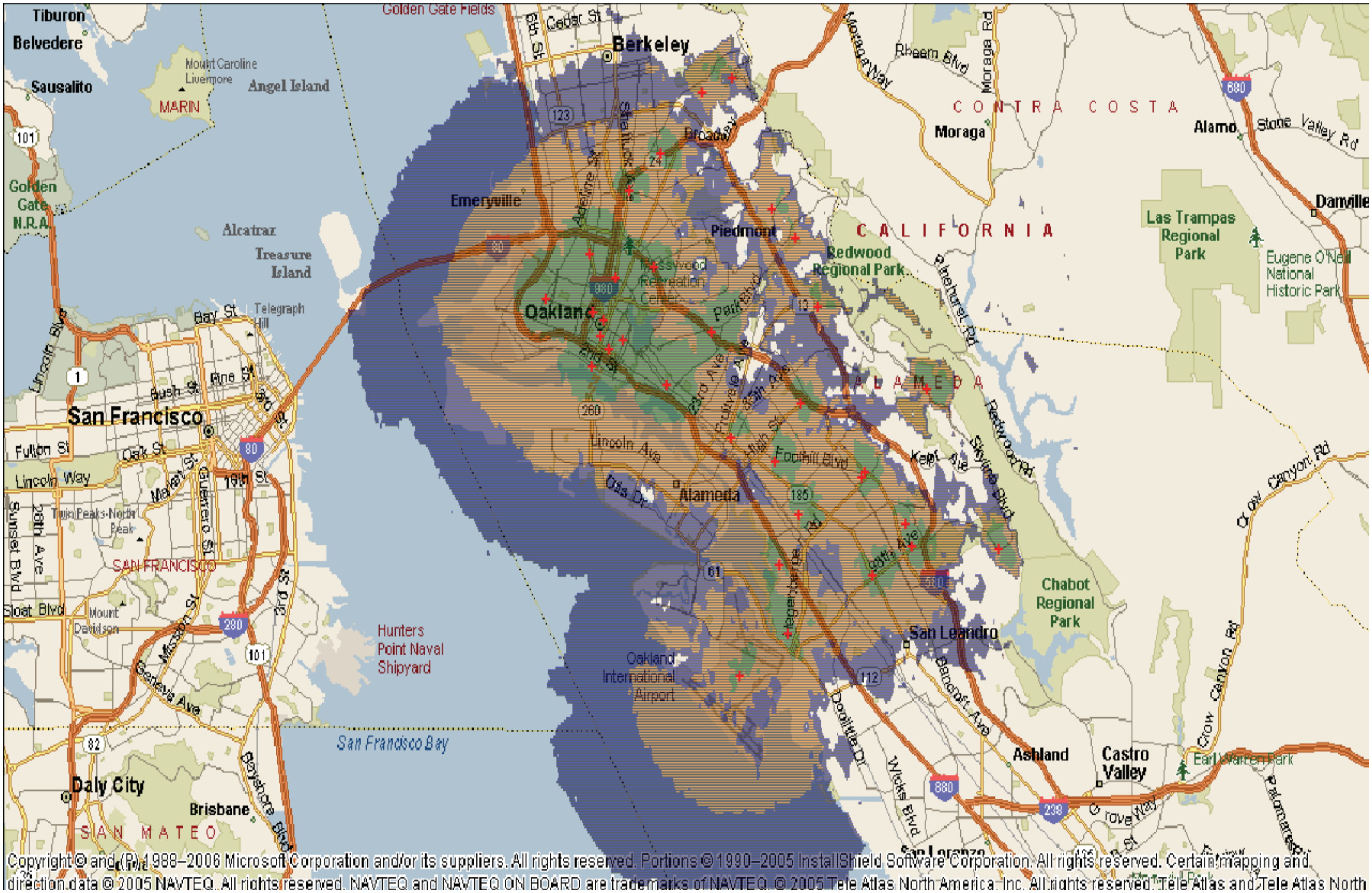
Base Station to Device = -95 dBm

Base Station to Device = -100 dBm

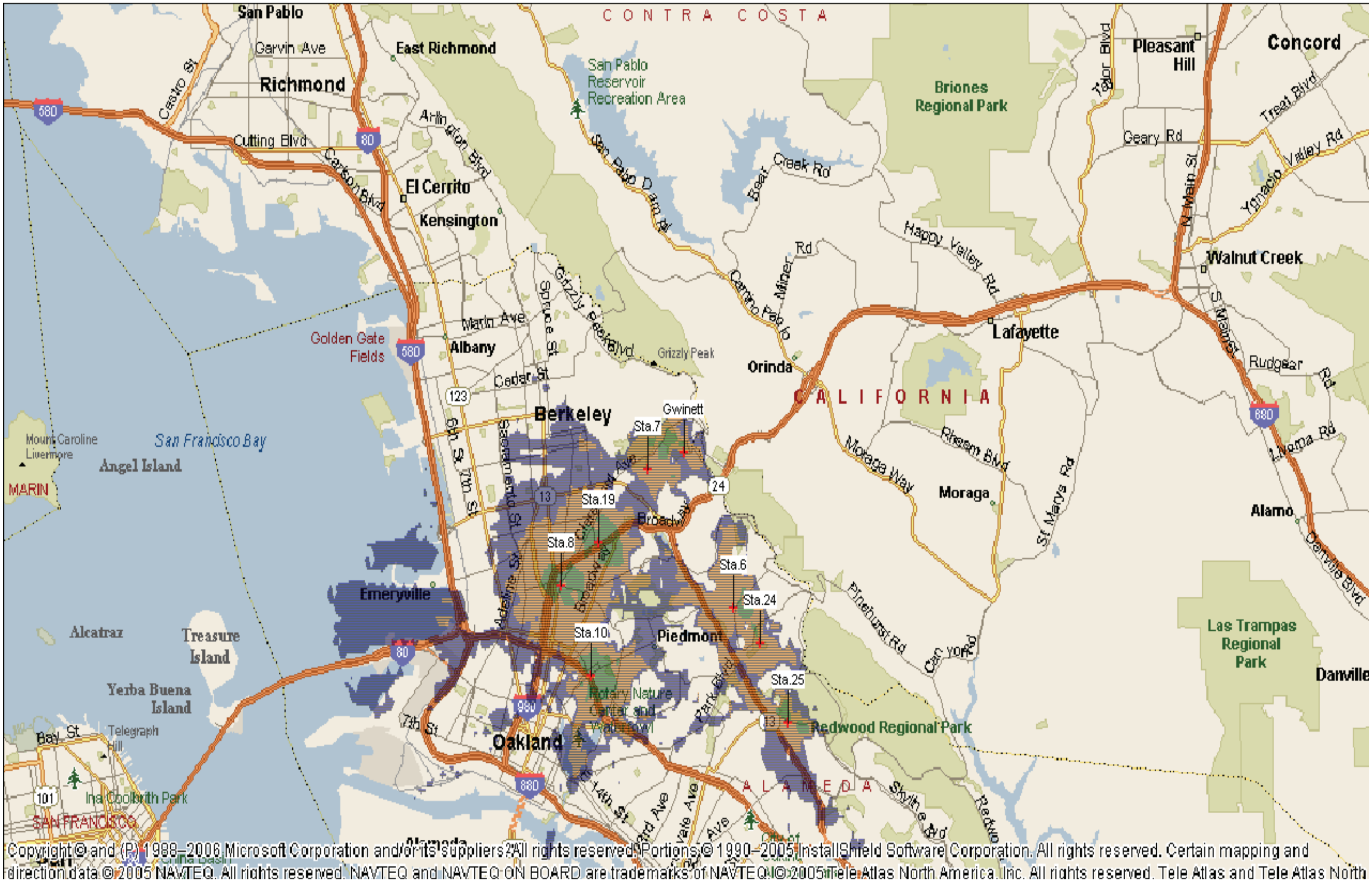
# Composite – 4.9 GHz



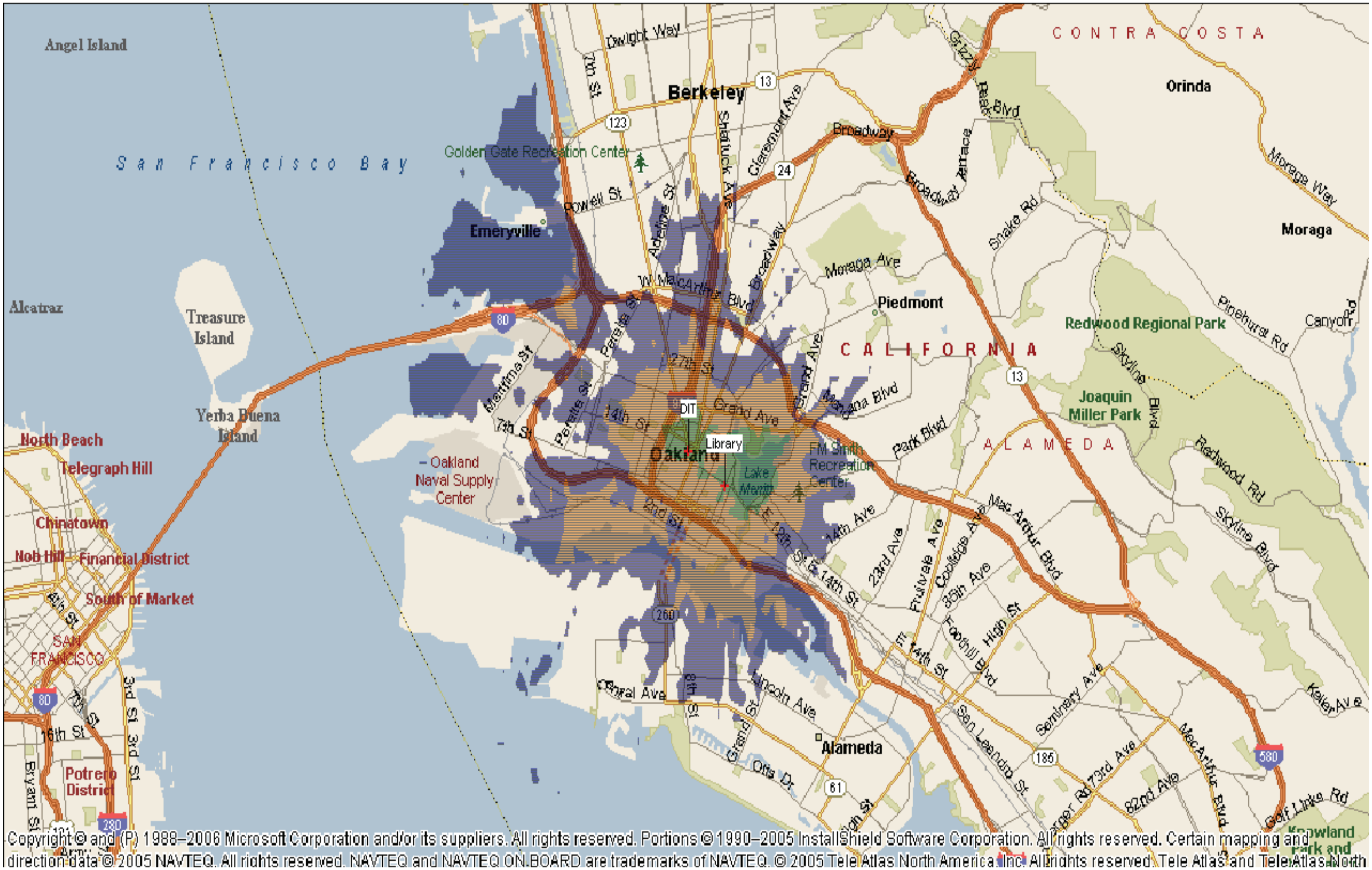
# Composite – 4.9 GHz



# Gwinnett – 4.9 GHz



# DIT- 4.9 GHz


Angel Island
San Francisco Bay
Alcatraz
Treasure Island
Yerba Buena Island
North Beach
Telegraph Hill
Chinatown
Nob Hill
Financial District
South of Market
SAN FRANCISCO
Potrero District
Emeryville
Golden Gate Recreation Center
Berkeley
Oakland Naval Supply Center
Oakland
DIT
Library
Lake Merritt
Piedmont
CALIFORNIA
CONTRA COSTA
ALAMEDA
Orinda
Moraga
Redwood Regional Park
Joaquin Miller Park
Alameda
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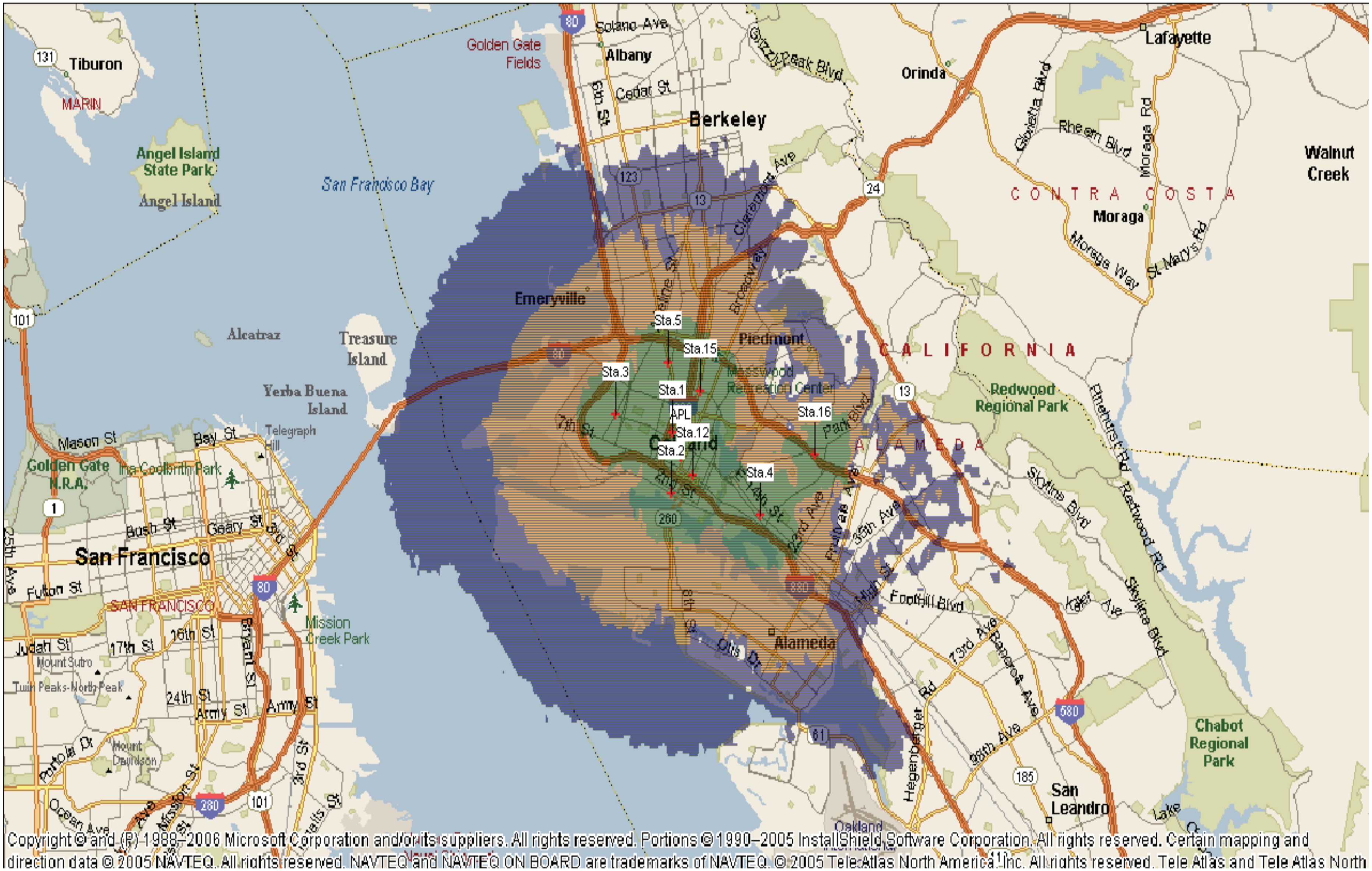
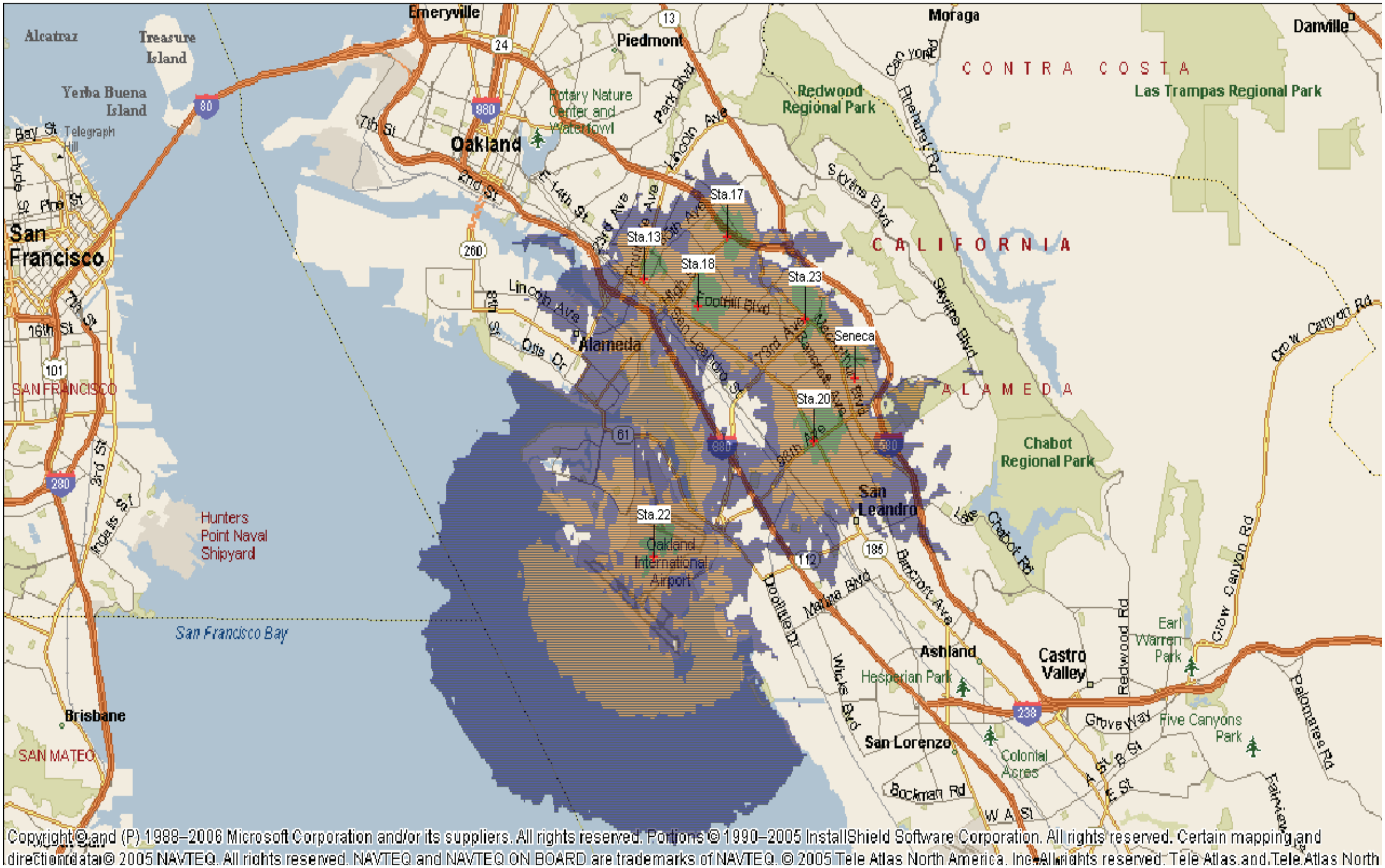
# APL - 4.9 GHz

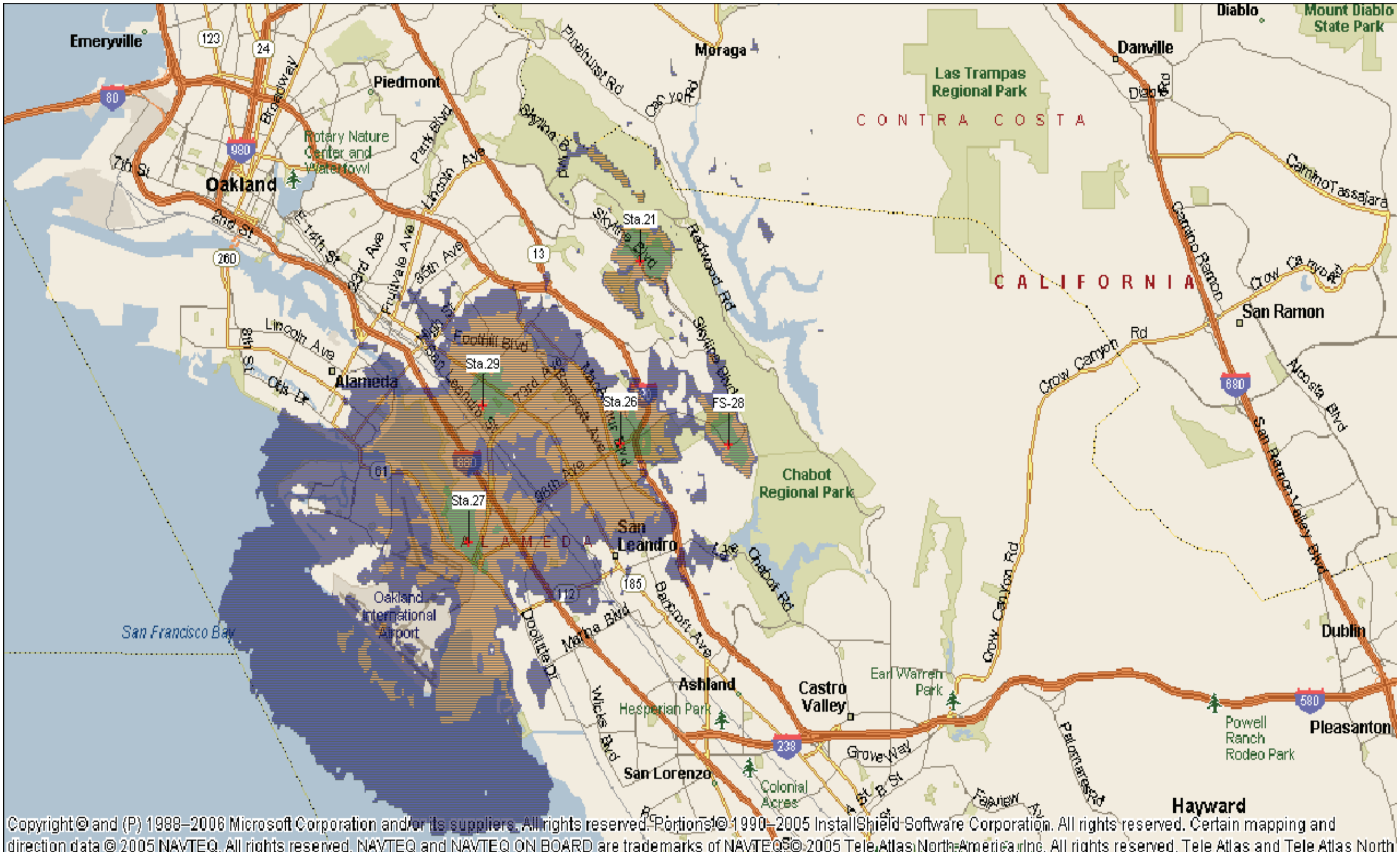


Sta.1
Sta.2
Sta.3
Sta.4
Sta.5
Sta.12
Sta.15
Sta.16
APL
Berkeley
Emeryville
Piedmont
Alameda
San Francisco
San Francisco Bay
Treasure Island
Yerba Buena Island
Alcatraz
Angel Island State Park
Tiburon
Orinda
Lafayette
Moraga
Walnut Creek
San Leandro
Redwood Regional Park
Chabot Regional Park
CALIFORNIA
CONTRA COSTA
ALAMEDA

# Seneca – 4.9 GHz



# FS 28 – 4.9 GHz


Emeryville
Oakland
Piedmont
Alameda
Moraga
Las Trampas Regional Park
CONTRA COSTA
CALIFORNIA
Danville
San Ramon
Diablo
Mount Diablo State Park
Sta.21
Sta.29
Sta.26
Sta.27
FS-28
Chabot Regional Park
San Leandro
ALAMEDA
Oakland International Airport
San Francisco Bay
Ashland
Castro Valley
San Lorenzo
Hayward
Dublin
Pleasanton
Powell Ranch Rodeo Park
Earl Warren Park
Hesperian Park
Colonial Acres
Rotary Nature Center and Waterfowl
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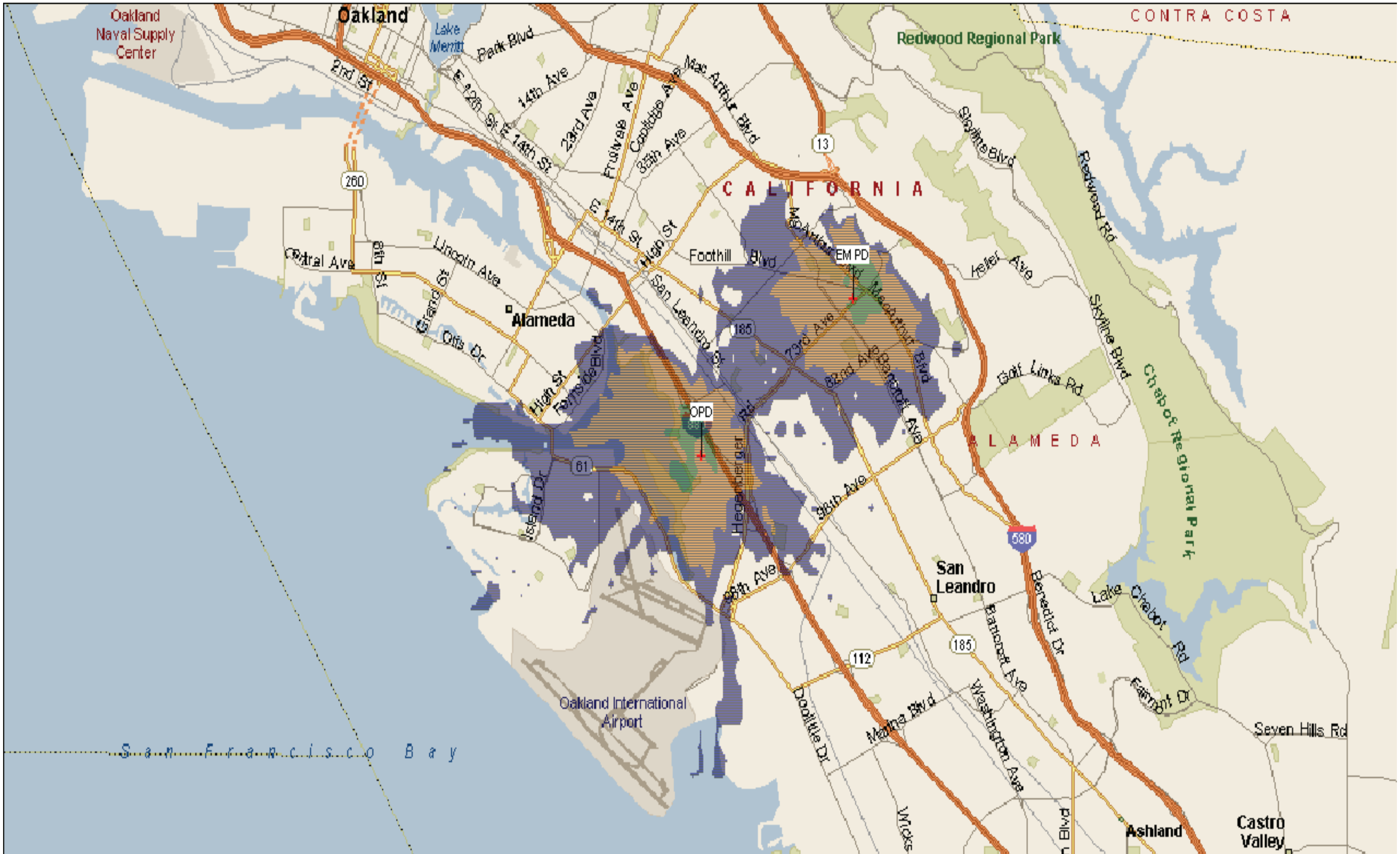
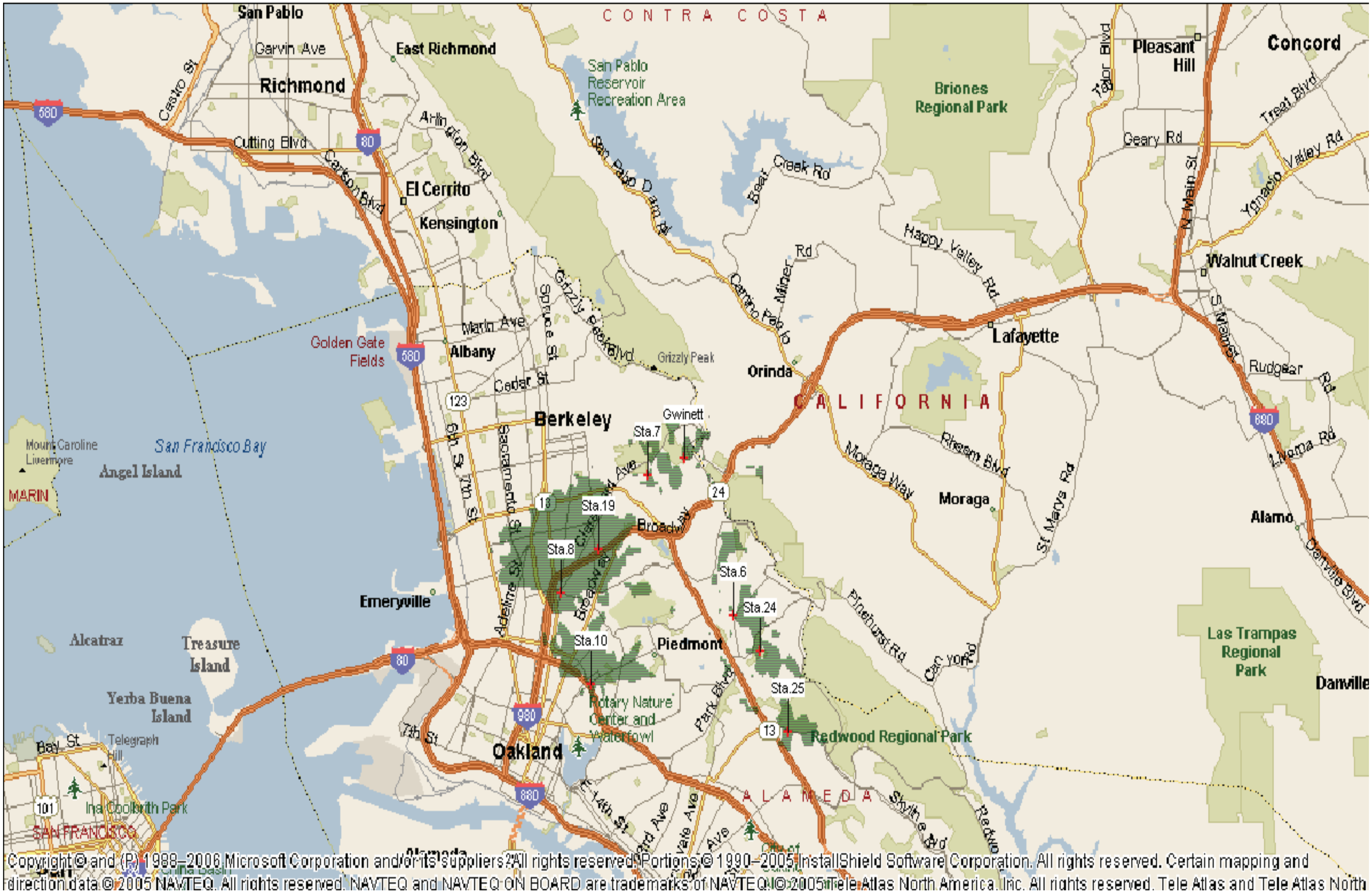
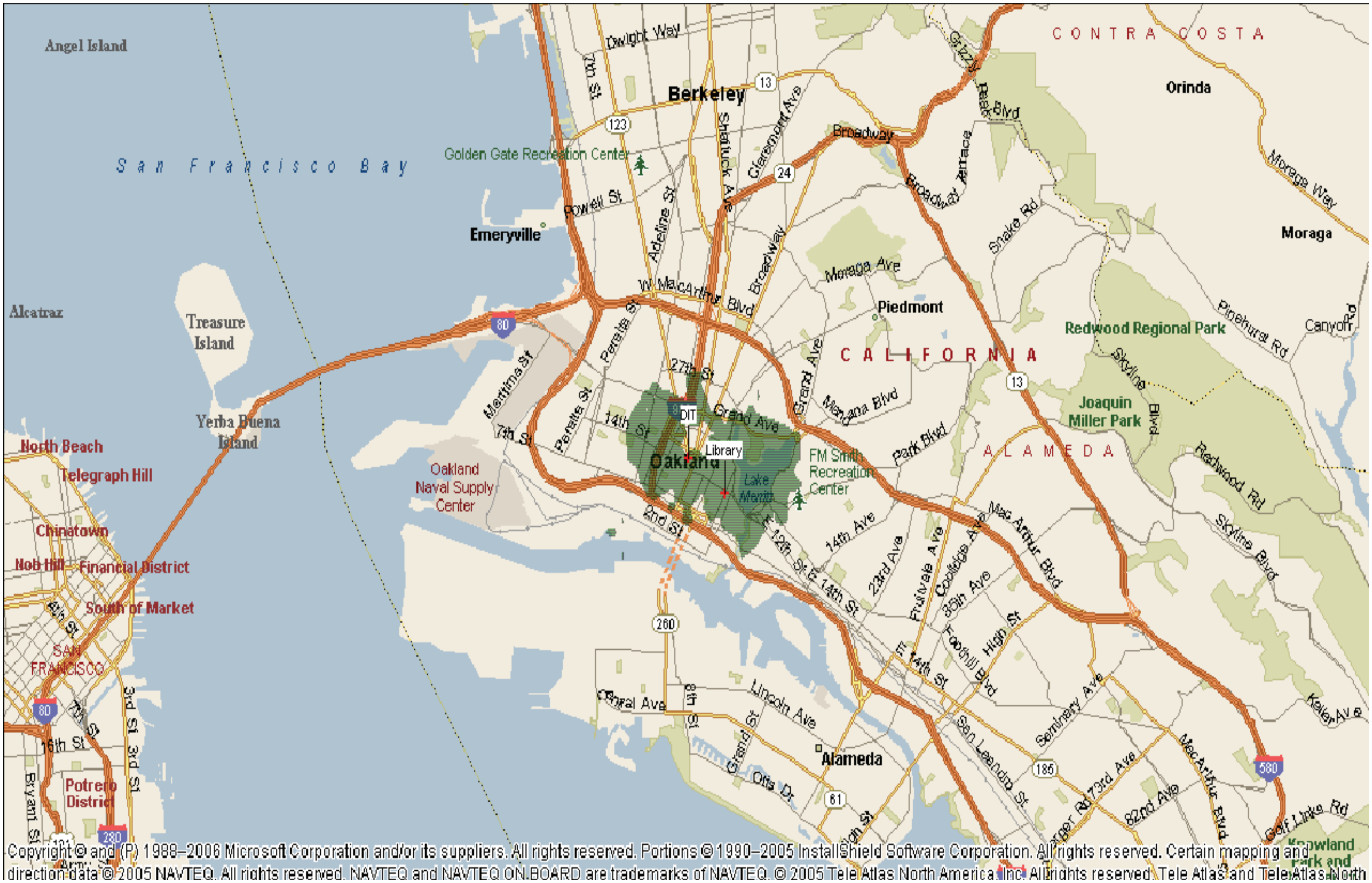
# OPD – 4.9 GHz


Oakland
Oakland Naval Supply Center
Lake Merritt
Park Blvd
2nd St
14th Ave
E 12th St
E 14th St
23rd Ave
Fruitvale Ave
Coolidge Ave
Mac Arthur Blvd
35th Ave
260
13
CALIFORNIA
CONTRA COSTA
Redwood Regional Park
Skyline Blvd
Redwood Rd
Central Ave
8th St
Lincoln Ave
Grand St
Alameda
Otis Dr
High St
Foothill Blvd
San Leandro St
185
EM PD
MacArthur Blvd
73rd Ave
82nd Ave
Bancroft Ave
Keller Ave
Golf Links Rd
Skyline Blvd
Chabot Regional Park
ALAMEDA
OPD
61
Island Dr
Hegenberger Rd
98th Ave
580
San Leandro
Benedict Dr
Lake Chabot Rd
Fairmont Dr
Oakland International Airport
San Francisco Bay
112
185
Doolittle Dr
Marina Blvd
Washington Ave
Wicks
Seven Hills Rd
Ashland
Castro Valley

# Gwinnett – 2.4 GHz

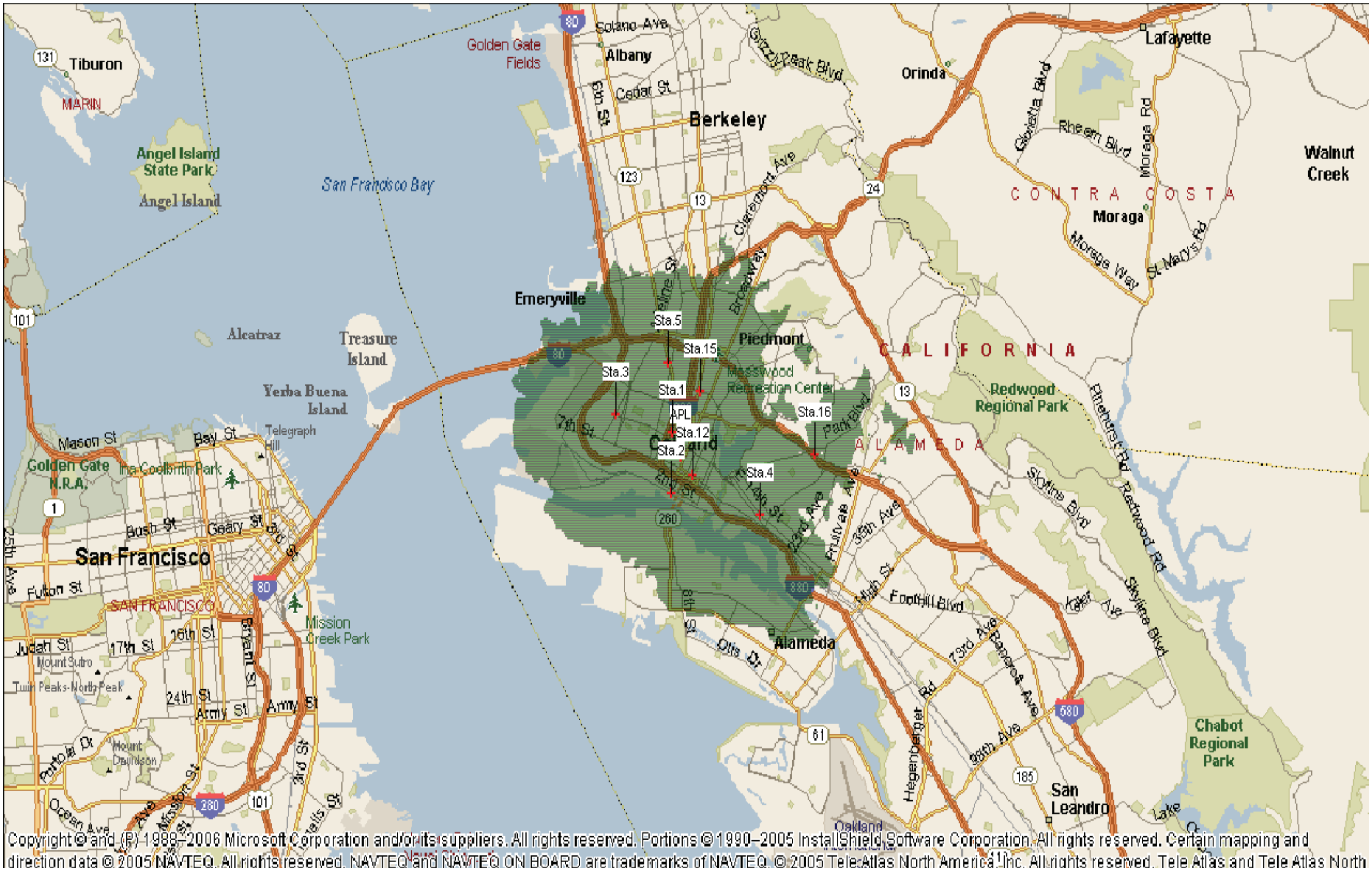


# DIT - 2.4 GHz



San Francisco Bay
Angel Island
Alcatraz
Treasure Island
Yerba Buena Island
North Beach
Telegraph Hill
Chinatown
Nob Hill
Financial District
South of Market
SAN FRANCISCO
Potrero District
Emeryville
Berkeley
Oakland
Piedmont
Alameda
Orinda
Moraga
Oakland Naval Supply Center
Golden Gate Recreation Center
Redwood Regional Park
Joaquin Miller Park
FM Smith Recreation Center
Lake Merritt
DIT
Library
CALIFORNIA
ALAMEDA
CONTRA COSTA

# APL - 2.4 GHz


Tiburon
MARIN
Angel Island State Park
Angel Island
San Francisco Bay
Golden Gate Fields
Albany
Berkeley
Emeryville
Alcatraz
Treasure Island
Yerba Buena Island
San Francisco
Piedmont
Orinda
Lafayette
Walnut Creek
Moraga
CONTRA COSTA
CALIFORNIA
ALAMEDA
Redwood Regional Park
Chabot Regional Park
Alameda
San Leandro
Sta.1
Sta.2
Sta.3
Sta.4
Sta.5
Sta.12
Sta.15
Sta.16
APL
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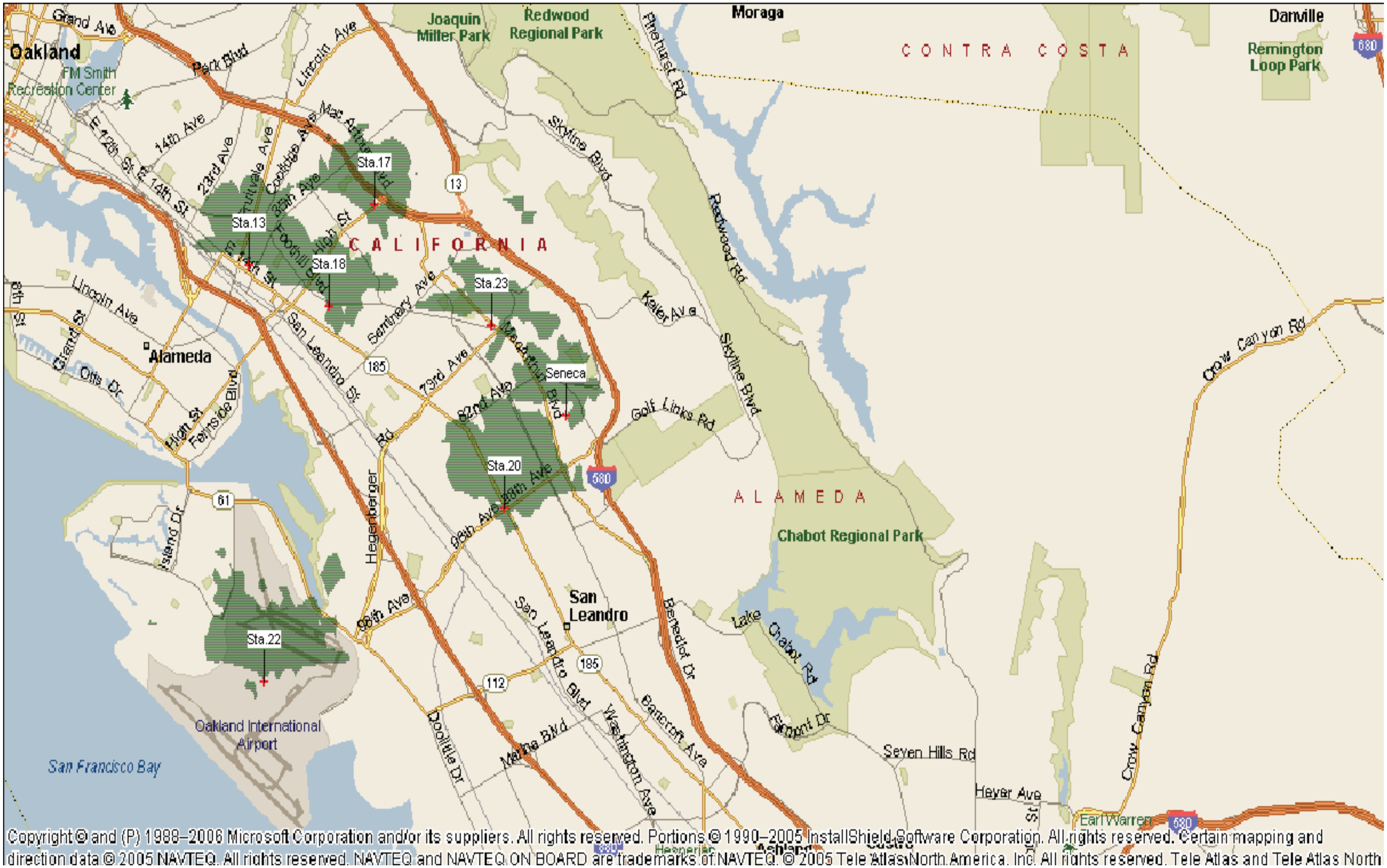
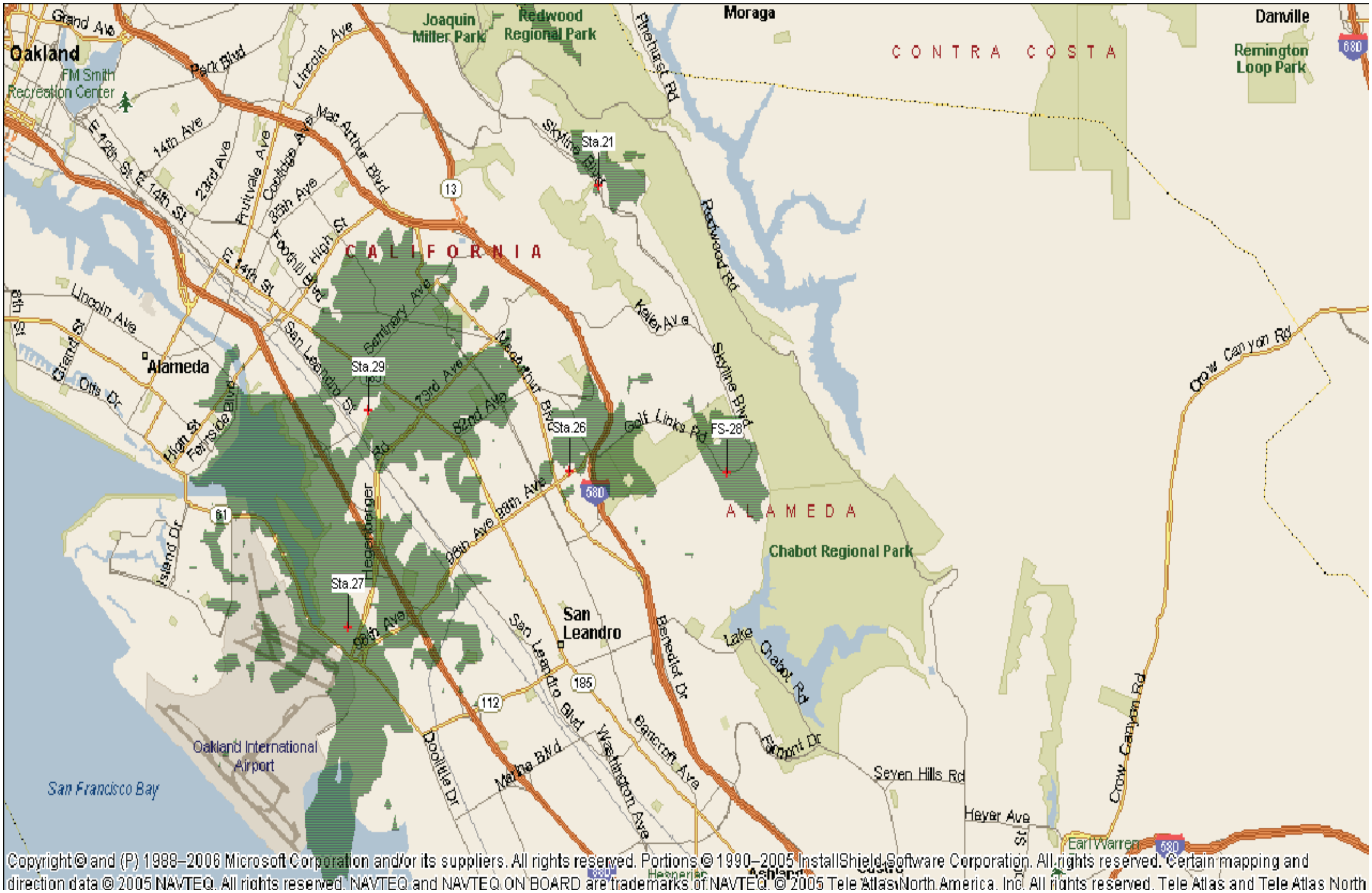
# Seneca – 2.4 GHz

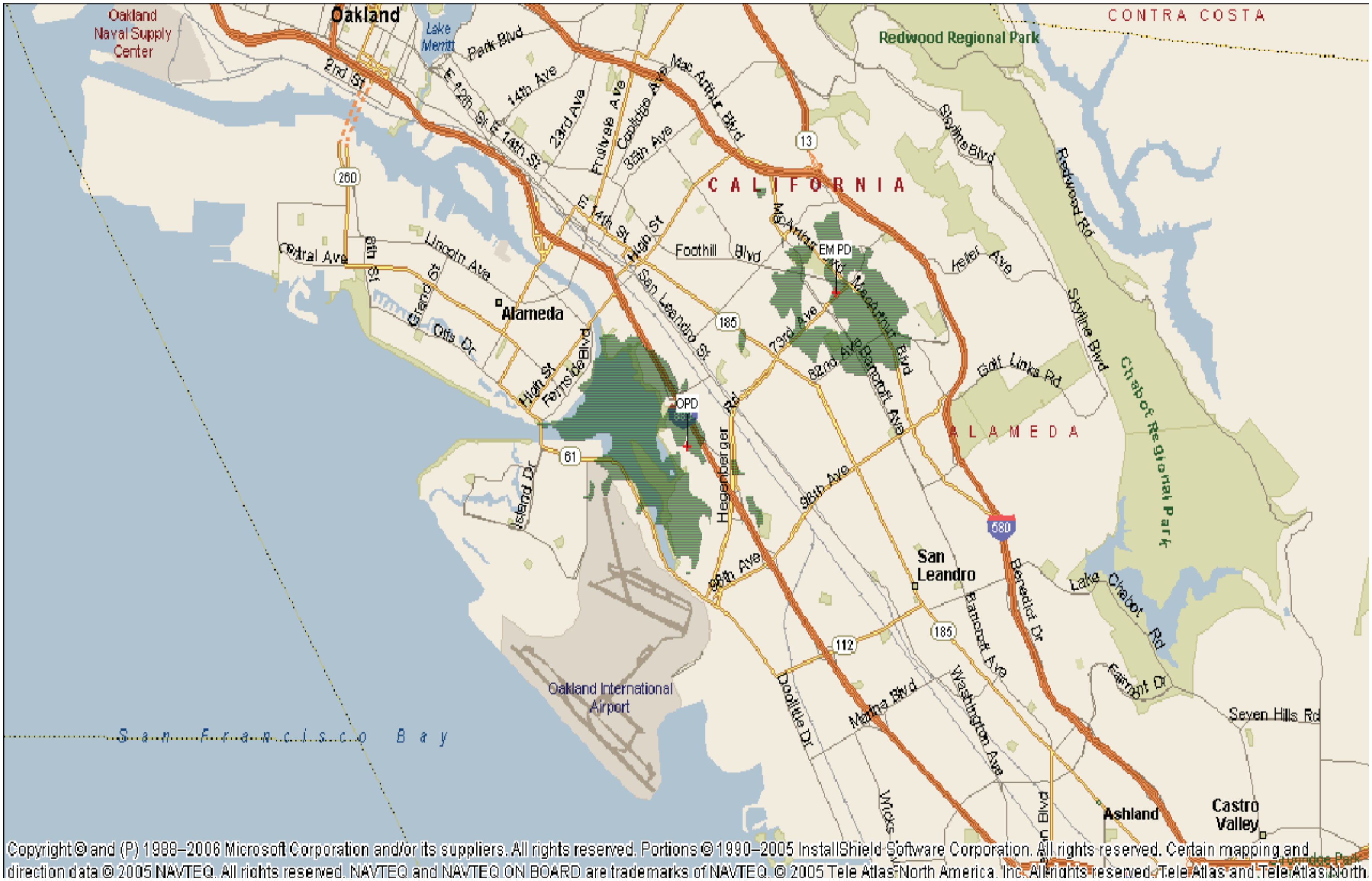


# FS 28 - 2.4 GHz



Oakland
Moraga
Danville
CONTRA COSTA
CALIFORNIA
ALAMEDA
Joaquin Miller Park
Redwood Regional Park
Remington Loop Park
Chabot Regional Park
FM Smith Recreation Center
Alameda
San Leandro
Oakland International Airport
San Francisco Bay
Sta.21
Sta.29
Sta.26
FS-28
Sta.27
Skyline Blvd
Redwood Rd
Keller Ave
Golf Links Rd
MacArthur Blvd
Seminary Ave
73rd Ave
82nd Ave
98th Ave
Hegenberger Rd
San Leandro Blvd
Doolittle Dr
Marina Blvd
Washington Ave
Bancroft Ave
Benedict Dr
Lake Chabot Rd
Fairmont Dr
Seven Hills Rd
Heyer Ave
Crow Canyon Rd
Earl Warren
Lincoln Ave
Park Blvd
14th Ave
23rd Ave
Fruitvale Ave
Coolidge Ave
35th Ave
High St
Foothill Blvd
E 12th St
E 14th St
Otis Dr
Island Dr
Fernside Blvd

# OPD – 2.4 GHz


Oakland
Oakland Naval Supply Center
Lake Merritt
Park Blvd
14th Ave
23rd Ave
Fruitvale Ave
Coolidge Ave
35th Ave
Mac Arthur Blvd
13
CALIFORNIA
Redwood Regional Park
CONTRA COSTA
Skyline Blvd
Redwood Rd
Keller Ave
Foothill Blvd
EM PD
260
Central Ave
8th St
Lincoln Ave
Grand St
Otis Dr
Alameda
High St
Fernside Blvd
San Leandro St
185
73rd Ave
82nd Ave
Bancroft Ave
Golf Links Rd
Chabot Regional Park
ALAMEDA
OPD
61
Hegenberger Rd
98th Ave
Island Dr
580
San Leandro
Benedict Dr
Lake Chabot Rd
Fairmont Dr
Seven Hills Rd
112
Doolittle Dr
Marina Blvd
Washington Ave
Wicks
Ashland
Castro Valley
Oakland International Airport
San Francisco Bay
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# Oakland Reference Architecture

## Coverage Maps

## 700 MHz

# 700 MHz Assumptions

- Maps are for informational purposes only.
- Do not assume a particular system design, other than frequency band.
- Maps do not account for subscriber density or multi channel access points.
- Maps are based on Talk Back – Subscriber Unit to Base Station.
- All maps are based upon a reliability of approximately 95% Area Reliability.

# Map Legend – 700 MHz

Mobile Device to Base Station = -95 dBm

# Composite – 700 MHz

# Gwinnett – 700 MHz

# DIT – 700 MHz


San Rafael
San Pablo Bay
El Sobrante
San Pablo
Pleasant Hill
Clayton
Richmond
El Cerrito
Kensington
Albany
Berkeley
Orinda
Lafayette
Walnut Creek
Shell Ridge Recreation Area
Mount Diablo State Park
C O N T R A C O S T A
M A R I N
Mt Tamalpais State Park
Golden Gate N.R.A.
Sausalito
Tiburon
Angel Island
Alcatraz
Treasure Island
Emeryville
DIT
Oakland
Piedmont
Moraga
Alamo
Danville
C A L I F O R N I A
Las Trampas Regional Park
San Francisco
Pacific Ocean
Alameda
San Leandro
San Ramon
Chabot Regional Park
A L A M E D A
Castro Valley
Dublin
Pleasanton
Daly City
South San Francisco
Brisbane
San Francisco Bay
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# APL – 700 MHz


San Rafael
Kentfield
Ross
Greenbrae
Larkspur
MARIN
Corte Madera
Mill Valley
Bolinas
Stinson Beach
Mt Tamalpais State Park
Tiburon
Sausalito
Paradise Cay
Golden Gate N.R.A.
Angel Island
Alcatraz
Treasure Island
Golden Gate
San Pablo Bay
El Sobrante
San Pablo
Richmond
El Cerrito
Kensington
Albany
Berkeley
Orinda
Emeryville
Golden Gate Recreation Center
Piedmont
APL
Oakland
Alameda
San Leandro
San Francisco
Mission Creek Park
Pacific Ocean
Junipero Serra Playground
Daly City
Broadmoor
Brisbane
South San Francisco
San Francisco Bay
CONTRA COSTA
Pleasant Hill
Walnut Creek
Lafayette
Moraga
Shell Ridge Recreation Area
Mount Diablo State Park
Mount Diablo
Alamo
Diablo
CALIFORNIA
Danville
Las Trampas Regional Park
Tassajara
San Ramon
Hidden Hills Park
Carter Verdes Recreation Center
Chabot Regional Park
ALAMEDA
Ashland
Castro Valley
San Lorenzo
Hayward
Five Canyons Park
Dublin
Pleasanton
Memorial Park and Plunge
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# Seneca – 700 MHz

# FS 28 – 700 MHz


FS-28
Pacific Ocean
San Francisco
Oakland
San Leandro
Hayward
Castro Valley
San Lorenzo
Foster City
Union City
Fremont
Newark
Dublin
Livermore
Pleasanton
San Ramon
Danville
Walnut Creek
Concord
Richmond
Berkeley
Vallejo
San Rafael
Novato
Point Reyes National Seashore
Farallon Islands
MARIN
SOLANO
CONTRA COSTA
ALAMEDA
CALIFORNIA
SONOMA
SACRAMENTO
SAN JOAQUIN
SAN MATEO
San Pablo Bay
Suisun Bay
San Francisco Bay
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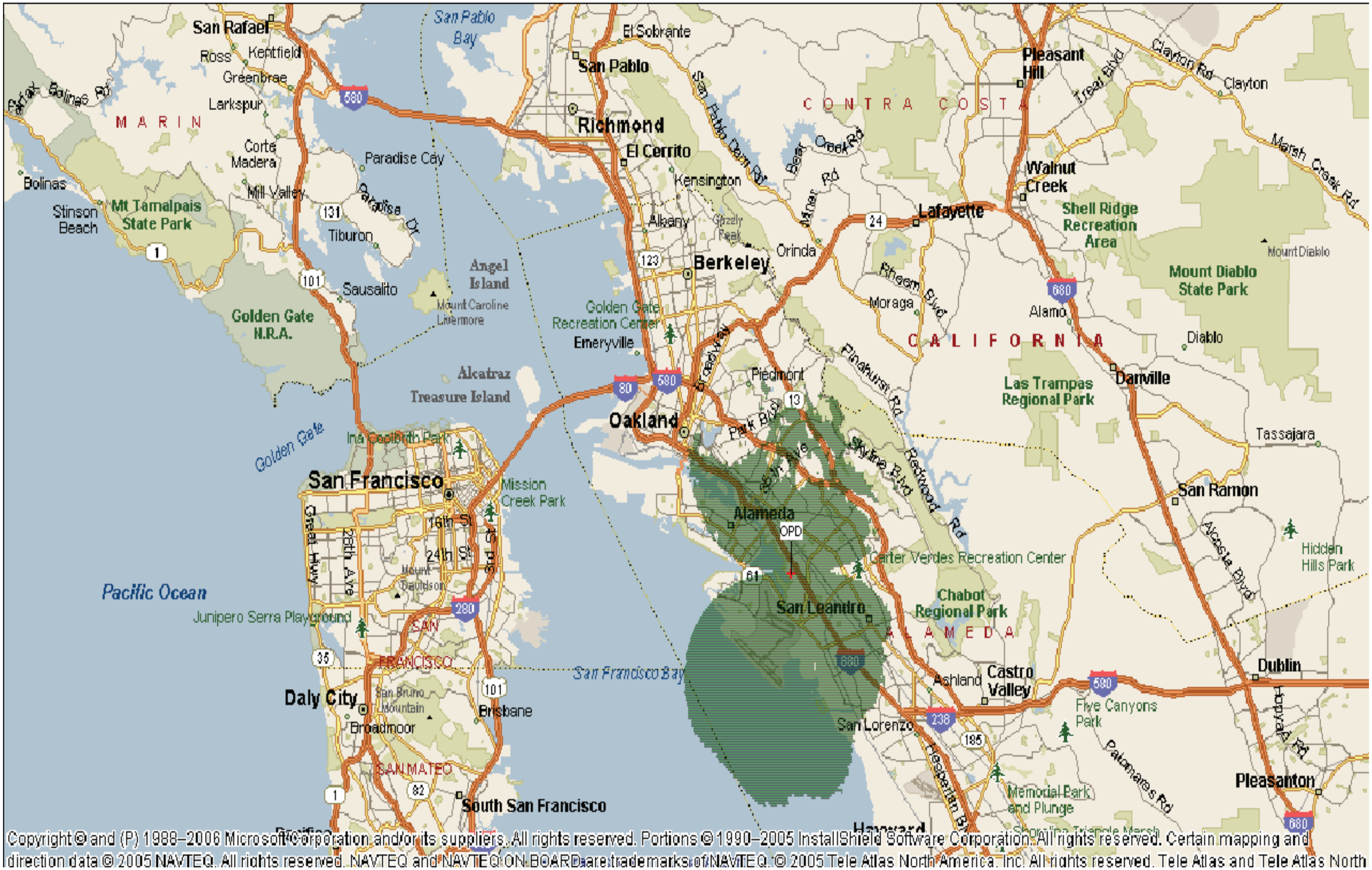
# OPD – 700 MHz



San Rafael
Ross
Kentfield
Greenbrae
Larkspur
MARIN
Corte Madera
Mill Valley
Bolinas
Stinson Beach
Mt Tamalpais State Park
Tiburon
Sausalito
Paradise Cay
Golden Gate N.R.A.
Angel Island
Alcatraz
Treasure Island
Golden Gate
San Pablo Bay
El Sobrante
San Pablo
Richmond
El Cerrito
Kensington
Albany
Berkeley
Orinda
Emeryville
Golden Gate Recreation Center
Oakland
Piedmont
Alameda
OPD
San Leandro
San Lorenzo
Hayward
Ashland
Castro Valley
CONTRA COSTA
Pleasant Hill
Walnut Creek
Lafayette
Moraga
Shell Ridge Recreation Area
Mount Diablo State Park
Mount Diablo
Alamo
Diablo
CALIFORNIA
Danville
Las Trampas Regional Park
Tassajara
San Ramon
Hidden Hills Park
Dublin
Pleasanton
Chabot Regional Park
ALAMEDA
Five Canyons Park
Memorial Park and Plunge
San Francisco
Mission Creek Park
Pacific Ocean
Junipero Serra Playground
Daly City
Broadmoor
Brisbane
SAN FRANCISCO
SAN MATEO
South San Francisco
San Francisco Bay
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# 10. Appendix C: Spreadsheets

| Business Model Summary | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operating Results** | | | | | | | | | | | | |
| **Funding Source** | | | | | | | | | | | | |
| Backbone Segment (15 Mbps Base) | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 |
| Public Safety Fixed/Nomadic Segment | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 |
| **Total** | $722,928 | $722,928 | $722,928 | $722,928 | $722,928 | $722,928 | $722,928 | $722,928 | $722,928 | $722,928 | $722,928 | $722,928 |
| **Operating Expense** | | | | | | | | | | | | |
| Backbone Segment (15 Mbps Base) | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 |
| Backbone Segment (100 Mbps Increment) | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 |
| Public Safety Fixed/Nomadic Segment | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 |
| **Total** | $292,385 | $292,385 | $292,385 | $292,385 | $292,385 | $292,385 | $292,385 | $292,385 | $292,385 | $292,385 | $292,385 | $292,385 |
| **Operating Surplus/(Deficit)** | | | | | | | | | | | | |
| Backbone Segment (15 Mbps Base) | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 |
| Backbone Segment (100 Mbps Increment) | ($29,175) | ($29,175) | ($29,175) | ($29,175) | ($29,175) | ($29,175) | ($29,175) | ($29,175) | ($29,175) | ($29,175) | ($29,175) | ($29,175) |
| Public Safety Fixed/Nomadic Segment | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 |
| **Total** | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 |
| **Capital Expense** | | | | | | | | | | | | |
| Backbone Segment (15 Mbps Base) | $1,198,697 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Backbone Segment (100 Mbps Increment) | $482,998 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Public Safety Fixed/Nomadic Segment | $1,693,428 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total** | $3,375,122 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Cash Flow Analysis** | | | | | | | | | | | | |
| **Cumulative** | | | | | | | | | | | | |
| Backbone Segment (15 Mbps Base) | ($1,168,113) | ($1,137,530) | ($1,106,947) | ($1,076,364) | ($1,045,781) | ($1,015,197) | ($984,614) | ($954,031) | ($923,448) | ($892,865) | ($739,949) | ($587,033) |
| Backbone Segment (100 Mbps Increment) | ($481,590) | ($480,182) | ($478,774) | ($477,366) | ($475,958) | ($474,551) | ($473,143) | ($471,735) | ($470,327) | ($468,919) | ($461,880) | ($454,841) |
| Public Safety Fixed/Nomadic Segment | ($1,264,293) | ($835,159) | ($406,024) | $23,111 | $452,245 | $881,380 | $1,310,515 | $1,739,650 | $2,168,784 | $2,597,919 | $4,743,592 | $6,889,266 |
| **Total** | ($2,913,996) | ($2,452,871) | ($1,991,745) | ($1,530,619) | ($1,069,494) | ($608,368) | ($147,242) | $313,884 | $775,009 | $1,236,135 | $3,541,764 | $5,847,392 |
| Net Present Value | ($2,775,235) | ($5,000,061) | ($6,720,605) | ($7,979,849) | ($8,817,825) | ($9,271,799) | ($9,376,441) | ($9,163,992) | ($8,664,414) | ($7,905,535) | ($1,062,547) | $9,100,705 |

| Capital Equipment Replacement | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accumulated Equipment** | | | | | | | | | | | | |
| Backbone Segment (15 Mbps Base) | $557,274 | $557,274 | $557,274 | $557,274 | $557,274 | $557,274 | $557,274 | $557,274 | $557,274 | $557,274 | $557,274 | $557,274 |
| Backbone Segment (100 Mbps Increment) | $310,778 | $310,778 | $310,778 | $310,778 | $310,778 | $310,778 | $310,778 | $310,778 | $310,778 | $310,778 | $310,778 | $310,778 |
| Public Safety Fixed/Nomadic Segment | $797,280 | $797,280 | $797,280 | $797,280 | $797,280 | $797,280 | $797,280 | $797,280 | $797,280 | $797,280 | $797,280 | $797,280 |
| **Total** | $1,665,332 | $1,665,332 | $1,665,332 | $1,665,332 | $1,665,332 | $1,665,332 | $1,665,332 | $1,665,332 | $1,665,332 | $1,665,332 | $1,665,332 | $1,665,332 |
| | | | | | | | | | | | | |
| Accumulated replacement needs | $166,533 | $333,066 | $499,600 | $666,133 | $832,666 | $999,199 | $1,165,732 | $1,332,266 | $1,498,799 | $1,665,332 | $2,497,998 | $3,330,664 |
| Net Present Value | ($2,775,235) | ($5,000,061) | ($6,720,605) | ($7,979,849) | ($8,817,825) | ($9,271,799) | ($9,376,441) | ($9,163,992) | ($8,664,414) | ($7,905,535) | ($1,062,547) | $9,100,705 |
| Nominal surplus/(deficit) | ($2,941,768) | ($5,333,127) | ($7,220,205) | ($8,645,982) | ($9,650,491) | ($10,270,998) | ($10,542,174) | ($10,496,258) | ($10,163,213) | ($9,570,867) | ($3,560,545) | $5,770,041 |

## Cash Flow Analysis Detail

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Backbone Segment (15 Mbps Base)** | | | | | | | | | | | | |
| Funding Source | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 |
| Operating Expense | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 |
| Operating Surplus/(Deficit) | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 |
| Capital Expense | $1,198,697 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($1,168,113) | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 |
| Cumulative Cash Flow | ($1,168,113) | ($1,137,530) | ($1,106,947) | ($1,076,364) | ($1,045,781) | ($1,015,197) | ($984,614) | ($954,031) | ($923,448) | ($892,865) | ($739,949) | ($587,033) |
| Net Present Value | ($1,112,489) | ($1,084,749) | ($1,058,330) | ($1,033,169) | ($1,009,207) | ($986,385) | ($964,650) | ($943,950) | ($924,236) | ($905,461) | ($824,173) | ($760,482) |
| **Backbone Segment (100 Mbps Increment)** | | | | | | | | | | | | |
| Base Surplus/(Deficit) | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 |
| Operating Expense | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 |
| Operating Surplus/(Deficit) | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 |
| Capital Expense | $482,998 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($481,590) | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 |
| Cumulative Cash Flow | ($481,590) | ($480,182) | ($478,774) | ($477,366) | ($475,958) | ($474,551) | ($473,143) | ($471,735) | ($470,327) | ($468,919) | ($461,880) | ($454,841) |
| Net Present Value | ($458,657) | ($457,380) | ($456,164) | ($455,006) | ($453,902) | ($452,852) | ($451,851) | ($450,898) | ($449,991) | ($449,127) | ($445,385) | ($442,453) |
| **Public Safety Fixed/Nomadic Segment** | | | | | | | | | | | | |
| Funding Source | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 |
| Operating Expense | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 |
| Operating Surplus/(Deficit) | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 |
| Capital Expense | $1,693,428 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($1,264,293) | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 |
| Cumulative Cash Flow | ($1,264,293) | ($835,159) | ($406,024) | $23,111 | $452,245 | $881,380 | $1,310,515 | $1,739,650 | $2,168,784 | $2,597,919 | $4,743,592 | $6,889,266 |
| Net Present Value | ($1,204,089) | ($814,851) | ($444,148) | ($91,098) | $245,140 | $565,367 | $870,345 | $1,160,800 | $1,437,424 | $1,700,876 | $2,841,483 | $3,735,178 |

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operating Results Detail** | | | | | | | | | | | | |
| **Backbone Segment (15 Mbps Base)** | | | | | | | | | | | | |
| **Funding Source** | | | | | | | | | | | | |
| Commercial carrier cost offsets | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 |
| **Total** | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 | $115,728 |
| **Operating Expense** | | | | | | | | | | | | |
| Equipment maintenance | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 |
| Site support & power | $3,680 | $3,680 | $3,680 | $3,680 | $3,680 | $3,680 | $3,680 | $3,680 | $3,680 | $3,680 | $3,680 | $3,680 |
| NOC operations | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 | $11,385 |
| IT support services | $3,795 | $3,795 | $3,795 | $3,795 | $3,795 | $3,795 | $3,795 | $3,795 | $3,795 | $3,795 | $3,795 | $3,795 |
| Engineering support | $1,518 | $1,518 | $1,518 | $1,518 | $1,518 | $1,518 | $1,518 | $1,518 | $1,518 | $1,518 | $1,518 | $1,518 |
| Legal & regulatory | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 |
| General & administrative | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 | $759 |
| Equipment replacement | $47,264 | $47,264 | $47,264 | $47,264 | $47,264 | $47,264 | $47,264 | $47,264 | $47,264 | $47,264 | $47,264 | $47,264 |
| Software upgrades & licensing | $4,600 | $4,600 | $4,600 | $4,600 | $4,600 | $4,600 | $4,600 | $4,600 | $4,600 | $4,600 | $4,600 | $4,600 |
| **Total** | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 | $85,145 |
| **Operating Surplus/(Deficit)** | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 | $30,583 |
| **Backbone Segment (100 Mbps Increment)** | | | | | | | | | | | | |
| Operating Expense | | | | | | | | | | | | |
| Equipment maintenance | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 |
| Site support & power | $575 | $575 | $575 | $575 | $575 | $575 | $575 | $575 | $575 | $575 | $575 | $575 |
| NOC operations | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 | $863 |
| IT support services | $288 | $288 | $288 | $288 | $288 | $288 | $288 | $288 | $288 | $288 | $288 | $288 |
| Engineering support | $115 | $115 | $115 | $115 | $115 | $115 | $115 | $115 | $115 | $115 | $115 | $115 |
| Legal & regulatory | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 |
| General & administrative | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 | $58 |
| Equipment replacement | $26,358 | $26,358 | $26,358 | $26,358 | $26,358 | $26,358 | $26,358 | $26,358 | $26,358 | $26,358 | $26,358 | $26,358 |
| Software upgrades & licensing | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total** | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 | $29,175 |
| **Operating Surplus/(Deficit)** | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 | $1,408 |

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Public Safety Fixed/Nomadic Segment** | | | | | | | | | | | | |
| **Funding Source** | | | | | | | | | | | | |
| Commercial carrier cost offsets | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 |
| **Total** | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 | $607,200 |
| | | | | | | | | | | | | |
| **Operating Expense** | | | | | | | | | | | | |
| Equipment maintenance | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 |
| Site support & power | $22,540 | $22,540 | $22,540 | $22,540 | $22,540 | $22,540 | $22,540 | $22,540 | $22,540 | $22,540 | $22,540 | $22,540 |
| NOC operations | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 | $33,810 |
| IT support services | $11,270 | $11,270 | $11,270 | $11,270 | $11,270 | $11,270 | $11,270 | $11,270 | $11,270 | $11,270 | $11,270 | $11,270 |
| Engineering support | $4,508 | $4,508 | $4,508 | $4,508 | $4,508 | $4,508 | $4,508 | $4,508 | $4,508 | $4,508 | $4,508 | $4,508 |
| Legal & regulatory | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 |
| General & administrative | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 | $2,254 |
| Equipment replacement | $67,619 | $67,619 | $67,619 | $67,619 | $67,619 | $67,619 | $67,619 | $67,619 | $67,619 | $67,619 | $67,619 | $67,619 |
| **Total** | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 | $178,065 |
| | | | | | | | | | | | | |
| **Operating Surplus/(Deficit)** | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 | $429,135 |

| General Government Alternatives | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Funding Source** | | | | | | | | | | | | |
| General Government Fixed Segment | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 |
| General Government Nomadic Segment | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 |
| **Total** | $5,370,885 | $5,370,885 | $5,370,885 | $5,370,885 | $5,370,885 | $5,370,885 | $5,370,885 | $5,370,885 | $5,370,885 | $5,370,885 | $5,370,885 | $5,370,885 |
| **Operating Expense** | | | | | | | | | | | | |
| General Government Fixed Segment | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 |
| General Government Nomadic Segment | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 |
| **Total** | $307,496 | $307,496 | $307,496 | $307,496 | $307,496 | $307,496 | $307,496 | $307,496 | $307,496 | $307,496 | $307,496 | $307,496 |
| **Operating Surplus/(Deficit)** | | | | | | | | | | | | |
| General Government Fixed Segment | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 |
| General Government Nomadic Segment | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 |
| **Total** | $5,063,389 | $5,063,389 | $5,063,389 | $5,063,389 | $5,063,389 | $5,063,389 | $5,063,389 | $5,063,389 | $5,063,389 | $5,063,389 | $5,063,389 | $5,063,389 |
| **Capital Expense** | | | | | | | | | | | | |
| General Government Fixed Segment | $1,966,369 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| General Government Nomadic Segment | $751,113 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Total** | $2,717,482 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Cash Flow Analysis** | | | | | | | | | | | | |
| General Government Fixed Segment | ($1,565,316) | ($1,164,264) | ($763,212) | ($362,160) | $38,893 | $439,945 | $840,997 | $1,242,050 | $1,643,102 | $2,044,154 | $4,049,416 | $6,054,677 |
| General Government Nomadic Segment | $3,911,223 | $8,573,560 | $13,235,897 | $17,898,234 | $22,560,570 | $27,222,907 | $31,885,244 | $36,547,581 | $41,209,917 | $45,872,254 | $69,183,938 | $92,495,621 |
| **Total** | $2,345,907 | $7,409,296 | $12,472,685 | $17,536,074 | $22,599,463 | $27,662,852 | $32,726,241 | $37,789,630 | $42,853,019 | $47,916,408 | $73,233,353 | $98,550,298 |
| Net present value | $2,234,197 | $8,954,647 | $19,729,022 | $34,155,993 | $51,863,264 | $72,505,710 | $95,763,639 | $121,341,148 | $148,964,586 | $178,381,104 | $344,801,636 | $527,920,340 |
| **Cash Flow Analysis Detail** | | | | | | | | | | | | |
| **General Government Fixed Segment** | | | | | | | | | | | | |
| Funding Source | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 |
| Operating Expense | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 |
| Operating Surplus/(Deficit) | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 |
| Capital Expense | $1,966,369 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($1,565,316) | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 |
| Cumulative Cash Flow | ($1,565,316) | ($1,164,264) | ($763,212) | ($362,160) | $38,893 | $439,945 | $840,997 | $1,242,050 | $1,643,102 | $2,044,154 | $4,049,416 | $6,054,677 |
| Net Present Value | ($1,490,778) | ($1,127,011) | ($780,567) | ($450,621) | ($136,386) | $162,886 | $447,906 | $719,354 | $977,876 | $1,224,087 | $2,290,054 | $3,125,266 |

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **General Government Nomadic Segment** | | | | | | | | | | | | |
| Funding Source | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 |
| Operating Expense | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 |
| Operating Surplus/(Deficit) | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 |
| | | | | | | | | | | | | |
| Capital Expense | $751,113 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | $3,911,223 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 |
| | | | | | | | | | | | | |
| Cumulative Cash Flow | $3,911,223 | $8,573,560 | $13,235,897 | $17,898,234 | $22,560,570 | $27,222,907 | $31,885,244 | $36,547,581 | $41,209,917 | $45,872,254 | $69,183,938 | $92,495,621 |
| Net Present Value | $3,724,975 | $7,953,852 | $11,981,353 | $15,817,069 | $19,470,132 | $22,949,240 | $26,262,675 | $29,418,328 | $32,423,712 | $35,285,982 | $47,678,115 | $57,387,675 |
| | | | | | | | | | | | | |
| **Operating Results Detail** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **General Government Fixed Segment** | | | | | | | | | | | | |
| **Funding Source** | | | | | | | | | | | | |
| Commercial carrier cost offsets | $88,981 | $88,981 | $88,981 | $88,981 | $88,981 | $88,981 | $88,981 | $88,981 | $88,981 | $88,981 | $88,981 | $88,981 |
| Market value of new facilities | $230,124 | $230,124 | $230,124 | $230,124 | $230,124 | $230,124 | $230,124 | $230,124 | $230,124 | $230,124 | $230,124 | $230,124 |
| Performance measure & efficiency gains | $304,914 | $304,914 | $304,914 | $304,914 | $304,914 | $304,914 | $304,914 | $304,914 | $304,914 | $304,914 | $304,914 | $304,914 |
| **Total** | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 | $624,019 |
| | | | | | | | | | | | | |
| **Operating Expense** | | | | | | | | | | | | |
| Equipment maintenance | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 |
| Site support & power | $34,615 | $34,615 | $34,615 | $34,615 | $34,615 | $34,615 | $34,615 | $34,615 | $34,615 | $34,615 | $34,615 | $34,615 |
| NOC operations | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 | $51,923 |
| IT support services | $17,308 | $17,308 | $17,308 | $17,308 | $17,308 | $17,308 | $17,308 | $17,308 | $17,308 | $17,308 | $17,308 | $17,308 |
| Engineering support | $6,923 | $6,923 | $6,923 | $6,923 | $6,923 | $6,923 | $6,923 | $6,923 | $6,923 | $6,923 | $6,923 | $6,923 |
| Legal & regulatory | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 |
| General & administrative | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 | $3,462 |
| Equipment replacement | $53,353 | $53,353 | $53,353 | $53,353 | $53,353 | $53,353 | $53,353 | $53,353 | $53,353 | $53,353 | $53,353 | $53,353 |
| **Total** | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 | $222,967 |
| | | | | | | | | | | | | |
| **Operating Surplus/(Deficit)** | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 | $401,052 |

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **General Government Nomadic Segment** | | | | | | | | | | | | |
| **Funding Source** | | | | | | | | | | | | |
| Market value of new facilities | $53,400 | $53,400 | $53,400 | $53,400 | $53,400 | $53,400 | $53,400 | $53,400 | $53,400 | $53,400 | $53,400 | $53,400 |
| Tax revenue enhancement | $2,504,252 | $2,504,252 | $2,504,252 | $2,504,252 | $2,504,252 | $2,504,252 | $2,504,252 | $2,504,252 | $2,504,252 | $2,504,252 | $2,504,252 | $2,504,252 |
| Performance measure & efficiency gains | $2,189,214 | $2,189,214 | $2,189,214 | $2,189,214 | $2,189,214 | $2,189,214 | $2,189,214 | $2,189,214 | $2,189,214 | $2,189,214 | $2,189,214 | $2,189,214 |
| **Total** | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 | $4,746,866 |
| **Operating Expense** | | | | | | | | | | | | |
| Equipment maintenance | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 |
| Site support & power | $9,890 | $9,890 | $9,890 | $9,890 | $9,890 | $9,890 | $9,890 | $9,890 | $9,890 | $9,890 | $9,890 | $9,890 |
| NOC operations | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 | $14,835 |
| IT support services | $4,945 | $4,945 | $4,945 | $4,945 | $4,945 | $4,945 | $4,945 | $4,945 | $4,945 | $4,945 | $4,945 | $4,945 |
| Engineering support | $1,978 | $1,978 | $1,978 | $1,978 | $1,978 | $1,978 | $1,978 | $1,978 | $1,978 | $1,978 | $1,978 | $1,978 |
| Legal & regulatory | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 |
| General & administrative | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 | $989 |
| Equipment replacement | $36,068 | $36,068 | $36,068 | $36,068 | $36,068 | $36,068 | $36,068 | $36,068 | $36,068 | $36,068 | $36,068 | $36,068 |
| | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 | $84,529 |
| **Operating Surplus/(Deficit)** | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 | $4,662,337 |

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BayRICS 700 MHz Scenarios** | | | | | | | | | | | | |
| Total network operating surplus/defiicit | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 | $430,543 |
| Operating Expense | $55,032 | $55,032 | $55,032 | $55,032 | $55,032 | $55,032 | $55,032 | $55,032 | $55,032 | $55,032 | $55,032 | $55,032 |
| Operating Surplus/(Deficit) | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 |
| Total network capex | $3,375,122 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| BayRICS 700 MHz scenario capex | $934,275 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total capex | $4,309,397 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($3,933,886) | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 | $375,511 |
| Cumulative Cash Flow | ($3,933,886) | ($3,558,376) | ($3,182,865) | ($2,807,354) | ($2,431,844) | ($2,056,333) | ($1,680,822) | ($1,305,311) | ($929,801) | ($554,290) | $1,323,264 | $3,200,817 |
| Net Present Value | ($3,746,559) | ($3,405,959) | ($3,081,579) | ($2,772,645) | ($2,478,423) | ($2,198,211) | ($1,931,343) | ($1,677,182) | ($1,435,125) | ($1,204,594) | ($206,515) | $575,506 |
| **Business & Entrepreneurship Scenario** | | | | | | | | | | | | |
| **Business and Entrepreneurship Opportunities** | | | | | | | | | | | | |
| Wholesale service income | $108,000 | $108,000 | $108,000 | $108,000 | $108,000 | $108,000 | $108,000 | $108,000 | $108,000 | $108,000 | $108,000 | $108,000 |
| Operating Expense | $94,209 | $94,209 | $94,209 | $94,209 | $94,209 | $94,209 | $94,209 | $94,209 | $94,209 | $94,209 | $94,209 | $94,209 |
| Operating Surplus/(Deficit) | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 |
| BEO capex | $129,164 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($115,373) | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 | $13,791 |
| Cumulative Cash Flow | ($115,373) | ($101,582) | ($87,792) | ($74,001) | ($60,210) | ($46,420) | ($32,629) | ($18,838) | ($5,048) | $8,743 | $77,696 | $146,650 |
| Net Present Value | ($109,879) | ($97,371) | ($85,458) | ($74,112) | ($63,307) | ($53,016) | ($43,215) | ($33,881) | ($24,991) | ($16,525) | $20,129 | $48,849 |

| Public Access Scenarios | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 15 | Year 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Drinking Fountain Model 1** | | | | | | | | | | | | |
| Discounted Market Value of New Facilities E | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 |
| Operating Expense | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 |
| Operating Surplus/(Deficit) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) |
| DFM capex | $593,193 | $790,924 | $593,193 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($628,852) | ($826,583) | ($628,852) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) |
| Cumulative Cash Flow | ($628,852) | ($1,455,435) | ($2,084,287) | ($2,119,946) | ($2,155,605) | ($2,191,264) | ($2,226,923) | ($2,262,581) | ($2,298,240) | ($2,333,899) | ($2,512,194) | ($2,690,488) |
| Net Present Value | ($598,907) | ($1,348,642) | ($1,891,868) | ($1,921,205) | ($1,949,144) | ($1,975,753) | ($2,001,095) | ($2,025,231) | ($2,048,217) | ($2,070,108) | ($2,164,887) | ($2,239,148) |
| **Drinking Fountain Model 2** | | | | | | | | | | | | |
| Discounted Market Value of New Facilities E | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 | $752,400 |
| Operating Expense | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 | $788,059 |
| Operating Surplus/(Deficit) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) |
| DFM capex | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Total | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) | ($35,659) |
| Cumulative Cash Flow | ($35,659) | ($71,318) | ($106,977) | ($142,635) | ($178,294) | ($213,953) | ($249,612) | ($285,271) | ($320,930) | ($356,589) | ($534,883) | ($713,177) |
| Net Present Value | ($33,961) | ($66,304) | ($97,108) | ($126,445) | ($154,384) | ($180,993) | ($206,336) | ($230,471) | ($253,457) | ($275,348) | ($370,127) | ($444,388) |

## Expense Summary

**Capital Expense**

| **Core Segments** | **Units** | **Units Cost** | **Installation** | **Licensing** | **Towers** | **Tower Cost** | **installation** | **Network** | **Installation** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|
| Backbone Segment (15 Mbps Base) | 66 | $613,267 | $157,680 | $74,400 | 35 | $77,438 | $31,500 | $208,713 | $35,700 | $1,198,697 |
| Backbone Segment (100 Mbps Increment) | 41 | $367,685 | $0 | $0 | 0 | $0 | $0 | $90,713 | $24,600 | $482,998 |
| 4.9 GHz Public Safety Fixed/Nomadic Segment | 196 | $1,175,988 | $282,240 | $235,200 | 0 | $0 | $0 | $0 | $0 | $1,693,428 |
| **Scenarios & alternatives** | | | | | | | | | | |
| General Government Fixed Segment | 301 | $682,294 | $435,600 | $190,800 | 111 | $245,588 | $99,900 | $245,588 | $66,600 | $1,966,369 |
| General Government Nomadic Segment | 86 | $627,273 | $123,840 | $0 | 0 | $0 | $0 | $0 | $0 | $751,113 |
| BayRICS 700 MHz Scenario | 6 | $885,000 | $18,000 | $14,400 | 0 | $0 | $0 | $13,275 | $3,600 | $934,275 |
| Business and Entrepreneurship Opportunities | 32 | $83,084 | $46,080 | $0 | 0 | $0 | $0 | $0 | $0 | $129,164 |
| Drinking Fountain Model Public Access | 647 | $927,130 | $931,680 | $0 | 20 | $44,250 | $18,000 | $44,250 | $12,000 | $1,977,310 |
| **Total** | 1,375 | $5,361,721 | $1,995,120 | $514,800 | 166 | $367,275 | $149,400 | $602,538 | $142,500 | $9,133,353 |

**Operating Expense**

| **Core Segments** | **Annual** |
|---|---|
| Backbone Segment (15 Mbps Base) | $85,145 |
| Backbone Segment (100 Mbps Increment) | $29,175 |
| 4.9 GHz Public Safety Fixed/Nomadic Segment | $178,065 |
| **Scenarios & alternatives** | |
| General Government Fixed Segment | $222,967 |
| General Government Nomadic Segment | $84,529 |
| BayRICS 700 MHz Scenario | $55,032 |
| Business and Entrepreneurship Opportunities | $94,209 |
| Drinking Fountain Model Public Access | $788,059 |
| **Total** | $1,537,181 |

[redacted]

**Backbone Segment (15 Mbps Base)**

| Point 1 | Point 2 | Bandwidth | Units | Units Cost | Installation | Licensing | Towers | Tower Cost | installation | Network | Installation | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIT | APL | 108 | 1 | $14,642 | $3,000 | $2,000 | 2 | $3,000 | $1,500 | $1,500 | $500 | $26,142 |
| DIT | Gwinett | 108 | 1 | $14,642 | $3,000 | $2,000 | 2 | $3,000 | $1,500 | $1,500 | $500 | $26,142 |
| DIT | Seneca | 108 | 1 | $14,642 | $3,000 | $2,000 | 2 | $3,000 | $1,500 | $1,500 | $500 | $26,142 |
| DIT | FS-28 | 108 | 1 | $14,642 | $3,000 | $2,000 | 2 | $3,000 | $1,500 | $1,500 | $500 | $26,142 |
| DIT | Edgewater | 108 | 1 | $14,642 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $23,892 |
| DIT | Eastmont PD | 108 | 1 | $14,642 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $23,892 |
| DIT | FS-1/EOC | 108 | 1 | $14,642 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $23,892 |
| APL | Station 2 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| APL | Station 3 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| APL | Station 4 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| APL | Station 5 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| APL | Station 12 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| APL | Station 15 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| APL | Station 16 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Gwinett | Station 6 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Gwinett | Station 7 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Gwinett | Station 8 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Gwinett | Station 10 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Gwinett | Station 19 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Gwinett | Station 24 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Gwinett | Station 25 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Seneca | Station 13 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Seneca | Station 17 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Seneca | Station 18 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Seneca | Station 20 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Seneca | Station 22 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Seneca | Station 23 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| FS-28 | Station 21 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| FS-28 | Station 26 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| FS-28 | Station 27 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| FS-28 | Station 29 | 15 | 1 | $6,460 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $15,710 |
| Backbone WiFi access | 2.4 GHz - access point | | 32 | $158,240 | $38,400 | $0 | 0 | $0 | $0 | $0 | $0 | $196,640 |
| NOC hardware | Terminals & networking | | 1 | | | | | | | $55,000 | $2,750 | $57,750 |
| NOC software | OSS | | 1 | | | | | | | $10,000 | $10,000 | $20,000 |
| Test equipment | Test equipment | | 1 | | | | | | | $30,000 | $1,500 | $31,500 |
| | | | | | | | | | | | | $0 |
| **Sub-total** | | 1,116 | 66 | $415,774 | $131,400 | $62,000 | 35 | $52,500 | $26,250 | $141,500 | $29,750 | $859,174 |
| Furnish | | | | $20,789 | | | | $2,625 | | $7,075 | | $30,489 |
| Engineering design | | | | $41,577 | | | | $5,250 | | $14,150 | | $60,977 |
| Project management | | | | $41,577 | $13,140 | $6,200 | | $5,250 | $2,625 | $14,150 | $2,975 | $85,917 |
| Acceptance & documentation | | | | $51,972 | | | | $6,563 | | $17,688 | | $76,222 |
| Security | | | | $41,577 | $13,140 | $6,200 | | $5,250 | $2,625 | $14,150 | $2,975 | $85,917 |
| **Total** | | 1,116 | 66 | $613,267 | $157,680 | $74,400 | 35 | $77,438 | $31,500 | $208,713 | $35,700 | $1,198,697 |

**Backbone Segment (100 Mbps Increment)**

| | Bandwidth | Units | Units Cost | Installation | Licensing | Towers | Tower Cost | installation | Network | Installation | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Option key upgrade (existing) | 311 | 7 | $7,000 | $0 | $0 | 0 | $0 | $0 | $10,500 | $3,500 | $21,000 |
| Hardware upgrade (to 108) | 108 | 24 | $196,368 | $0 | $0 | 0 | $0 | $0 | $36,000 | $12,000 | $244,368 |
| New radios (108) | 108 | 5 | $40,910 | $0 | $0 | 0 | $0 | $0 | $7,500 | $2,500 | $50,910 |
| Option key upgrade (new) | 311 | 5 | $5,000 | $0 | $0 | 0 | $0 | $0 | $7,500 | $2,500 | $15,000 |
| Other | 0 | 0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 | $0 | $0 |
| Other | 0 | 0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 | $0 | $0 |
| **Sub-total** | | 41 | $249,278 | $0 | $0 | 0 | $0 | $0 | $61,500 | $20,500 | $331,278 |
| | | | | | | | | | | | |
| Furnish | | | $12,464 | | | | $0 | | $3,075 | | $15,539 |
| Engineering design | | | $24,928 | | | | $0 | | $6,150 | | $31,078 |
| Project management | | | $24,928 | $0 | $0 | | $0 | $0 | $6,150 | $2,050 | $33,128 |
| Acceptance & documentation | | | $31,160 | | | | $0 | | $7,688 | | $38,847 |
| Security | | | $24,928 | $0 | $0 | | $0 | $0 | $6,150 | $2,050 | $33,128 |
| **Total** | | 41 | $367,685 | $0 | $0 | 0 | $0 | $0 | $90,713 | $24,600 | $482,998 |

**4.9 GHz Public Safety Fixed/Nomadic Segment**

| Location | Type | Bandwidth | Units | Units Cost | Installation | Licensing | Towers | Tower Cost | installation | Network | Installation | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIT | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| APL | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Gwinett | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Seneca | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| FS-28 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Edgewater | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Eastmont PD | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| FS-1/EOC | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 2 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 3 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 4 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 5 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 6 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 7 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 8 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 10 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 12 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 13 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 15 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 16 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 17 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 18 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 19 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 20 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 21 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 22 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 23 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 24 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 25 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 26 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 27 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Station 29 | 4.9 GHz - Base station | | 3 | $17,790 | $3,600 | $3,000 | 0 | $0 | $0 | $0 | $0 | $24,390 |
| Vehicle-mounted units | 4.9 GHz - Nomadic Sub Units | | 100 | $228,000 | $120,000 | $100,000 | 0 | $0 | $0 | $0 | $0 | $448,000 |
| Security monitoring sites | 4.9 GHz - Outdoor CPE | | 0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 | $0 | $0 |
| **Sub-total** | | | 196 | $797,280 | $235,200 | $196,000 | 0 | $0 | $0 | $0 | $0 | $1,228,480 |
| | | | | | | | | | | | | |
| Furnish | | | | $39,864 | | | | $0 | | $0 | | $39,864 |
| Engineering design | | | | $79,728 | | | | $0 | | $0 | | $79,728 |
| Project management | | | | $79,728 | $23,520 | $19,600 | | $0 | $0 | $0 | $0 | $122,848 |
| Acceptance & documentation | | | | $99,660 | | | | $0 | | $0 | | $99,660 |
| Security | | | | $79,728 | $23,520 | $19,600 | | $0 | $0 | $0 | $0 | $122,848 |
| **Total** | | | 196 | $1,175,988 | $282,240 | $235,200 | 0 | $0 | $0 | $0 | $0 | $1,693,428 |

**General Government Fixed Segment**

| Location(s) | Type | Bandwidth | Units | Units Cost | Installation | Licensing | Towers | Tower Cost | installation | Network | Installation | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DIT-Main Library DS-3 | 18 GHz - 108 Mbps | 108 | 1 | $14,642 | $3,000 | $2,000 | 1 | $1,500 | $750 | $1,500 | $500 | $23,892 |
| Security monitoring sites | 4.9 GHz - Outdoor CPE | | 157 | $177,253 | $188,400 | $157,000 | 0 | $0 | $0 | $0 | $0 | $522,653 |
| Base stations | 3.65 GHz - Access point | | 33 | $179,487 | $39,600 | $0 | 0 | $0 | $0 | $0 | $0 | $219,087 |
| Library - T1 replacement | 3.65 GHz - Outdoor CPE | | 16 | $13,264 | $19,200 | $0 | 16 | $24,000 | $12,000 | $24,000 | $8,000 | $100,464 |
| Other - T1 replacement | 3.65 GHz - Outdoor CPE | | 25 | $20,725 | $30,000 | $0 | 25 | $37,500 | $18,750 | $37,500 | $12,500 | $156,975 |
| Parks & Rec - T1 replacement | 3.65 GHz - Outdoor CPE | | 6 | $4,974 | $7,200 | $0 | 6 | $9,000 | $4,500 | $9,000 | $3,000 | $37,674 |
| Parks & Rec unwired sites | 3.65 GHz - Outdoor CPE | | 32 | $26,528 | $38,400 | $0 | 32 | $48,000 | $24,000 | $48,000 | $16,000 | $200,928 |
| Human Services unwired sites | 3.65 GHz - Outdoor CPE | | 31 | $25,699 | $37,200 | $0 | 31 | $46,500 | $23,250 | $46,500 | $15,500 | $194,649 |
| **Sub-total** | | | 301 | $462,572 | $363,000 | $159,000 | 111 | $166,500 | $83,250 | $166,500 | $55,500 | $1,456,322 |
| | | | | | | | | | | | | |
| Furnish | | | | $23,129 | | | | $8,325 | | $8,325 | | $39,779 |
| Engineering design | | | | $46,257 | | | | $16,650 | | $16,650 | | $79,557 |
| Project management | | | | $46,257 | $36,300 | $15,900 | | $16,650 | $8,325 | $16,650 | $5,550 | $145,632 |
| Acceptance & documentation | | | | $57,822 | | | | $20,813 | | $20,813 | | $99,447 |
| Security | | | | $46,257 | $36,300 | $15,900 | | $16,650 | $8,325 | $16,650 | $5,550 | $145,632 |
| **Total** | | | 301 | $682,294 | $435,600 | $190,800 | 111 | $245,588 | $99,900 | $245,588 | $66,600 | $1,966,369 |

**General Government Nomadic Segment**

| Location(s) | Type | Bandwidth | Units | Units Cost | Installation | Licensing | Towers | Tower Cost | installation | Network | Installation | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Library network sites | 2.4 GHz - access point | | 17 | $84,065 | $20,400 | $0 | 0 | $0 | $0 | $0 | $0 | $104,465 |
| Parks & Rec sites | 2.4 GHz - access point | | 38 | $187,910 | $45,600 | $0 | 0 | $0 | $0 | $0 | $0 | $233,510 |
| Human Services sites | 2.4 GHz - access point | | 31 | $153,295 | $37,200 | $0 | 0 | $0 | $0 | $0 | $0 | $190,495 |
| **Sub-total** | | | 86 | $425,270 | $103,200 | $0 | 0 | $0 | $0 | $0 | $0 | $528,470 |
| | | | | | | | | | | | | |
| Furnish | | | | $21,264 | | | | $0 | | $0 | | $21,264 |
| Engineering design | | | | $42,527 | | | | $0 | | $0 | | $42,527 |
| Project management | | | | $42,527 | $10,320 | $0 | | $0 | $0 | $0 | $0 | $52,847 |
| Acceptance & documentation | | | | $53,159 | | | | $0 | | $0 | | $53,159 |
| Security | | | | $42,527 | $10,320 | $0 | | $0 | $0 | $0 | $0 | $52,847 |
| **Total** | | | 86 | $627,273 | $123,840 | $0 | 0 | $0 | $0 | $0 | $0 | $751,113 |

**BayRICS 700 MHz Scenario**

| Location(s) | Type | Bandwidth | Units | Units Cost | Installation | Licensing | Towers | Tower Cost | installation | Network | Installation | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hub locations | 700 MHz - base station | | 6 | $600,000 | $15,000 | $12,000 | 0 | $0 | $0 | $9,000 | $3,000 | $639,000 |
| | 700 MHz - base station | | 0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 | $0 | $0 |
| | 700 MHz - base station | | 0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 | $0 | $0 |
| | 700 MHz - base station | | 0 | $0 | $0 | $0 | 0 | $0 | $0 | $0 | $0 | $0 |
| **Sub-total** | | | 6 | $600,000 | $15,000 | $12,000 | 0 | $0 | $0 | $9,000 | $3,000 | $639,000 |
| | | | | | | | | | | | | |
| Furnish | | | | $30,000 | | | | $0 | | $450 | | $30,450 |
| Engineering design | | | | $60,000 | | | | $0 | | $900 | | $60,900 |
| Project management | | | | $60,000 | $1,500 | $1,200 | | $0 | $0 | $900 | $300 | $63,900 |
| Acceptance & documentation | | | | $75,000 | | | | $0 | | $1,125 | | $76,125 |
| Security | | | | $60,000 | $1,500 | $1,200 | | $0 | $0 | $900 | $300 | $63,900 |
| **Total** | | | 6 | $885,000 | $18,000 | $14,400 | 0 | $0 | $0 | $13,275 | $3,600 | $934,275 |

**Business and Entrepreneurship Opportunities**

| Location(s) | Type | Bandwidth | Units | Units Cost | Installation | Licensing | Towers | Tower Cost | installation | Network | Installation | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hub facility | 3.65 GHz - Access point | | 2 | $10,878 | $2,400 | $0 | 0 | $0 | $0 | $0 | $0 | $13,278 |
| T-1 equivalent business circuit | 3.65 GHz - Outdoor CPE | 5 | 25 | $20,725 | $30,000 | $0 | 0 | $0 | $0 | $0 | $0 | $50,725 |
| Hotspot service | 2.4 GHz - access point | 5 | 5 | $24,725 | $6,000 | $0 | 0 | $0 | $0 | $0 | $0 | $30,725 |
| **Sub-total** | | | 32 | $56,328 | $38,400 | $0 | 0 | $0 | $0 | $0 | $0 | $94,728 |
| | | | | | | | | | | | | |
| Furnish | | | | $2,816 | | | | $0 | | $0 | | $2,816 |
| Engineering design | | | | $5,633 | | | | $0 | | $0 | | $5,633 |
| Project management | | | | $5,633 | $3,840 | $0 | | $0 | $0 | $0 | $0 | $9,473 |
| Internet bandwidth | | | | | | | | | | | | $0 |
| Acceptance & documentation | | | | $7,041 | | | | $0 | | $0 | | $7,041 |
| Security | | | | $5,633 | $3,840 | $0 | | $0 | $0 | $0 | $0 | $9,473 |
| **Total** | | | 32 | $83,084 | $46,080 | $0 | 0 | $0 | $0 | $0 | $0 | $129,164 |

**Drinking Fountain Model Public Access**

| Location(s) | Type | Bandwidth | Units | Units Cost | Installation | Licensing | Towers | Tower Cost | installation | Network | Installation | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Additional base stations | 3.65 GHz - Access point | | 20 | $108,780 | $24,000 | $0 | 20 | $30,000 | $15,000 | $30,000 | $10,000 | $217,780 |
| Schools & educational facilities | 3.65 GHz - Outdoor CPE | 5 | 200 | $165,800 | $240,000 | $0 | 0 | $0 | $0 | $0 | $0 | $405,800 |
| Community organizations | 3.65 GHz - Outdoor CPE | 5 | 80 | $66,320 | $96,000 | $0 | 0 | $0 | $0 | $0 | $0 | $162,320 |
| Neighborhood partnerships | 3.65 GHz - Outdoor CPE | 5 | 80 | $66,320 | $96,000 | $0 | 0 | $0 | $0 | $0 | $0 | $162,320 |
| Community housing | 3.65 GHz - Outdoor CPE | 5 | 267 | $221,343 | $320,400 | $0 | 0 | $0 | $0 | $0 | $0 | $541,743 |
| **Sub-total** | | | 647 | $628,563 | $776,400 | $0 | 20 | $30,000 | $15,000 | $30,000 | $10,000 | $1,489,963 |
| | | | | | | | | | | | | |
| Furnish | | | | $31,428 | | | | $1,500 | | $1,500 | | $34,428 |
| Engineering design | | | | $62,856 | | | | $3,000 | | $3,000 | | $68,856 |
| Project management | | | | $62,856 | $77,640 | $0 | | $3,000 | $1,500 | $3,000 | $1,000 | $148,996 |
| Internet bandwidth | | | | | | | | | | | | $0 |
| Acceptance & documentation | | | | $78,570 | | | | $3,750 | | $3,750 | | $86,070 |
| Security | | | | $62,856 | $77,640 | $0 | | $3,000 | $1,500 | $3,000 | $1,000 | $148,996 |
| **Total** | | | 647 | $927,130 | $931,680 | $0 | 20 | $44,250 | $18,000 | $44,250 | $12,000 | $1,977,310 |

**Capex Data**

| | Basic Unit | Antenna | Power Suppl | Mount | Cable | Unit Total | Installation | License |
|---|---|---|---|---|---|---|---|---|
| **Paired Links (2 points)** | | | | | | | | |
| 18 GHz - 15 Mbps | $4,780 | $1,500 | $0 | $125 | $55 | $6,460 | $3,000 | $2,000 |
| 18 GHz - 108 Mbps | $12,056 | $1,526 | $880 | $125 | $55 | $14,642 | $3,000 | $2,000 |
| Option key (311 Mbps) | $1,000 | $0 | $0 | $0 | $0 | $1,000 | $0 | $0 |
| **Single Units (1 point)** | | | | | | | | |
| 4.9 GHz - Base station | $5,190 | $560 | | $125 | $55 | $5,930 | $1,200 | $1,000 |
| 4.9 GHz - Outdoor CPE | $649 | $300 | | $125 | $55 | $1,129 | $1,200 | $1,000 |
| 4.9 GHz - Indoor CPE | $599 | $300 | | $125 | $55 | $1,079 | $1,200 | $1,000 |
| 4.9 GHz - Nomadic Sub Units | $1,610 | $490 | | $125 | $55 | $2,280 | $1,200 | $1,000 |
| 3.65 GHz - Base station | $5,190 | $560 | | $125 | $55 | $5,930 | $1,200 | $0 |
| 3.65 GHz - Access point | $4,699 | $560 | | $125 | $55 | $5,439 | $1,200 | $0 |
| 3.65 GHz - Outdoor CPE | $649 | $0 | | $125 | $55 | $829 | $1,200 | $0 |
| 3.65 GHz - Indoor CPE | $599 | $0 | | $125 | $55 | $779 | $1,200 | $0 |
| 3.65 GHz - Nomadic CPE | $1,610 | $490 | | $125 | $55 | $2,280 | $1,200 | $0 |
| 3.65 GHz - USB unit | $500 | $0 | | | | $500 | $0 | $0 |
| 2.4 GHz - access point | $4,595 | $0 | $0 | $250 | $100 | $4,945 | $1,200 | $0 |
| 2.4 GHz - mesh access point | | | | | | | | |
| 2.4/3.65 GHz - access point | | | | | | | | |
| 2.4/4.9 GHz - access point | $5,595 | $0 | $0 | $250 | $100 | $5,945 | $1,200 | $0 |
| 700 MHz - base station | $100,000 | $0 | $0 | $0 | $0 | $100,000 | $2,500 | $2,000 |
| Towers | | | | | | | | |
| 50 foot Rohn 25 g | $1,500 | | | | | $1,500 | $750 | $0 |
| **Network** | | | | | | | | |
| Cisco switch | $1,500 | | | | | $1,500 | $500 | $0 |
| Network total | $1,500 | $0 | $0 | $0 | $0 | $1,500 | $500 | $0 |
| **NOC & Maintenance** | | | | | | | | |
| Terminals & networking | $50,000 | | | | $5,000 | $55,000 | $2,750 | $0 |
| OSS | $10,000 | | | | | $10,000 | $10,000 | $0 |
| Test equipment | $30,000 | | | | | $30,000 | $1,500 | $0 |

### Other Capex Data

| | |
|---|---|
| Furnish & commissioning | 5% |
| Engineering design | 10% |
| Project management | 10% |
| Acceptance & documentation | 12.5% |
| Security | 10% |

| **Capital Expense Annual Rollout** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Year 6** | **Year 7** | **Year 8** | **Year 9** | **Year 10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Core Segments** | | | | | | | | | | |
| Backbone Segment (15 Mbps Base) | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Backbone Segment (100 Mbps Increment) | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 4.9 GHz Public Safety Fixed/Nomadic Segment | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| General Government Fixed Segment | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| General Government Nomadic Segment | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| **Scenarios & alternatives** | | | | | | | | | | |
| BayRICS 700 MHz Scenario | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Business and Entrepreneurship Opportunities | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Drinking Fountain Model Public Access | 30% | 40% | 30% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

| **Capital Equipment Cost** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Year 6** | **Year 7** | **Year 8** | **Year 9** | **Year 10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Core Segments** | | | | | | | | | | |
| Backbone Segment (15 Mbps Base) | $557,274 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Backbone Segment (100 Mbps Increment) | $310,778 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| 4.9 GHz Public Safety Fixed/Nomadic Segment | $797,280 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| General Government Fixed Segment | $629,072 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| General Government Nomadic Segment | $425,270 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| **Scenarios & alternatives** | | | | | | | | | | |
| BayRICS 700 MHz Scenario | $609,000 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Business and Entrepreneurship Opportunities | $56,328 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Drinking Fountain Model Public Access | $197,569 | $263,425 | $197,569 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |

| | |
|---|---|
| Cost of Capital | 5.0% |
| Anticipated equipment lifetime (years) | 10 |

## Operating Expense

### Backbone Segment (15 Mbps Base)

| Item | Unit Type | Annual Rate | Units | Unit Cost | Overhead | Total | Annual + |
|---|---|---|---|---|---|---|---|
| Equipment maintenance | Maintenance per node | | 66 | $150 | 15% | $11,385 | 0% |
| Site support & power | Site fee | | 32 | $100 | 15% | $3,680 | 0% |
| NOC operations | Op support per node | | 66 | $150 | 15% | $11,385 | 0% |
| IT support services | IT per node | | 66 | $50 | 15% | $3,795 | 0% |
| Engineering support | Engineering per node | | 66 | $20 | 15% | $1,518 | 0% |
| Legal & regulatory | Legal per node | | 66 | $10 | 15% | $759 | 0% |
| General & administrative | G&A per node | | 66 | $10 | 15% | $759 | 0% |
| Equipment replacement | Percent of hardware capex | 5% | | $821,979 | 15% | $47,264 | 0% |
| Software upgrades & licensing | Percent of software capex | 20% | | $20,000 | 15% | $4,600 | 0% |
| **Total** | | | | | | $85,145 | |

### Backbone Segment (100 Mbps Increment)

| Item | Unit Type | Annual Rate | Units | Unit Cost | Overhead | Total | Annual + |
|---|---|---|---|---|---|---|---|
| Equipment maintenance | Maintenance per node | | 5 | $150 | 15% | $863 | 0% |
| Site support & power | Site fee | | 5 | $100 | 15% | $575 | 0% |
| NOC operations | Op support per node | | 5 | $150 | 15% | $863 | 0% |
| IT support services | IT per node | | 5 | $50 | 15% | $288 | 0% |
| Engineering support | Engineering per node | | 5 | $20 | 15% | $115 | 0% |
| Legal & regulatory | Legal per node | | 5 | $10 | 15% | $58 | 0% |
| General & administrative | G&A per node | | 5 | $10 | 15% | $58 | 0% |
| Equipment replacement | Percent of hardware capex | 5% | | $458,398 | 15% | $26,358 | 0% |
| Software upgrades & licensing | Percent of software capex | 20% | | $0 | 15% | $0 | 0% |
| **Total** | | | | | | $29,175 | |

### 4.9 GHz Public Safety Fixed/Nomadic Segment

| Item | Unit Type | Annual Rate | Units | Unit Cost | Overhead | Total | Annual + |
|---|---|---|---|---|---|---|---|
| Equipment maintenance | Maintenance per node | | 196 | $150 | 15% | $33,810 | 0% |
| Site support & power | Site fee | | 196 | $100 | 15% | $22,540 | 0% |
| NOC operations | Op support per node | | 196 | $150 | 15% | $33,810 | 0% |
| IT support services | IT per node | | 196 | $50 | 15% | $11,270 | 0% |
| Engineering support | Engineering per node | | 196 | $20 | 15% | $4,508 | 0% |
| Legal & regulatory | Legal per node | | 196 | $10 | 15% | $2,254 | 0% |
| General & administrative | G&A per node | | 196 | $10 | 15% | $2,254 | 0% |
| Equipment replacement | Percent of hardware capex | 5% | | $1,175,988 | 15% | $67,619 | 0% |
| **Total** | | | | | | $178,065 | |

### General Government Fixed Segment

| Item | Unit Type | Annual Rate | Units | Unit Cost | Overhead | Total | Annual + |
|---|---|---|---|---|---|---|---|
| Equipment maintenance | Maintenance per node | | 301 | $150 | 15% | $51,923 | 0% |
| Site support & power | Site fee | | 301 | $100 | 15% | $34,615 | 0% |
| NOC operations | Op support per node | | 301 | $150 | 15% | $51,923 | 0% |
| IT support services | IT per node | | 301 | $50 | 15% | $17,308 | 0% |
| Engineering support | Engineering per node | | 301 | $20 | 15% | $6,923 | 0% |
| Legal & regulatory | Legal per node | | 301 | $10 | 15% | $3,462 | 0% |
| General & administrative | G&A per node | | 301 | $10 | 15% | $3,462 | 0% |
| Equipment replacement | Percent of hardware capex | 5% | | $927,881 | 15% | $53,353 | 0% |
| **Total** | | | | | | $222,967 | |

### General Government Nomadic Segment

| Item | Unit Type | Annual Rate | Units | Unit Cost | Overhead | Total | Annual + |
|---|---|---|---|---|---|---|---|
| Equipment maintenance | Maintenance per node | | 86 | $150 | 15% | $14,835 | 0% |
| Site support & power | Site fee | | 86 | $100 | 15% | $9,890 | 0% |
| NOC operations | Op support per node | | 86 | $150 | 15% | $14,835 | 0% |
| IT support services | IT per node | | 86 | $50 | 15% | $4,945 | 0% |
| Engineering support | Engineering per node | | 86 | $20 | 15% | $1,978 | 0% |
| Legal & regulatory | Legal per node | | 86 | $10 | 15% | $989 | 0% |
| General & administrative | G&A per node | | 86 | $10 | 15% | $989 | 0% |
| Equipment replacement | Percent of hardware capex | 5% | | $627,273 | 15% | $36,068 | 0% |
| **Total** | | | | | | $84,529 | |

### BayRICS 700 MHz Scenario

| Item | Unit Type | Annual Rate | Units | Unit Cost | Overhead | Total | Annual + |
|---|---|---|---|---|---|---|---|
| Equipment maintenance | Maintenance per node | | 6 | $150 | 15% | $1,035 | 0% |
| Site support & power | Site fee | | 6 | $100 | 15% | $690 | 0% |
| NOC operations | Op support per node | | 6 | $150 | 15% | $1,035 | 0% |
| IT support services | IT per node | | 6 | $50 | 15% | $345 | 0% |
| Engineering support | Engineering per node | | 6 | $20 | 15% | $138 | 0% |
| Legal & regulatory | Legal per node | | 6 | $10 | 15% | $69 | 0% |
| General & administrative | G&A per node | | 6 | $10 | 15% | $69 | 0% |
| Equipment replacement | Percent of hardware capex | 5% | | $898,275 | 15% | $51,651 | 0% |
| **Total** | Standard | | | | | $55,032 | 0% |

**Business and Entrepreneurship Opportunities**

| Item | Unit Type | Annual Rate | Units | Unit Cost | Overhead | Total | Annual + |
|---|---|---|---|---|---|---|---|
| Equipment maintenance | Maintenance per node | | 32 | $150 | 15% | $5,520 | 0% |
| Site support & power | Site fee | | 32 | $100 | 15% | $3,680 | 0% |
| NOC operations | Op support per node | | 32 | $150 | 15% | $5,520 | 0% |
| IT support services | IT per node | | 32 | $50 | 15% | $1,840 | 0% |
| Engineering support | Engineering per node | | 32 | $20 | 15% | $736 | 0% |
| Legal & regulatory | Legal per node | | 32 | $10 | 15% | $368 | 0% |
| General & administrative | G&A per node | | 32 | $10 | 15% | $368 | 0% |
| Internet bandwidth | DS-3 | | 1 | $60,000 | 10% | $66,000 | 0% |
| Equipment replacement | Percent of hardware capex | 5% | | $83,084 | 15% | $4,777 | 0% |
| Franchise & facilities fee | Percent of revenue | 5% | | $108,000 | 0% | $5,400 | 0% |
| **Total** | Standard | | | | | $94,209 | 0% |

**Drinking Fountain Model Public Access**

| Item | Unit Type | Annual Rate | Units | Unit Cost | Overhead | Total | Annual + |
|---|---|---|---|---|---|---|---|
| Equipment maintenance | Maintenance per node | | 647 | $150 | 15% | $111,608 | 0% |
| Site support & power | Site fee | | 647 | $100 | 15% | $74,405 | 0% |
| NOC operations | Op support per node | | 647 | $150 | 15% | $111,608 | 0% |
| IT support services | IT per node | | 647 | $50 | 15% | $37,203 | 0% |
| Engineering support | Engineering per node | | 647 | $20 | 15% | $14,881 | 0% |
| Legal & regulatory | Legal per node | | 647 | $10 | 15% | $7,441 | 0% |
| General & administrative | G&A per node | | 647 | $10 | 15% | $7,441 | 0% |
| Internet bandwidth | DS-3 | | 5 | $60,000 | 10% | $330,000 | 0% |
| Equipment replacement | Percent of hardware capex | 5% | | $971,380 | 15% | $55,854 | 0% |
| Franchise & facilities fee | Percent of revenue | 5% | | $752,400 | 0% | $37,620 | 0% |
| **Total** | Standard | | | | | $788,059 | 0% |

**Opex Data**

| | Unit Type | Annual Rate | Unit Cost | Overhead | Annual + |
|---|---|---|---|---|---|
| Equipment maintenance | Maintenance per node | | $150 | 15% | 0% |
| Site support & power | Site fee | | $100 | 15% | 0% |
| NOC operations | Op support per node | | $150 | 15% | 0% |
| IT support services | IT per node | | $50 | 15% | 0% |
| Engineering support | Engineering per node | | $20 | 15% | 0% |
| Legal & regulatory | Legal per node | | $10 | 15% | 0% |
| General & administrative | G&A per node | | $10 | 15% | 0% |
| Internet bandwidth | DS-3 | | $60,000 | 10% | 0% |
| | | **Annual Rate** | | **Overhead** | **Annual +** |
| Equipment replacement | Percent of hardware capex | 5% | | 15% | 0% |
| Software upgrades & licensing | Percent of software capex | 20% | | 15% | 0% |
| Franchise & facilities fee | Percent of revenue | 5% | | 0% | 0% |
| Totals | Standard | | | 15% | 0% |

## Annual Funding Sources

**Notes**

### Summary

| | Annual + | Base Annual |
|---|---|---|
| **Backbone Segment** | | |
| Commercial carrier cost offsets | 0% | $115,728 |
| Sub-total | | $115,728 |
| **Public Safety Fixed/Nomadic Segment** | | |
| Commercial carrier cost offsets | 0% | $607,200 |
| Sub-total | | $607,200 |
| **General Government Fixed Segment** | | |
| Commercial carrier cost offsets | 0% | $88,981 |
| Market value of new facilities | 0% | $230,124 |
| Performance measure & efficiency gains | 0% | $304,914 |
| Sub-total | | $624,019 |
| **General Government Nomadic Segment** | | |
| Market value of new facilities | 0% | $53,400 |
| Tax revenue enhancement | 0% | $2,504,252 |
| Performance measure & efficiency gains | 0% | $2,189,214 |
| Sub-total | | $4,746,866 |
| **Total Annual Funding** | | $6,093,813 |

## Commercial Carrier Cost Offsets

### Backbone Segment

| | Units | Monthly | Annual | Total | Notes |
|---|---|---|---|---|---|
| Fire Department - T1 | 26 | $115 | $1,380 | $35,880 | DIT |
| EOC - DS3 | 1 | $1,424 | $17,088 | $17,088 | DIT - EOC to Internet |
| Police Department - T1 | 2 | $115 | $1,380 | $2,760 | DIT |
| Police Department - DS3 | 2 | $2,500 | $30,000 | $60,000 | Eastmont & Edgewater to DIT |
| Total | 31 | | | $115,728 | Calc |

### General Government Fixed Segment

| | Units | Monthly | Annual | Total | Notes |
|---|---|---|---|---|---|
| Library - T1 | 16 | $115 | $1,380 | $22,080 | DIT |
| Library - DS3 | 1 | $1,424 | $17,088 | $17,088 | DIT - Main Library to Internet |
| Parks & Rec fixed lines | 1 | $1,276 | $15,313 | $15,313 | DIT |

| | | | | | |
|---|---|---|---|---|---|
| Other - T1 | 25 | $115 | $1,380 | $34,500 | DIT |
| Other - DS3 | 0 | $0 | $0 | $0 | |
| Total | 43 | | | $88,981 | Calc |

**Public Safety Nomadic**

| | Units | Monthly | Annual | Total | |
|---|---|---|---|---|---|
| Police department - data cards | 842 | $50 | $600 | $505,200 | DIT |
| Fire department - data cards | 50 | $50 | $600 | $30,000 | DIT |
| Public works - data cards | 120 | $50 | $600 | $72,000 | DIT |
| Total | | | | $607,200 | Calc |

## Market Value of New Facilities Enabled

### General Government Fixed Segment

| | Units | Monthly | Annual | Total | |
|---|---|---|---|---|---|
| Unwired Parks & Rec facilities | 32 | $115 | $1,380 | $44,160 | Reference |
| Unwired Human Services facilitie | 31 | $115 | $1,380 | $42,780 | |
| Security monitoring | 157 | $76 | $912 | $143,184 | DIT data, FY07-09 Budget |
| | | | $0 | $0 | |
| Total | | | | $230,124 | Calc |

### General Government Nomadic

| | Units | Monthly | Annual | Total | |
|---|---|---|---|---|---|
| FMA - parking enforcement | 6 | $50 | $600 | $3,600 | FY07-09 Budget |
| FMA - tax auditors & officers | 20 | $50 | $600 | $12,000 | FY07-09 Budget |
| Human Services - case workers | 16 | $50 | $600 | $9,600 | FY07-09 Budget |
| Human Services - outreach | 2 | $50 | $600 | $1,200 | FY07-09 Budget |
| CEDA - field inspectors | 45 | $50 | $600 | $27,000 | Reference |
| Other | 0 | $50 | $600 | $0 | |
| | | | | $53,400 | |

## Tax Revenue Enhancement

### General Government Nomadic

| | | | |
|---|---|---|---|
| Field auditors | 26 | | Calc |
| Per capita program cost | $192,635 | | Reference |
| Efficiency gain | 12.5% | | Reference |
| Budgetary value of efficiency gai | $626,063 | | Calc |
| City Auditor revenue/cost ratio | 4 | | Calc |
| Tax revenue enhancement | | $2,504,252 | Calc |

## Performance Measure & Efficiency Gains

| General Government Fixed Se( | Sites | Hours/week | FTE | FTE Value | |
|---|---|---|---|---|---|
| Parks & Rec locations | 32 | 64 | 1.6 | $140,451 | Calc/reference |
| Human Services locations | 31 | 62 | 1.6 | $80,694 | Calc/reference |
| Security monitoring locations | 157 | 39 | 1.0 | $83,768 | Calc/reference |
| Total | | | | $304,914 | |

**General Government Nomadic**

| | | | |
|---|---|---|---|
| **CEDA** | | | |
| Additional permit inspections | 5,625 | | Calc |
| Additional code inspections | 4,375 | | Calc |
| Permit inspector FTE gain | 2.8 | | Calc |
| Code inspector FTE gain | 2.7 | | Calc |
| Value of FTE gain | | $678,455 | Calc |
| **Human Services** | | | |
| Additional clients served | 94 | | Calc |
| Case manager FTE gain | 1.7 | | Calc |
| Value of FTE gain | | $87,853 | Calc |
| **PWA** | | | |
| Per capita personnel cost (overal | $94,860 | | Calc |
| Personnel with laptops | 120 | | Reference |
| Value of efficiency gain | | $1,422,906 | Calc |
| Total (general government nomadic) | | $2,189,214 | Calc |

## Calculations & Data

| | | |
|---|---|---|
| **Efficiency Gain Estimates** | | |
| Remote access - average daily ti | 1 | Estimate |
| Average work day (hours) | 8 | Estimate |
| Efficiency gain | 12.5% | Calc |
| New fixed service - average weel | 2 | Estimate |
| Average work week (hours) | 40 | Estimate |
| Efficiency gain | 5.0% | Calc |
| New security monitoring - averag | 0.25 | Estimate |
| Average work week (hours) | 40 | Estimate |
| Efficiency gain | 0.6% | Calc |
| **CEDA - Development Permit & Code Enforcement Inspections** | | |
| Permit inspections performed | 45,000 | FY07-09 Budget |
| Code inspections performed | 35,000 | FY07-09 Budget |
| Inspections/permit inspector | 2,000 | FY07-09 Budget |
| Inspections/code inspector | 1,600 | FY07-09 Budget |

| | | |
|---|---|---|
| Permit inspectors | 23 | Calc |
| Code inspectors | 22 | Calc |
| Total | 44 | Calc |
| Total budgeted inspectors | 45 | FY07-09 Budget |
| Unfilled inspector positions | 10 | OSCS report |
| Personnel budget 08-09 | $9,968,512 | FY07-09 Budget |
| FTE 08-09 | 81.5 | FY07-09 Budget |
| Average per position | $122,313 | Calc |

| | | | |
|---|---|---|---|
| **Human Services** | | | |
| Case managers | 10.5 | | FY07-09 Budget |
| Nurse case managers | 3 | | FY07-09 Budget |
| Case management clients | 750 | | FY07-09 Budget |
| Clients per case manager | 56 | | Calc |
| | | | |
| Program personnel budget 08-09 | $5,802,710 | | FY07-09 Budget |
| FTE 08-09 | 111.5 | | FY07-09 Budget |
| Average per position | $52,061 | | Calc |
| | | | |
| **Parks & Recreation - Central Administration** | | | |
| Personnel budget 08-09 | $1,729,307 | | |
| FTE 08-09 | 19.7 | | |
| Average per position | $87,782 | | |
| | | | |
| **PWA - Overall** | | | |
| Personnel budget 08-09 | $65,577,014 | | FY07-09 Budget |
| FTE 08-09 | 691.3 | | FY07-09 Budget |
| Field FTE 08-09 | 400 | | DIT |
| Average per position | $94,860 | | Calc |
| | | | |
| **PWA - Facilities & Management** | | | |
| Personnel budget 08-09 | $13,110,882 | | FY07-09 Budget |
| FTE 08-09 | 153.6 | | FY07-09 Budget |
| Average per position | $85,368 | | Calc |
| | | | |
| **Finance & Management Agency - Financial Management Program** | | | |
| Personnel budget 08-09 | $16,127,420 | | FY07-09 Budget |
| FTE 08-09 | 135.0 | | FY07-09 Budget |
| Average per position | $119,462 | | Calc |
| | | | |
| O&M budget 08-09 | $9,878,270 | | FY07-09 Budget |
| Average per position | $73,172 | | Calc |
| | | | |
| Total per capita program cost | $192,635 | | Calc |
| | | | |
| Total revenue 08-09 | $512,413,998 | | FY07-09 Budget |
| | | | |
| | Rev source | % City rev | |
| Business license tax 08-09 | $49,139,920 | 4.6% | FY07-09 Budget |
| Transient occupancy tax 08-09 | $13,031,524 | 1.2% | FY07-09 Budget |

| | | | | |
|---|---|---|---|---|
| Parking tax 08-09 | $17,695,438 | 1.7% | | FY07-09 Budget |
| Percent of parking tax from airport | | | 50% | FY07-09 Budget |
| Non airport parking rev | $8,847,719 | 0.8% | | Calc |
| Field-auditable revenue | $71,019,163 | 6.6% | | Calc |
| | | | | |
| FAR as percent of program | 13.9% | | | Calc |
| | | | | |
| Rev return/audit cost metric: | | | | |
| FMA | 1 | | | FY07-09 Budget |
| City Auditor | 4 | | | FY07-09 Budget |

| PWA Personnel Summary | | |
|---|---|---|
| Administration | $3,698,847 | FY07-09 Budget |
| Electrical | $2,278,790 | FY07-09 Budget |
| Environmental | $706,116 | FY07-09 Budget |
| Facilities | $13,110,882 | FY07-09 Budget |
| Fleet | $6,378,003 | FY07-09 Budget |
| Clean | $10,769,990 | FY07-09 Budget |
| Grounds | $8,310,874 | FY07-09 Budget |
| Recycling | $1,326,975 | FY07-09 Budget |
| Safety | $319,082 | FY07-09 Budget |
| Sewer | $7,958,534 | FY07-09 Budget |
| Streets | $5,351,096 | FY07-09 Budget |
| Transportation | $2,202,446 | FY07-09 Budget |
| Trees | $3,165,379 | FY07-09 Budget |
| | $65,577,014 | Calc |

## Business and Entrepreneurship Opportunities

### Wholesale Services

| | Units | Monthly | Annual | Total |
|---|---|---|---|---|
| T-1 equivalent business circuit | 25 | $300 | $3,600 | $90,000 |
| New installation & maintenance | 1 | $500 | $6,000 | $6,000 |
| Hotspot service | 5 | $200 | $2,400 | $12,000 |
| Total | | | | $108,000 |

| | |
|---|---|
| Annual + | 0% |

## Drinking Fountain Model Public Access

### Discounted Market Value of New Facilities Enabled

| | Units | Monthly | Annual | Total | |
|---|---|---|---|---|---|
| Schools & educational facilities | 200 | $100 | $1,200 | $240,000 | T-1 equivalent service |
| Community organizations | 80 | $100 | $1,200 | $96,000 | |
| Neighborhood partnerships | 80 | $100 | $1,200 | $96,000 | |
| Community housing | 267 | $100 | $1,200 | $320,400 | |
| Total | 627 | | | $752,400 | |

**Parks & Recreation**

| | Facility | Address | Phone | Lines | Monthly Cos | Termination |
|---|---|---|---|---|---|---|
| **Recreation Centers** | Allendale Recreation Center | 3711 Suter Street | (510) 535-5635 | | | |
| | Arroyo Viejo Recreation Center | 7701 Krause Avenue | (510) 615-5755 | | | |
| | Brookdale Recreation Center | 2535 High Street | (510) 535-5632 | | | |
| | Bushrod Recreation Center | 560 59th Street | (510) 597-5031 | | | |
| | Carmen Flores | 1637 Fruitvale Avenue | (510) 535-5631 | | | |
| | DeFremery Recreation Center | 1651 Adeline Street | (510) 238-7739 | | | |
| | Dimond Recreation Center | 3860 Hanly Road | (510) 482-7831 | | | |
| | Discovery Center – East | 2521 High Street | (510) 535-5657 | | | |
| | Discovery Center – West | 935 Union Street | (510) 832-3314 | | | |
| | FM Smith Recreation Center | 1969 Park Boulevard | (510) 238-7742 | | | |
| | Franklin Recreation Center | 1010 East 15th Street | (510) 238-7741 | | | |
| | Golden Gate Recreation Center | 1075 62nd Street | (510) 597-5032 | | | |
| | Ira Jinkins Recreation Center | 9175 Edes Avenue | (510) 615-5959 | | | |
| | Lincoln Square Recreation Center | 250 10th Street | (510) 238-7738 | | | |
| | Manzanita Recreation Center | 2701 22nd Street | (510) 535-5625 | | | |
| | Montclair Recreation Center | 6300 Moraga Avenue | (510) 482-7812 | 1 | $210 | 150 FOP |
| | Mosswood Recreation Center | 3612 Webster Street | (510) 597-5038 | | | |
| | Poplar Recreation Center | 3131 Union Street | (510) 597-5042 | | | |
| | Rainbow Recreation Center | 5800 International Boulevard | (510) 615-5751 | 1 | $76 | Sonitrol |
| | Redwood Heights Recreation Center | 3883 Aliso Avenue | (510) 482-7827 | 1 | $210 | 150 FOP |
| | San Antonio | 1701East 19th Street | (510) 535-5608 | | | |
| | Sheffield Village Recreation Cntr | 247 Marlow Drive | (510) 638-7190 | | | |
| | Studio One Arts Center | 365 45th Street | (510) 597-5027 | 2 | $400 | 150 FOP, Int |
| | Tassafaronga Recreation Center | 975 85th Avenue | (510) 615-5764 | | | |
| | Verdese Carter Recreation Center | 9600 Sunnyside Street | (510) 615-5758 | | | |
| **Swimming Pools** | Castlemont | 8601 MacArthur Boulevard | (510) 879-3642 | | | |
| | DeFremery | 1269 18th Street | (510) 238-2205 | | | |
| | Fremont | 4550 Foothill Boulevard | (510) 535-5614 | | | |
| | Lions | 3860 Hanly Road | (510) 482-7852 | 1 | $210 | 150 FOP |
| | Live Oak | 1055 MacArthur Boulevard | (510) 238-2292 | | | |
| | McClymonds | 2607 Myrtle Street | (510) 879-8050 | | | |
| | Temescal | 371 45th Street | (510) 597-5013 | | | |
| **Rental Facilities** | Joaquin Miller Community Center | 3594 Sanborn Drive | (510) 238-3187 | | | |
| | Lake Merritt Sailboat House | 568 Bellevue Avenue | (510) 238-3187 | 1 | $170 | 150 FOP |
| | Leona Lodge | 4444 Mountain Boulevard | (510) 238-3187 | | | |
| | Marsha J. Corprew Garden Center | 666 Bellevue Avenue | (510) 238-3187 | | | |
| | Morcom Rose Garden | 700 Jean Street | (510) 238-3187 | | | |
| | Sequoia Lodge | 2666 Mountain Boulevard | (510) 238-3187 | | | |
| | | | | 7 | $1,276 | |

| | | | |
|---|---|---|---|
| | Unwired facilities | | 32 |
| | Wired faciities | | 6 |
| **Community Gardens** | Arroyo Viejo | 79th Ave & Arthur St cul de sac | |
| | Bushrod | 584 - 59th Street | |
| | Golden Gate | 1068 - 62nd Street | |
| | Lakeside Kitchen Garden | 666 Bellevue Ave | |
| | Marston Campbell | Btwn 16th & 18th St. and Market & West St. | |
| | Temescal | 876 - 47th Street | |
| | Verdese Carter | Corner 96th Ave & Bancroft Ave | |

## Human Services

| | Facility | Address | Phone | Lines | Monthly Cos | Termination |
|---|---|---|---|---|---|---|
| **Head Start/Early Head Start** | 85th Avenue | 8501 International Blvd. | 510-544-3389 | | | |
| | 92nd Avenue | 9202 International Blvd. | 510-568-1057 | | | |
| | Arroyo Viejo | 7701 Krause Ave. | 510-615-5944 | | | |
| | Brookfield | 9600 Edes Ave. | 510-615-5736 | | | |
| | City Towers | 1050 7th Street | 510-238-5230 | | | |
| | De Colores | 1155 35th Avenue | 510-533-1271 | | | |
| | Eastmont Mall | 7200 Bancroft Ave. #203 | 510-562-1790 | | | |
| | Fannie Wall | 647 55th Street | 510-597-5044 | | | |
| | Foothill Square | 10700 MacArthur Blvd #10 | 510-553-9926 | | | |
| | Frank G. Mar | 274 12th Street | 510-832-5042 | | | |
| | Franklin | 1010 E. 15th Street | 510-238-1304 | | | |
| | Manzanita | 2701 22nd Ave. | 510-535-5624 | | | |
| | San Antonio CDC | 2228 E. 15th Street | 510-534-6189 | | | |
| | San Antonio Park | 1701 E. 19th Street | 510-535-5609 | | | |
| | Seminary | 5818 International Blvd | 510-615-5924 | | | |
| | Sungate | 2563 International Blvd. | 510-535-5648 | | | |
| | Tassafaronga | 975 85th Ave. | 510-639-0580 | | | |
| | Thurgood-Marshall | 1117 10th Street | 510-836-0543 | | | |
| | Virginia | 4335 Virginia Ave. | 510-261-1484 | | | |
| | West Grand | 1058 West Grand Avenue | 510-238-2267 | | | |
| **Senior Centers** | Downtown Oakland Senior Center | 200 Grand Avenue | 510-238-3284 | | | |
| | East Oakland Senior Center | 9255 Edes Avenue | 510-615-5731 | | | |
| | Fruitvale/San Antonio Senior Center | 3301 E. 12th Street | 510-535-6123 | | | |
| | Hong Lok Senior Center | 275 7th Street | 510-763-9017 | | | |
| | North Oakland Senior Center | 5714 Martin Luther King Jr. Way | 510-597-5085 | | | |
| | West Oakland Senior Center | 1724 Adeline Street | 510-238-7017 | | | |
| **Shelters** | Covenant House | 2781 Telegraph Ave | 510.625.7800 | | | |
| | East Oakland Community Project | 5725 International Blvd. | 510.532.3211 | | | |
| | Health Care for the Homeless | 1900 Fruitvale Ave., Suite 3E | 510.533.4663 | | | |
| | Henry Robinson Multi-Service Center | 559 16th St. | 510.419.1010 | | | |
| | Oakland Army Base Temporary Winter Shelter | 1145 Midway St. | 510.839.8005 | | | |
| | | | | 0 | 0 | |
| | Unwired facilities | | | 31 | | |
| | Wired facilities | | | 0 | | |

**Other**

| | |
|---|---|
| Public Safety | 31 |
| General | 43 |
| | |
| Total faciilities | 300 |
| Unaccounted for locations | 157 |

**Oakland Unified School District**

| | | |
|---|---|---|
| Acorn Woodland Cdc | (510) 879-0861 | 1029 81st Ave |
| Acorn Woodland Elementary | (510) 879-0190 | 1025 81st Ave |
| Adult Ed - Abe/Ase | 510-879-4040 | 2455 Church Street |
| Adult Ed - Awd | 510-879-4090 | 920 53rd Street |
| Adult Ed - Cte | 510-879-8620 | 2455 Church Street, Rm. 106 |
| Adult Ed - Esl | 510-879-4020 | 750 International Blvd |
| Adult Ed - Oa | 510-879-4090 | 920 53rd Street |
| Adult Ed - Pfca/Cbet | 510-879-2944 | 750 International Blvd |
| Adult Education Administrative Office | (510) 879-3036 | 2607 Myrtle Street |
| Alice Street Cdc | (510) 879-0856 | 250 17th Street |
| Allendale Elementary | (510) 879-1010 | 3670 Penniman Ave |
| Alliance Academy | (510) 879-2733 | 1800 98th Ave |
| Alternative Learning Community | | 9736 Lawlor Street |
| Arroyo Viejo Cdc | (510) 879-0802 | 1895 78th Avenue |
| Ascend Elementary | (510) 879-3140 | 3709 E 12th St |
| Bella Vista Cdc | (510) 879-1657 | 2410 10th Avenue |
| Bella Vista Elementary | (510) 879-1020 | 1025 E 28th St |
| Best At Mcclymonds | (510) 879-3030 | 2607 Myrtle St |
| Bret Harte Middle School | (510) 879-2060 | 3700 Coolidge Ave |
| Bridges Academy At Melrose | (510) 879-1410 | 1325 53rd Ave |
| Brookfield Pre-K | (510) 879-0806 | 401 Jones Avenue |
| Brookfield Village Elementary | (510) 879-1030 | 401 Jones Ave |
| Bunche Academy | (510) 879-1730 | 1240 18th St |
| Burckhalter Elementary | (510) 879-1050 | 3994 Burckhalter Ave |
| Business & Information Technology High Schoo | (510) 879-3010x443 | 8601 Macarthur Blvd |
| Carl Munck Elementary | (510) 879-1680 | 11900 Campus Dr |
| Castlemont Community Of Small Schools | (510) 879-3010 | 8601 Macarthur Boulevard |
| Centro Infantil Annex Cdc | (510) 879-081 | 314 East 10th Street |
| Centro Infantil De La Raza Cdc | (510) 879-1521 | 2660 East 16th Street |
| Chabot Elementary | (510) 879-1060 | 6686 Chabot Rd |
| Claremont Middle School | (510) 879-2010 | 5750 College Ave |
| Cleveland Elementary | (510) 879-1080 | 745 Cleveland St |
| Cole Middle School | (510) 879-1091 | 1011 Union St |
| Coliseum College Prep Academy | (510) 879-2456 | 1390 66th Ave |
| College Prep & Architecture Academy | (510) 879-1131 | 4610 Foothill Blvd |
| Community Day Hs | (510) 879-8450 | 4917 Mountain Blvd |
| Community United Elementary School | (510) 879-1340 | 6701 International Blvd |
| Cox Ece Center | (510) 879-0807 | 9860 Sunnyside Street |
| Crocker Highlands Elementary | (510) 879-1110 | 525 Midcrest Rd |
| Dewey Academy | (510) 879-3100 | 1111 2nd Avenue |
| East Oakland Pride | | 8000 Birch Street |

| | | |
|---|---|---|
| East Oakland School Of The Arts | (510) 879-3010x498 | 8601 Macarthur Blvd |
| Edna M Brewer Middle School | (510) 879-2100 | 3748 13th Ave |
| Edward Shands Adult Education Center | (510) 879-4040 | 2455 Church Sreet |
| Elmhurst Community Prep | (510) 879-2021 | 1800 98th Ave |
| Emerson Cdc | (510) 879-0811 | 4801 Lawton Avenue |
| Emerson Elementary | (510) 879-1150 | 4803 Lawton Ave |
| Encompass Academy | (510) 879-0207 | 1025 81st Ave |
| Esperanza Academy | (510) 879-1551 | 10315 E St. |
| Excel At Mcclymonds | (510) 879-8490 | 2607 Myrtle St |
| Explore College Preparatory Middle | (510) 879-1040 | 3550 64th Avenue |
| Far West | (510) 879-1580 | 5263 Broadway Terrace |
| Franklin Elementary | (510) 879-1160 | 915 Foothill Blvd |
| Fred T. Korematsu Discovery Academy | (510) 879-2795 | 10315 E St. |
| Fremont Federation | (510) 879-3020 | 4610 Foothill Blvd |
| Frick Middle School | (510) 879-2030 | 2845 64th Ave |
| Fruitvale Cdc | (510) 879-2825 | 3200 Boston Ave. |
| Fruitvale Elementary | (510) 879-1170 | 3200 Boston Ave |
| Futures Elementary | | 6701 International Blvd |
| Garfield Elementary | (510) 879-1180 | 1640 22nd Ave |
| Glenview Elementary | (510) 879-1190 | 4215 La Cresta Ave |
| Global Family School | | 2035 40th Ave. |
| Golden Gate Cdc | (510) 879-0814 | 6232 Herzog Street |
| Golden Gate Pre-K | (510) 879-0813 | 6200 San Pablo Avenue |
| Grass Valley Cdc | | 4720 Dunkirk Ave. |
| Grass Valley Elementary | (510) 879-1220 | 4720 Dunkirk Ave |
| Greenleaf Elementary | | 6328 East 17th Street |
| Harriet R Tubman Cdc | (510) 879-0825 | 800 33rd Street |
| Highland Campus | (510) 879-1260 | 8521 A St |
| Highland Cdc | (510) 879-0815 | 1322 86th Avenue |
| Hillcrest Elementary | (510) 879-1270 | 30 Marguerite Dr |
| Hintil Kuu Ka Cdc | (510) 879-0840 | 11850 Campus Drive |
| Hoover Elementary | (510) 879-1700 | 890 Brockhurst St |
| Horace Mann Elementary | (510) 879-1360 | 5222 Ygnacio Ave |
| Howard Cdc | (510) 879-0816 | 8755 Fontaine Street |
| Howard Elementary | (510) 879-1660 | 8755 Fontaine St |
| International Cdc | (510) 879-4293 | 2825 International Boulevard |
| International Comm. Elementary | (510) 879-4286 | 2825 International Blvd |
| James Madison Middle School | (510) 879-2150 | 400 Capistrano Dr |
| Jefferson Cdc | (510) 879-0817 | 1975 40th Avenue |
| Jefferson Elementary | (510) 879-1280 | 2035 40th Ave |
| Joaquin Miller Elementary | (510) 879-1420 | 5525 Ascot Dr |
| Kaiser Elementary | (510) 549-4900 | 25 S Hill Ct |

| | | |
|---|---|---|
| La Escuelita Elementary | (510) 879-1210 | 1100 3rd Ave |
| Lafayette Elementary | (510) 879-1290 | 1700 Market St |
| Lakeview Cdc | (510) 879-0857 | 746 Grand Avenue |
| Lakeview Elementary | (510) 879-1300 | 746 Grand Ave |
| Laurel Cdc | (510) 879-0820 | 3825 California Street |
| Laurel Elementary | (510) 879-1310 | 3750 Brown Ave |
| Lazear Elementary | (510) 879-1320 | 824 29th Ave |
| Leadership Preparatory High School | (510) 879-3010x457 | 8610 Macarthur Blvd |
| Learning Without Limits | | 2035 40th Ave |
| Life Academy | (510) 534-0282 | 2101 35th Avenue |
| Lincoln Elementary | (510) 879-1330 | 225 11th St |
| Lockwood Cdc | (510) 879-0823 | 1125 69th Avenue |
| Lockwood Elementary | (510) 879-1340 | 6701 International Blvd |
| Lockwood School Preschool | (510) 879-0827 | 6701 E.14th St. |
| M L King Jr Elementary | (510) 879-1820 | 960 10th St |
| Mandela High School | (510) 879-1141 | 4610 Foothill Blvd |
| Manzanita Campus | (510) 879-1370 | 2409 E 27th St |
| Manzanita Cdc | (510) 879-0829 | 2618 Grand Vista |
| Manzanita Community School | (510) 879-1370 | 2409 E 27th St. |
| Manzanita Seed | (510) 879-1373 | 2409 E. 27th St |
| Markham Elementary | (510) 879-1380 | 7220 Krause Ave |
| Marshall Elementary | (510) 879-1740 | 3400 Malcolm Ave |
| Maxwell Park Elementary | (510) 879-1390 | 4730 Fleming Ave |
| Mcclymonds Community Of Small Schools | (510) 879-3030 | 2607 Myrtle St |
| Media College Prep | (510) 879-1597 | 4610 Foothill Blvd |
| Melrose Leadership Academy | (510) 879-1530 | 5328 Brann Street |
| Met West | (510) 879-0235 | 314 E 10th St |
| Ml King Cdc | (510) 879-0822 | 960A 10th Street |
| Montclair Elementary | (510) 879-1430 | 1757 Mountain Blvd |
| Montera Middle School | (510) 879-2110 | 5555 Ascot Dr |
| Neighborhood Centers | (510) 879-4020 | 750 International Blvd |
| New Highland Academy | (510) 879-1260 | 8521 A St |
| Oakland High School | (510) 879-3040 | 1023 Macarthur Blvd |
| Oakland International High School | | 4521 Webster St |
| Oakland Technical High School | (510) 879-3050 | 4351 Broadway |
| Parker Cdc | (510) 879-0828 | 7901 Ney Avenue |
| Parker Elementary | (510) 879-1440 | 7929 Ney Ave |
| Peralta Cdc | (510) 879-0858 | 460 63rd Street |
| Peralta Creek Middle School | (510) 879-8465 | 2101 35th Ave |
| Peralta Elementary | (510) 879-1450 | 460 63rd Street |
| Piedmont Avenue Cdc | (510) 879-0832 | 86 Echo Avenue |
| Piedmont Avenue Elementary | (510) 879-1460 | 4314 Piedmont Ave |

| | | |
|---|---|---|
| Pleasant Valley Adult School | (510) 879-4090 | 920 53rd Street |
| Preparatory Literary Academy Of Cultural Exce | (510) 879-1470 | 920 Campbell St |
| Prescott Cdc | (510) 879-0835 | 800 Campbell Street |
| Reach Academy | (510) 879-1100 | 9860 Sunnyside St. |
| Redwood Heights Elementary | (510) 879-1480 | 4401 39th Ave |
| Rise Community School | (510) 879-2553 | 8521 A St |
| Robeson School Of Visual & Performing Arts | (510) 879-1237 | 4610 Foothill Blvd |
| Roosevelt Middle School | (510) 879-2120 | 1926 19th Ave |
| Roots International Academy | (510) 879-2625 | 1390 66th Ave |
| Rudsdale Continuation | (510) 879-4237 | 1180 70th Avenue |
| Sankofa Academy | (510) 879-1610 | 581 61st St |
| Santa Fe Cdc | (510) 879-0837 | 5380 Adeline Street |
| Santa Fe Elementary | (510) 879-1500 | 915 54th St |
| Sequoia Cdc | (510) 879-0846 | 3730 Lincoln Avenue |
| Sequoia Elementary | (510) 879-1510 | 3730 Lincoln Ave |
| Skyline High School | (510) 879-3060 | 12250 Skyline Blvd |
| Sobrante Park Elementary | (510) 879-1540 | 470 El Paseo Dr |
| Sojourner Truth Independent Study | (510) 879-2980 | 9736 Lawlor St. |
| Stonehurst Campus | (510) 879-1550 | 10315 E St |
| Stonehurst Cdc | (510) 879-0838 | 901 105th Avenue |
| Street Academy | (510) 879-3130 | 417 29th St |
| Think College Now | (510) 879-1490 | 2825 International Blvd |
| Thornhill Elementary | (510) 879-1570 | 5880 Thornhill Dr |
| Tilden Elementary | (510) 879-1560 | 4551 Steele St |
| Tilden Pre-K | (510) 879-0841 | 4655 Steele Street |
| United For Success Academy | (510) 879-1494 | 2101 35th Ave |
| Urban Promise Academy | (510) 879-1640 | 3031 E. 18th Street |
| Washington Cdc | (510) 879-0839 | 6097 Racine Street |
| Webster Academy | (510) 879-1620 | 8000 Birch St |
| Webster Academy Ece | (510) 879-0842 | 7980 Plymouth Street |
| West Oakland Middle School | | 991 14th Street |
| Westlake Middle School | (510) 879-2130 | 2629 Harrison St |
| Whittier Elementary | (510) 879-1630 | 6328 E 17th St |
| Yes, Youth Empowerment School | (510) 879-8877 | 8251 Fontaine St |
| Yuk Yau Cdc | (510) 879-0824 | 291 10th Street |
| Yuk Yau-Annex | (510) 879-0821 | 314 East 10th Street |

**Other Schools**

- California College of Arts & Crafts
- California State University, Hayward
- Holy Names University
- Mills College
- Patten University
- Alameda College
- Laney College
- Merritt College
- Vista College
- Samuel Merritt College
- San Francisco State University - Extended Learning
- Holy Names High School

**City Statistics**

| | | |
|---|---|---|
| Land area (sq. mi.) | 53.8 | FY07-09 Budget |
| Lake area (sq. mil.) | 3.5 | FY07-09 Budget |
| Total area | 57.3 | |
| Miles of Streets | 835.8 | FY07-09 Budget |
| Population | 411,600 | FY07-09 Budget |
| Number of businesses | 19,720 | FY07-09 Budget |

**Network Specifications**

| | | |
|---|---|---|
| Access points/sq. mi. | 16 | Estimate |

# 11. Appendix D: Communications

## 11.1. Communications Outline

I. Communications Objectives

A. Awareness. Build brand public awareness of the Wireless Oakland Initiative (WOI) project in the Oakland Metropolitan Area amongst its diverse population. The goal is to have 60% of the constituent community be aware of the WOI within the first six months.

B. Education/Buy-in. Educate the public on the key details of the WOI program and the benefits it will provide the citizens of Oakland – both short and long term. The goal w to educate as many people as the budget permits.

C. Image/Reputation. Increase Oakland's reputation as a smart, progressive city; one that is on the forefront of technology. Increase favorable image of Oakland as a great place to visit, live and do business.

II. Key Communications Strategies

A. A. Positioning. Position the WOI program as a major initiative (versus other City initiatives) by "branding" the program with its own unique image.

B. Elements of a "Branded Initiative"

- Name
- Logo (City of Oakland logo)
- Positioning
- Vision
- Personality
- Brand promise
- Value proposition
- Core brand message
- Theme (e.g., "Building a Digital Future Today")

C. Continuity of Messaging. All initiative messaging should be consistent across all communications channels so they reinforce the key elements of the brand.

III. Key Communications Tactics

A. The communications plan will include both an introductory phase (first 90 days) and an ongoing support phase. The plan will use the most cost-effective communication tools available to reach the various target audiences.

B. The communications tactics recommended are an integrated mix of traditional media, Web media and the new social media.

C. The current thinking on the elements that should be involved include:

1. Fact sheet (several languages).
2. Q and A document (both printed ad online).
3. Community meetings.
4. Presentation to community groups and service clubs.
5. Media Relations Kit: Introductory and Ongoing.
6. A micro-site as part of the City's master Web site.
7. Quarterly e-mail newsletter campaign.
8. A social media presence (blog, Twitter, Facebook) to reach the digital generation.
9. Optional: Special Education and Teaching Module, budget permitting.

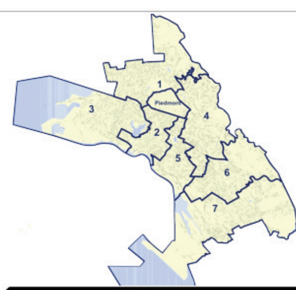
## 11.2. Presentation

# City of Oakland Wireless Broadband Feasibility Study

Tellus Venture Associates

# Comprehensive assessment of needs, goals & priorities

- Assessment meetings with DIT staff
- Technical survey of city assets & environment
- Workshops for police, fire, emergency services, public works, finance, administration, parks, library, museum, human services
- Workshops for business, education, non-profits, public agencies
- Public focus groups by district
- Town Hall meeting
- Public comment via phone and email



*Study Objective:*
*Conduct the necessary fact finding that will support the establishment of a sound vision for the deployment of an achievable and sustainable wireless broadband network.*

Broad, nearly unanimous agreement...

✓ Public Internet access via community anchor institutions

✓ Pay-as-you-go opportunities for business

⊘ Wireless Internet service to homes or individuals

➡ Widespread financial and technical failure in other cities

Tellus Venture Associates

## Needs, goals & priorities led to operational requirements

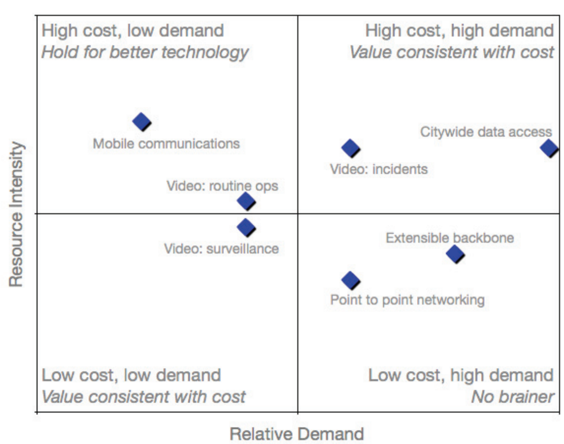
| Priority | Strategic Goals |
|---|---|
| 1 | Sound financial planning |
| 2 | Free school access |
| 3 | Free public access at libraries, community centers, parks, etc. |
| 4 | Affordable access for the public |
| 5 | System facilitates improved productivity |
| 6 | Public project awareness |

| Operational Requirement | Public Safety | Emergency Services | Public Works | Finance & Admin | CEDA | Human Services | Parks & Recreation | Other Agencies | Business | Non-Profits | Public |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Citywide data access | X | X | X | X | | X | X | X | | | |
| Mobile communication | X | X | X | | | | | | | | |
| Video: routine operations | X | X | X | X | | | | | | | |
| Video: incidents & events | X | X | X | | | | X | X | | | |
| Video: surveillance & monitoring | X | | X | | | | X | | X | | |
| Point to point networking | | | | | X | | X | X | X | X | |
| Extensible network backbone | | | | | X | | X | X | X | X | X |

Tellus Venture Associates

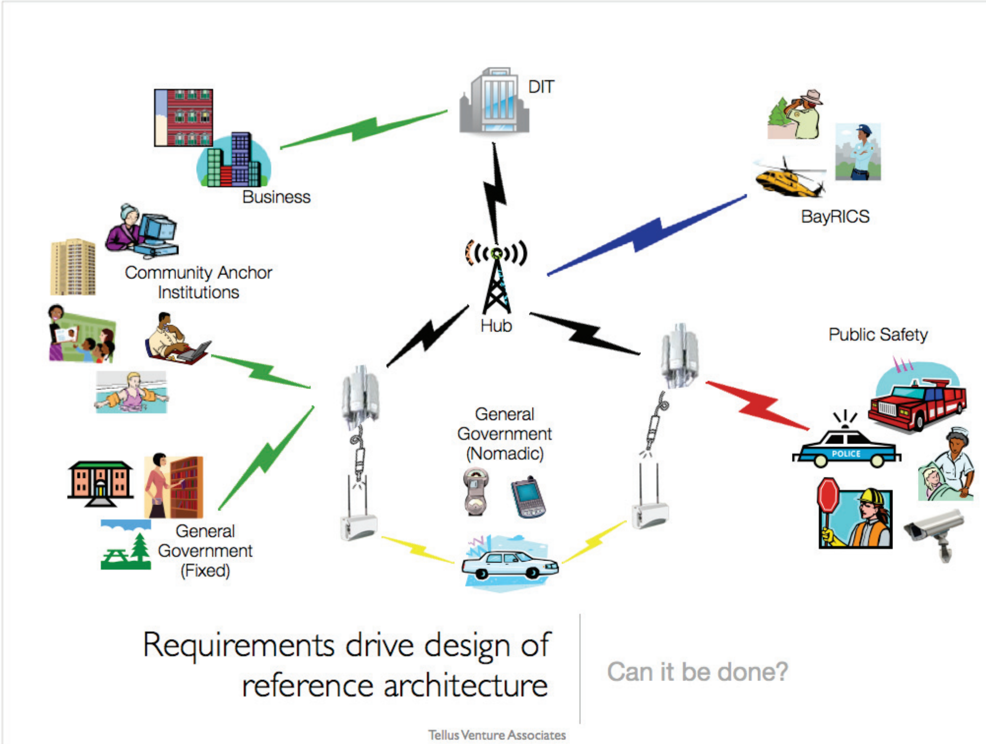
## Is desire consistent with cost?

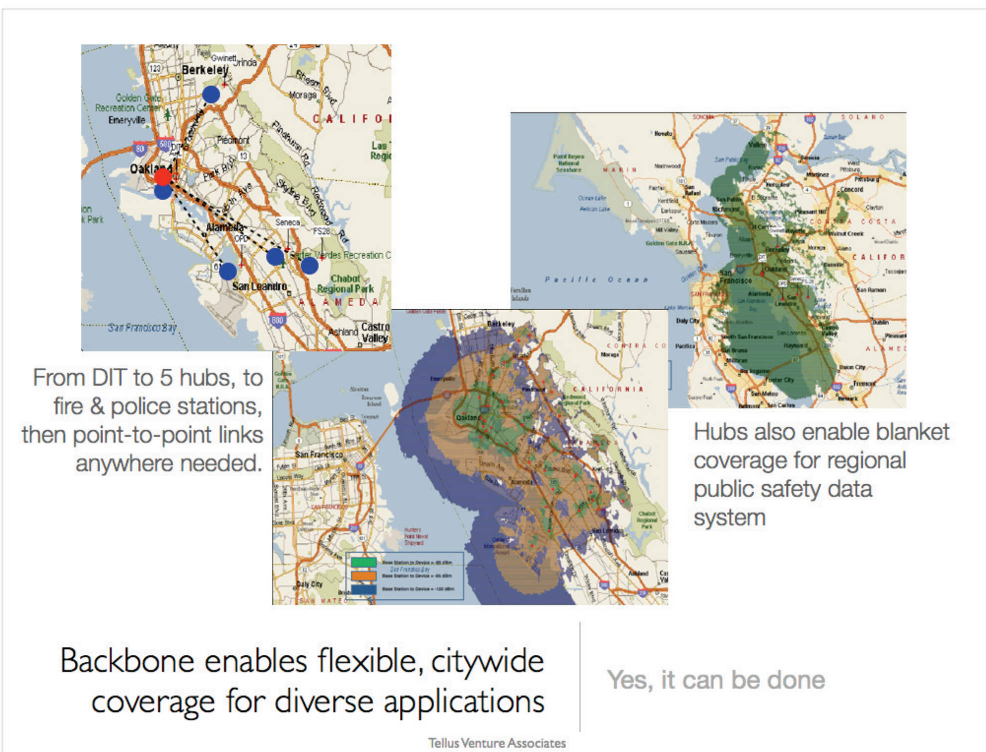
### Setting operational requirement priorities for the City of Oakland

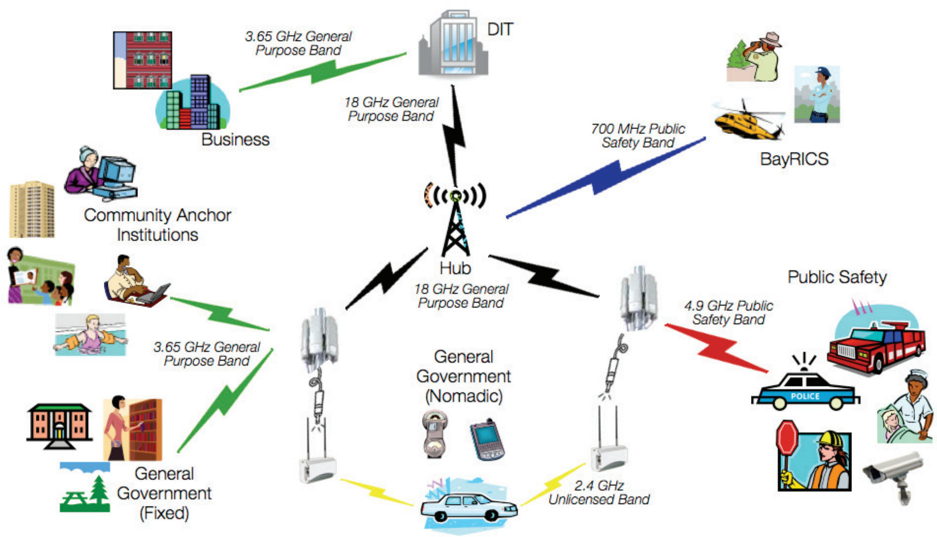



1. Extensible network backbone
2. Point to point networking
3. Citywide data access
4. Video: incidents
5. Video: surveillance
6. Video: routine operations
7. Mobile communications

Tellus Venture Associates


DIT
Business
BayRICS
Community Anchor
Institutions
Hub
Public Safety
General
Government
(Nomadic)
POLICE
General
Government
(Fixed)
Requirements drive design of
reference architecture
Can it be done?
Tellus Venture Associates


From DIT to 5 hubs, to
fire & police stations,
then point-to-point links
anywhere needed.
Hubs also enable blanket
coverage for regional
public safety data
system
Backbone enables flexible, citywide
coverage for diverse applications
Yes, it can be done
Tellus Venture Associates




Coverage, service levels technically feasible

Reference architecture one example of how

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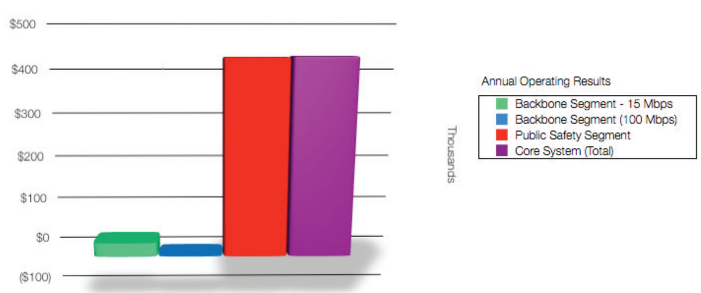


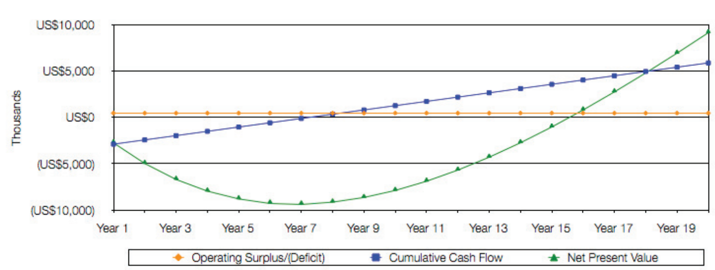


Core system operates at a surplus, pays full cost over time

Higher capacity, and hard savings on current leased lines

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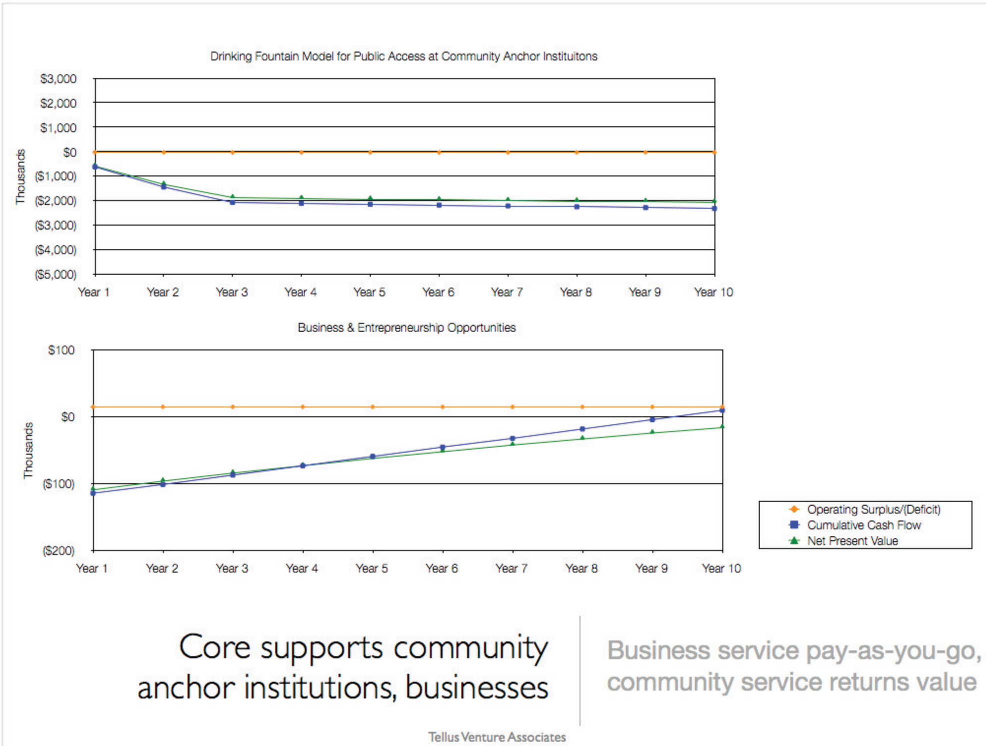
Drinking Fountain Model for Public Access at Community Anchor Instituitons
$3,000
$2,000
$1,000
$0
($1,000)
($2,000)
($3,000)
($4,000)
($5,000)
Thousands
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10
Business & Entrepreneurship Opportunities
$100
$0
($100)
($200)
Thousands
Operating Surplus/(Deficit)
Cumulative Cash Flow
Net Present Value
Core supports community anchor institutions, businesses
Business service pay-as-you-go, community service returns value
Tellus Venture Associates


Community Anchor Institutions
Schools & Educational Facilities - 200
Community Organizations - 80
Neighborhood Partnerships - 80
Community Housing - 267
Note: numbers are examples only, to illustrate capacity. Actual site selection process is TBD.
Business-grade service
City sells network access and packaged solutions on a wholesale basis to small, local companies, who in turn re-sell it to underserved commercial properties, downtown and potentially elsewhere.
Human Services - 31
Libraries - 17
Parks & Rec - 38
City of Oakland Facilities
Model supports hundreds of potential public access sites
Creates opportunities for local entrepreneurs
Tellus Venture Associates

## Next steps

Stimulus program application deadline sets immediate agenda

- Determine which broadband grant programs are available to the City.
- Develop an implementation plan that meets schedule requirements and criteria for “shovel-ready” projects.
- Identify complementary stimulus program-funded projects and potential partners, per applications guidelines.
- Determine the source for the required 20% matching funds, including making any necessary applications to State of California agencies.
- Prepare and submit grant applications covering as many categories as practical by the 14 August 2009 deadline.
- Release an RFP to support the grant applications as soon as possible.

Tellus Venture Associates

Creating and implementing fundable business plans for community broadband projects is a speciality of Tellus Venture Associates.

Since 1996, our clients have built, funded, launched and managed wireless, fiber optic and satellite networks that serve consumers and communities around the world. Our experience includes:

- Financial and technical feasibility studies
- Primary market research to determine demand and community support
- Business case assessment
- Business model and funding development
- Public/private partnerships
- Reference designs
- RFP development and support

Stephen Blum, the president of Tellus Venture Associates, has led many successful projects and served in several senior executive positions on a consulting basis, including...

- Principal consultant for a successful $5 million grant application for a regional broadband consortium.
- Chief operating officer of a wireless ISP.
- Due diligence lead for an NGO delegation to Angola
- Team leader for an NGO project in the Philippines.
- Principal negotiator for a cable system sale to a top tier MSO.
- Managing consultant for a public/private WiMAX network deployment.
- Principal consultant for comprehensive feasibility studies for municipal wireless broadband systems.
- Management advisor for satellite broadcasting systems in North and South America, Asia, the Pacific Rim, Africa, the Middle East, and Europe, including most recently Italy, Cambodia and New Zealand.

Contact information:

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