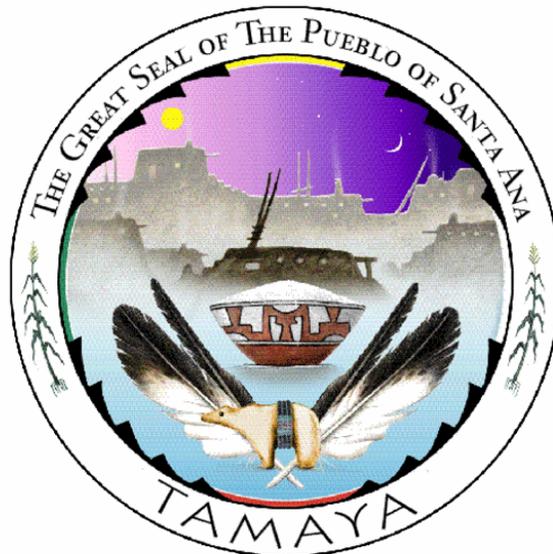


PUEBLO OF SANTA ANA
TRIBAL COMMUNITY EMPOWERMENT:
INNOVATION THROUGH WIRELESS
TRIBAL GOVERNMENT SERVICE DELIVERY
FINAL REPORT
JUNE 30, 2005



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Submitted to:

Technology Opportunities Program
U.S. Department of Commerce

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EXECUTIVE SUMMARY

The Pueblo of Santa Ana received a Technology Opportunities Program (TOP) grant, "Pueblo of Santa Ana Tribal Community Empowerment: Innovation through Wireless Tribal Government Service Delivery" from the U.S. Department of Commerce in FY2000. This project implemented a community network that linked all of the Tribe's 14 Government departments and 188 citizen homes. The completed network includes: 1) a Santa Ana community intranet to facilitate information sharing among the Tribal Government and community members in their homes using networked computers; 2) Internet access for all Government departments and community members; and 3) a Santa Ana Government local area network (LAN) for secure information sharing. Pueblo residents received computers for home use and were trained to use computers and the Internet. Interns from area Pueblos served as information technology interns and helped deploy and maintain the wireless network and home computers. The Georgia Tech Research Institute (GTRI) is a partner and sub-recipient on this grant, and provided technical assistance and evaluation expertise to Santa Ana in fulfillment of the grant's requirements.

PROJECT OVERVIEW

The Pueblo of Santa Ana is a federally recognized Indian nation comprising 79,034 desert acres within the state of New Mexico in the United States. The U.S. Constitution recognizes the sovereign status of Indian Tribes by classing Indian treaties as among the “Supreme Law of the land.” The members of Santa Ana, the *Tamayame* (the name of the people in the Keres language), have lived in their present location north of Albuquerque, New Mexico since at least the early 1500s. The Pueblo possesses its own Government structure with 14 departments, each with its own mission and goals. Each of the units within the Santa Ana Government realize a significant need to share information with other departments, with outside organizations, and with Pueblo residents in 188 homes on the reservation.

As the use of new information and communication technologies (ICTs) becomes widespread, Native American communities are the ethnic group to be the most disadvantaged in the U.S. in terms of access to technological resources. Rural Native Americans have the lowest access in the U.S. to telephones, computers, and the Internet. Sixty-one percent of rural American Indian households are without telephone service. Even when there is phone service, household personal computer ownership with Internet access is less than 15 percent, compared to a national penetration level of more than 42 percent. American Indians are the ethnic group the most likely to be caught on the wrong side of the digital divide. Prior to this project, the Pueblo of Santa Ana fit this profile as few people used computers or the Internet on the reservation.

The Pueblo of Santa Ana faced numerous obstacles in using ICTs before the implementation of this project. These include:

- *Value:* One particularly daunting aspect of the digital divide is that those without access often do not consider content on the Internet to be relevant to them. As a result, many Native Americans are at a serious risk of being marginalized in society as more and more daily functions take place online. There is a real need for Internet content created for and by Native Americans.
- *Complexity:* Use of the Internet and other telecommunications technologies can be daunting for inexperienced users. A sharp learning curve must first be overcome to possess the know-how to set up Internet service—either for a first time user of a telephone modem, broadband, or through wireless Internet service becoming

increasingly available.

- *Cost:* For many Native American communities, the initial cost of setting up telephone and/or Internet service is too prohibitive. The primary barrier to phone service is not the monthly fee for service—it is the telecom provider’s cost of extending landline service. Telephone carriers generally pass these costs on to consumers.
- *Lack of suitable infrastructure:* A key difficulty is the remoteness of Indian populations scattered over areas with little infrastructure and in many cases, the available infrastructure is so poor and degraded that digital communications are severely limited.

Through the use of information and communication technologies, Native American communities can promote self-determination, sovereignty, and social and political empowerment. Moreover, technology can help to achieve these goals without sacrificing Tribal concepts of community, conservation, and environmental harmony.

*“In this day and age, not having [the Internet] is impossible to consider.
Good or bad is beside the point.” – Survey Respondent*

Citizens and the Government of the Pueblo of Santa Ana realize the importance of telecommunications access and digital skills in today’s fast-paced economy and seek to incorporate the use of these technologies into Tribal operations in a manner consistent with the Tribe’s culture. Prior to implementation of this project, the Tribe faced three primary barriers to self-sufficiency that it now uses telecommunications technologies to help overcome:

- Tribal Government leaders and community members relied on in-person and static communication channels to spread news about Pueblo events. This was highly inefficient for a Tribe of 646 people on nearly 80,000 acres of land and prohibits timely response to economic development opportunities.
- Few Tribal members had expertise in telecommunications technologies and as a result, the Tribe hired non-Tribal employees to fill technology-related Government positions.

- Tribal members with post-secondary level educations had few employment opportunities available to them within the Tribe.

As a result of this program, the Pueblo of Santa Ana implemented a broadband wireless community network to link all of the Tribe's 14 Government departments and 188 citizen homes using an innovative and cost-effective broadband wireless approach on the reservation. The Santa Ana community network builds on traditional Tribal communication channels by using technology to strengthen community bonds and prepare its younger population for life in the digital age. The network includes 1) a Santa Ana community intranet to facilitate information sharing among the Tribal Government and community members in their homes using networked computers; 2) Internet access for all Government departments and community members; and 3) a Santa Ana Government local area network (LAN) for secure information sharing. Researchers at the Georgia Institute of Technology provide technical and evaluative assistance to Tribal members implementing the project.

“In some situations where I work I need to learn some things over the Internet. It is a quick and easy place to do my exploring.” – Santa Ana Community Member

This project empowered the Tribe to meet its objective of self-sufficiency through six primary project goals:

1. Active participation in Tribal decision-making through improved communication among Government entities and Santa Ana community members;
2. Improved community access to Government resources via access to the Tribe's intranet with content available in written and spoken English and spoken Keresan in each community member's home;
3. Leadership and 21st century skills in the younger population via internships and mentorships in Tribal Government units and tailored information technology courses;
4. Information and digital skills among all age groups of the Santa Ana community;

5. An innovative, cost-effective, and scaleable model of wireless broadband telecommunications application in a rural community; and
6. Formative (process) and summative (outcome) project evaluation for ongoing project improvements and project replication in other communities.

The following Project Activities section describes how each of these six goals were accomplished over the four years of the Technology Opportunities Program project.

PROJECT ACTIVITIES

At the beginning of this project, phone service on the reservation was limited. All the phone lines on the Pueblo were already used up, and some homes did not have any phone service at all. Most families did not have a computer in the home as only seven homes out of 188 had computers. Those that did have computers had difficulty getting connected to the Internet. Even if they could get connected, the connections were so slow that surfing the Internet was impossible for all but the most patient. Similarly, the Pueblo Government had a few computers but most were not networked, with the exception of the Department of Natural Resources.

Through departmental surveys conducted by Tribal Administration at the beginning of this endeavor, each of the Government departments expressed a keen interest in using telecommunications technologies to facilitate information sharing and community input in Tribal operations. The result of these surveys is a Technology Goals statement and departmental intranet use plan for the Pueblo with 10 key points for improving the digital literacy of the residents of the Santa Ana Pueblo.

Figure 1:
Pueblo of Santa Ana Technology Goals Statement

1. All young people are computer literate.
2. When students go to 2-year or 4-year colleges, they take computer skills with them.
3. Adult Tribal members interested in computer literacy have the resources available to them to become computer literate.
4. Tribal members who are interested in pursuing computer-related careers are qualified to do so.
5. When the Tribe hires for a computer-related position for its business enterprises, it has talented, qualified Tribal members in the employment pool.

6. Computer technical training leading to career paths is available to all qualified Tribal members.
7. Santa Ana is an example of excellence to other Tribes in the area of computer skills and training.
8. Computers are used to assist Tribal members in improving reading, writing, math and other scholastic skills.
9. Every Santa Ana Tribal member who wants one, has a computer at home. Computer owners, however, will know more than just how to use a computer. They also possess basic maintenance and trouble-shooting skills. They will know how to evaluate software and hardware upgrades. They will know how to purchase computer and technical services, if they find it necessary to do this.
10. Computers are a valuable tool for Tribal members in maintaining communications among themselves, for preserving their culture and language, and for communicating their ideas and values with other Indian and non-Indian people around the world.

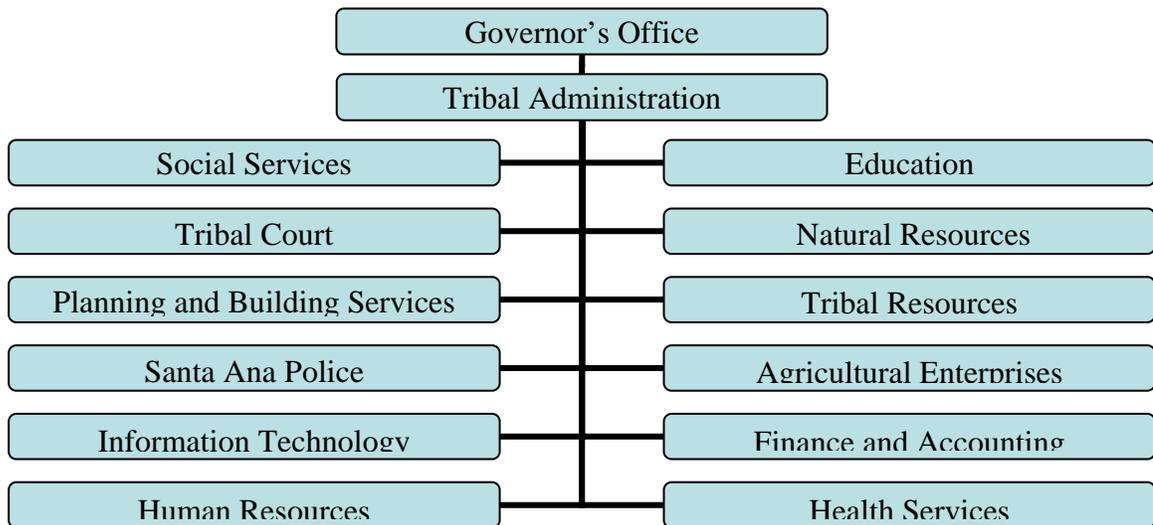
This project actively addresses these Tribal Technology Goals. By providing each resident and Government employee with a fully networked computer, this project addresses six project goals that exceed these initial Tribal expectations for technology on the reservation. The activities that took place to reach each of these six project goals are explored below.

Improved Tribal Communications

- 1. Encourage active participation in Tribal decision-making through improved communication among Government entities and Santa Ana community members**

Prior to project implementation, the Pueblo of Santa Ana had 13 Government departments. A U.S. Indian Health Services office on the reservation is independently operated but also had a need for frequent communications with Tribal Government and community residents. After this project was funded, the Tribe set up an Information Technology Services Department to oversee project activities and technology implementation. The Tribal Administration oversees each of the Government departments which are spread throughout various buildings on the Pueblo. See Figure 2 for a Tribal Government organization chart and Table 1 for a description of each entity.

Figure 2:
Pueblo of Santa Ana Tribal Government Organization Chart



**Table 1:
Tribal Government Department Functions**

Government Department	Department Purpose
Governor's Office	Oversees all Tribal operations and performs strategic planning for future Tribal directions. Works with outside resources to ensure successful Tribal operations.
Tribal Administration	Day-to-day operations of Government and all related Tribal activities; inform Governor of Tribal administrative matters; review Tribal financial status and monitor budgets; authorize purchases; negotiate with state and federal Governments; participate in strategic planning
Department of Social Services	Provides prevention services, community education, and other program resources to support Tribal families, encourage family preservation, promote successful parenting and discourage problem social behaviors
Department of Education	Provides support for Tribal members of all ages in acquiring the skills necessary to succeed in educational endeavors. Offers a variety of programs including tutoring, computer education, scholarships, academic and vocational counseling, as well as language and cultural retention for all Tribal members
Tribal Court	Hears cases and decides sentences; Coordinates with the Social Services Department to provide intervention and/or education to discourage repeat offenses
Department of Natural Resources	Preserves, records, monitors, plans, and administers the Tribe's natural resource base. Promotes education in the community.
Planning and Building Services	Provides housing, utility, planning and building services to the community
Tribal Resources	Administers Tribal Archives and Census enrollment activities
Santa Ana Police Department	Detects and prevents crime in the Santa Ana community. Responds to the safety needs of community members
Agricultural Enterprises	Coordinates agricultural activities of Santa Ana community members and enterprises
Santa Ana Medical Clinic	Administered by Indian Health Services; coordinates healthcare for Santa Ana residents
Information Technology Services	Provides technology assistance and training to Santa Ana Government departments and community members and maintains wireless network

As with any network, the network's value increases with each additional user. The Tribe therefore implemented the community network strategically, with the goal of reaching the most users first. In the first phase, each of the Government departments were networked. The second phase networked homes in each of the three Tribal villages (Chical, Ranchito, and Rebahane) with access to the Santa Ana intranet and Internet access. The network configuration is explained more fully in the Technical Considerations section below.

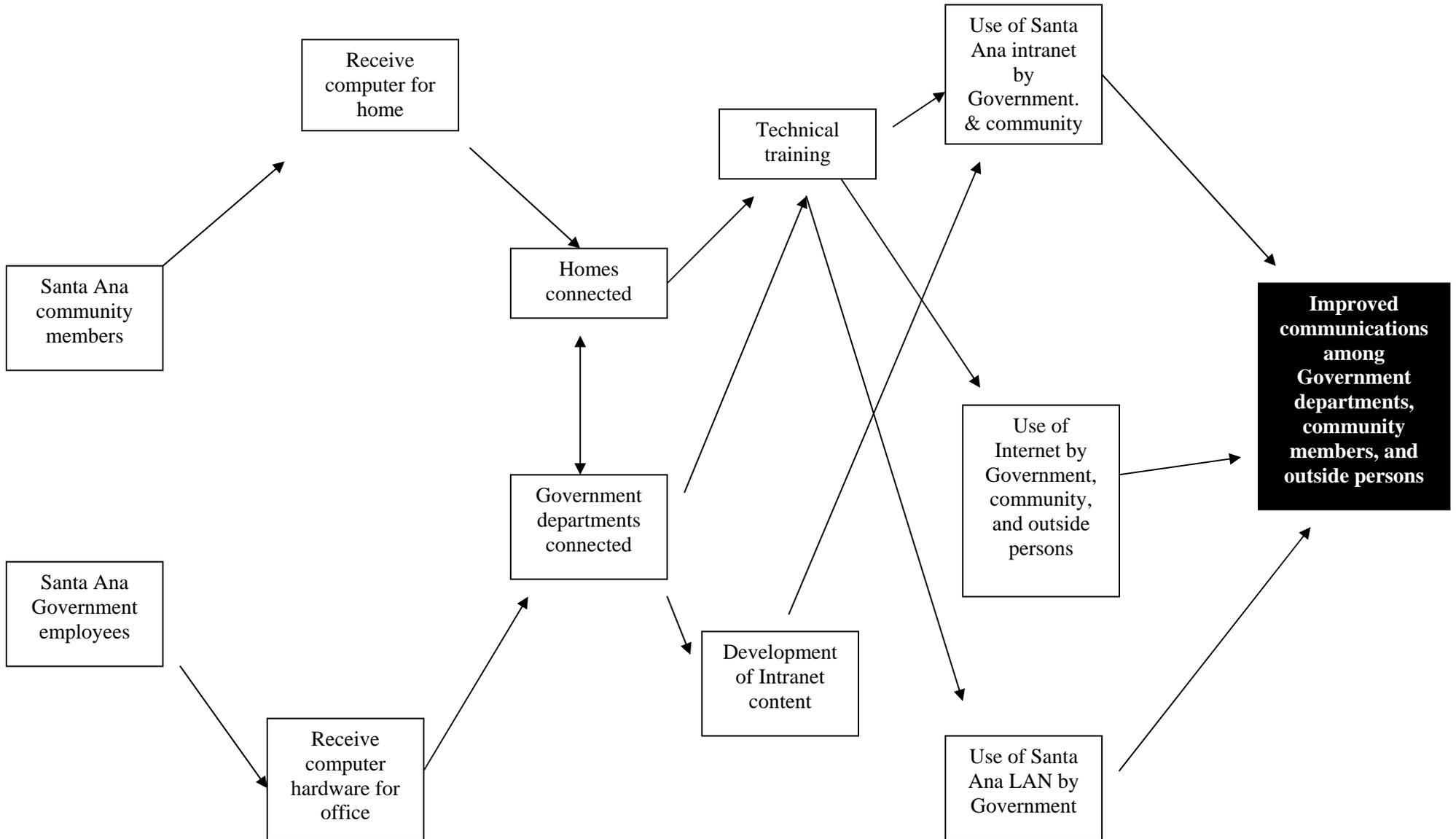
The Tribal local area network (LAN) and Pueblo intranet facilitate Tribal decision making and improved communication among the Santa Ana Government and community members. The LAN networks employees' computers in the 14 Santa Ana Government departments for easy information sharing. Government employees now use instant messaging frequently to communicate with other employees. Each Government department has their own server on the LAN for sharing information.

A project intern tests the strength of wireless signals across the Pueblo..



Additionally, the Pueblo intranet is accessible to all residents and Government employees. The Tribal Government uses the Tribal intranet for the following three purposes: 1) information access: to provide Pueblo members with greater information access to Tribal resources through departmental websites; 2) service delivery: to provide citizens with ready access to Government services via online requests; and 3) communications: to facilitate more efficient communication linkages among Government officials and Tribal citizens.

Figure 3:
Improved Communications through Networking Model



The intranet includes listservs for various members of the Pueblo including a listserv for everyone on the network (including residents and employees), for directors of programs, for managers, and various others. Government employees and residents use these listservs to share information and announce events taking place at the Pueblo. For example, a recent listserv message to all of the Pueblo residents and employees announced a gathering in which Pueblo children made and showcased Native American crafts. Information provided over the Tribal intranet is explained more fully under the second goal.

The three components of the network (1- Santa Ana community intranet; 2) Internet access; and 3) Santa Ana Government LAN) are each used to improve communications. For instance, communications among Santa Ana Government employees may be made via the Santa Ana intranet, e-mail (Internet), or the Santa Ana LAN. Santa Ana community members use either the Santa Ana intranet or Internet access to communicate with each other. (Santa Ana community members do not have access to the secure Santa Ana LAN as it is used solely by Government employees to share information.) Next, communications between Santa Ana Government employees and Santa Ana community members take place either by the Santa Ana intranet or Internet access provided by the project. The Internet is used for communications with persons outside the Pueblo since persons outside the reservation do not have access to the Tribal intranet or LAN. Table 2 illustrates how each communication group (Government employee, community member, or outside person) interact using the three components of the network.

Table 2:
Network Components for each Communication Group

	Santa Ana Intranet	Internet	LAN
Government → Government	√	√	√
Government → community	√	√	
Government → outside persons		√	
Community → community	√	√	
Community → outside persons		√	

Community Access to Government Resources

- 2. Improve community access to Government resources via access to the Tribe’s intranet with content available in written and spoken English and spoken Keresan in each community member's home.**

Each of the homes and Government departments at the reservation is connected to a Santa Ana Pueblo intranet that includes pointers to relevant Internet resources. The intranet improves community access to Government resources via departmental websites. One of the project’s interns interviews directors of each of the Government departments on a weekly basis to find out new information to post to the intranet websites.

*Community residents
can access
Government
resources via the
Tribal intranet rather
than having to visit
Government
buildings.*



The intranet is organized along the following pages:

- Kuwa Tsina:

Kuwa tsina is an expression in Keres that roughly translates as “what’s happening!” This section of the intranet provides updated details on new items posted to the website such as the Wellness Center’s newsletter; wildfire cautions and alerts; Native American links; activities taking place with the Santa Ana Youth Group; hours of operation at the Santa Ana fitness center; and updates on the community networking project.

- Accounting and Finance:

Since many departments within the Santa Ana Government have their financial information managed by the Accounting and Finance Department, this page provides contact information for each of the employees and descriptions of their roles within the department. Additionally, the department provides online notifications to Tribal residents to let them know that their Tribal checks are available for pickup in the office. This is a significant upgrade from the previous method of posting paper messages to a bulletin board hanging in the department.

- Clinic and Wellness Center:

The Indian Health Services office provides many health-related services to the Santa Ana community. Details on these services are provided here. Additionally, descriptions and schedules of Santa Ana Community Wellness programs are available.

- Department of Education:

This section of the intranet provides details about the computer lab hours; library hours and contact information for employees; schedules of classes provided such as Women’s Language classes and Weaving and Pueblo Embroidery classes; postings of student work; and homework reference sites for K-12 students.

“I think [the Internet] is good to have since our library is not equipped with too many resources. And finding the time to travel to libraries in Albuquerque or Rio Rancho can be time consuming.” – Santa Ana Community Member

- Elderly Care Center:

The Santa Ana Elderly Care Center provides services to the elders in the community. This section of the intranet provides information on services available to elders such as a calendar of breakfast and lunch menus served at the Center for the month.

- Governor’s Corner:

This section provides a means of the Tribal Governor to communicate with Pueblo residents. For example, waste disposal on the reservation was becoming an issue so photos of inappropriate waste disposal are posted to bring awareness to the issue. Another issue at Santa Ana is dog ownership. This section provides details on dog owner responsibilities and prohibited dog breeds on the reservation. Updates of the Pueblo *Kuwa tsina* newsletter are posted as well.

- Head Start Childcare Program:

Details about the Head Start childcare program are posted here to provide information to parents about enrolling their children in the program and the activities that take place.

- Human Resources:

The Human Resources section of the intranet provides information to existing and potential Santa Ana employees. For example, existing employees can learn about the Pueblo's 401K plans and health benefits available to them. Potential employees can find out about open positions at the reservation and complete an online application.

- Internet Project:

Because this project has generated plenty of community interest, details about the program goals, timelines, schedule of upcoming classes, and project updates are posted here. Additionally, a FAQ answers many common questions posed by the Santa Ana community.

- Map and Location:

A map of the Pueblo and driving instructions to distributed facilities across the reservation is provided here.

- New Fire Restrictions:

Wildfires are a significant problem faced by desert communities as they can spread quickly and post a danger to Pueblo residents. Alerts from the Governor are posted here.

- Department of Natural Resources:

General information about the Department of Natural Resources is posted here in addition to department news, a directory of employees with contact information, a map and directions to the department's offices, a multimedia gallery of environmental work on the reservation, and information about environmental education programs. Additionally, divisions within the department have their own section of the intranet including the Restoration Division, Rangeland/Wildlife Division, Water Resources Division, and Geographical Information Systems and Information Technology Division.

- Planning and Building Services Department:

This department posts a description of their services with hours and contact information for employees responsible for specific activities.

The Cooking Post (a Tribal enterprise) has set up a website with help from interns in the Information Technology department that allows for them to take commercial orders through the web. The Cooking Post's website accepts credit card payments using secure transactions.

- Tribal Enterprises:

The Pueblo of Santa Ana has a variety of businesses operating on the reservation. Each of these has a section of the intranet where they post information about their activities and services. These businesses include the Cooking Post, the Prairie Star Restaurant, the Garden Center, Southern Sandoval Investments, the Star Casino, the Golf Course, the Hyatt Regency Tamaya resort, and Native Plant Nursery.



The Tribal intranet and Internet websites provide details about plants available at the Santa Ana Native Plants Nursery.

- Tribal Calendar:

This page provides a calendar of Native American events and dances taking place at the Pueblo of Santa Ana.

- Tribal Resources:

Census data about Pueblo residents and community members is provided here. Details about residency on the reservation and Pueblo identity are also provided.

- Other Sections:

Other sections of the Pueblo intranet include a phone and email directory for employees in each of the Government departments, a photo gallery of sites and activities around the Pueblo, information from the Santa Ana Police Department and Social Services Department, and information from Tribal Utilities about utility services on the reservation.

The Pueblo intranet enhances the ability of Tribal members to enrich community relationships. Information in Keres — a Native American language spoken by Santa Ana — is also provided including a video demonstrating the traditional Tribal method of corn roasting in both English and Keres that is available via videostreaming. Keres could not be used for written content on the website as it is a non-written verbal language. Videostreaming of a Pueblo event in which the audio is in Keres helps preserve the language among Tribal members.

In addition to the intranet website, the Pueblo developed a public Internet website (<http://www.santaana.org>) for public access to information about the Pueblo of Santa Ana. This website provides extensive details on Tribal enterprises such as the wholesale Native Plant Nursery, Hyatt Regency Tamaya resort, and the Cooking Post. This website has undergone several iterations and modifications and is now a valuable tool for promotion of the Pueblo.

Internships in Tribal Government

3. Cultivate leadership and 21st century skills in the younger population via internships in Tribal Government units and tailored information technology courses.

The Pueblo of Santa Ana, as a means of self-sufficiency and empowerment, recognizes the need to hire Tribal members to perform Tribal Government functions. However, many students who left the reservation to go to college found jobs elsewhere. Tribal leaders see two primary difficulties with this situation: (1) Some students are ill-prepared academically and socially to go from a rural, insulated setting to the institutional setting of a university. The Tribe has found that even the high school honor roll students feel overwhelmed and as a result, often drop out; and (2) If all the school hurdles are met and students achieve their degrees, they face an additional problem. With few jobs requiring college-level skills in or near the Pueblo community, they are forced to go elsewhere, even if they would prefer to return to Santa Ana to contribute their expertise

for the benefit of the Pueblo community. To address this concern, the Tribe set up an internship program for Native Americans.

One intern success story is that a Santa Ana mother of four who initially had few computer skills enrolled in a local community college and learned webpage design skills using expert software such as Dreamweaver. Using these new skills, she designed many of the Pueblo's webpages. Additionally, she was so successful that she now works for the Santa Ana Department of Education and is charge of all training that takes place in the computer lab.

Through this project, the Tribe hired six students at Santa Ana and other local Native American reservations (including Zia, Santa Domingo) to develop and maintain the community network. Students each semester received scholarships funded by the Santa Ana Tribe for books and fee expenses at local colleges and vocational educational institutions. These students also received paid internships within the Santa Ana Government's Information Technology Department. The interns were trained on the job to install and maintain a wireless network. They are also responsible for developing and updating the Tribal intranet websites.

A second success story is that another intern designed an alternative antenna for wireless reception at residents' homes. In this case, she researched the antenna configuration requirements based upon specific frequencies in order to optimize both the antenna gain of the system as well as maintaining a wide field of view. The "cantenna" was made out of a standard coffee can and measurements showed that it operated with similar parameters to those of a commercial system.



One of the project's interns shows the "cantenna" she developed that is used to network residents' homes on the reservation.

Information Literacy and Digital Skills

4. Attain information literacy and digital skills among all age groups of the Santa Ana community.

As outlined in the Pueblo of Santa Ana Technology Goals Statement (Figure 1), the Tribe seeks to attain information literacy and digital skills for all Pueblo residents. The Pueblo hired a Network Administrator to maintain the network with the goal of transferring this responsibility to Tribal members. Interns learned to maintain the network, thereby learning important employable technical skills.

"I can access a whole world I would never know of otherwise." – Survey Respondent

Pueblo residents were provided a home computer equipped with wireless network access. Out of 188 homes on the reservation, 158 chose to use a computer. Thirty

residences chose not to participate in this project. Prior to receiving their home computers, Santa Ana residents were required to complete three computer training courses provided by the Network Administrator and interns. Residents were notified via flyers in their mailboxes and by going door-to-door to talk to Pueblo residents about the project. Training took place in the Information Technology Department offices, Tribal Conference room, and computer lab in the Department of Education.

One Pueblo resident is now using his home computer to maintain a website he designed for his own record label which sells Native American music.

Three training courses took place with four sessions for each course provided at distributed times to ensure that all residents could participate. The first training session took place in March 2003 and explained how to set up a computer straight from the box. The second course explained Internet security and applications, such as email and searching for information on the World Wide Web. The third course was more application oriented and explained how to use applications¹ installed on their computer.

“I believe the Internet is very good for the Pueblo. It helps out anyone who is willing to try it, from young to old. It allows the younger kids to have various options when doing homework and older people and young adults the technology to take online courses.” – Santa Ana Community Member

The Department of Education maintains a computer lab that is accessible to all of the Santa Ana community. The lab has 19 computers which are all networked with a T-1 connection and access to printers. Typical users include K-12 students after school and adults in higher education programs. The Department of Education promotes distance

¹ Software that was pre-installed on computers for residents include: Encyclopedia Britannica; various games; Roxio CD Creator; Microsoft Internet Explorer; Adobe Acrobat; Wordperfect Productivity Pack; and Outlook Express for email.

learning opportunities to the community because the reservation is relatively isolated. Distance learning provides access to learning opportunities that would otherwise be unavailable to Tribal members.



Each of the computers in the Department of Education's computer lab are fully networked to the Internet and printers.

To meet the needs of Santa Ana's youngest citizens, five kid-friendly computers were purchased for children participating in the Head Start program. These computers are designed to facilitate use by some of the youngest Tribal members.

The computer lab is set up in a friendly manner to encourage participation from all age groups.



Each resident and Government employee at Santa Ana receives space on a network attached storage (NAS) box with 1.6 terabytes. This provides enough storage space to allow everyone to back up their computer over the network. Additionally, the NAS box is also backed up, providing a safe place for each user. Each Pueblo resident also received an email address hosted on santaana.org such that a resident's email address is their first name and last initial @santaana.org.

Wireless Broadband Model

5. Demonstrate an innovative, cost-effective, and scalable model of wireless broadband telecommunications application in a rural community.

A principal goal of the Santa Ana Technology Opportunities Program (TOP) is the establishment of a Tribal wide network to all Tribal members on the Pueblo. Several design goals are important, including the delivery of high-speed Internet services, Tribal Government services and information, and learning technologies and applications for advancing Pueblo opportunities while maintaining cultural awareness. This requires a scalable, future looking network that can support the demands for services that will evolve in this network for years to come.

The network design used emerging wireless technologies to provide access to the LAN, Pueblo intranet, and to the Internet. Considerations for the network design are detailed in the Network Architecture section below.

Evaluation Methods

6. Employ formative (process) and summative (outcome) project evaluation for ongoing project improvements and project replication in other communities.

An ongoing evaluation of the project has provided information that modified some of the original plans during project implementation. A formative evaluation assessed the project as it was ongoing and a summative evaluation provides details on the outcomes of the project at the end of project funding from the U.S. Department of Commerce. However, the cessation of grant funding for the project does not mean the project has ended. Instead the Pueblo sustains the project by reaching the objective of having the Tribe maintain its own community network. Details of the project evaluation follow in the Evaluation section, as does an examination of how other Pueblos in the area are using information learned from this project in their own communities.

NETWORK ARCHITECTURE

Technical Considerations

A principal goal of the Santa Ana Technology Opportunities Program (TOP) is the establishment of a Tribal wide network to all Tribal members on the Pueblo. Several design goals are important, including the delivery of high-speed Internet services, Tribal Government services and information, learning technologies, and applications for advancing Pueblo opportunities while maintaining cultural awareness. This requires a scalable, future looking network that can support the demands for services that will evolve in this network for years to come.

Definition of Basic Pueblo Network Requirements:

- Establish a secure, private Pueblo network (Intranet) with full Internet access;
- Provide data rates capable of supporting video streaming to homes at a minimum of 200 kbps per residence, with 384 kbps being preferred for quality;
- Provide Internet services to each home with a reasonable statistical bandwidth offering (up to 2 Mbps ideally for high quality video); and
- Develop a flexible network that allows for future services, such as voice over the network.

When the TOP proposal was submitted, a number of technologies and approaches were considered to accomplish the baseline requirements. These included:

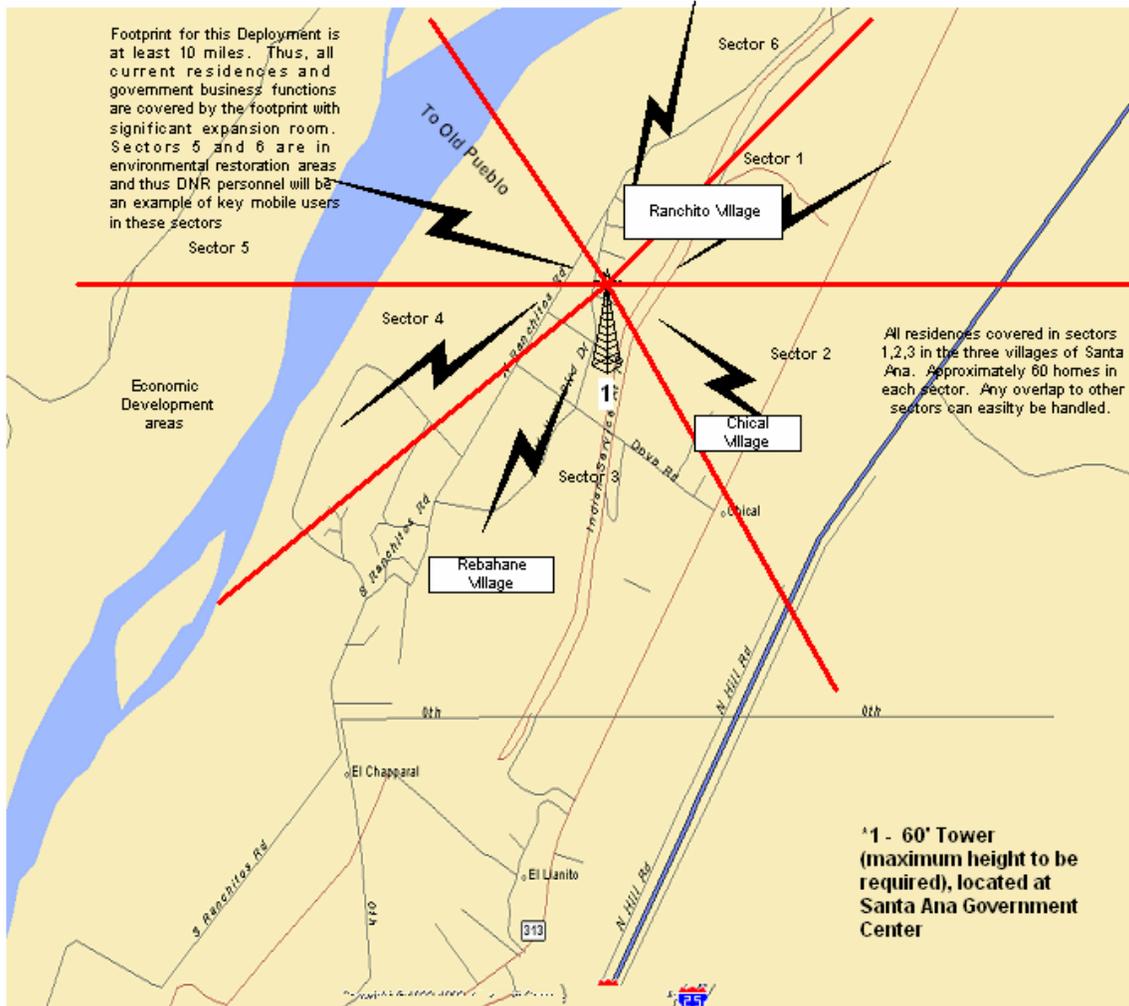
- Phone line/modem;
- Several variations of wireless data service; and
- DSL delivery.

Due to cost, access network availability off the Pueblo, and immaturity of various technologies at the time of the proposal submission, several potential technologies were eliminated. DSL services were discussed at length at the time of the proposed concept network but Qwest, the local service provider, had no plans to support DSL delivery for a

minimum of two to three years. The possibility of developing a Competitive Local Exchange Carrier (CLEC) to provide service at the Pueblo was considered but given the initial lack of service and experience at the Pueblo for supporting broadband service, the CLEC concept was determined to be too risky for cost, deployment, and management. The initial proposed system became a wireless system operating in the unlicensed frequency band at 2.4 GHz. The wireless option required no approvals for deployment or operations, wired solutions were too costly at the time, and the Pueblo did not have the rights of way to provide data services to its residences over the existing phone line plant. However, it was understood as the proposal was developed that due to the height /density of the Valley Cottonwoods, wireless signaling to many of the residences — specifically in Ranchitos and Rebahene — could be blocked since 2.4 GHz radio waves can be rapidly absorbed and attenuated by foliage, making the wireless approach more costly or less reliable without additional towers and radio units.

Specifically, the original design called for the use of the highest bandwidth available system at the time – 3 Mbps units from Breezecom that would provide service from a tower at the Pueblo Government center in 360 degrees by separating the circle into six sectors of approximately 60 degrees for each radio unit. Figure 4 depicts the original concept of the single tower with six sectors delivering service across the Pueblo.

Figure 4
Original Network Concept



In addition to the wireless design, a baseline wired network architecture was developed. In order to meet data throughput as requirements and security issues for isolating specific Government data from potential public access, the network designed to include at a minimum two sub networks. One network would provide services to the 188 homes plus businesses across the Rio Grande well as support limited mobile networking requirements. The second network would be supported through the Cisco router to the Government side of the network, allowing total separation between the two while still allowing managed access across both networks. A third port on the router was dedicated to connect the DRN network (already in place). The final, Wide Area Network (WAN)

connection was designed to be a T-1 (1.544 Mbps) network access to the Internet. The basis of this network design was carried forward as technology advances supported an increase in the capabilities and complexities of the Pueblo network.

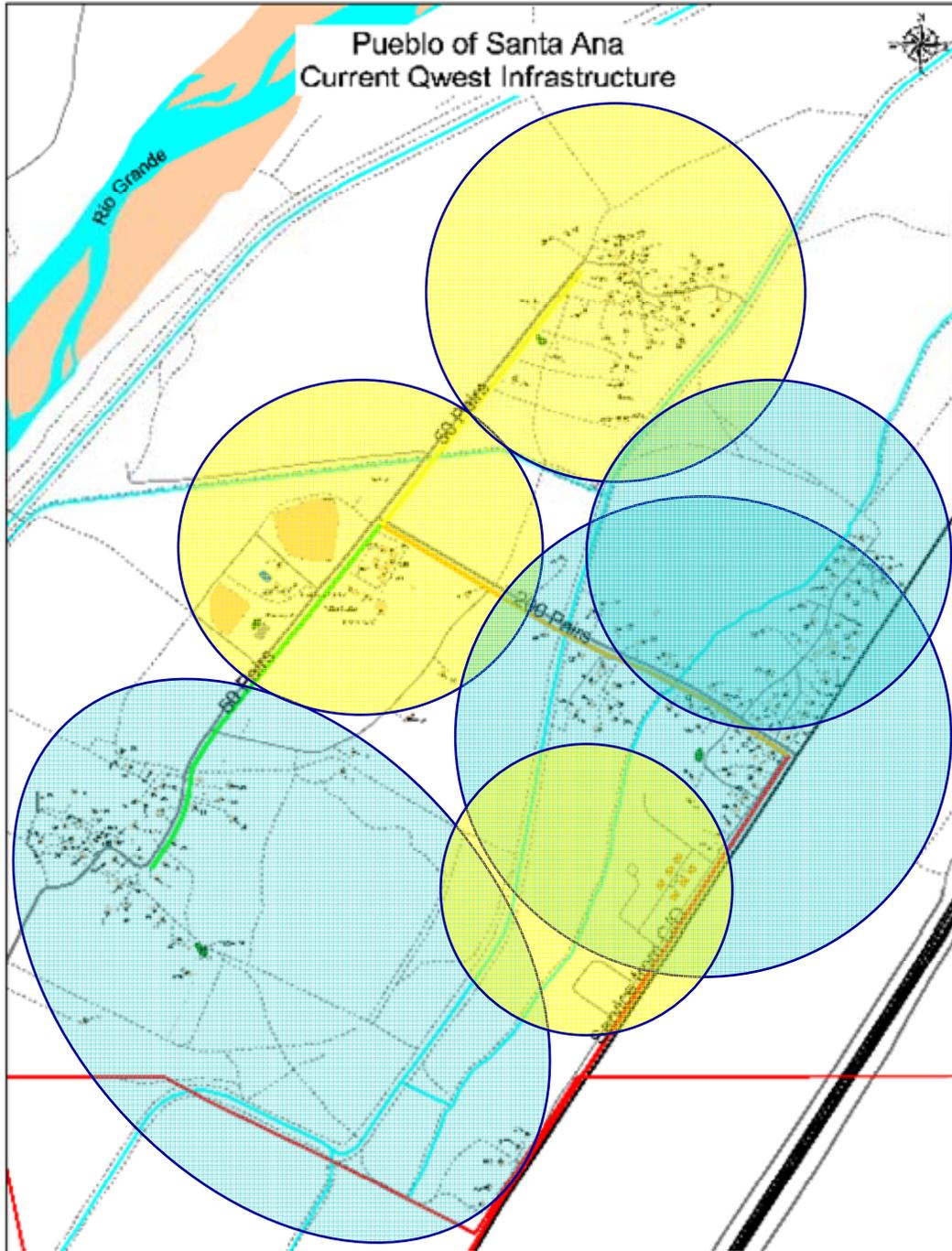
While functional and meeting the TOP baseline goals, there were several problems with the initial design. It was based on a frequency hopped radio frequency approach, which was not the path the majority of the wireless industry followed as wireless technology moved into commercial deployment. Technology in the 802.11b area developed rapidly after the initial TOP proposal submission, and it was determined early in the first year of the program that the newer 11 Mbps Direct Sequence equipment with newly approved standards would be a more appropriate system due to the higher bandwidths. Cisco Aironet equipment was selected based on reliability and thus a number of bridges, antennas, and access points were purchased for Government network connectivity.

Based on the Aironet program, the initial Phase I of the program — the Government LAN and Intranet — was completed during the first year of the effort. Extensive testing for antenna systems and data throughput was conducted and wireless service was deployed during the first year from the Government Center to the Department of Human Resources, the Police Department, Education facilities, and across the Rio Grande to the economic development areas for the Pueblo.

The resulting data gathered from these measurements indicated that a second tower for delivery of wireless service to the village of Rebehanne was definitely necessary due to the cottonwood trees. However, it was observed that one tower was already in place at the Government Center and used for VHF/UHF radios for police and other communication functions. With advancements in wireless access points and bridges with advanced management features, as well as detailed measurements at various locations around the Pueblo, it was determined that a distributed wireless architecture could offer improved bandwidth service to each home. In this case, several points were chosen for installation of a bridge. In this scenario, bridges from the Government Center would communicate in a point-to-point mode to a bridge in an outlying area. By configuring this bridge for both bridge functionality as well as behaving as an 802.11b

Access Point, local users (in this case, residential homes) could connect to the bridge close to their homes. This improved throughput from the home by increasing the signal strength of the wireless network. Figure 5 shows a view of the distributed wireless network with coverage areas depicted by each of the circled, shaded areas.

Figure 5
Network Coverage Areas



This network deployment was completed approximately half way through Year 2, or Phase 2, of the program. The basic premise of the Year 2 effort consisted of two primary components: 1) procurement of PCs or terminal devices for each home on the Pueblo; and 2) build-out of the described wireless network to provide broadband connectivity for those computers. As the wireless design to residential areas was being deployed, additional technologies were being reviewed. There were several emerging networking options for broadband connectivity to the homes based on continued improvement in last mile technologies. The design described above was functional and provided a baseline of 11 Mbps “shared” network to every residence within the given sector of an 802.11b radio unit. However, newer technologies expanded this baseline bandwidth to each home, which if deployed would provide greater capabilities for high-end applications well into the future. The objective was defined to provide a broadband signal to each home in the three Santa Ana villages with a target of 15 Mbps data rate (based upon the potential offered by a high-speed wireless service called 802.16 or DSL services were deemed satisfactory based upon interoperability, scalability, and cost-effectiveness). That data rate would be adequate to support phone services, intranet/internet access, video channels and the services that can be built on them. Thus, a trade study of the new technologies, cost, and capabilities compared to the existing 802.11 was conducted with the results depicted in Table 3.

Table 3
Networking Technology Options

Services	Wireless Options		Wireline Options	
	802.11	802.16	LRE*	LRE+Gigabit Ethernet
Data	✓	✓	✓	✓
Voice		✓	✓	✓
Video		✓	✓	✓
Nominal data range (per house)	100K	1-10M	15-22M	15-22M

* LRE: long-range ethernet

Costs for the 802.11 wireless option and LRE+Gigabit Ethernet are similar, while costs for 802.16 are significantly higher (and not standardized) as would be cost of a

distributed LRE using fiber deployment or requiring a DSL access multiplexing (DSLAM). Extensive meetings were held with Qwest and Cisco to determine the most technically and cost-effective networking option based on utilization of the existing phone cabling infrastructure on the Pueblo. A demonstration of LRE technology was developed during the 2nd year utilizing what is termed “dry line” or unconnected pairs of copper lines from the Government Center switch box to homes in each of the three villages. The longest reach was approximately 5000 feet, which is considered to be at the maximum range of the LRE equipment. All of the links worked at up to 15 Mbps except for the longest run, which operated at a 5 Mbps link. However, these discussions will continue into the early stages of the next year of the program. It is anticipated that LRE demonstrations will be conducted to evaluate the performance over existing Tribal copper infrastructure.

Following the TOP award, 802.11b had become an industry standardized protocol and the architectural design was immediately upgraded to using Cisco 340 Bridge Radio units operating at 11 Mbps, providing an immediate 3-fold increase in capabilities. Other options were also evaluated, such as using Local Multipoint Distribution Service (LMDS), a very high speed wireless service. However, this required an FCC license to utilize the service and the respective owners, after initial discussions, did not want to allow the Pueblo to utilize their frequency spectrum. In the intervening time, technologies available to support the Tribal network requirements continued to expand. The following establishes the final baseline of network services designed for the Santa Ana Pueblo, the available options considered, the associated cost of the respective systems, and a ranking of the various options for use by Pueblo Tribal leadership decision makers. Residential computers and Government network applications are not directly addressed by this report.

Wireless options:

As described above, the original proposal specified a wireless network based on technology that would deliver sum total (shared) of 3 Mbps to each village. This was the most capable, balanced system for cost and services at the time of the proposal. However, new wireless options based on a standard termed 802.11b quickly emerged that offered

an average of 6 Mbps services per bridge (the average throughput for an “11 Mbps” system). This service was immediately deployed on a trial network around the Pueblo Government Center and to several of the Pueblo owned businesses across the river. GTRI engineers, working with the Pueblo TOP staff, performed extensive measurements across the residences based on initial 802.11b service deployment. While this service was adequate for basic service, in order to be as forward-looking as possible for network service and application requirements in the future, newer wireless technologies were examined. Communicating at a higher unlicensed frequency band (5.7 GHz) and termed 802.11a, this equipment provides up to 30-35 Mbps per bridge. Deployment is identical to that of the original TOP proposal. While data rates for this service are clearly superior, there is an increase in cost and some concerns on distance limitations. In the process of evaluating wireless in general, a wireline capability supported by new Cisco technology was uncovered and was developed into another option for service delivery. Finally, a third wireless option was considered based on the developing rural broadband wireless service call WiMax, based on the 802.16 protocol standard. However, completion of a standard was two to three years away and thus was not considered a very viable option.

The following table expands the details for the three primary options for wireless deployment under the TOP—originally proposed wireless network, 802.11b system, and 802.11a – each with cost, advantages and disadvantages. Note that there are similar options for local Government services and for high speed communications to the “west-side” of the reservation. A wireless network based on the 802.11b system is currently in operation for both Government and west-side operations. Also, the table includes pricing for the wired option, which will be discussed in the following section. Based on the multiple methods for network access, a detailed assessment with advantages and disadvantages of each of the technologies was developed and presented to the Pueblo Tribal council approximately half way through Year 2 of the program.

Original: BreezeCom FH System				-Range -Better security than other wireless options -Cost (from original TOP proposal)	-Throughput (3Mbps per AP), least by far of any option -Requires at least one tower, perhaps two -Requires installation at each home as in other options. -Limited future apps.
UNI-16 Directional Antenna	8	\$275.00	\$2,200		
Residential Install	188	\$200.00	\$37,600		
Client Adapter	188	\$300.00	\$56,400		
Access Point	8	\$1,100.00	\$8,800		
Residential Antenna	188	\$95.00	\$17,860		
Total			\$122,860		

Analysis and Presentation of Wired and Wireless Access Technologies

Wired Option:

A basic wired option that has always been available to the Pueblo is simply installing modems to each home with a modem network multiplexer at the Government center. However, using simple analog (traditional modem) options would support a maximum data rate connection of 53 kbps, clearly not sufficient for the scalable multimedia application plans for the Pueblo. In fact, due to distances back to the Qwest Bernallio Central Office (CO), typical modem access was limited to less than 24 kbps. For Internet access, the definition of broadband services is a minimum of 200 kbps (Federal Communications Commission definition), enough to support reasonable streaming video. Clearly, standard modem options were not sufficient and thus were not considered further for this program.

At the time of the TOP proposal, wired services were considered where the existing Tribal telephone network would be used with the addition of Digital Subscriber Line Equipment (DSL) to each home. As described, Qwest Communications would not support DSL services so the Pueblo would have to deploy their own DSL Access Multiplexer (DSLAM) and support the IP network, in addition to gaining approvals for “overlying” this network on existing Qwest maintained phone lines to each home. For these technical reasons and the state of DLSAM and equipment cost at the time of the proposal, DSL-based network was not recommended.

In year two of the TOP, Cisco Systems introduced a new wireline technology called Long Reach Ethernet. LRE extends and Ethernet class signal (10Mbps) over 6600 ft using standard telephone wiring. The ease of implementation, low cost, and the

relatively high bandwidth per residence makes LRE particularly attractive for this project. Furthermore, it can easily be separated from voice traffic over the phone network so there is no impact on voice service. Thus, the installation is extremely simple, with no required installations at a Tribal member's house except for the placement of an LRE modem and connection to the computer. The vast majority of installation issues are satisfied at the Government center.

Since LRE uses Qwest's copper plant, an "arrangement" must be made with them to put our data services on their facilities. The delays in obtaining this arrangement were significant, and caused at least a year's delay in the project already. The "arrangement" was described as taking a number of different forms.

The Qwest Proposal:

The retail group at Qwest proposed that the Pueblo purchase its "outside plant" on the Pueblo, purchase a fiber optic link from Qwest (voice and data services running over fiber), and modify the physical plant to distribute both voice and data to the residences. This requires an expansion of the existing PBX and cash outlays to purchase/modify the plant and purchase LRE equipment. The price tag is estimated to be approximately \$260K.

The project costs were significant and it was unsure as to whether the proposed solution would meet all the Pueblo's requirements. Therefore, the effort was broken into smaller pieces to help the Pueblo TOP personnel better understand the technologies, and more easily manage the change.

What the Pueblo Requested from Qwest

Based on the need to confirm what the LRE technology could do in a real network deployment (available bandwidth under load, and the total extent of connectivity, i.e., total distance), it was understood that Pueblo network requirements on Qwest needed to be flexible. The following approach was derived:

Step 1 (Immediate) – Requires the Tribal Administrator’s Approval

- 1) A line sharing agreement where Qwest maintains their existing residential POT services, but allows the Pueblo to camp data on (e.g., insert a data stream on the existing copper) “the last mile” for purposes of proving that the LRE technology selected for the TOP Program actually works. The line sharing agreement would allow the Pueblo to test the concept while deferring the cost of the PBX upgrade until we know that the approach works.

There has been some written indication in Cisco’s literature that the LRE services may degrade when put into a full cable bundle as we propose to do for the villages. However, the Pueblo would like to minimize all parties “exposure” if the LRE does not perform as expected. By maintaining all their existing POTS services, Qwest’s interests are maintained, and a minimum of effort would be required to return everyone to their original state.

- 2) The Pueblo requires modifications to the existing copper plant to provide termination of all the cables running past 2 Dove Road in a wiring closet in Building 02C, and removal of any and all incumberances (bridge taps etc.) so that we have a direct connection to each residence. The Star configured network would be based at 2 Dove Road rather than at the current POP on Rt. 313. Voice services would still be maintained from the Bernalillo CO., but a drop/insert point for data would be created at the 2 Dove Road location.

The plant reconfiguration and line sharing agreement would allow the Pueblo to test the technology and to decide if we should pursue this particular approach to achieving the goals of the project and the Tribe. In Step 1, the Pueblo would rollout LRE to the villages of Ranchitos and Rehabene, gain experience with the technology, while creating the smallest change to the existing environment. Pueblo residences would not be impacted; telephone services to the Pueblo residents would be maintained; and if, for any reason, the technology did not pan out as expected, there would be almost no impact to the Pueblo.

If the trial results are positive, additional project phases were considered possible.

Step 2 (Spring 2003) – Requires Tribal Administrator’s Approval – Complete the TOP Program Requirements for Data Infrastructure to Residences.

- 1) Complete the LRE rollout to the Village of Chicale. The TOP program would fund the modifications to the copper plant to support the village of Chicale. Qwest would be contracted to make the modifications. The line sharing agreement with Qwest would be extended to cover the additional residences in Chicale.

Step 3 Possible Extensions - Requires Tribal Council Approval

- 1) Purchase or lease the copper plant on the Pueblo.
- 2) Provide Dial Tone as well as Data to Residences (would require the resale sections of the agreement).
- 3) Optical Fiber Links to Bernalillo CO

Figure 6 depicts the proposed infrastructure to the Pueblo, with Qwest running a new network to the Government center and each of the bundled pairs (50 to Rebahene, 50 to Ranchitos, and 100 to Chicale) being terminated at the Government Center telecommunications room. This location provides optimum network installation and management.

Technical Conclusions and Recommendations

With the development of the Qwest initiative and the initial wireless designs, two primary methods of delivering a forward looking, scalable network to the Pueblo have been presented. A summary of the advantages and disadvantages of each are provided in the following sections. Based on all available knowledge, tests, and future Pueblo requirements, it was recommended that the LRE approach was the optimum solution. Both solutions would work and the LRE required additional up front cost that would be returned to the Tribe over time. The following describes the tradeoffs in detail and the final recommendations made to the Tribal Council.

Alternative 1: Wired Data to Residences

The Cisco LRE will satisfy the requirements of the Pueblo for a long-term, high speed Intranet and Internet service to the residences. The advantages are as follows:

- Extremely easy to deploy, with only wiring changes made at Government Center;
- Equipment cost much lower than wireless;
- Easy to maintain, maintenance can be performed from a central site
- No security concerns for outside “hackers”;
- High bandwidths allow for a many future applications, including high-quality Internet-based video delivery;
- The cost of plant purchase can be recovered very quickly based on how the Pueblo handles phone service charges; and
- Suggested method of deployment (2 villages first) minimizes risk to Pueblo while confirming the performance of the LRE. If this does not work as stated, then the wireless option is still available for deployment with minimal sunk cost in cable wiring by the Pueblo.

Disadvantages:

- Initial cost of the copper plant. Two recommendations for cost: one to purchase the plant and the second to lease the plant.
- Purchasing the phone plant requires the Pueblo to provide voice service or negotiate a lease back to Qwest to provide voice service. While the equipment

required is relatively straightforward, the requirements for 24x7 support is a decision for the Tribe;

- Cannot realize significant potential cost savings if not taking over voice service;
- LREs are not standardized. However, with the rewiring of the cable plant, other vendor systems can easily be deployed if the Cisco LRE were to be somehow discontinued;
- This is a significant change to the original proposal for a wireless network. Since a case can be made that it is a superior solution we anticipate no problems with approval of changes by TOP representatives but this does remain an issue;
- Total additional upfront cost for this approach as opposed to wireless is approximately the same if the plant is not purchased. However, this would not allow for potential future savings. Thus, if the plant is purchased, the total cost reaches approximately \$172,444.52. This exceeds the original cost of the wireless approach by approximately \$52,000 (assuming wireless 802.11a). However, the wireless cost does not include a tower. If two towers are needed, this would add at least \$12,000 to the wireless, reducing the difference to \$40,000, while providing significantly less capability with wireless than with the LRE;
- Note that the Tribe must allocate additional funding outside of the TOP funding in order to complete the LRE option with plant purchase.

Alternative 2: Wireless Data to Residences

In the past two years we have evaluated several wireless alternatives. The options continue to change rapidly. We have evaluated both proprietary and standardized approaches, but it's a moving target. Possibly the biggest issue is the incompatibility between vendor's equipment and the difficulty/cost of upgrading to a faster technology in the future.

The original goals of the TOP project can be achieved using off-the-shelf wireless equipment from a number of vendors. The fact that the bandwidth is shared among a number of households makes it less attractive for advanced services and this approach would incur more "installation" costs and inconveniences to Pueblo residents. An antenna would be required on many residences requiring entry points (holes) to be drilled into the houses. The wiring is relatively large and unsightly. While we would minimize

this inconvenience where possible, the deployment of antenna masts on rooftops or side gables of a large number of residences will likely be required.

Wireless advantages:

- Offers some degree of mobility around the Pueblo, although difficult to assure communications without certain antennas;
- A number of vendor solutions that are nearly all interoperable;
- Lower cost than the LRE due to no plant purchase;
- No impact on existing voice service as far as residences and Qwest are concerned.

Wireless disadvantages:

- Line of sight issues require at least one 60-foot minimum tower install, perhaps a second tower. Cost is approximately \$6,000 minimum per tower. These will require a “guy wire” (4 minimum) for each tower, using a foot print of 25 feet or greater around the tower to tie down the structure for wind loading.
- Installation of equipment attached to each house (or attached to a window) and thus invasive to every resident. The estimated install is \$200 each house. LRE installation costs are zero (will be done by the Tribal TOP personnel) and require no modifications or additions to the house structure.
- Security due to wireless hacking is an issue, although we believe this could be resolved.
- Shared bandwidth limits performance when many users are connected; thus if multiple videostreaming connections are being run simultaneously, performance may suffer. Sharing of 802.11b gives approximately 125 kbps to each. Not a completely fair comparison because it requires everyone to be on and receiving information at the same time. Statistically, more like +300 kbps. Thus, satisfies bandwidth requirements for FCC broadband definition but still only 5 percent of the total throughput to each household that the LRE can achieve.

Alternative 3: Fiber Optic Connections to Residences

The project team has discussed this option a number of times. It provides the best long-term bandwidth and infrastructure for the Pueblo, but is severe overkill for the TOP project requirements, is significantly more expensive requiring trenching fiber to each

residence, and brings little incremental benefit for the foreseeable future. Thus, no detailed description of this option was provided. The LRE option serves the same purpose at a much lower cost.

Final Summary

The wireless option will work and will address the basic needs of the Pueblo while fulfilling the requirements of the TOP grant. Furthermore, no additional cash expenditure should be required by the Pueblo beyond the commitment in the original TOP grant. It is recommended that wireless be deployed for the near future (as it already is) from the Government Center to points across the Rio Grande. This allows low cost service provisioning; it's a point-to-point link and thus not shared bandwidth; and since there are few points, the existing tower is sufficient. It also leaves open the possible application of wireless network service to more remote areas of the Pueblo across the Rio Grande.

However, with the emergence of the LRE equipment, a much wider range of future applications from video, voice options, and multimedia Internet applications are made possible to the Pueblo residential members. This approach offers much higher data rates, should be easier to maintain, has fewer security concerns, and has no installation issues for the residences. You simply plug the LRE into a wall phone outlet. However, there is a significant one time capital cost of wiring to the Pueblo. If the plant is not purchased, the rewiring cost plus equipment costs are still less than the wireless option. **At a minimum, this approach was recommended.** The one issue here was the negotiating with Qwest to become a DLEC (data local exchange carrier).

The Pueblo could purchase the plant, although total cost would now exceed the wireless option by approximately \$40,000, including wireless towers. **We do recommend** the purchase of the plant based on the phased approach described in this report. If satisfactory negotiations are reached with Qwest as described, there is minimal technical and financial exposure to the Pueblo. This allows the Pueblo maximum flexibility to have another service provider at some point, lease back to Qwest for voice service, or become their own phone provider, which is addressed in the final phase.

The final phase would result in purchase by the Pueblo of PBX's and the Pueblo hosting their own voice services. Technically, this is straightforward provided the Pueblo will commit to supporting the voice service 24x7. Cost would be approximately \$85,000, making the total additional cost to the Pueblo beyond the TOP grant equipment budget of approximately \$125,000. However, cost can be recouped within approximately two years depending upon decisions for local phone service cost to the Pueblo residential users (since it would now be under control of the Pueblo Tribal Council) and then it becomes a potentially significant financial benefit. **This option is recommended**, but final decision can be delayed until Phase 3 of the process. Again, this approach allows the Pueblo to make a deliberate, careful decision.

**Table 5:
Final Costs for Pueblo Tribal Council Analysis**

Wired Solutions with all options listed			802.11a Wireless Option		
<u>LRE Solution</u>	Qt.	Total	<u>802.11a Solution</u>	Qt.	Total
LRE 24 port 2950 series	10	\$31,470.00	1200 series AP (11a)	8	\$7,280.00
		0	cisco yagi 13.5db	8	\$1,680.00
		\$19,488.00	proxim skyline 11a adapter	188	\$43,052.00
CPE single port 24pk	8	0	cisco 9db patch antenna	188	0
48 port POTS splitter	5	\$3,485.00			\$31,584.00
		\$54,443.00	Residential Install	188	0
Total		0			\$37,600.00
Additional Plant Cost options					
*see attachment A for details			Total	\$121,196.00	
Plant Purchase		\$54,320.10			
Wiring Plant Rewire *required		\$64,531.82	Additional Cost : 2 towers 60ft est. \$12,000		
PBX purchase		\$85,000	(if to 100 ft., add approx. \$6k)		
Total Wired, no Plant/PBX purchase \$119,000			Total Cost for Wireless: est. \$133,196		
Total Wired with Plant purchase \$173,294					
Total Cost for Wired est. \$258,293					

Capabilities and Overview of the Deployed LRE Equipment:

The Cisco LRE equipment was approved for deployment. This system provides voice/video and data service over a data network using existing copper cabling over distances to 5,000 feet at data rates from 5 to 15 Mbps. In the case of the Pueblo, the Cisco LRE equipment delivers data network access over the existing phone lines and provides what amounts to Very High-speed DSL (VDSL) service. The basic complement of equipment includes the Cisco Catalyst®2900 LRE XL switches, the Cisco 575 LRE Customer Premise Equipment (CPE) device, and the Cisco LRE 48 POTS Splitter. The POTS splitter is designed to separate voice traffic from the data network and thus voice services are currently provided to the residential network using traditional analog phone service. The Pueblo Government Center is serviced with the LRE as a data service and the voice is converted to Voice over IP (VoIP) and thus is also delivered to the Government personnel as a data service with managed Quality of Service. This VoIP deployment was quite possibly the first case of VoIP delivery in New Mexico – certainly among pueblos. Utilizing a hybrid network of wireless and LRE wired service combined with a VoIP supported architecture provides a unique and forward looking network service that will benefit the Pueblo for many years.

Year 2 completion:

Completion of year two of the program had a completed Santa Ana Tribal Intranet created, full email service, and voice services integrated to the desktop of all Government personnel with the installation of a Shoreline VoIP PBX. Furthermore, wireless broadband deployment to nearly all residential homes was completed. At the end of Year 2, 140 residences (80 percent of the homes) were linked to the Santa Ana Tribal Internet using 802.11b wireless and computer distribution to the residences and training of those users was largely completed. The final phase focused upon the ordering and deployment of the shared distribution loops necessary to provide LRE data services to each residence with a Qwest telephone. The data rates for the network design were on the order of 15 Mbps to these residences and several residences were brought up using “dry” phone line connections to demonstrate the feasibility.

Year 3 and 4 completion:

With extensive delays in discussions with Qwest for gaining the necessary approvals, network modifications, and purchase and deployment of LRE equipment, a one year extension for the TOP program was requested and granted.

Future Directions for the Pueblo Network:

Upon completion of the TOP program, the objectives for network delivery were either met or exceeded. There are several possible extensions to the network and the applications available to foster more diverse use of the network. As described, the architecture uses a centralized design based at the Santa Ana Pueblo Government Complex. This centralized design with the LRE and wireless providing access to the Government, the residential, and business areas, allows for improved applications as well as expanded service from Qwest for Internet access.

First, there are potentially significant cost savings to the Pueblo by deploying VoIP service to all of the residences. The discussions with Qwest required so much time during the program that a full analysis of the cost savings was not completed prior to end of TOP but an initial estimate is up to \$60,000 a year in cost savings. There would be some cost outlays for purchase of IP-phones, additional VoIP PBX modules for the primary network center, and at least two additional T-1 lines from Qwest with dialing number (referred to as DIDs in the industry). The second issue would be in creating the network management and sustained support to insure voice service. However, a detailed analysis would likely show a major cost savings and should be considered for future use.

With a 15 Mbps per home switched network architecture in place, data applications also should be expanded. A major capability would be expanding the opportunities and use of video streaming to the residential customers. This would include the deployment of a high speed video streaming server that would provide Native language-based teaching, events of interest to the Pueblo captured in video for storage and delivery, and additional applications. With more usage of the network, this will place demand on the single T-1 Internet data connection. Thus, in the near future, as T-1 lines

are added for voice and for higher-end Internet usage, the multiple T-1s would be supplanted by a single fiber connection carrying at a minimum an DS-3 (45 Mbps) line. Voice and data would reside on this single connection in separate virtual network paths, providing much easier network management and a cost saving to the Pueblo.

PROJECT EVALUATION

The project evaluation uses mixed quantitative and qualitative methods for both process and outcome measures. Semi-structured and open-ended interviews, surveys, and observations of network usage inform the evaluation. The process and outcome measures are explained below.

Process Evaluation

The process evaluation questions sought to learn what factors work to make the project effective and what factors inhibit project success. The qualitative data collected from the observations and interviews was synthesized for reporting to the project implementers during the course of the project, who then revised the project as appropriate. The project plans were modified such that the beneficial factors were used to further project accomplishments while the negative factors were lessened or removed as project components. Table 6 illustrates the process evaluation components.

**Table 6:
Process Evaluation Components**

	Question	Data Source	Sample	Analysis
	Success factors			
F1	For what purposes do Tribal members use the Santa Ana community network?	Semi-structured interviews Observations	Random sample of community members and Government employees	Data is used to understand how Tribal members use the network to find whether modifications of services provided should be made to make the network more meaningful to its users.
F2	What incentives encourage Tribal	Open-ended interviews	Random sample of community	Data is used to understand the best

	members to use the network?	Observations	members and Government employees	ways to encourage individuals to use the network.
F3	Who are the formal, informal, or potential leaders in the technology adoption cycle and how have they influenced other Tribal members?	Open-ended interviews Observations	Random sample of community members and Government employees	Data is used to find who the first users of the network were and to understand how their enthusiasm could be leveraged to encourage other network users/non-users.
F4	With whom do Tribal members communicate using the network?	Semi-structured interviews Observations	Random sample of community members and Government employees	Data is used to understand who Tribal members are communicating with over the network and if the network can be enhanced to facilitate these communications.
	Inhibiting factors			
F5	Do Tribal members have negative perceptions of the community network? If so, how did these perceptions evolve?	Open-ended interviews Observations	Random sample of community members and Government employees	Data is used to change any parts of the network that contribute to negative perceptions and if the perceptions are not accurate, then to disseminate appropriate information to users.
F6	Are the communications needs of Tribal members being met by the community network? If not, how can the project be	Open-ended interviews Observations	Random sample of community members and Government employees	Data is used to enhance network communication options to better meet the communication needs of its users

	adapted to better meet their communication needs?			
F7	Are there outside factors (such as the need for more technology training, etc.) that limit use of the community network?	Open-ended interviews Observations	Random sample of community members and Government employees	Data is used to modify project plans if necessary to provide additional training or other needed component.

F1: For what purposes do Tribal members use the Santa Ana community network?

The Tribal Government LAN, intranet, and Internet access are used by the Santa Ana community in many different ways. Some examples of Government applications used over the LAN include:

- The Accounting and Finance Department uses a departmental server to host a financial database system to share financial information and applications;
- The Santa Ana Police Department uses the Internet to conduct background and criminal investigations; and
- The Department of Natural Resources (DNR) is an extensive user of the LAN and server space to share Geographical Information System (GIS) data with Pueblo Government and residents. Additionally, the DNR set up a virtual private network (VPN) to enable the Army Corps of Engineers to easily share large data files with the DNR.

The Tribal intranet is used by the Government and community residents to interact, share information, and organize Government services. Internet access on the reservation is used to communicate professionally and with outside family and friends.

“[The Internet] has facilitated instant access to information and data that is imperative to successfully complete our police functions.” – Survey Respondent

F2: What incentives encourage Tribal members to use the network?

Tribal members use the network more extensively when they are comfortable with their level of expertise in using information technologies. Therefore, training provided by the Information Technology department to community members proved to be highly important in network use. Additionally, information and applications provided to community members by the Government departments were accessed more frequently when the content on each webpage was updated frequently and contained information relevant to his or her life. For example, the Elderly Care Center posted information on its website about daily breakfast and lunch menus. Elders could then decide whether to have a meal at the Center that day. Information relevant to each individual proved to be most important to community members.

F3: Who are the formal, informal, or potential leaders in the technology adoption cycle and how have they influenced other Tribal members?

Not surprisingly, school-age children were some of the first users of the network as they had previous knowledge of using websites from school activities. These children were then influential in getting their parents and grandparents to use the network. Oftentimes an elder grandparent would be comfortable learning from his or her grandchild as it was more comfortable than attending a training session and it allowed for quality time with each other.

F4: With whom do Tribal members communicate using the network?

Both Government employees and Tribal residents used email extensively to communicate with each other and with persons outside the reservation. Some Tribal members commented how having Internet access was now allowing them to be in more frequent contact with family living in other parts of the United States. Government

employees commented that Internet access provided them with far more efficient ways of communicating with vendors and contract officers for projects funded by grants.

F5: Do Tribal members have negative perceptions of the community network? If so, how did these perceptions evolve?

Most persons interviewed had very positive comments to say about the community network. More than 150 families of the 188 houses on the reservation chose to have computers and Internet access in their home. Only approximately 30 homes chose not to take part in the project. Additionally, the project plan initially called for residents to choose between set-top boxes or computers for their homes as the logic of the project implementers was that set-top boxes which used televisions to access the Internet may be less intimidating to first-time Internet users. However, this assumption was proved false. Every single family chose the computer option rather than the set-top box.

For those that did not choose to participate in the project, the reason was usually not because of negative perceptions of the community network; rather it was because he or she did not feel that network access would provide them with much benefit. However, over the course of the four years of the project, some of these concerns were alleviated as they began to realize the diverse uses of the network through interactions with other Pueblo residents. Some of the hesitation could be attributed to both cultural and technology-adverse points of view which was not unexpected. These thought processes are now being slowly overcome.

F6: Are the communications needs of Tribal members being met by the community network? If not, how can the project be adapted to better meet their communication needs?

For Tribal Government, the network has been very valuable in speeding up communication processes and for sharing files. With community residents, several of those interviewed mentioned that they have the homepage on their home computer set to another site, rather than the Santa Ana intranet homepage. One strategy to increase the

intranet's use has been to encourage Tribal members to set their home page to the Tribal intranet website so they can frequently observe new information and updates, keeping the content fresh and interesting for each user. Additionally, implementation of additional push technologies could encourage additional use.

F7: Are there outside factors (such as the need for more technology training, etc.) that limit use of the community network?

One factor that initially proved to be a problem was the prevalence of viruses and spyware on home computers. New Internet users were downloading many freeware files which commonly included some hidden spyware which eventually slowed down the system's operations. Additionally, few home computers had virus protection software installed on the computers which resulted in a rash of computers being brought back to the Information Technology department to be fixed. The problem was fixed by installing a network-level virus protection system which prohibits viruses from being transmitted through the system.

Outcome Evaluation

The Santa Ana Tribal Community Networking Empowerment Model is presented below in Figure 7. The model shows how the community network project affects the Tribe's long-term goals of Tribal self-sufficiency and empowerment. This model provides a basis for the outcome evaluation.

Figure 7:
Pueblo of Santa Ana Tribal Community Empowerment Model

For Whom → Assumptions → Process → Outcomes → Long-term Impact

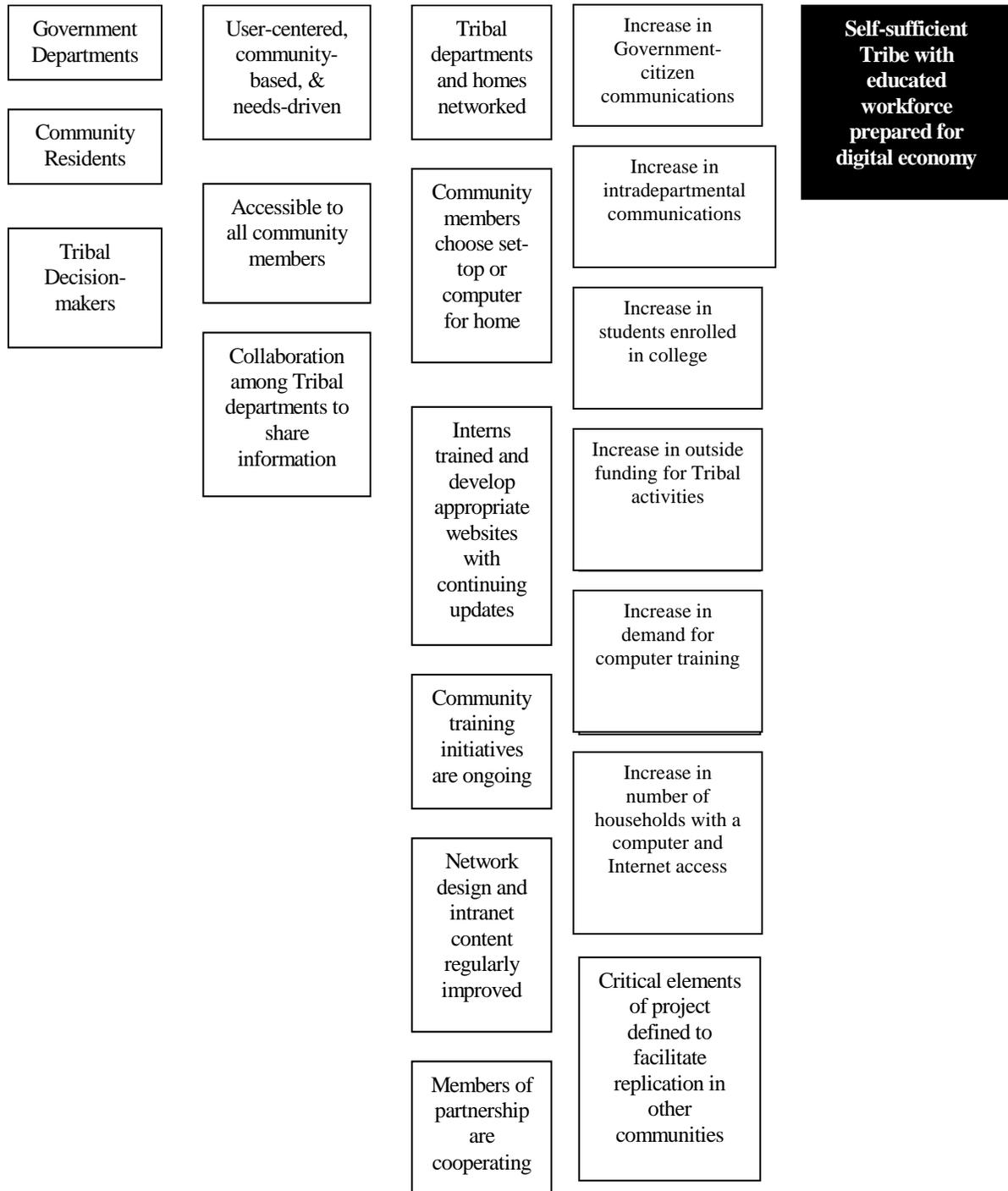


Table 7 presents the data sources, sample, and analyses used to evaluate the project along the various outcome measures in the model.

**Table 7:
Outcome Evaluation Components**

	Question	Data Source	Sample	Analysis
O1	How have communication patterns among Santa Ana Government employees and residents changed since implementation of the community network?	Open-ended interviews	Random sample of Government employees and community members	Will be compared to baseline data collected to find whether changes in the type of communication medium and whether increases in the number of communications.
O2	How have communication patterns between Santa Ana Government employees changed since implementation of the community network?	Survey	Random sample of Government employees	Will be compared to baseline and subsequent survey data collected to find whether changes in the type of communication medium and whether increases in the number of communications.
O3	How has the number of students enrolled in post-secondary education changed since the beginning of the project?	Tribal Department of Education enrollment figures	N/a	Will compare baseline data of 2 students enrolled at beginning of project to the number of students enrolled at end of

				project.
O4	How has the amount of funding from outside sources changed for Tribal activities since the beginning of the project?	Tribal Finance Department accounting data	N/a	The Finance Department collected figures on outside funding sources (such as grants and contracts) for Tribal activities prior to project implementation. This information will be used as baseline data for expected increases in funding as Tribal employees use the new networks to pursue additional funding opportunities.
O5	How has the demand for computer training from Tribal residents and Government employees changed since the beginning of the project?	Tribal Department of Education figures	N/a	The Tribal Dept of Education keeps records of the number of Tribal employees enrolled in and seeking computer training courses. We expect these numbers to increase as the project progresses and community members receive computers and Internet access in their homes.
O6	How has the number of households with a computer and Internet access increased since the beginning of the project?	Survey	Community members	Initial surveys of homes measured the number of households with computers and Internet access to be fewer than 10 of 188 households. These figures will be used as baseline data to indicate how the

				project reduced the digital divide on the reservation.
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O1: How have communication patterns among Santa Ana Government employees and residents changed since implementation of the community network?

Government employees and residents initially interacted via flyers put in mailboxes, telephone calls, office visits, and door-to-door visits. With implementation of the community network, Government employees and residents now interact also via email and website postings. It appears that the number of face-to-face interactions has decreased as communication methods became more efficient through the network.

O2: How have communication patterns between Santa Ana Government employees changed since implementation of the community network?

At the beginning of the project in April 2001, a survey was administered to a random sample of each of the Government departments in the Pueblo of Santa Ana. (See Appendix A for a copy of the survey.) The purpose of the survey was to collect baseline data about communication patterns within Tribal Government prior to implementation of the Tribal Government LAN, Tribal Intranet, and Internet access in all Government departments. The survey asked respondents to indicate approximately how many times per week he/she communicated with other Government employees via various communication methods. This survey was repeated at the end of the project. The data used from this survey is used to gauge changes in communication patterns as Government employees became more familiar with using technology as a communication medium over time.

Survey results

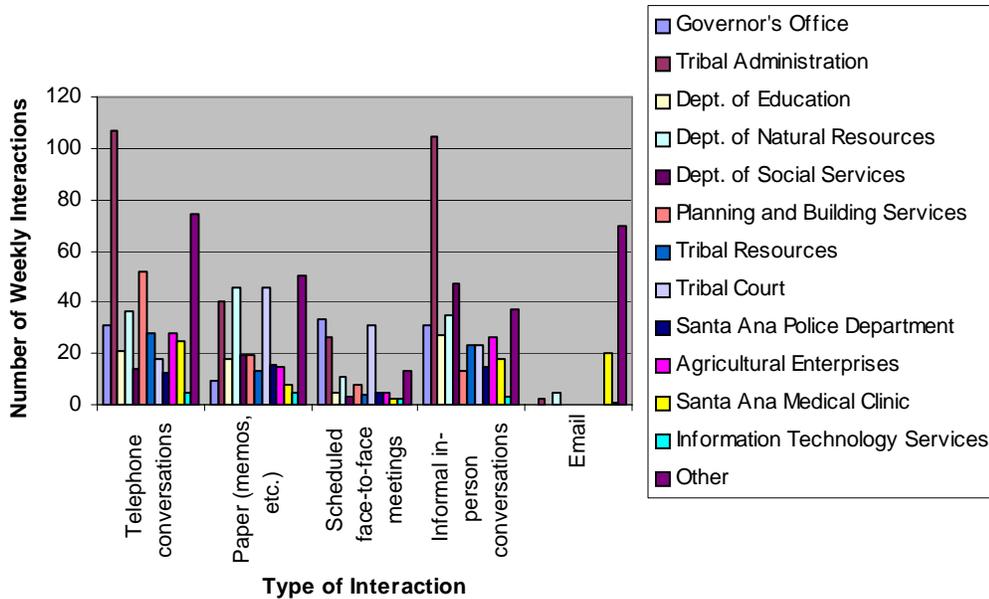
Results from the first survey are presented in Table 8.

Table 8:
First Survey Results:
Weekly Communications Among Tribal Government Departments

	Telephone conversations	Paper (memos, etc.)	Scheduled face-to-face meetings	Informal in-person conversations	Email	TOTAL
Governor's Office	31	9	33	31	0	104
Tribal Administration	107	41	26	105	2	281
Department of Education	21	18	5	27	0	71
Department of Natural Resources	37	46	11	35	5	134
Department of Social Services	14	20	3	47	0	84
Planning and Building Services	52	20	8	14	0	94
Tribal Resources	28	14	4	24	0	70
Tribal Court	18	46	31	23	0	118
Santa Ana Police Department	13	16	5	15	0	49
Agricultural Enterprises	28	15	5	27	0	75
Santa Ana Medical Clinic	25	8	2	18	20	73
Information Technology Services	5	5	2	3	1	16
Other	75	51	13	37	70	246
TOTAL	454	309	148	406	98	1,415
% of total	32%	22%	10%	29%	7%	

Telephone conversations and informal in-person conversations together account for 61 percent of communication interactions among Government employees in the first survey. At this point, with only a few departments having access to email, email interactions account for only seven percent of communication interactions by department heads. Figure 8 presents a graphical version of Tribal Government communication patterns for each department in 2001.

**Figure 8:
Number of Weekly Interactions
by Type of Interaction and Government Department**



According to survey results, 11 respondents indicated that they use a computer in their department. Of these, nine had Internet access. However, one respondent indicated that the current bandwidth was a very slow baud rate. Only three respondents shared files via a computer network with other Tribal Government employees.

In the second survey administered in 2004, similar results were obtained. Results are presented in Table 9. Results indicate a:

- 2 percent increase in telephone conversations
- 9 percent decrease in paper communications
- 2 percent decrease in face-to-face meetings
- 1 percent decrease in informal in-person communications; and
- 9 percent increase in email use.

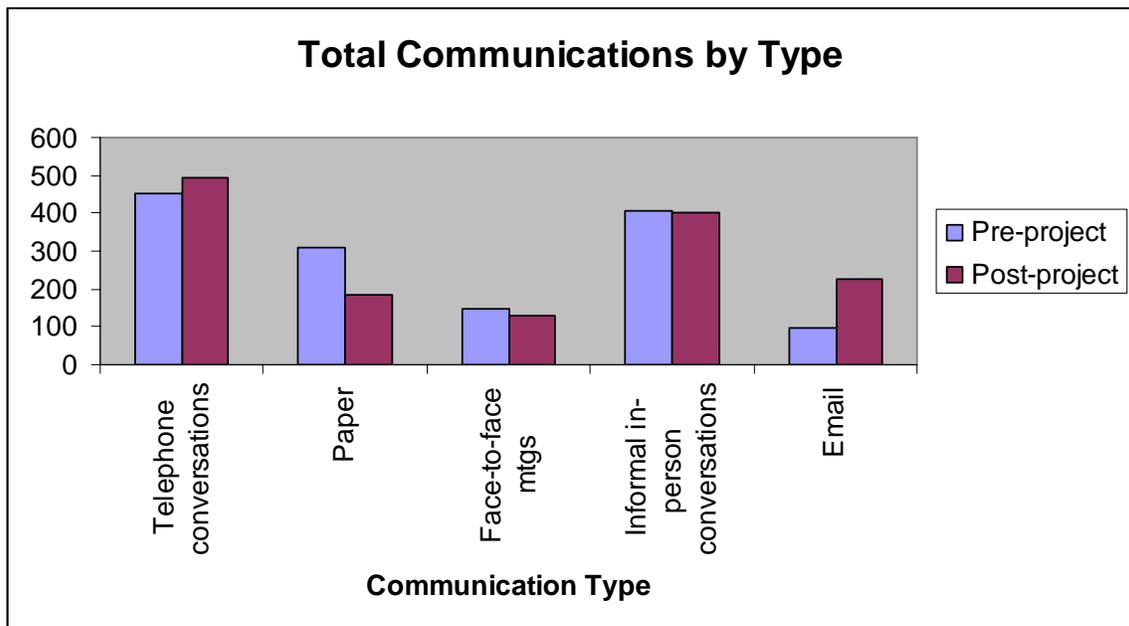
Table 9:
Second Survey Results:
Weekly Communications Among Tribal Government Departments

	Telephone conversations	Paper (memos, etc.)	Scheduled face-to-face meetings	Informal in-person conversations	Email	TOTAL
Governor's Office	67	26	10	34	6	143
Tribal Administration	114	49	18	111	56	348
Department of Education	46	12	11	52	8	129
Department of Natural Resources	80	28	28	63	45	244
Department of Social Services	12	6	5	12	0	35
Planning and Building Services	14	5	4	11	6	40
Tribal Resources	15	6	5	13	0	39
Tribal Court	6	8	3	8	0	25
Santa Ana Police Department	24	13	13	15	11	76
Agricultural Enterprises	3	4	10	15	0	32
Santa Ana Medical Clinic	3	12	10	15	1	41
Information Technology	47	6	4	32	62	151

Services						
Other	62	10	7	22	33	134
TOTAL	493	185	128	403	228	1,437
% of total	34%	13%	9%	28%	16%	
% change	2% increase	9% decrease	2% decrease	1% decrease	9% increase	

A comparison of communication type usage from the beginning of the project to the end of the project is presented in Figure 9.

Figure 9:
Comparison of First and Second Survey Data



O3: How has the number of students enrolled in post-secondary education changed since the beginning of the project?

Prior to project implementation, only two Santa Ana students were enrolled in post-secondary education. According to data from the Santa Ana Department of Education, 26 students from Santa Ana were enrolled in post-secondary education in 2004. This is a significant increase that can partially be attributed to the interns participating in this project and Pueblo residents who were taking distance education courses via Internet access in their homes.

O4: How has the amount of funding from outside sources changed for Tribal activities since the beginning of the project?

The Accounting and Finance Department collects figures on outside funding sources (such as grants and contracts) for Tribal activities. Prior to project implementation, Government employees had difficulty finding out about new grant opportunities as the federal Government, state Government, foundations, and corporations were posting funding opportunities on the Internet. Without Internet access, the Pueblo had inefficient means of finding out about these opportunities. The community network provides Internet access to all Government departments. In interviews, Government employees commonly expressed how having Internet access has made finding out about funding opportunities far easier. Additionally, these employees indicated that the Internet not only facilitates finding out about opportunities, but it is also extremely helpful in fulfilling contract terms such as reporting requirements to the sponsor.

O5: How has the demand for computer training from Tribal residents and Government employees changed since the beginning of the project?

As compared to the number of Santa Ana community members who sought training via programs offered by the Santa Ana Department of Education prior to project implementation, demand for training from both the Department of Education and

Information Technology Department has increased significantly. Prior to receiving their home computers, residents were required to take three computer courses presented by the Information Technology Department. Throughout the project, staff in this department provided free technical assistance with computers to individuals in their homes and used these interactions as informal training opportunities with the home users. Additionally, the Department of Education has offered several courses on computer applications and residents continue to request additional topics.

Q6: How has the number of households with a computer and Internet access increased since the beginning of the project?

As compared to the 10 homes that had a computer and Internet access prior to project implementation, the number of computers in Pueblo homes has increased significantly. Currently 158 computers are distributed via this project to families on the reservation. This figure does not account for computers and laptops that are purchased by individuals for their use at home.

Project replication in other communities

As part of the formative evaluation framework, aspects of the program that facilitated the community network deployment and use by the Pueblo were noted. Hurdles and roadblocks were also documented. These aspects of the program are explored in detail in the Lessons Learned section of this report. These findings will be useful to other communities seeking to implement similar projects. Additionally, the Pueblo of Santa Ana serves as a model project for surrounding Pueblos and frequently receives requests for information from the Pueblo about ways to do something similar on their own reservation.

LESSONS LEARNED

For the most part, project implementation went smoothly with a few modifications along the way. These include revisions to the intern program, revisions to the network plan, and revisions to the evaluation strategy. These are examined below.

Revision of Intern/Mentor Program

The original TOP proposal outlines the intern program as an integral component of the Santa Ana TOP project. Once the project was underway, the Pueblo needed to revise the intern program to meet project goals for a variety of reasons. When the proposal was submitted, an internship program seemed an effective avenue for 1) increasing Tribal student enrollment in higher education; 2) grooming students for Tribal leadership; and 3) developing Governmental website content. However, the Tribe faced difficulties in recruiting 12 interns to fill the available positions, based on numerous factors including the requirement that interns be enrolled at the Southwestern Indian Polytechnic Institute (SIPI), a vocational school, or other 2-4 year college. Additionally, 26 Tribal students are now enrolled in higher education—indicating the success of other Tribal measures in increasing student enrollment.

Progress on the TOP project indicated that personnel changes would increase the IT capabilities of the Tribal network and website. Budget allocations for ten open intern positions and the career skills coordinator position were shifted to new IT intern positions. The objective of this change was to address the realities of implementing the program. Interns serving in the IT department worked with the project director and were responsible for gathering content and developing the Tribal Intranet website. One intern met with individuals from each Government department on a weekly basis to gather content for the intranet. The other interns learned networking skills and assisted in networking the Government departments to the Government LAN, connecting residents' homes wirelessly, and maintaining the network. Overall, up to six interns worked in the IT department at any given point in time.

Revisions to the Network Plan

As expected, in the time between submitting the proposal to the U.S. Department of Commerce and receiving project funds, available technologies improved significantly and costs decreased. The technical architecture was redesigned to take advantage of these technical advancements. Full details on revisions to the technology plan is outlined in the Technical Considerations section of this report.

One difficulty that the network faced were computer viruses and spyware programs. Virus protection came with the computers installed in the homes but it expired in 30 days and computer owners did not update their virus protection. In the first few months of computer deployment in the homes, the Information Technology department had to reformat the hard drives of approximately 20 computers due to viruses. The IT department did not want to require specific virus software to be on home computers as is required on Government computers, but later determined that it was necessary to require virus protection. To meet this requirement, the IT department bought a site license to a virus protection package and as a requirement of giving home computer users access to the network again, the computer owner was required to complete a virus training session offered by the IT department and also install virus protection on their computer. Now the IT department sends updates to residents on a regular basis. This seems to have solved the problem with viruses that are transmitted as attachments in email and in downloaded files from the Internet. Spyware programs also proved to be a challenge as one computer that needed repair had 1,726 versions of spyware on it. The IT later showed individuals how to use spyware protection tools.

Revisions to the Evaluation Strategy

The initial evaluation strategy for the project included participatory research methods. Participatory research is a unique form of inquiry that involves study participants as “researchers” in order to produce knowledge that might help stimulate social change and empower the oppressed. The use of participatory evaluation methods did not seem to be an effective method of evaluating this project and as a result, efforts

were shifted to more traditional formative (process) and summative (outcome) evaluation approaches for three reasons:

1. **Lack of generalizability:** Rarely are participatory evaluation findings generalizable to other projects. Participatory evaluation approaches generally seek to provide information for internal use, rather than evaluation agendas set by an outside funding source. In participatory evaluation, both the role of the evaluator and that of the project change. The evaluator is no longer the expert on evaluation metrics, but instead a collaborator and participant in an evaluation process. Organization members are integrally involved in establishing the questions to be asked and the methods to be used, in collecting and analyzing data, and in writing up findings. Interested community members are involved in deciding whether to evaluate, what to evaluate, how to draw conclusions, how and when to disseminate findings, and how and when to implement recommendations. Since a primary goal of the TOP program is to learn from the experiences of funded projects, having a non-generalizable evaluation did not seem appropriate.
2. **Little community interest:** The project implementers also found that there was little interest among Tribal community members in engaging in the project as participatory evaluators. Participatory evaluation can be much more time-consuming for both the evaluator and the organization than a traditional goal-oriented evaluation where the questions to be asked and the methods to be used are set in advance, or established by the evaluator working with only one or two administrators. Staff would need to be allowed time off from regular duties in order to participate effectively in the evaluation, and community members may need special assistance to become integrally involved in the evaluation. To assure adequate participation by all involved, rewards would have to be clearly spelled out. In the case of this project, we found that few (if any) Tribal Government or community members were interested in actively committing to the project evaluation. While Government and community members were willing to work with the outside evaluator to discuss the project's progress and collect necessary qualitative and quantitative data, the evaluation was better served having a centralized evaluation process rather than a participatory evaluation framework.
3. **Inability to set details of evaluation in advance:** For an entire evaluative process to be participatory, the details of the evaluation cannot be fully identified in advance (such as to a funding source). This is because specific reporting criteria or other evaluation guidelines dictated by sponsors limit the participation and input of both evaluators and non-evaluators. The final result of a true participatory process is entirely in the hands of the participants, not the evaluator or an outside source.

While participatory evaluation methods were not used in the project evaluation, the revised evaluation plans met TOP's evaluation requirements through complementary formative and summative evaluation frameworks.

FUTURE ACTIVITIES

One significant outcome of this project is that the Pueblo of Santa Ana serves as a model for surrounding pueblos on an effective means of computer networking on a rural and desert reservation. Staff at Santa Ana frequently interact with the surrounding pueblos to share their expertise. One method of information sharing is through the interns working on the project as several of them are from surrounding reservations. They bring their new expertise in computer networking back to their own pueblo. Santa Ana is in discussions with several surrounding pueblos to develop a pueblo-wide network which is being referred to as “PuebloNet.” The idea is to network several of the pueblos together using wireless connections. This group is considering applying to a U.S. Department of Agriculture program called the Community Connects program. Its purpose is to provide funds for network infrastructure in rural areas.

A second proposed follow-on to this project is to use the network to provide Voice over IP to residents’ homes on the reservation. This would offer residents significant cost savings over the current telecommunications setup. The New Mexico Public Service Commission will be installing new gas lines on the Santa Ana reservation, thereby opening up trenches in which additional networking infrastructure could be installed without the added cost of digging trenches. The Pueblo is investigating options for taking advantage of this opportunity.

The Federal Communications Commission is hosting a conference in New Mexico in the coming months on Native American telecommunications issues. Organizers for this event contacted the Pueblo of Santa Ana and asked the Pueblo to present a session on this project and its successes. The project manager for this project will be a featured speaker at the conference.

FINAL REMARKS

The Pueblo of Santa Ana is demonstrating successful application of new information and communication technologies for Tribal empowerment. Rather than withdrawing from technological change, the Tribe is embracing communication innovations as a means of furthering Tribal goals. However, the Tribe implements these tools with an eye toward maintaining its cultural heritage. Using a Tribal intranet, Santa Ana members will retain ownership over their own communications and use culturally appropriate designs.

Project goals for the four years of the project were each successfully met. In the first year, all Tribal Government departments were networked through a Tribal LAN. In the second and third years, Tribal members homes were connected and the Tribal intranet was developed and deployed. The Santa Ana community network project promises to be a successful model of how indigenous communities can successfully adapt and implement new technologies for community empowerment.

APPENDIX A: GOVERNMENT COMMUNICATION PATTERNS SURVEY

3/27/01

To: Santa Ana Pueblo
Department Heads

Background:

Santa Ana received a large grant from the U.S. Department of Commerce to provide Internet connections and a Tribal Government network to each Government department. As part of this grant, we are required to evaluate the impacts of Internet and network access among the Tribal departments.

Please take a few moments to answer the following short questionnaire prepared by our project partners at Georgia Tech about your existing communications within Tribal Government. All responses are anonymous and will simply be used to better understand how the Tribe is impacted from new network connections.

If you have any questions about this project, please contact me at 867-3301 ext 12.

Please return the questionnaire to: Steve Cooper, Tribal Administration by close of business March 30.

Thanks very much for your participation!

Questionnaire for Pueblo of Santa Ana Tribal Government Employees

1. In which department do you currently work?

- Governor's Office
- Tribal Administration
- Department of Education
- Department of Natural Resources
- Department of Social Services
- Planning and Building Services
- Tribal Resources
- Tribal Court
- Santa Ana Police Department
- Agricultural Enterprises
- Santa Ana Medical Clinic
- Information Technology Services
- Other (please specify: _____)

2. For each of the Government departments (including the one you work in), please specify approximately **how many times per week** you communicate with other employees via the following ways:

	Telephone conversations	Paper (memos, etc.)	Scheduled face-to-face meetings	Informal in-person conversations	Email
Governor's Office					
Tribal Administration					
Department of Education					
Department of Natural Resources					
Department of Social Services					
Planning and Building Services					
Tribal Resources					
Tribal Court					
Santa Ana Police Department					
Agricultural Enterprises					
Santa Ana Medical Clinic					
Information Technology Services					
Other (please specify)					

3. Do you use a computer in your department? yes no (skip questions #4-6)

4. Does this computer have Internet access? yes no not sure

5. Do you use email on this computer for Tribal business? yes no

6. Do you share files via a computer network with other Tribal Government employees?
 yes no

APPENDIX B: SECOND SURVEY

August 12, 2004

To: Santa Ana Pueblo
Government Employees

Background:

Santa Ana received a large grant from the U.S. Department of Commerce to provide Internet connections and a Tribal Government network to each Government department. As part of this grant, we are required to evaluate the impacts of Internet and network access among the Tribal departments.

Please take a few moments to answer the following short questionnaire prepared by our project partners at Georgia Tech about your existing communications within Tribal Government. All responses are anonymous and will simply be used to better understand how the Tribe is impacted from new network connections.

If you have any questions about this project, please contact me at 867-3301 ext 12.

Please return the questionnaire to: Steve Cooper, Tribal Administration by September 15th, 2004.

Thanks very much for your participation!

Questionnaire for Pueblo of Santa Ana Tribal Government Employees

1. In which department do you currently work?

- Governor's Office
- Tribal Administration
- Department of Education
- Department of Natural Resources
- Department of Social Services
- Planning and Building Services
- Tribal Resources
- Tribal Court
- Santa Ana Police Department
- Agricultural Enterprises
- Santa Ana Medical Clinic
- Information Technology Services
- Other (please specify: _____)

2. For each of the Government departments (including the one you work in), please specify approximately **how many times per week** you communicate with other employees via the following ways:

	Telephone conversations	Paper (memos, etc.)	Scheduled face-to-face meetings	Informal in-person conversations	Email
Governor's Office					
Tribal Administration					
Department of Education					
Department of Natural Resources					
Department of Social Services					
Planning and Building Services					
Tribal Resources					
Tribal Court					
Santa Ana Police Department					
Agricultural Enterprises					
Santa Ana Medical Clinic					
Information Technology Services					
Other (please specify)					

3. Do you use a computer in your department? yes no (skip questions #4-6)

4. Does this computer have Internet access? yes no not sure

5. Do you use email on this computer for Tribal business? yes no

6. Do you share files via a computer network with other Tribal Government employees? yes no

7. Did you work for Santa Ana prior to each government department having Internet access?
 yes no not sure

8. If you use the Internet, what do you use it for (i.e., searching for funding opportunities, communicating with friends and relatives, communicating with other government employees)?

9. Has Internet access changed the way the Santa Ana Government operates? If so, in what ways?

10. Is Internet access good or bad for Santa Ana? Please explain.....

APPENDIX C
RESPONSES TO SURVEY QUESTIONS ABOUT INTERNET USE

If you use the Internet, what do you use it for (i.e., searching for funding opportunities, communicating with friends and relatives, communicating with other Government employees)?

- Conducting criminal-history inquiries
- Emailing other SAPD employees
- Communicating with other LE agencies
- Checking for information from other departments.
- Searching for information.
- Communication, business, school
- Communication with friends. Communication with other Government employees.
- Research for student trips.
- Information on places we will visit.
- Student services; homework, research
- Looking up recipes, nutritional information, communicating with other employees within the department, and looking up prices for program equipment
- Communicating with other Tribal employees
- Research for projects; presentations, creating educational materials
- Our department uses it to communicate with the community. (from Community Wellness)
- Email. Searching the web. News. Police sites
- News/info
- Communication with friends and relatives
- As far as communicating with Government employees, it is not much better to call or simply walk over to one's office to relay info.
- Searching for various computer resources, hardware, software and technical assistance
- Primarily communication w/other employees and outside contacts. Also some research for technical info and funding.
- Electronic paper exchange.
- Research. Payroll, benefits, communicating
- Work with other pueblo entities. TEI, STAR, SAGC, SSI, and Hyatt
- Work with our bank, actually do payroll functions
- Communicate with lawyers
- Travel accommodations
- Communicate with federal agencies
- Receive invoices
- Searching for funding
- Searching for activities
- Communication with Government employees and SA library employees
- Shopping for supplies
- Listening to the radio

- Background investigations
- I use the Internet to find products, search grant opportunities, communicate with friends and Government employees, problem solving, file sharing
- Funding opportunities.
- Tech research
- Communications via email with granting agencies and professional contacts
- Financial status reports. Drawdowns. Information on grants ie. Davis Bacon Act, Federal Regs
- Product research (building supplies)
- News
- Email CAD files
- Plant, insect, disease information, seed, plant, fertilizer sources – and quality.
- Communicate with both outside and Tribal entities.
- Research – academic, job related, personal
- Communication via email
- Grant applications
- Yahoo, etc
- Online information
- Communication with coworkers
- Search information
- Communication: work and personal
- Research
- Funding ops
- Vendors – technical products
- Sending information w/work related issues
- When and if I do it's to search for funding opportunities
- Communications with federal agencies and contractors involved in project work
- Communication with other employees at DNR and the Tribe in general. Searching for information needed to carry out duties.
- For direct marketing business, eg. Take orders
- Communicating with customers

Has Internet access changed the way Santa Ana Government operates? If so, in what ways?

- Yes. It has facilitated instant access of information and data that is imperative to successfully completing our police function.
- Yes. Less physical interaction between employees.
- Yes. There is more emailing occurring. Previously everything was hand delivered. Now it's sent electronically.
- More up-to-date internet services.
- I don't think so. I haven't really noticed any changes. Maybe just that some people might abuse internet usage during working hours by using it for personal reasons.

- For me, it cuts down on paper.
- It simplifies communication.
- I can access a whole world I would never know of otherwise, ex: recent findings in diabetes education; management
- I wouldn't say that it changed it too much. Departments in the Tribal Governments and utilities are not even able to share info online with one another, ie. Tribal courts and SAPD, Tribal social services, admin and others.
- TOP has a lot of work to do to make this of any real benefit to SA.
- I think that it has helped by allowing different departments to search for help in using their computers and has provided a way for a faster response time from outside contacts along with information verification.
- Yes, much more efficient. Much easier to communicate in a timely way.
- Yes, more efficient.
- No.
- Yes. It is easier to share information. Records showing information was received. Lowered costs (no need for travel agents, saves paper, etc.)
- Eliminating paper
- Speeds correspondence
- Yes. It is much easier to send/get documents and information over the Internet that affects the Tribal Government.
- Yes, by communicating via email we use less paper and have less filing.
- Did not have prior access to the Internet. I think the Internet allows more flexibility and productivity for each user.
- I am sure. Not sure exactly how
- Yes, information is much more accessible.
- For the better. You can access things that are useful for the office and other things.
- Because I am isolated from Tribal offices; file sharing and internet is very useful
- Yes. Faster communication and less gas for car
- Yes. Quick communication is better. The Internet access is more reliable and much faster than it used to be. I enjoy the flexibility that Internet brings to the office.
- Yes, quick and it's more efficient way of doing business at times
- Yes, faster ways of communication and sending information without printing and passing information and waiting for answers.
- For those employees who know how to use Internet have experienced good changes, ie sending draft resolutions/correspondence to each other for review/business
- Saves time having to meet
- Yes. Improved communication with funding agencies. Improved communication with contractors. Information gathering needed for project implementation
- As it affects us, not really. The few emails sent by Tribal Admin could be handled with a note in the mailboxes

Is Internet access good or bad for Santa Ana? Please explain....

- It is very good. It permits for instant communication, as well as documentation.
- Good. Opens window to vaster options.

- Good. Information, communication, business
- Overall it's good. People use it for business, school, communication, etc. but there is always going to be those that use it for the wrong reasons.
- Good communication for those who use it and don't get out!
- It's good. More efficient.
- Good. Keeps us informed and able to access what is going on in the world.
- Internet access is both good and bad. It is good because people are able to look up updated and sometimes mostly accurate information for various reasons, ie school projects, work, health related topics. I think it is good because I'm able to communicate with relatives that live in other states/countries without paying a hefty phone bill. One reason why it might be bad is because it causes inactivity among younger adults/children depending on their usage.
- It is good for me as an employee in that I can do many things more efficiently. So I'm more efficient. I assume that it is better for SA. I hope the educational materials I develop with the help of the Internet are useful to the SA community. It is easier to communicate with IHS personnel too.
- Good for those who don't have Internet access at home, like me.
- I think it's good to have since our library is not equipped with too many resources. And finding time to travel to libraries in Albuquerque/ Rio Rancho can be time consuming.
- I believe that the Internet is very good for the Pueblo. It helps out anyone who is willing to try it, from young to old.. It allows the younger kids to have various options when doing homework and older people and young adults the technology to take online courses.
- Good. Efficiency with ability to communicate same message to multiple individuals. Much easier to get info fast.
- Good. It allows SA to effectively participate in the business world.
- I think it is good. We can communicate easier and it saves money.
- Good of course. Due to the many research and communication possibilities.
- It can be both good and bad. It allows everyone to have access to information without going anywhere. It also allows us to communicate with each other wherever we may be at.
- Overall, the internet is good for SA because it makes the individual more efficient at their job. Contractors can be contacted via email or prices searched more efficiently. One letter can be sent to many people at one click.
- Good. Provides rapid access to information; but you need to be able to assess the quality of the information
- Helps greatly with communication
- Good. Keep up with what's going on. Mileage rates, regulations, etc.
- Good. Information and access to info improved for employees and Tribal members
- Both, people (some) need to be monitored how long they stay in. And that's in all depts.
- Good. More technology is a good tool
- It depends on how you look at it, of course. I think the access to the Internet is invaluable. There are many complicated elements to delivery and usage of the Internet. Does the west side have Internet? Does utilities have Internet? Overall the Internet is better than having television.

- Good. In some situations where I work I need to learn some things over the Internet. It is a quick and easy place to do my exploring
- Good. Opens links of convenient communication (e.g. email) and allows quick access to research information for job related activities
- Internet access is good but also has its cons such as all the viruses that are out there. TOP program has done a good job of blocking and saving people from having a virus problem
- It's good if we remember to use it, if we're comfortable using Internet. Takes practice using the Internet and some of us don't have the time to 'play' with our computers to learn all the neat things it can do for us.
- Good. Brings opportunities to the Tribe that they otherwise would not have been able to take advantage of
- In this day and age, not having it is impossible to consider. Good or bad is besides the point.