Data Collection Methodology for GIS

Metodología para la Recolección de Datos para el GIS

July 2, 2001

Bach. Ana Maria Ortega O.
Encargada de Comput.
El Cuerpo de Bomberos de Costa Rica
San José, Costa Rica

Dear Srta. Ortega,

Enclosed is our report entitled Data Collection Procedure for GIS. It was written at the office of El Cuerpo de Bomberos de Costa Rica between May 12 and July 2, 2001. Copies of this report are being submitted simultaneously to Professors Guillermo Salazar and Michael Elmes for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library of Worcester Polytechnic Institute. We appreciate the time and support that you, Esteban, Walter and Don Hector have devoted to us.

Sincerely,

Eric Kenney

Lisette Manrique

Natalie Woodworth

El 2 de julio de 2001

Bach. Ana María Ortega O.
Encargada de Comput.
El Cuerpo de Bomberos de Costa Rica
San José, Costa Rica,

Estimado Srta. Ortega,

Incluido es nuestro informe titulado el Metodología para la Recolección de Datos para el GIS. Estaba escrito en la oficina de El Cuerpo de Bomberos de Costa Rica entre el 12 de mayo y el 2 de julio de 2001. Estamos sometiendo copias de este informe simultáneamente a Profesores Guillermo Salazar y Michael Elmes para la evaluación. Después de la revisión de facultad, la copia original de este informe se catalogará en la Gordon Library de Worcester Polytechnic Institute. Nosotros apreciamos el tiempo y apoyo que usted, Esteban, Walter y Don Héctor ha consagrado a nosotros.

Sinceramente,

Eric Kenney
Eric Kenney

Lisette Manrique
Lisette Manrique

Natalie Woodworth

Report Submitted to:

Professors Michael Elmes and Guillermo F. Salazar

Costa Rica Project Center

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El Cuerpo de Bomberos de Costa Rica

DATA COLLECTION PROCEDURE FOR GIS

July 2, 2001

This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of El Cuerpo de Bomberos de Costa Rica or Worcester Polytechnic Institute

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.

Abstract

This report was prepared for El Cuerpo de Bomberos de Costa Rica, the firefighting division of Instituto Nacional de Seguros (INS). It explains the procedure used to develop forms for the collection of data necessary for a Geographical Information System; in addition, it outlines the proper process for using these forms and creating additional forms in the future. This report also compares the options available to Los Bomberos in their data collection process and makes recommendations to help this process in the future.

Authorship

This report entitled Data Collection Procedure for GIS was written through the equal contributions of Eric Donato Kenney, Lisette Marie Manrique, and Natalie Michelle Woodworth. All three authors took part in writing and revising all sections of the report.

Eric Donato Kenney

Lisette Marie Manrique

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July 2, 2001

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Executive Summary

The data used by Los Bomberos in their current emergency response system is becoming outdated and increasingly unable to meet Costa Rica's needs.

Within the past four years, the data for fire response that concerns hazardous structures and hydrant location has been collected by each fire station. This data has been uniform, but has not been shared with other fire districts or the dispatchers that relay emergency information (Oficina de Control Operaciones). Additional information, including location and type of emergency, which Los Bomberos currently use during fire response is communicated to the station from dispatchers at OCO, but OCO is not able to assist Los Bomberos any further, since additional data necessary for fire response is stored at the station.

Los Bomberos' have decided that the solution to bettering their fire response is to implement a Geographical Information System. A GIS is a highly visual computer-based system that combines cartographic and demographic data to create a powerful organization and analysis tool. The data Los Bomberos currently have is not detailed enough to support the implementation of a GIS, since the information in a GIS database must be complete and well-structured.

In order to collect the necessary information to better Costa Rica's fire response, we created a data collection procedure which could be used to complement the implementation of a GIS.

Prior to developing the proper data collection procedure, we researched the types of data necessary for a GIS that functions in fire-response. Using the information that we derived from this research, we developed forms for data collection. They were thoroughly revised by the engineering and administrative staff of Los Bomberos as well as through the input of chiefs from the seven San Jose area stations. After the forms were finalized we began field-testing by distributing them to several stations for use. Next, we collected and analyzed samples of completed forms from each station that participated in data collection. Using a rating system, we measured the performance of the data collection forms by examining the information that was omitted from and included in the form. Simultaneous to the form analysis, we conducted elite interviews with the fire chiefs of all participating stations to determine their preference between using the paper form or hand held computer for data collection, as well as between using the GPS or pin locating method

The results which were produced by these methods provided us with a way to develop useful forms and measure the effectiveness of the forms in data collection. From our reviewing of the literature and talking to fire and GIS experts, we learned what necessary data should be included in a GIS for fire response.Through reading their proposal we determined what information Los Bomberos needed to include in the GIS. When observing the Pavas station's field work, the data collector ensured us that the form was complete and easy to use. We received similar feedback regarding form performance from our elite interviews with the station chiefs of Barrio Luján , Estacion Central, and Tibas. These chiefs stated that the paper form collection method functioned well, but that they were excited about using the hand held computer for future GIS data collection. These interviews also resulted in the unanimous suggestion of using both the pins and the GPS to locate water sources during data collection. Each fire chief explained the old data collection method used to obtain information necessary in fire response. All of the data collectors were also pleased about the alternative of using a hand held computer in data collection. Based on their responses and the fact that the hand held computer is more rapid and avoids error in data entry the purchase of this equipment was easily justified. Because the GPS was 300 meters off of the actual point being located, the pin system was determined to be a better locating method to currently meet the needs of Los Bomberos. Each data collector agreed that when the GPS is calibrated to work correctly, both systems will be important since the GIS database requires coordinates for its digital maps. From the elite interviews we conducted, we learned that the data that is relevant to fire response changes often.

Our results and analysis led us to conclude that the water source form functioned very well and met the needs of Los Bomberos. The interview results also led us to conclude that the hand held computer would be helpful to Los Bomberos in future data collection by speeding up the process of and reducing the potential error in data entry. The GPS and pin location methods were both found to be necessary at the time that this project was completed, but in the future GPS will be the only necessary method. Based on these conclusions, we made the following recommendations:

1) The stations that are currently using the paper forms to collect data should continue using them and data collection should be continued until the Pocket PCs are made available.
2) Purchase Pocket PCs (or their equivalent) as soon as possible for future data collection; once they are purchased, a trial period should be used to ensure they function correctly before they are put into general use. Switch data collection method from the paper forms to the electronic versions after intitial testing.
3) Stations should complete data collection using only one method for each data information layer. If a station has already started collecting the data using the paper form they should finish collecting with the paper form.
4) Use the GPS , after it has been calibrated, in conjuncture with the Pin system to locate the water sources until a digital map can be produced by the GIS.
5) Make sure data that cannot be collected in the field (flow) is calculated in the station and entered into the appropriate space on the form as soon as possible. Be sure to specifically note on the form that this data needs to be collected later.
6) A procedure should be set up to ensure the data collected remains both uniform and of a high quality.
7) Training should be provided for all persons involved in the collection and entry of data necessary for the implementation of a GIS.

1.0 Introduction

This report was prepared by members of Worcester Polytechnic Institute Costa Rica Project Center. The relationship of the Center to El Cuerpo de Bomberos de Costa Rica and the relevance of the topic to El Cuerpo de Bomberos de Costa Rica are presented in Appendix A.

1.1 Costa Rica

The Republic of Costa Rica is best known for its democratic government and national stability (Sabath, 2000, pp. 100-101). In addition to this, its friendly people and bio-diverse environments attract many tourists. Inland a range of volcanic mountains splits the country, yet most Ticos (Costa Rica's natives) live in the Meseta Central, or Central Valley, where the capital city of San José is located. More than half of the 3.5 million people that populate Costa Rica live in San José.

Christopher Columbus named Costa Rica in 1502 when he and the Spanish conquistadors found the land. Costa Rica gained its independence in 1821 when its primary export was coffee (Sabath, 2000, pp. 100-101). In 1856 William Walker, followed by an army of Nicaraguan slaves, invaded Costa Rica. Juan Rafael Mora, who was president at the time, unified the country by gathering a civilian army and repelling the foreign invaders. Free elections soon followed this incident.

Since then, Costa Rica has maintained a democracy with few attempts to disrupt the established order (Sabath, 2000, pp. 100-101). After Costa Rica's civil war in 1948, the nation underwent many long-reaching changes. In 1949, Costa Rica gained much political distinction by abolishing its army and giving blacks and women the right to vote. Since then the country has stood as a model for establishing peace initiatives and its former President Oscar Arias received the Nobel Peace Prize in 1987 for his contributions to peace.

1.2 Los Bomberos

This project is sponsored by El Cuerpo de Bomberos, a division of Instituto Nacional de Seguros (INS). Los Bomberos are the firefighting unit in Costa Rica, and the INS is the agency responsible for emergency management in Costa Rica. Last year the 1300 Bomberos, 300 paid employees and 1000 volunteers, responded to just over 12,000 fire related calls and just over 2,100 paramedic calls (INS, Estadistica, 2001). The provinces of San José and Alajuela accounted for just over half the total fire calls, and nearly all the paramedic calls. San José accounts for 2500 of the 14,000 annual calls received by Los Bomberos. Of the 51 fire stations in Costa Rica 15 of them accounted for over 60% of the total calls, and five of the top 8 stations for fire calls are located in the capitol, San José.

1.3 Problem

The problem faced by Los Bomberos is that the data used in their current emergency response system is becoming outdated and increasingly unable to meet Costa Rica's needs. The data being used in their current response system consists of a collection of files stored at each fire station. These files include data about structural hazards, hydrant location, and hazardous materials for each district; but the data is not shared between districts. In addition to the files stored at each station, Los Bomberos are provided with information from the dispatchers of the Oficina de Control Operaciones using the Sistema de Informacion para Bomberos (SIBO) which includes data about emergency location, responding fire station(s), and the type of emergency. SIBO is a text-based database, which relies heavily on the knowledge of the O.C.O. personnel and may include a certain amount of inaccurate or obsolete information. To modernize and improve their response system, the Bomberos have decided to implement a Geographical Information System (GIS). Our role is to help them obtain the data that is necessary for the implementation of a GIS, keeping in mind that a GIS has specific data requirements. For example, the database needs to be organized so that the GIS can use each feature separately in individual map layers. A detailed data collection procedure and data collection forms for the GIS will be the products of this project. This procedure will take the form of a set of instructions for the use of the data collection forms.

1.4 Project Significance

This project is significant because by using the forms we designed, Los Bomberos will be able to collect the necessary data for their GIS. These forms will standardize the collection process, making it both more efficient and accurate. When fully implemented, the GIS will allow Los Bomberos to fight fires more effectively. The GIS will help Los Bomberos in analyzing and using data about water sources, buildings and occupants by supplying vital information about the fire site. The water source data that is collected will solve problems such as not knowing whether a hydrant is functional before they try to connect to it; as well as not having records of hydrant flow rate and pressure. It will also assist in reaching fires in a more time efficient manner by using the mapping feature of the database to plot the best course to the fire. These improvements will allow Los Bomberos to do their job in a more efficient manner, which will save both lives and property. Our work will help the implementation of the system to be a quicker, more organized process, which will save Los Bomberos valuable fire response time. The introduction of the Pocket PCs will help Los Bomberos incorporate state-of-the-art technology that will allow them to use their resources more efficiently. Finally, as El Cuerpo de Bomberos has expressed an interest in becoming a world-known leader in firefighting, the data collection procedure will take them one step closer to that goal.

1.5 Goals and Objectives

1.5.1 Overall goal

We developed a plan to collect data necessary for the implementation of a GIS for El Cuerpo de Bomberos of Costa Rica. The overall goal of Los Bomberos is to implement a GIS that will improve their current response system, and result in faster response times to fire-related emergencies.

1.5.2 Objectives

To reach the project goal we identified certain objectives that we needed to complete. First we determined what information was required for Los Bomberos to implement a GIS. Once this was determined, we created data collection forms in order to obtain this information. We resolved which water source locating method was best, GPS or Pin/Map system. We also determined which data collection procedure was optimal, the paper form or the hand held computer. Finally, we determined the advantages of the new data collection procedure over the old process.

1.6 Initially Expected Findings

When the project began, it was expected that the result would be a detailed procedure for the collection of all necessary data for the implementation of a GIS. This would allow Los Bomberos to begin the collection of this data with out any further research.

1.7 Agency's Use of Findings

As Los Bomberos are presently using these forms and procedures, our products are proving to be useful to the INS and Los Bomberos in collecting the data required to implement a GIS. These procedures and forms are serving as guidelines for the standardized collection of GIS data throughout the country. O.C.O. (Oficina de Control Operaciones) is the dispatch office of INS that works in conjunction with Los Bomberos. O.C.O. will be interested in our work, as they will be directly affected by having the advantages of a GIS when dispatching firefighters to respond to emergency calls. Each fire station will also have new abilities to better determine information about a fire, which will lead to the saving of lives.

1.8 Other Interested Parties

Many people will be interested in our report. The people in Costa Rica will be interested in our findings because the implementation of a GIS system will be of great value to the safety of both the residents and businesses in the country. This report may also be useful to other fire departments world wide that are looking to implement a GIS to improve their fire fighting techniques, as it will show the methods necessary to collect the required data. Additionally, ICE (Instituto Costarricense de Electricidad) may be interested in our findings as a complementary system to their own GIS.

1.9 Methodologies

To complete all of our objectives and reach our goals, we used various methods including interviewing, creating forms for data collection, and on-site fieldwork. We interviewed fire-protection experts as well as experts on GIS to gain a better understanding of the requirements and capabilities of a GIS used in fire-response.

We designed several forms to help standardize the collection of the data necessary for the implementation of a GIS. These forms were revised according to the recommendations of the administration and engineers of Los Bomberos. After the forms were deemed acceptable, they were taken into the field to ensure they were both complete and functional. We observed their use in the field and interviewed the fire chiefs who were filling them out to test the usability of our forms. We then developed a standard for the performance of the forms in order to rank their completeness. We created instructions to explain the proper procedure for use of the forms and how to create future forms for similar data collection.

1.10 Science and Society: The IQP

The Interactive Qualifying Project program was developed specifically to allow WPI students to apply the technical skills learned at the university to real life situations. This helps these students to better understand the role of technology in society. This IQP applies technical knowledge from the MIS field to problems that El Cuerpo de Bomberos are experiencing in fire response. The main goal of this project is to develop a procedure for the collection of fire response data that will become integrated into a GIS used by Los Bomberos. The data collected using our recommended data collection procedure will have a positive societal impact directly through its use by Los Bomberos. Currently Los Bomberos data is outdated, partially incorrect, and scattered. They also had to search their fires for information on hydrants, building hazards, and hazardous materials after receiving the emergency call. The centralized GIS system that they plan on implementing will contain frequently updated, correct fire response data that was collected using the procedure designed through this project. Having this reliable and correct data given to them while responding to an emergency call will save Los Bomberos precious response time. By having this new data in the GIS system, they will not have to search through paper files to find the necessary information, allowing them to respond to the fire sooner. When responding to emergencies, this extra time can make the difference in a successful rescue.

This project also helps to improve the state of technology within INS and El Cuerpo de Bomberos. By proving that using technology will help the performance of Los Bomberos, other employees of INS and Los Bomberos can see the advantages that it can offer. The people who are currently participating in the collection process are likely to trust the information stored in the database since they helped to create it. Therefore, they will also have greater trust in the technology that is involved. Less experienced Bomberos will benefit from learning about sources of water by participating in the data collection process. Overall, social aspect of this project is that when the GIS is implemented, it will aid the citizens Costa Rica by both decreasing the reaction time and increasing the effectiveness of Los Bomberos' response to an emergency call. These changes will help them prevent injury, or loss of property and life. Thus, although this impact is not a one step direct process, our project has great long-term effects on the Costa Rican society as a whole.

2.0 Literature Review

2.1 Fire Response in Costa Rica

2.1.1 Existing Data Collection Procedure for Fire Response

The data collection procedure used by Los Bomberos in the last four years has been uniform throughout the stations, but each station has data only concerning their own district. Their method for data collection included using a form labeled 'Informacion Sobre Riesgo Peligroso' (Information about Hazardous Risks). See Appendix M for the entire form. Each station did field work within their district and collected information about potentially hazardous situations. The data on the form included the station that would respond to the emergency, the hazardous materials present, if danger to life existed, and the data collector's name. Information about the building included the address, number of floors, the name of the building, and the basic floor plans, which could be drawn in a large empty square on the front of the form. On the backside of the form was another blank area allowing the data collector to draw a small map of the building's surrounding area. By illustrating road and well-known landmarks, Los Bomberos were able to find the building when later responding to an emergency. Additional information was listed on the bottom of the backside of the sheet, it pertained to: telephone contact information, structural hazards, building contents, hazardous materials, hydrants, existing security systems, the company which administered water use, and building use. They also left a space on the form for additional information not accounted for in the form.

In this manner, each station collected data about the potential hazards within their district. They maintained three copies of each form, two of which were filed in the stations, and the third was put in a binder that was kept in the fire truck for use during emergency response.

2.1.2 Current Response Procedure

Currently the fire response system in Costa Rica relies heavily on the knowledge of dispatchers at O.C.O. (Oficina de Control Operaciones) to relay and store fire information. (Malone, Churchill, Cook, Rieper, 2000, pp. 165-6). Presently there are two telephone based emergency response systems used in Costa Rica, 911 and 118. The Bomberos use 118 as their emergency response number, while 911 is the general emergency number. At this point, the 118 system is better equipped to receive and respond to emergency calls than the 911 system is. It (118) can handle eight calls at once, while the 911 system can only handle a single call at a time.

Currently, Los Bomberos do not have a 118 system with capabilities to automatically obtain the phone number and address of the location of a fire. The 911 system does not have this capability either. The lack of a standard address system in Costa Rica is not very effective or accurate because it requires that the operator must know the entire region in order to effectively dispatch the firefighters. When an emergency call is received, the operator has to obtain from the caller all the necessary information about the emergency's location and relay it to the firefighters. The operator also must relay to the firefighters via radio information about the emergency type, and the station that should respond. The difficulty with obtaining this information from the caller is that it is a time-consuming process, especially under the pressure of an emergency. Due to the Tico address system, it is often difficult for the caller to accurately describe their location, causing more of a delay in emergency response. By having the capability of automatically obtaining the phone number and location of an emergency, the dispatchers would save precious time in relaying information to the responding firefighters. In turn, the firefighters would arrive at the emergency more rapidly, allowing them to better control the crisis.

The dispatchers also provide information about the building type, and presence of hazardous materials if they have it. This data is obtained through SIBO (Sistema de Información por Bomberos), the text-based database system used by Los Bomberos. While SIBO contains large amounts of data, its graphical capabilities are very limited, and Los Bomberos have decided to implement a GIS to replace it. Additional data needed to respond to emergencies is taken from the Information about Hazardous Risks forms (described in Section 2.1.1), which are carried with Los Bomberos when they respond to emergencies. Obtaining data from both the stations and O.C.O. during emergency response complicates the response procedure because the information contained at each location is different. By consolidating this information, and permitting both the fire stations and O.C.O. to access it simultaneously allows for smoother communication and quicker response.

Last year 1300 Bomberos, 300 paid and 1000 volunteer workers, responded to just over 14,000 fire related calls and just over 2,100 paramedic calls

(INS, Estadistica, 2001). Over a third of the fire calls received were rubbish fires, a sixth were rescue calls and approximately one tenth were short-circuit, electrical problems. The majority of the fire calls are received during the months of December through April the Costa Rican dry season, with an average of twice the number of calls in these months than the rest of the year. The paramedic calls were spread evenly throughout the year, with only slight variations. The provinces of San José and Alajuela accounted for just over half the total fire calls, and nearly all the paramedic calls. Of the 51 fire stations in Costa Rica 15 of them accounted for over 60% of the total calls and five of the top 8 stations for fire calls are located in the capitol city, San José.

2.1.3 Problems in Current Costa Rican Fire Response System

The current computer system used by Los Bomberos, SIBO (Information System for Firefighters), is a DOS based system, which means it is solely a text-based system (Malone, Churchill, Cook, Rieper, 2000,pp. 165-6). It contains information on such things as hydrant locations, stations, fire units, hazardous materials and other information. However, the current system does not give information about routes to the fire or other vital information about the buildings or occupants. SIBO also lacks graphical capabilities, which means that only text-based information is available. The system cannot store information such as building plans, evacuation routes and other information vital to firefighting. It also cannot display digital maps outlining the quickest route to the fire, has no abilities for determining addresses, and is known to contain a certain amount of incorrect and outdated information. While the hardware system is relatively new

(1-2 years old at the time of the interview) and it has the capability to store large amounts of data, it no longer meets the needs of Los Bomberos.

2.1.4 Response with Geographical Information Systems

With a fully implemented Geographical Information System (GIS), the response would be very different (Churchill, et al., 2000, p. 68). Each fire truck would be equipped with its own mobile workstation that has a GIS program installed on it. When the CAD (Computer Aided Dispatch) receives a call a recommended path would be proposed, and if the operator with the information approves it, it would be relayed to the closest fire truck. The quickest path would be shown on a computer display screen in the truck that is equipped with CAD software capable of generating onboard maps. Additional information about the fire scene would be available through pop up screens on the computers in both the trucks and in the dispatch station. Using this interface, the fire fighters would be able to pull up information on occupants, access problems, such as barbed wire, or security systems, hazardous materials (haz-mats) and any other pre-fire survey information on the location. Haz-mats are substances such as toxic chemicals, radioactive material or explosive materials that could pose a threat to the firefighters or people in the surrounding area. In addition the fire fighters would have access to a wide range of hydrology information including locations of hydrants and other water sources, as well as the flow rates associated with these sources (Conley, 1998, pp. 3-20).

2.1.5 Bomberos' Plans for Implementing a GIS

Los Bomberos currently have started the implementation process of this system. They have given us a copy of their proposal to allow us to become familiar with the remaining parts of the implementation plan (Appendix C).

The plan for implementing a GIS begins by explaining the capabilities of one, why it could be helpful to Costa Rican fire response, and how they want to use it. They have determined what software and hardware they plan to use, and in what prioritized order they want to collect data.

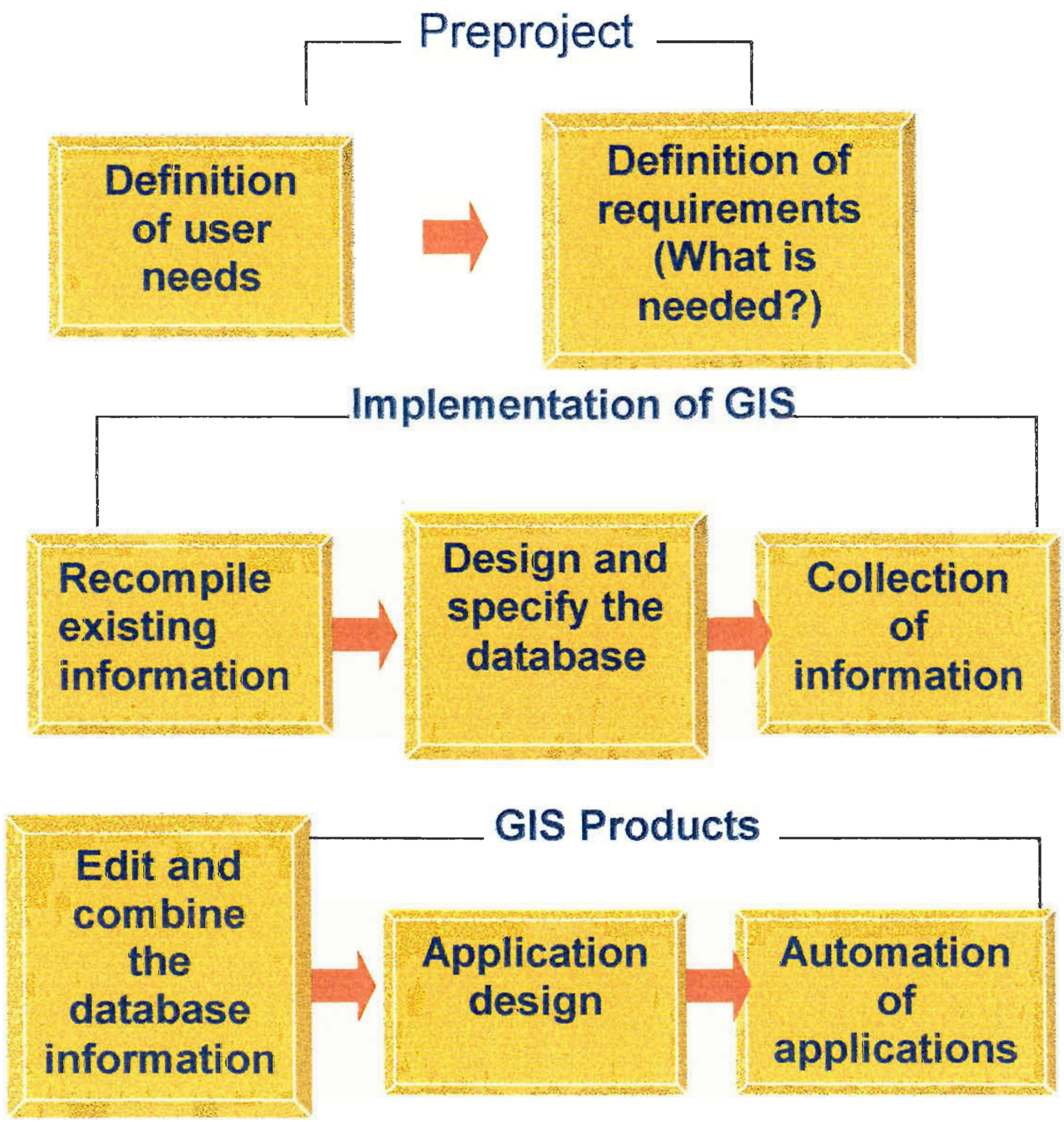
Los Bomberos are considering several different software programs at this time, which include ArcView, Map Info, IDRISI, ArcInfo Geomedia, Visual Basic and Auto Cad (INS Propuesta Sistemas de Informacion Geografica, 2001). These programs will be combined and used in both the main server as well as the workstations to produce the most effective and complete GIS possible. For hardware, they have decided on using a Pentium III, 800MHZ computer with 512 megabytes of RAM and a 60-gigabyte hard drive as the server. The workstations will be PIII's with 800MHZ chips, along with 256 MB RAM and 20 GB hard drives; they will be able to display all the necessary data in a timely manner. In addition to the main server, they plan to use digital maps, scanners, and plotters to transfer the analog data to a digital format and vise versa as necessary.

They plan to use three scales of digital maps. 1:10,000, 1:25000 and 1:50000 for the various data layers. The smaller scale maps will be used to accurately plot specific data points such as water sources, center lines and hydrographic information. The larger scale will be used for larger scale features such as topographical lines and road systems.

Los Bomberos have prioritized the order in which they want to collect the data; this order is water sources, infrastructure information, and then information on the stations and incidents. They have produced detailed lists of what information each layer is to contain based on the specific needs of El Cuerpo de Bomberos. In addition to the data contained in these layers they are planning on including digital photographs of buildings, which when combined with floor plans will produce a clear and complete overview of the building they are entering when responding to an emergency. This data will reflect the most recent information Los Bomberos have on the building and the immediate area.

At the time the proposal was written, Los Bomberos already had a detailed plan to obtain this necessary data. Los Bomberos plan on working in the field to precisely locate each of the data points necessary for their GIS (Geo-referencing). In addition to the fieldwork they planed on exporting the existing data in SIBO into their GIS and using photographic data to augment the data generated by these two procedures. By combining these procedures, Los Bomberos hope to develop a GIS that contains all the necessary data in an organized manner so that it will aid them in their goal of improving their response capabilities.

Figure 1: Bomberos Plan for Implementing GIS (translated from Propuesta Sistemas de Información Geográfica)



After Los Bomberos collect the necessary data it will be entered into Excel based databases (Example: Appendix H) before it is transferred into the GIS (Ana Maria Ortega, June 22, 2001). The data will be stored in this format until the purchase of the hardware and software, scheduled for November 2001, is completed. At this point, they will hire two additional staff members who will help administer the system and digitalize the data so it will be in a format compatible with the GIS. They currently have two people working specifically on the GIS implementation, one who works in the Dirección Informatica (Information Systems Department) as the administrator of the GIS for INS. According to the proposal written by INS, this administrator will act as a coordinator between the GIS and the Dirección de Bomberos (Firefighters Department). O.C.O. will also have access to the GIS through coordination with the Dirección de Bomberos.

2.2 Geographical Information Systems

In a broad sense, a geographical information system can be explained as any programmed system having the abilities to collect and analyze geographical data and organize them with the use and creation of maps (Antenucci, Archer, Brown, Croswell, Kevany, 1991, p. 6).

In 1988 Francis Hanigan stated that a GIS is "any information management system which can:

- Collect, store, and retrieve information based on its spatial location
- Identify locations within a targeted environment which meet specific criteria
- Explore relationships among data sets within that environment
- Analyze the related data spatially as an aid to making decisions about that environment.

- Facilitate selecting and passing data to application-specific analytical models capable of assessing the impact of alternatives on the chosen environment.
- Display the selected environment both graphically and numerically either before or after analysis" (Antenucci, et al., 1991, p. 7).

GIS can also be defined as consisting of information on the characteristics of and the associations between objects which are distinctively "georeferenced" (Bernhardsen, 1992, p.3). More basically stated, a GIS is a collection of data that can be manipulated to form different layers of maps, which each display a unique portion of the data. Of course, before these layers can be constructed, a sufficient amount of correct data has to be collected and entered into a system so that it can be digitally understood.

2.3 Data Collection and Entry

2.3.1 Data Sources

Data used in GIS may come from sources "in various digital forms [and] non-digital graphics, such as conventional maps, photographs, sketches, and schematic diagrams" (Bernhardsen, 1992, p. 95). They can also be found in conventional documents in registers and files, conclusions of scientific reports, and collections of survey measurements expressed in coordinates. For example, in the United States, the state and federal governments are often required to conduct research in order to survey buildings to make sure they are up to code, whether it be pertaining to fire laws or asbestos renovation. To collect data about houses, one might use these research results to obtain non-graphic data about the houses that is not otherwise available to them.

2.3.2 Data Entry Functions

A data entry function is any method that is used for data to be entered into a GIS. Some data entry functions that can be used in the implementation of a GIS are: digitizers, photogrammetric instruments, surveying stations, GPS [Geographical Positioning System], scanning and pattern recognition, miscellaneous entry programs (Bernhardsen, 1992, p. 173). A digitizer, or digitizer table, uses its own internal coordinate system to convert graphic information from digital to analog form in order to be used in a computer (Antenucci, et al., 1991, p. 280). A photogrammetric instrument, as its name implies, is used to take aerial photos of an area in order to obtain specific information, such as elevation data (Antenucci, et al., 1991, p. 286). Surveying stations are simply locations where geographical data about a region are stored, which clarify descriptions of the area, as well as property ownership. A detailed description of GPS can be found further on in this chapter. Scanning and pattern recognition functions refer to the use of an "optical laser or other electronic device" to scan an existing map and convert its images to digital format (Antenucci, et al., 1991, p. 288).

2.3.3 Data Storage Criteria

Data for a GIS database should be: "stored and maintained in one place, stored in a uniform, structured, and controlled manner, able to be divided as needed, and easily updated with new data" (Bernhardsen, 1992, p. 5). It is obvious to see why this would be necessary in a complex system such as a GIS. To make the system more efficient and easier to use, one must store data in one place so that a new user can effortlessly find any required data. By storing data in an organized manner, it only makes it easier to understand which numbers or symbols refer to certain data. In addition, by using an organized system, expanding data sets quickly becomes much more feasible.

2.3.4 Types of Data

The data used in a GIS can be divided into two categories: graphic and non-graphic data.

"Graphic data are digital descriptions of map features" (Antenucci, et al., 1991, p. 85). They may consist of pictures, signs, and conventions that characterize "cartographic elements on a map" (Antenucci, et al., 1991, p. 85). These types of symbols would display the locations of houses, roads, fire hydrants, and water mains. Graphic data are applied by the GIS to generate a "map or cartographic 'picture'" through some type of electronic tool such as a "display device (computer screen)" (Antenucci, et al., 1991, p. 85). There are six types of marks used to characterize and explain maps, which include "points, lines, areas, grid cells, pixels, and symbols" (Antenucci, et al., 1991, p. 86).

Non-graphic data are depictions of traits or associations between "map features and geographical locations; they are typically kept in "alphanumeric formats," although GIS equipment has recently been coupled with executive systems that handle data as "graphic images in raster format" (Antenucci, et al., 1991, p. 85). An example of non-graphic data would be how many people live in a certain house, how old a house is, or what material was used to build the house. There are four basic types of non-graphic data: "non-graphic attributes, geographic referenced data, geographic indexes, and spatial relationships" (Antenucci, et al., 1991, p. 93). Non-graphic attributes use words and numbers to describe something that has been represented by a graphic symbol. Any physical observable facts, manufactured structures, or events that occur at a specific location are described as geographically referenced data. Geographic indexes assist in locating map features and data by using their "geographic identifiers" (Antenucci, et al., 1991, p. 86). Spatial relationships describe how close features are, which features are next to one another, and how they connect.

2.4 Implementation Requirements

In order to make good use of the data collected for analysis, appropriate software and hardware should be chosen. There are different types of software, which are made specifically to be suitable for particular styles of GIS. The following gives a description of what types of hardware and software are needed for the implementation of a GIS, as well as a brief explanation of software used in fire-related geographical information systems.

A layered model of the hardware-software relationship of GIS would show the computer hardware in the center, with surrounding software layers (from the inside out) including: operating system, special system support programs, and application software (Antenucci, et al., 1991, p. 162). "The operating system comprises programs that supervise and direct the system operations and that control communications with hardware devices connected to the computer." Special system utilities "support programs that perform certain routine functions required frequently by users" such as, language compilers, special file management utilities for manipulating files in mass storage, and special drivers for communication with peripheral devices. "Application software, at the outer layer of our model, consists of the programs directly accessed by a user to generate a particular product."

"Hardware devices can be classified into two main categories: the processing unit and peripheral devices" (Antenucci, et al., 1991, p. 133). The central processing unit directs and executes system operations. Peripheral devices include auxiliary storage units; devices used to enter, analyze, and display information and generate hard copy; and devices designed to facilitate communications.

In order to select a processing unit for a GIS, one should calculate the amount of power needed by examining user satisfaction and response time where a GIS with similar applications is already being used (Antenucci, et al., 1991, p. 133). For example, in order to locate a computer system that is suitable for a fire-related GIS, one can look to previously installed systems at other fire departments. Winston-Salem, for example, has implemented a GIS as their fire-response system and has the computer capabilities to make such a system work efficiently (Conley, 1998, pp. 3-20). The following categories of information technology can be associated with previously developed hardware/software systems: engineering mapping systems, property or parcel information systems, generalized thematic and statistical mapping systems, bibliographic systems, geographic base file systems, and image processing systems (Peuquet & Marble, 1990, p. 33).

2.4.1 Computer Characteristics

Choosing a computer system is simple when it comes to comprehensible details and prices, but problems arise when trying to find a system that will be functional for a long period of time (Bernhardsen, 1992, pp. 249-250). Thus, efforts to develop a pilot system often exaggerate the importance of equipment and software. This method of development is proved erroneous by the following table. By viewing Table 1, one can see that the average useful lifetime of the collected data is vastly longer than that of computer hardware or software; thus showing the importance of data, serving as the foundation of an operating GIS.

Table 1- Longevity of Components

Part of GIS Facility	**Average useful lifetime**
Computer equipment	2 to 5 years
Software programs	3 to 6 years
Data	15 to 20 years or more

(Bernhardsen, 1992, p. 250).

2.4.2 Software

When considering the type of software to use for a GIS, one should take into account functionalism, user friendliness, accessory modules, and its ability to be customized (Bernhardsen, (1992), p. 250).

Software requirements should include:

- Structure of basic system and application programs
- System openness to support user-defined application programs, communications programs, etc.
- Macro programming capability
- User instructions and system support documentation
- Freedom to change databases
- Facilities for restricted access
- Operational records and user accounting
- Tools for restructuring databases
- Selection of languages available for entry of error messages and commands
- Programming language
- Support of data interchange with other systems
- Man-machine interface (response time, error messages, commands)
- Support and follow-up

(Bernhardsen, (1992), p. 252).

Some basic ideas should be taken into consideration when choosing software for Los Bomberos. The software should be: easy to use, enticing to the user/user friendly, organized, graphically pleasing, and it should have a complete set of practical and effective features.

2.4.3 Hardware

Hardware systems used specifically for GIS should include the computer, the display, a quantizer, and a plotter or other output device (Bernhardsen, 1992, pp. 77-87).

The computer system consists of any circuitry needed to analyze and execute programs for processing data and controlling peripheral equipment (Bernhardsen, 1992, pp. 77-87). Three types of computers can be used in GIS. The most commonly used is the personal computer (PC) and the workstation. Another type is a mainframe, a large system hub serving various users, which can also be used. Minicomputers or small mainframe computers can be used for smaller GIS. PCs are preferable because they can be used in a Local Area Network (LAN) configuration in order to give access to several users while maintaining an unrestricted local computing ability. Workstations are less common, but give the user direct access to a larger computer.

The display is the screen or monitor through which all visual communication is provided to the user by the computers (Bernhardsen, 1992, pp. 87-93). In a GIS, quality, high-definition, color screens are important in distinguishing between map features.

Quantizers are devices that convert analog data into digital data (Bernhardsen, 1992, pp. 87-93). The most commonly used quantizers include digitizers, scanners, video, and automatic line tracers. Simply stated, a digitizer is a flat surface that uses electromagnetic sensing to determine positions on a map. Scanners consist of an automatic electromechanical system to convert a picture into pixel format. Video cameras are also often used to digitize pictures. Automatic line tracers follow lines on a map and convert the data to digital map form. Plotters are output devices that use the digital data stored in the computer to produce map images.

2.5 The Capabilities and Applications of a GIS

Using a GIS allows for motorized exactness when densely storing and quickly retrieving vast and complicated data sets (Peuquet & Marble, 1990, p. 5). Computers provide the ability and efficient data processing necessary for many "quantitative and analytical techniques" to manage great amounts of "observational data"; without the use of computers, the sensible use of many techniques created in the earth sciences such as, "transport planning, urban planning, and natural resource management" is highly restricted (Peuquet & Marble, 1990, p. 5). In a complementary manner, as more data become directly available in digital form, more digital tools are being used.

The capabilities of a GIS include cartographic capability, data management capability, and analytical capability. When put together, these capabilities allow users to have, "an enhanced ability to manipulate and use data more effectively" (Antenucci, et al., 1991, p. 10). Precise maps and "engineering drawings" can be created "efficiently" by cartographic capability (Antenucci, et al., 1991, p. 9). Data management capability makes possible the well organized storage and handling of both "graphic and non-graphic" geographic data. Refined processing and "interpretation of spatial data" are achieved with analytic capability.

Applications of GIS vary through many types of occupations including: "business, election administration and redistricting, infrastructure management, map and database publishing, oil, gas, and mineral exploration, public health and safety, real estate information management, renewable resources management, surveying and mapping, transportation and logistics, urban and regional planning, and research and education" (Antenucci, et al., 1991, p. 34).

2.6 Case study: Winston-Salem, North Carolina

The Winston Salem Fire Department Comprises 17 stations, 254 firefighters and provides service to 106.5 square miles and 171,000 people (Conley & Lesser, 1998). Their GIS project, I.N.F.O (Integrated Network Fire Operations), was funded through a federal grant from the Department of Commerce as well as matching non-federal funds. This system allows more efficient communication between the fire stations as well as providing the fire fighters with graphical information about the fire site. The system incorporates a Global Positioning System, GPS, which when combined with their GIS allows the system to determine the optimum route from a station to the fire site. The system is also capable of finding routes if the optimum route is unavailable due to a newly existing change, such as downed trees or power lines. Available to the firefighters through the graphical interface is information on hydrant locations and flow rates, railroads, streams, and schools. Using a touch sensitive screen, the firefighters can pull up floor diagrams, including information on utilities, fire suppression devices, such as sprinklers, pre-fire survey information, such as hazardous materials and handicapped residents, as well any other documents about the fire location that may exist. The firefighters are able to access the information from laptops that have been modified to withstand the elements that they may be exposed to while on site at a fire. This is much more efficient than the previous method of radioing fire information, and using binders with the pre-fire information.

2.6.1 Components

The fire stations are connected to the city's existing network through ISDN circuits, which allow the stations to communicate as well as to have access to the Internet (Conley & Lesser, 1998). The main server is located in the Fire Administration Office. Layers of data that are used specifically by the fire department are stored and created on the city's SUN Solaris GIS servers, while layers common to other departments are stored in different servers in the city.

In the emergency vehicles is a "ruggedized" Mobile Data Computer that has both GIS and imaging software (Conley & Lesser, 1998). When E911 Computer-Aided Dispatch receives a call, it identifies the nearest appropriate vehicle, and the emergency dispatch information is relayed over the radio to the appropriate vehicle. Because the speed of transmission over the radio is insufficient to transfer the graphical information to the mobile workstations, CDs are used to transfer copies of the data. These CDs, which contain all the relevant data, are then loaded onto the hard drives where the data about the fire site and routing information can be obtained en route to the fire. These CDs are updated monthly to ensure the data are consistent with the actual physical environment.

The GIS comes into play by working with E911 to help determine the best route to a fire for the specific vehicle location (Conley & Lesser, 1998). Because of the specific needs of the fire fighters, it was necessary to modify the existing GIS coverage and to develop additional coverage as well. By using GPS and the existing street files, the city developed a routing framework. GIS coverage was also developed for hydrants, fire demand zones, pre-fire surveys, hazardous materials, schools, fire stations, handicapped residents and multiple address locations. The route generated takes into account speed limits, one-way roads, allowed turns and any other street related information that would come into play in determining the fastest route to a fire. This component was created using Microsoft Visual Basic 5.0 and MapObjects (Environmental Systems Research Institute, Inc). Some of the major capabilities of the system include:

- Recommend quickest route
- Provide text descriptions of route
- Provide graphical view of route- with zoom capabilities
- Identify fire hydrant locations
- Highlight critical information
    - Hazardous materials
    - Pre-fire surveys
    - Physically challenged residents
- Identify multiple address locations

- Change origin/destination of route
- Close/Open roads based on current conditions
- Select map layer
  - Fire Demand Zones
  - Home territories
  - Schools
  - Hydrology
  - Fire Stations
- Select feature and view data in a table form

2.6.2 Development of GIS

As stated in the report, "the success of the GIS routing application depended on the development and availability of the necessary GIS coverage" (Conley & Lesser, 1998). Data for the GIS were obtained from several sources, including: physical maps, city and county mainframes and GIS. Existing GIS were upgraded with information about hydrographic information and railroads. When data were not available, new GIS coverage was constructed. These included the coverage of hydrants, fire demand zones, multiple address locations, school, fire stations, hazardous materials and physically challenged residents. The most important part of the GIS is the centerline, the part of the system that allows routing to the fires. Using data from two mainframes, one holding planning information the other CAD street files, allowed for the creation of this GIS. A graphic only version maintained by the FC Assessor's Office was also used as a reference point. The Institute of Transportation and Research (ITRE) was contracted by the city to use GPS to build the centerline coverage. Data on exact street locations as well as the attributes of these streets, names, speed limits, etc., were collected through the joint funding of the city and the county.

For a break down of each component included in the Winston-Salem system, including the nature of each component, development brief and brief comments, please see Appendix B.

2.7 Global Positioning Systems

2.7.1 Introduction

Global Positioning Systems, or GPSs, are fast becoming one of the world's most popular and useful navigational tools. A GPS is a very accurate and powerful tool, as some versions of it can be extremely accurate (within 0.5mm) in determining location (Lange, 1992, p. 106). GPS is useful in many settings, its most well known use being for navigation. However, it can be very useful when used in conjunction with GIS, especially to update and create very accurate maps. To understand GPS functions, we must first understand the theories that come together to make it work.

2.7.2 How a GPS Works

GPS is, by definition, a satellite navigation system (Dana, 2000, p.1). In short, about 24 satellites, controlled by the U.S. Department of Defense (DoD) send coded signals to a GPS receiver, which computes position, velocity and time.

Many people use GPS worldwide, including the Department of Defense (Kennedy, 1996, p. 11).

A satellite that orbits the earth with the specific purpose of relaying GPS information is known as a space vehicle, or SV (Dana, 2000, p. 2). There are more than 24 operational space vehicles in orbit currently. An SV orbits the earth in 12 hours, and repeats almost the same ground track (as the earth turns beneath it) once a day. The master control facility for all SV's is Schriever AFB in Colorado. This facility measures signals from all SVs and from them formulates a model for each satellite, which computes the orbital data and clock corrections for each satellite. These are then uploaded to the SVs, which then relay the information to GPS receivers worldwide over radio waves.

2.7.2.1 Types of GPS Signals

There are two types of GPS signals (Dana, 2000, p. 3). The most common type is known as Standard Positioning Service (SPS). Civilians worldwide use this type of GPS, under the Federal Radio navigation act. It is used by aircraft, ships, ground vehicles, and hand-carrying individuals. It is not quite as accurate as the signals used by the government, but still very close. See Table 2 for accuracy details. Precise Positioning Service, or PPS, is used only by those authorized. These users must have special cryptographic equipment and receivers. Only US and allied militaries, certain US government agencies, and selected civil users specifically approved by the US government can use PPS.

Table 2-Predictable Accuracy of PPS and SPS Signals, as Controlled by the US DoD

Accuracy	PPS	SPS
Horizontal (m)	22	100
Vertical (m)	27.7	156
Nanosecond time	200	340

These measurements are guaranteed to be 95% within the ranges given above by the US Department of Defense (Kennedy, 1996, p. 119). The DoD intentionally degrades all signals to be less accurate, especially those used by civilians (Lange, 1992, p. 107) using a process called selective availability (SA). This is so that the signal will not fall into the wrong hands; the military does not want an enemy soldier to know where he is. However, this signal can be improved using a technique called differential GPS.

2.7.3 Differential GPS

Differential GPS is a very useful technique that is used to make a GPS signal much more accurate (Kennedy, 1996, p.120). This correction is done by setting a GPS receiver at a point known as a base station, which is a precisely known geographic point. Since the base station knows exactly where it is, it can assess the lies being told to it by the GPS signals. These signal errors will be almost equivalent to the signal errors affecting other GPS receivers in the local area, so the accuracy of locations calculated by those other receivers may be improved, sometimes dramatically, by information supplied by the base station.

A surveyor who uses GPS equipment (usually primarily for GIS mapping) can locate a point within a centimeter because of this differential correction.

2.7.4 GPS and GIS

As described briefly above, GPS can be used extensively in the surveying of land, which aids immensely in setting up a GIS system. GPS can also be used with GIS for obtaining digital map data, ground-checking satellite imagery data, and creating or updating GIS databases (Lange, 1992, p. 109). GPS wins over all other methods of creating position information (i.e. maps) because it is so accurate; it can provide horizontal accuracies of less than one centimeter (Kennedy, 1996, p. 9). To georeference a satellite image, the user of the GIS can first identify a number of natural and cultural features, for example the intersection of two roads, which can be identified on the image and found on the ground. Each point can be visited by the GPS to set exact coordinates, which are then exported to the GIS (Lange, 1992, p. 109).

GPS is also helpful because it is easy to use. Anyone who can read coordinates and find the corresponding position on the map can use a GPS receiver (Kennedy, 1996, p. 9). GPS makes mapping easier in helping to solve major problems in GIS databases. One of the major problems is trying to correlate data from separate sources. A GPS solves this problem by georeferencing each individual layer of the GIS database.

2.7.5 Equipment

GPS receivers have been continuously getting smaller and smaller (Langley, 2001, p. 1), and currently a small GPS receiver can cost as little as

$200. This type of GPS is usually for recreational navigational use, and not of much use to the surveyor whose job is to gather information for a GIS. Data recording GPS receivers have been designed specifically for GIS application. They are rugged, portable, battery-powered, data recording systems comprised of a lightweight GPS receiver, usually an optional remote antenna if available, a data recorder, and software. Usually included with the software is a suite of post processing programs, some of which are specifically designed for GIS data formatting (Lange, 1992, 109). Equipment of this type can be very costly, perhaps up to $50,000.

2.8 How to Write a Form

2.8.1 User's Perspective

As with any document, one must consider it's reader while writing it. The writer of the document must consider carefully the reader's use of the document and the reader's attitude towards it. Also, the reader's level of education and other factors, such as cultural issues, should be considered. Making these considerations will ensure that the document is properly suited for its user. See the section 2.9 (How to write a manual) for more on this.

2.8.2 Organization

A form must be organized so that it is easy for the user to read, understand, and most importantly, complete. Similar sections of the form should be logically grouped together. For example, data that can be answered by a checkmark should also have an area for description if needed. By keeping all the checkmark data together, the form can flow smoothly and later lead to open-ended questions.

2.8.3 How to Revise a Form

Experienced researchers know that one draft of a document is rarely sufficient (Funk & O'Hare, 2000, p.453). For this reason, and because of the important data that forms collect, it is imperative to revise each draft carefully. Revisions can be made through examining the form and determining that it's purpose is clear, and that the tone used is appropriate and consistent for the purpose. They also can be made by scanning the document for surface errors such as punctuation and mechanics. During revisions, the writer should also consider the readers and how they will respond to the document, and if the form is in a logical and organized design.

Revisions can also be made by asking another person for feedback about the document. This can be helpful because someone else can often see the places where the writer thought that they were being clear but were actually filling in details in their head, not on the page (Funk & O'Hare, 2000, p.39). When someone is reviewing their work, the writer should keep in mind to specify the kind of help they want from the other person, ask productive questions, and not be defensive. This revision method can often be very effective.

2.9 How to Write a Manual

To write this document so that it will be effective and understood, we carefully considered how to prepare it. It contains a collection of the instructions of how to use the forms we created and how to design forms in the future.

2.9.1 Writing the Document

Numerous factors needed to be considered before we could begin to write the document. First, the level of knowledge and experience of the readers was examined (Houp, 1998: 16). This is very important, because the content of the manual depended on the reader's knowledge and experience with the subject matter. A manual that is written for users who have little or no knowledge of its topic contains extra details to give the user background material that will help him or her to understand the manual. A manual that is intended for users who have a very good understanding of its topic will not contain so much background detail, if any at all.

Cultural relationships and attitudes should also be paid attention to. The writer of a document must understand what their relationship is to the readers of the document. When the writer determines what type of relationship is present, they can establish what tone to use to convey the information. In addition, a writer must consider cultural attitudes of their readers. Some cultures may require instructions to be written in a very abstract format, while others need to have instructions that are concise and to the point.

The reader's point of view must also be considered (Houp, 1998: p.492). This means that the content of the work should be altered depending on why someone is reading this document. If a document is written as a set of instructions for a data collection procedure, the writer may assume that readers will be reading it so that they can perform the tasks described in the instructions. This means that the instructions should be written (considering this and other factors discussed above) so that the reader can easily understand them and carry out the necessary tasks.

2.9.2 Writing Instructions

It is important to also consider the purpose of the instructions (Houp, 1998: p.492). The writer should consider who the reader will be and how they will use the instructions. This will help in determining how to organize and format the instructions, and what to include in the content. An example of a content outline would be (Houp, 1998: p494):

- Introduction
- Theory or Principles of Operation
- List of Equipment and Materials
- Descriptions of Mechanism
- Warnings
- How-to instructions
- Tips and Troubleshooting Procedures
- Glossary

Most sets of how-to instructions use a list format (Houp, 1998: p.509). In a list format, each step is kept distinct from the other step. The list format is often used because it makes it easy for readers to find their place on the page, to see how many steps there are, and to be able to use these instructions as a checklist. This might not be the best option for a project in which more than one thing may have to happen at once because the directions need to be described in paragraph. However, all of the methods discussed before about the reader's point of view, knowledge and experience, relationship with the writer(s) and what the reader intends to do with the information presented them, still apply.

2.10 Conducting Interviews

In-depth interviewing is a data collection method relied on quite extensively by qualitative researchers, as it is a useful way to get a large amount of data quickly. It is one of the fundamental methods of qualitative data collection (Marshall & Rossman, 1995, p. 80).

2.10.1 Semi Structured Interviewing

It is described as "a conversation with a purpose" (Kahn & Cannell, 1957, p.149). An interview is much more like a conversation than a questionnaire or survey, which are formal events with predetermined response categories. During the interview, the researcher explores a few general topics to help undercover the participant's perspective, but otherwise respects how the participant frames and structures the responses (Marshall & Rossman, 1995, p. 80). A degree of systematization in questioning should be used in a multi-case study where many participants are interviewed. If numerous people are being interviewed separately for the same purpose, their separate interviews should be conducted in a very similar manner, and the questions that they are asked should be similar.

Interviews have particular strengths and weaknesses (Marshall & Rossman, 1995, p. 80). As stated above, they are an excellent way to obtain large amounts of data quickly. Immediate follow up and clarification are possible.

2.10.2 Elite Interview

An elite interview is a specialized case of interviewing that focuses on a particular type of interviewee (Marshall & Rossman, 1995, p.81). Elite individuals are people that are influential and prominent members of an organization. Elite interviews have many advantages. Valuable information can be gained from these participants because of the positions they hold in political, social and administrative realms. They usually can provide an overall view of an organization, and report on an organizations policies, past histories and future plans.

Elite interviewing also has disadvantages. These people are often busy and hard to access. They operate under demanding time constraints and are hard to reach.

2.10.3 Focus Groups

A focus group is comprised of about 7 to 10 people who share specific characteristics pertinent to the study being conducted (Marshall & Rossman, 1995, pp. 84-85). The moderator creates a comfortable environment in which he is permitted to ask focused questions in order to spark discussion within the group. By remaining neutral during topic discussion, the moderator can take note of differing opinions and points of view. This method was formed from the idea that often people reflect better on a topic after having listening to another's opinion. By doing this, one's attitudes and beliefs toward a subject are more accurate.

The advantages of conducting a focus group include avoiding an artificial one-on-one interview, having the flexibility to explore unexpected topics, obtaining quick results, low cost, and studying a larger sample size (Marshall & Rossman, 1995, pp. 84-85). Unfortunately, the moderator also has less control over the group and results can sometimes be difficult to analyze. It is helpful to have more than one person observing the group while the moderator runs the focus group.

2.11 Analyzing Data Quality

The review of documents is an unobtrusive way of supplementing observations and interviews (Marshall & Rossman, 1995, p. 85). These reviews can be used to prove (or disprove) hypothesis developed during the research portion of the study.

Analyzing documents often requires an approach called content analysis (Marshall & Rossman, 1995, p.85). This method represents the systematic and objective examination of modes of communication to objectively document patterns. Generally, this procedure is applied to written materials (forms, letters etc.) but it can be adapted to other modes of communication (music, pictures etc.).

The greatest advantage of this method is that it is "unobtrusive and nonreactive" (Marshall & Rossman, 1995, p.86). This means that the analysis can be performed without affecting the data itself. The person performing the analysis can determine which parts of the document being analyzed require the most emphasis. This can be determined after the data is collected so the collection itself is not biased towards expected results. Finally, the mode of analysis can be easily followed by a reader, the facts can be checked and the methods of analysis can be reviewed as well.

2.12 Pocket PC

2.12.1 Pocket PC Information

The H3600 series Pocket PC is a handheld personal computer produced by Compaq (Appendix N). The Pocket PC had a 206MHz StrongARM processor with 32 MB of RAM which makes it faster at opening applications then its competitors (Brooks, 2000). However, being the only handheld device using StrongARM, some applications have not been formatted to run off this system. It weighs in at 6.3 ounces, which is significantly less then comparable devices that weight about 9 ounces. The lithium-polymer battery used by the Pocket PC provides a battery life of 12 hours which significantly longer then other handheld devices (8 hours for the Jornada 548, 6 hours for the Cassiopeia E-115 and 9 hours for the Palm IIIc). The display screen features a 12-bit color display that is easy to read in all lighting conditions. This is achieved by an ambient light sensor that can automatically adjust the screen brightness based on the ambient light present. The Pocket PC supplies the best display for "variable-lighting situations" however while in areas of low light, such as indoors, the display takes a milky appearance. In addition, there is no way to control the contrast of the display, an option offered in many of its competitors. For communication between the Pocket PC and a computer, the H3600 series offers both a USB port, an optional expansion jacket and Infrared capabilities. The expansion jackets allow the Pocket PC to be connected to existing hardware while the USB and Infrared allow easy communication between the computer and the Pocket PC. In performance tests the Pocket PC was able to receive a 2MB file in 25 sec, while a comparable device, the Jornada took 75 seconds. At the time of this article, the H3600 series Pocket PC cost $500 U.S. compared to $599 U.S. for Casio's Cassiopeia E-115 and HP's Jornada 548.

2.12.2 Entering Data into the Hand Held Computer

For the entering of data into a cell of a Microsoft Excel spreadsheet, first a cell needs to be highlighted by tapping it once with the stylus. Highlighting the cell tells the computer that this cell will receive text. Next, the long white rectangular box in the top right corner (just below the blue title bar) should be tapped on once. This makes a cursor appear in this box and a rectangular window appears from the bottom of the screen. This window, which is either the character recognizer or the keyboard, is the data input function. The user can choose whether he or she would like to use the keyboard or character recognizer by tapping the small black triangle at the bottom right corner of the screen; a dialogue box will appear with the two options, and the stylus is used to select one or the other.

Entering data using the keyboard is quite simple. The keyboard is a graphic representation of a computer keyboard. It is used by simply tapping each desired 'key' with the stylus. The character recognizer is not quite so easy to use initially, as it requires some practice to understand how to use. The character recognizer window is split into three recognizing columns with an additional column of option icons to the far right. From left to right, the first column recognizes capital letters, the second column lowercase letters, and the third numbers and symbols. The icon options column contains icons for backspace, left and right arrows, return, space, help, and special characters. Touching each of these once with the stylus will make the action occur once, touching the help and special character icons again will make their respective windows disappear. The character recognizer has many different options and features that should be learned by the user before he or she attempts to operate it. There is a help program and a demo included in the Microsoft Excel software that are very useful.

After the user has entered the desired text into the cell, they can move to another cell by either entering return (using the keyboard or character recognizer) or hitting tab (keyboard). (This information was obtained by testing of the Microsoft Pocket Excel software on a Compaq iPaq Pocket PC, model 3630)

3.0 Methodology

This chapter describes the methods and rationale used to accomplish the goal of the project. To complete our project we used elite interviews, informal interviews, focus groups, field-testing, and unobtrusive observations.

3.1 Orientation to Project

The first thing we did for our project was to meet with members of Los Bomberos and INS to discuss the goals and objectives of the project. At this meeting, there were two INS staff members from the IS department, as well as Engineers from the Dirección de Ingeniería en Prevención de Los Bomberos (Walter Mora, Esteban Ramos Sub-Jefe de Ingeniería, Héctor Cháves León Jefe de Ingeniería). In addition we talked to Ana Maria Ortega from the Direccion de Bomberos. From these meetings we obtained a detailed outline of their plan for the implementation of the GIS (Propuesta Sistemas de Información Geográfica) and a better idea of what we were to do.

Next, we visited the Office of Operation Controls, which contains Los Bomberos' dispatch system. We conducted this visit in order to see the existing problems in their current database, SIBO. This information about the SIBO database was gained through unobtrusive observation and informal interviewing. We used unobtrusive observation to examine how O.C.O. operated on a day-to-day basis. Informal interviewing was used to get a closer look of how SIBO worked and to clarify our questions regarding the database.

3.2 Determining Necessary Data

By reviewing INS' GIS implementation proposal, talking to members of Los Bomberos' engineering department, and conducting several meetings with various members of Los Bomberos, we determined what data needed to be collected for a functional GIS (See Appendix J for meeting notes). These meetings took the form of informal interviews with members of the Engineering and Administration Departments of Los Bomberos. We informally interviewed Esteban Ramos and Walter Mora to determine what data our first form (water sources) needed to collect. We chose this method because it was both quick and effective, since they were knowledgeable about the data requirements for a fire response GIS and were readily available to help us.

3.3 Form Design for Obtaining Necessary Data

We designed the data collection forms based on the following criteria established by Los Bomberos:

- Include all data required for the GIS
- Be compatible with knowledge level of Los Bomberos
- Use terminology familiar to Los Bomberos
- Be written in Spanish
- Be clear, concise and fit on one page
- Clearly define choices for data entry in each section

Since Los Bomberos listed water source information as their first priority, the first form created was one to collect data about water sources; following the completion of that form we created forms for infrastructure, stations and incidents. We created forms that would allow for future data collection to be carried out in an organized and structured format.

3.3.1 Developing the Forms in a Logical and Organized Manner

The form creation process began by looking at the data requirements that Los Bomberos listed in their proposal for implementing a GIS. For example, on the water form some of the required data included flow rates of hydrants, volumes of tanks, access conditions and physical state of hydrants. (See Appendix D for the English versions of forms and Appendix E for the Spanish versions of the forms). The forms had to be organized logically to be useful, therefore, we organized this information beginning with the most general, such as the location of the water source, and moved on to more specific details, such as the number of turns required to release the water from a hydrant.

During the creation of the forms, the knowledge level of the users was taken into account. To determine this we informally interviewed members of the Engineering Department to ensure the terminology we used was the same terminology used by Los Bomberos. This was done so that the users would be able to fully understand the entire form and accurately record the necessary information. Table 3 shows the entrance requirements to become a permanent Bombero.

Table 3: Bomberos Entrance Requirements

■ Licencia de Conducir Tipo B1	Drivers license Type B1
■ Bachiller de Colegio	High School Diploma
■ Mayor de 18 y menor de 26 anos	Older than 18 but younger than 26
■ Ganar examen psicometrico	Pass a psychiatric exam.

The Bachiller de Colegio, equivalent of a high school diploma, ensures Los Bomberos will have completed sufficient education to be able to fully understand the terminology we used in our form. This data was obtained through an informal interview with Esteban Ramos on June 13, 2001.

The forms were carefully designed with the help of Walter Mora and Esteban Ramos to be grammatically correct as well as functionally complete. We wrote the forms in either Spanish or English depending on which language was more practical for our purposes. The forms were then translated so that we had copies in both languages.

In order to make the forms clear and easy to use, both check boxes and blanks were used to obtain detailed information about each type of data. This format was used based on the initial suggestions of Los Bomberos prior to the creation of the form. We felt this was the best method to follow since it fit the organization criteria of Los Bomberos.

Another important factor that we considered in the construction of the forms was the perspective of the user. Keeping this in mind, the forms were designed to be both short and concise, and to fit on one page. The forms were made this way so that users would not find completing them to be a tedious, time-consuming task, but one that could be completed quickly and without complications.

3.3.2 Revisions of Form

Like any important written document, the forms that were created had to be edited, proof read, and revised until they were ready to be used. We used various methods to revise these forms, including feedback from administrators in El Cuerpo de Bomberos (Walter Mora, Esteban Ramos, Héctor Cháves León and Ana Maria Ortega), gained through informal and elite interviews, as well as testing the forms in the field.

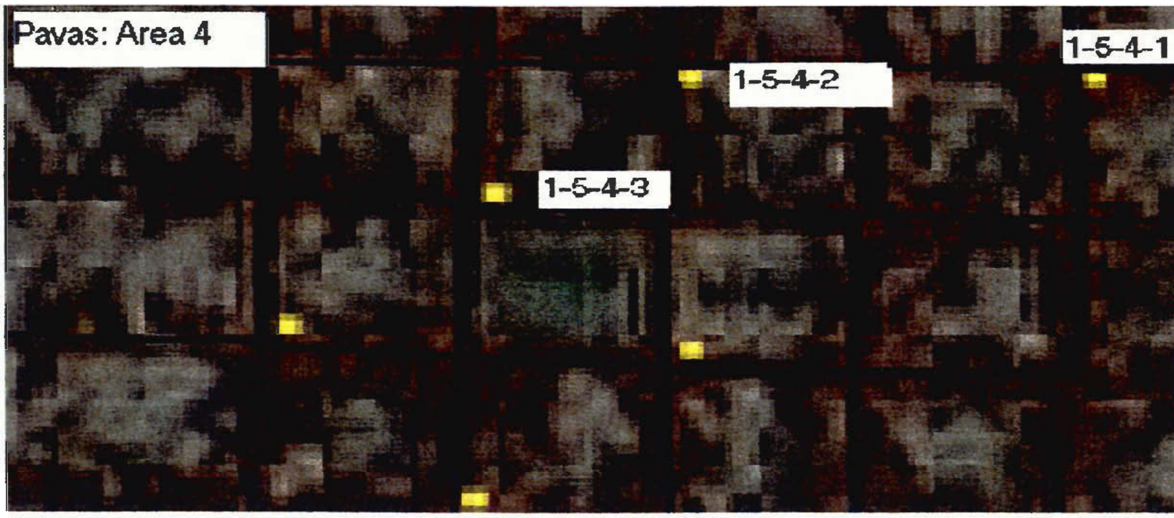
3.3.2.1 In Office Revisions

In the office, after the first draft of the form was written, it was submitted to Esteban Ramos, Héctor Cháves León, and Ana Maria Ortega. We conducted informal interviews with them in order to record their feedback and know how to improve the form. We used the informal interview method so they could each provide their own opinions about the form independent of each other. This allowed us to change our questions according to their area of expertise in Los Bomberos.

In addition, we also took into consideration the suggestions made during two focus groups with between 7 and 10 station chiefs from several districts of San Jose (See Appendix J for the meeting notes). These focus groups took place during one week of the form revision process. Héctor Cháves León mediated these focus groups in order to create a more comfortable environment for the attendees. These focus groups were also facilitated in this manner in order to encourage discussion and comments regarding the data collection forms. During the first focus group the organization and format of the form were discussed and debate. At the second focus group the data collection procedure was delivered in the form of a Power Point presentation presented by Héctor Cháves León. The intent of this focus group was to explain the data collection procedure to be used with the form and to clarify any unclear steps within the procedure. We felt a focus group would be the best method for explaining the data collection procedure because it would allow the procedure to be explained to all the station chiefs at the same time. During this session the procedure for assigning codes to water sources was also explained.

The code assignment method was chosen so that each water source has a unique four-digit code that describes its location. This method labels the water sources using a 4 digit code: the first 2 digits refer to the fire station in the district, the 3rd digit refers to the Area that the water source is located in, and the last digit assigns a unique number to that water source. For example, Figure 4 below shows how this method is completed when labeling the first few water sources within the Pavas district (1-5) and in the 4th Area.

Figure 5: Pavas Area 4 Coding



This figure, used in the Power Point presentation, is a digital picture of a paper map demonstrating the use of pins to locate the water sources. As demonstrated by Figure 5, the codes are designated in order beginning from one corner of the Area and continuing toward the other corner of the Area.

3.3.3 Test Form in Field

At this point all stations within San Jose were field-testing the water form by collecting data in their respective districts. Each station had fifteen days to complete the collection of information on the water sources in their district.

We began the on-site work in a district of the Greater San Jose area covered by the Pavas fire station (Appendix K Pavas Observations). Pavas was chosen because it is a diverse section of San Jose and is comprised of residential, industrial, and commercial zones. Pavas contains (among many things) hospitals, embassies, schools, parks, a sports stadium, each of which could have a unique effect on our data collection procedure. In addition to the infrastructure, the natural environment, which contains rivers and federally protected land, also varies greatly throughout the district.

On Monday the 4th of June we went to the Pavas fire station (one of seven districts in San Jose) with Walter Mora, a member of the engineering department of Los Bomberos. We accompanied eight members of the Pavas fire station as they collected the water source data in Area 1 of the Pavas fire zone (this area comprises the area between two major rivers in Pavas and includes most of downtown Pavas). We unobtrusively observed their use of the forms as they collected the data on hydrants in order to determine how well the form functioned in the field through first-hand observation. In addition we were able to observe their use of the predetermined method for assigning codes to water sources. This method had been explained to each station chief during the second focus group. In addition to our observation we also used informal interview techniques to speak with Jarol Hidalgo, the data collector for the Pavas station. We used the informal interview to find out what Jarol Hidalgo's opinion of the procedure was.

3.3.4 Finalizing Forms

In order to determine what changes needed to be made to the Fuentes de Agua form, we reviewed the feedback gained through all the methods used while testing the form. We took into consideration information gained from each method in order to have a complete and accurate understanding of what needed to be improved.

3.4 Transfer Form to Pocket PC

The use of a Pocket PC was considered as an alternative technology-based collection method. After we determined that we would be testing the use of the Pocket PC for data collection, we began the process of transferring our forms from the Microsoft Word format into a Microsoft Excel format. The Pocket PC version of the form, the Excel format, retained the same format as the Word version, but used fields and other Excel based options to make it easier to fill out in the field. We then conducted an informal interview with Jose Conejo, the designer of SIBO, in order to determine the best way to transfer electronic data from the Pocket PC to a computer database. We relied on his advice because we knew he had extensive experience with database use.

3.5 Interviews

3.5.1 Interviews with San Jose Area Station Chiefs

On June 14th, we traveled to 5 different stations within San Jose and conducted elite interviews with the Jefes at three of these stations (Appendix J). We used elite interviews as opposed to focus groups because of time constraints and the difficulty of coordinating their busy schedules.

The stations visited were Guadalupe, Desamparados, Central, Tibas, and Barrio Luján . Ulises Cornejo, an engineer from the Direccion de Los Bomberos, escorted us to the stations. We conducted the elite interviews with chiefs from Estacion Central, Tibas and Barrio Luján . The station Jefes (Henry Morales Alvarado at Tibas, Jorge Murillo Araya in Estacion Central and Walter Sanchun Arnaez at Barrio Luján) were interviewed to determine their preference between the paper forms and the electronic form. They were also interviewed to determine how the collection of data using the paper form was progressing, whether GPS or pin-on-map locating worked best, and to probe about previous data collection methods. Each man was asked relatively the same questions. Some questions were framed slightly differently than others as the interviews progressed and we were able to see that certain questions needed to be changed or removed.

We began the interview by asking the chiefs about the GPS and Pin mapping options. We interviewed them to gain their opinions regarding which locating system worked better. We asked the chiefs which methods they thought were best for their station to help us determine what method(s) to recommend that they use.

Next, we showed the chiefs the alternative data collection form, the electronic form on the Pocket PC. We asked these three men questions about the function of the paper form. We then demonstrated how the Pocket PC worked and allowed them to try out the electronic form. We then asked which data collection method they would prefer to use, electronic or paper. This method was used to determine firefighter preference between methods, to see if we could make the data collection process easier for Los Bomberos.

After asking the interviewee about his Form preference, we asked him questions about the previous data collection methods. We did this because it was important to know the difference between the data collection methods being used today and those used in the past. We asked him how data had been collected, if there had been a previous form, and exactly what data had previously been collected. We then asked the chief which method he preferred to use as a data collection procedure. Also, to gain a better understanding of how these stations used SIBO through O.C.O., we asked our interviewees what information they received from the O.C.O. dispatchers when an emergency call was received. We used the elite interviews in order to gain feedback on each topic quickly and in an unbiased manner.

3.5.2 Interviews With Guanacaste Province Bomberos

From June 25 to June 27 we interviewed Bomberos from, Cañas, Nicoya and Liberia in the Guanacaste Province (Appendix J). This was done to determine if there were major differences in the needs of Los Bomberos in rural areas compared to the needs of Bomberos in San Jose. We visited each station twice so that Los Bomberos could take the time to look over the form and test it in the field before giving us their final opinions.

On the first visit, we explained the forms and asked their initial opinions on the completeness and usefulness of the forms. Next, we explained how the Pocket PC could be used in data collection and asked which method they felt would be best for data collection in their station. We also asked about O.C.O. and how they use it in fire response as well as their previous data collection methods. As the last step on our first visit, we left Los Bomberos copies of the forms to look over and make comments or observations. We also asked them to test the form in their area to see how well it functioned and so we could observe how complete the data they recorded was.

On our second visit to the stations, we did brief informal interviews with Los Bomberos who we had given our forms to. We asked them if they had any suggestions about the information included and about the ease of completing the form. We collected the completed forms so we could see how complete they were and to see if there were differences in the way they were filled out.

3.6 Analysis of Data Quality

We also collected ten copies of the completed Fuentes de Agua forms from four stations during our elite interviews and with the help of Walter Mora. We collected these forms for the purpose of being able to use them to determine the quality of the data being collected which in turn allowed us to determine the effectiveness of our form.

Each form that we obtained was examined carefully, and then rated on a scale of one to five, five being the best score. This scale was determined based on the completeness and correctness of the form. See the table below for the rating system.

Table 4-Form Rating System

One – Unusable. Form is missing most important sections, such as address and important data about the water source.
Two - Almost Usable. Form contains some useful information, but lacks key points. Address, but no description of water source.
Three – Contains essential information (address,, and type of water source) and some (two or less) characteristics about the source it self.
Four – Almost all necessary information is contained. Address, and water source type and characteristics. Two or less pieces of less important water source info may be missing for example the number of turns necessary to open the hydrant
Five – All information necessary is filled out. The form answers all questions about the source of water and leaves nothing to speculation.

After each form was rated according to this scale, the average rating was calculated. This allowed us to see if all forms were performing well or not, on average. This calculation will let us know what kind of recommendations we will need to make to Los Bomberos about what to include in and how to design future forms, and how to write the instructions for completing the forms so that the data collector will not neglect important parts of the data collection. This rating system was designed measure form performance by taking into account how completely filled out the forms were. It was not designed to measure the accuracy of the data that was collected because the accuracy of the data does not reflect the performance of the form. Instead it reflects the performance of the data collector.

3.7 Write Instructions for Proper Use of Water Source Form

To ensure there would be no confusion while using the forms we wrote a set of instructions explaining each section of the form as well as a set of instructions describing the methodology to be used with it (See Appendices F, G, & I). We designed these instructions to define the terms used and give a detailed explanation of each option. The instructions were edited by Walter Mora to ensure their completeness, accuracy and grammar. We decided to have Walter Mora edit them as he was both readily available and knew how the instructions needed to be written so that Los Bomberos could easily understand them.

3.8 Use of Data After Collection is Complete

In order to find out how the collected data would be used, we conducted an informal interview with Ana Maria Ortega on June 22, 2001 and reviewed the plans mentioned in the Propuesta Sistemas de Informacion Geografica. This was necessary in order to give a scope on how our project fits in with the entire implementation of the GIS. By examining the proposal, we were able to observe what they had planned on doing as of the beginning of May, when we received the proposal. By interviewing Ana Maria on June 22, we were able to see if further decisions had been made or if changes had occurred over the six-week period.

4.0 Data Results and Analysis

This chapter deals with the data we collected and the analysis of this data.

4.1 Form Requirements

As an outcome of our initial meetings with the staff of the Direccion de Bomberos and by reviewing the Propuesta Sistemas de Información Geográfica we quickly gained a good knowledge of the information that needed to be collected for a GIS to be used with fire response. By visiting the Oficina de Control Operaciones (Office of Operations Control) we learned that the information in SIBO consisted mostly of records of previous fires, personal information about each firefighter, and some additional data regarding hazardous materials. It did not, however, include information more vital to fire response, such as water source location, information about buildings, or data regarding potential hazards. By becoming aware of the setup of SIBO, we found they did not have information vital to fire response that could be used by both the fire stations and O.C.O.

Prior to the initiation of our project the data that Los Bomberos defined as necessary for a GIS was divided into four major categories, according to the proposal produced by the IS department of INS. These categories were infrastructure, water sources, fire stations, and emergency incidents. In order to make the problem easier to handle these categories were broken into smaller, more manageable pieces as specified by INS' proposal.

4.2 Form Design and Revision

By using the list of necessary information included in INS' proposal, we produced a form capable of collecting all of the data. We gained valuable advice regarding how to improve the forms from our interviews. Esteban gave advice, which helped to improve the wording of the form so that Los Bomberos would better understand it. Ana Maria Ortega took the data collector's point of view by contributing feedback that concentrated more on the form's organization. She also seemed to have a greater understanding of how the data entry personnel would want such a form to be organized in order to easily enter the data from paper to a computerized database. Finally, Héctor Cháves León (Jefe of Engineering) reviewed the form and kept in mind the most necessary data useful for Los Bomberos when responding to a fire. He also insisted that each form not exceed one page in length. These three administrators were instrumental in the development of the data collection forms and devoted much time to this part of the project. The suggestions we received from the focus groups with the station chiefs in Estacion Central helped in making the form clear by avoiding misunderstandings in commonly used fire language. For example in the header we changed "zone" to "area" because "zone" could be confusing due its other uses in the fire fighting community. After taking all of these opinions into consideration, we produced a form that maintained all of the important features and satisfied all the reviewers. These revision processes resulted in fully functional data collection forms that are currently being used in the field.

The final version of the form included all the information required by Esteban, Walter and Don Hector and put it in a format approved by Ana Maria. This form of which some excerpts are shown below, represents the combined recommendations of both the station chiefs and the members of the administration of Los Bomberos.

An example of the layout produced by this revision process can be found in the additional access tool section of the Fuentes de Agua (Water Sources) form. There are check boxes for the five different tools Los Bomberos may need to open a hydrant and a space for describing the location of the tool. The choices of hydrant tools were clearly defined so that data collected by each station was uniform; this also helped to reduce confusion when filling out the form.

Figure 2: Example of Form Organization: Fuentes de Agua

Indique aquí si se requieres accesorios adiciónales para extraer el agua:

Llave de hidrante ☐ Llave de cañería ☐

Llave de cubo ☐ Volante de válvula ☐

Válvula Adicional ☐

Disponible en:____

In addition to the complementing data fields, we arranged the forms so that each section followed logically from the last.

For example, at the top of each form is general information that applies to each water source. (See Figure 3)

Figure 3: General Information: Fuentes de Agua

1)Ubicación, dirección   Código de toma de agua ______-______-______

X,Y Coordenadas ____________ , ____________

Dirección por señas ____

This example is taken from the first section of the Fuentes de Agua form where the most basic information is entered. There are spaces for the location and address of the water source, using both X,Y (GPS) coordinates and a description. In addition there is a space for the unique code that is assigned to each water source.

Following this general information, the more specific information was included further down the form in appropriate sections.

Figure 4: Specific information: Fuentes de Agua

3) Hidrantes

Conectado a:

Red publica ☐   Tanque ☐

Características del Tanque:

Superficial ☐ Subterráneo ☐ Aéreo ☐

Volumen (m^3) ____________________

This example is taken from the third section of the Fuentes de Agua Form, Hidrantes. This is where the Bombero would select the type of connection the hydrant used, either a red publica (public line) or a tanque (tank). If the hydrant is attached to a tank, the Bombero would fill out the characteristics of the tank, including volume and physical location (superficial, Subterráneo or Arreó, which means above ground, below ground, or aerial).

4.3 Paper form or Pocket PC

This section deals with the results of our analysis of the performance of the paper form as well as the comparison of the paper form versus the Pocket PC version.

4.3.1 Paper Form

4.3.1.1 Field Testing Paper Form

Due to the extensive review period the forms went through, when they were finally brought into the field, there were very few questions about their use. As a result of conducting on-site fieldwork we were able to observe another person using our form, determine the important steps needed during the data collection process, and determine the performance of the paper forms in the field.

At this time 7 metropolitan districts within the San Jose area were using the paper forms in their field work. While at Pavas, Jarol Hidalgo completed the form with little help from any of the other Bomberos. The other Bomberos did the physical work of opening the hydrants and measuring the pressure and mouth diameter. They would verbally relay the information to Jarol Hidalgo and he would record it on the form. As expected, the forms were termed "easy to use" by those who have been using it (Jarol Hidalgo of Pavas, Henry Morales Alvarado at Tibas, Jorge Murillo Araya in Estacion Central and Walter Sanchun Arnaez at Barrio Luján). Jarol Hidalgo had a few questions about the presence of a space for dynamic pressure and the flow rate. We answered his questions by explaining to him their importance in the form even though they would not always be filled out in the field. They were able to fill out the form in less time than it took to test the hydrant (Approximately 5 minutes). This means that the only limitation on the speed of the data collection was the time it took to test each hydrant and locate the next one. On June 4th, while we shadowed the Pavas collection team, they completed about thirty forms within about five hours. In addition the forms were inexpensive to reproduce, as several thousand of these forms were distributed.

4.3.1.2 Paper Form Feedback from Elite Interviews

When asked if there were problems with the paper form data collection process, Henry Morales Alvarado (Tibás) stated that the dynamic pressure was not relevant to their collection, since when connected to the same pipelines the static pressure is the only thing they need to determine flow rate. He did not fill out flow rate on their forms either, because he said that they could calculate it later at the station. Henry Morales Alvarado also stressed that the form was simple to understand and easy to complete. He liked that it was very detailed and explicit. Jorge Murillo Araya (Central) was in agreement that the form was simple, but complained that they could not record the pressure and flow rate because they are located in downtown San Jose and it is difficult to bring the fire truck with them to collect data. He stated that they would collect this information later, over the weekends or at night. The other comment he made was that the volume of tanks would not always be accurate, since some are filled with rain water, or used regularly, and the volume of water inside varies. Jorge Murillo

Araya also stated that the explicitness of the form was necessary for optimal fire response. Walter Sanchun Arnaez (Barrio Luján) expressed that they prefer the volume to be in gallons rather than cubic meters. He found the flow rate easy to find with the use of the fire truck.

4.3.2 Pocket PC

This section refers to the use of the Pocket PC in the data collection procedure, including the feedback we received from fire chiefs and our analysis of their responses.

4.3.2.1 Transferring Form to Pocket PC

The Pocket PC version of the form was designed so that it could be easily transferred to a Microsoft Access database. The decision to use a Microsoft Access format was based on the suggestions of Jose Conejo, the designer of the SIBO database, which were obtained during an informal interview with him. By using the advice of someone well versed in the use of databases, our electronic form was greatly improved. We used his advice to create a form, which when completed could be easily transferred from the Pocket Excel file format to a Microsoft Access database. The Pocket PC solved the problem of entering the data from the paper forms into computer database. The Microsoft Excel file could be transferred from the Pocket PC to Microsoft Access and put directly into a database without the need to re-enter the data, this eliminated the chance for error while transferring the information on the paper form to a computer database.

4.3.2.2 Feedback on Pocket PC

While visiting each station, we showed the chiefs the alternative data collection method of using the Pocket PC. We instructed them on how to open the programs icon in order to select Microsoft Pocket Excel, and then showed them how to select the necessary file. We then explained the differences in the format of the form, such as using an 'X' to fill in a box, instead of the check boxes in the paper forms. Based on the opinions of the fire chiefs who were interviewed (Henry Morales Alvarado at Tibas, Jorge Murillo Araya in Estacion Central and Walter Sanchun Arnaez at Barrio Luján) they found the Pocket PC to be a very attractive alternative to the paper form. Both Jorge Murillo Araya (Central Station) and Walter Sanchun Arneaz (Barrio Luján) felt that the Pocket PC would be practical and faster. Henry Morales Alvarado (Tibas) was a bit more hesitant toward the high-tech apparatus and stated that he thought it was complicated. He did agree though, that it would be a worthwhile investment for future data collection. If use of the Pocket PC can be justified by its superiority over the paper form, then El Cuerpo de Bomberos' purchase will be justified as well.

4.3.3 Analysis: Paper Form or Pocket PC

By completing interviews with three of the fire chiefs of the seven districts in San Jose and the three in Guanacaste, we recognized several patterns in their responses to questions regarding their preference of data collection methods. First, each fire chief interviewed stated that they found the paper form very easy to fill out and since they had already begun data collection for water sources in this manner, they preferred to continue this method. They did, however, feel that using the Pocket PC in future data collection would make the overall data collection process more efficient and rapid. Their profound interest in having this alternative data collection method provided a rationale for the purchase of this equipment for each fire station.

4.4 GPS or Pin/Map System

This section deals with the comparison of using the GPS or the Pin and Map system to locate the water sources.

4.4.1 GPS

While the GPS was easy to use, Los Bomberos simply had to push the button to determine their location; it ran into problems early on in its use. When Los Bomberos checked the location of the test, the location produced by the GPS was 300 m Southeast from the location of the point on the maps they had used. They repeated the procedure to verify the results and again it produced a location 300m to the Southeast of the real point. These tests were performed in Central San Jose. Due to this problem, Los Bomberos have stopped using the GPS until it can be calibrated to accurately reflect its actual position. Therefore the fire chiefs that were interviewed had little or no experience using the GPS in the water source data collection. Fortunately, as found from the interviews, they were all familiar with the equipment's capabilities and how to record the GPS readings.

4.4.2 Pin/Map System

Like the GPS system the Pin and Map system was also easy to use for Los Bomberos. They simply read the location off the form and placed a pin at that point. But like the GPS this process also ran into some problems. The biggest problem was associating the pins on the maps with the corresponding data form. It was difficult for them to mark the pin, as there was very little space on the pin to give each water source its code. In addition, Los Bomberos were concerned with the difficulties of transferring this data on the maps into their GIS database when the time came. However, based on its ease of use Los Bomberos have worked around this problem. They are using "flags" to label each of the pins with the code, which will allow them to match the pin with the data sheet. This system was more accurate then the GPS as Los Bomberos were familiar with the area they were working in, and their locating of the hydrants reflected this experience.

4.4.3 Analysis: GPS or Pin/Map System

When the fire chiefs were asked whether they found the GPS or the pin method to be better in collecting water source location data, they all agreed that both were important. Henry Morales Alvarado(Tibas) explained that the GPS readings are currently not important when responding to emergencies, since the existing address system uses major landmarks to describe location. Therefore the pin system worked better for initial data collection because they could physically see where the water sources were, rather than having to read X and Y coordinates to find them on the map. According to Walter Sanchun Arneaz (Barrio Luján) the location shown by the pins is easier to communicate during fire response than GPS coordinates. We found that they tend to prefer the pin method partially due to their familiarity with this type of address system, but it was encouraging that they all recognized the importance of collecting the X and Y coordinates with the GPS for use in the GIS database.

4.5 The Instructions

The review period that the instructions underwent was based on the feed back from Jarol Hidalgo and Walter Mora. Jarol Hidalgo had said that the form was easy to use, this let us know that our instructions did not have to be an in-depth document explaining the form, but rather a brief explanation just to clear up any questions about the form use. After we had submitted the instructions to Walter Mora for review and he had given it back we made the suggested changes and resubmitted it as the final version of the instructions. Below is an example of how the instructions were formatted. This example consists of the explanation of how to assign the code for each individual water source.

Figure 6: Example of Instructions

Código de toma de Agua:

En este espacio se asignara a cada fuente un código único.

Ejemplo: 1-5-3-2

Este es el código único para un hidrante en el tercer área del distrito de Pavas

Los primero dos números, 1-5, designan la estación. (Pavas)

El tercer numero, 3, designa el área.

El cuarto numero, 2, designa la fuente específica

4.6 Data Quality

This section deals with the results and analysis of the quality of data that was collected.

4.6.1 Form Scores

At this point we have reviewed forty forms, ten from each of the following stations: Tibas, Estacion Central, Barrio Mexico and Barrio Luján (Appendix L for Examples of completed forms). Based on these forms we were able analyze the data supplied by these forms. Using the 5 point rating system described in the methodology we assigned each form a rating, these ratings were then combined and averaged to give a station average. The Tibas station scored a 4.7 based on the completeness of the forms. Estacion Central scored a 3, B° Luján received a 4 and B° Mexico received a 3 based on the same criteria.

4.6.2 Analysis of Form Scores

The Tibas station forms received eight 5's a 4 and a 3. This means 8 of the 10 forms we reviewed were fully completed. One form about a tank was missing the volume, since this is an important fact about a tank, it scored a 3. It is still usable as it gives the location and the method of access, but we felt that volume was important enough to warrant a 3. The 4 was given to a hydrant where the "numero de vueltas" section was left out, it was felt that this was not as important as other data, such as mouth size and therefore we only took off one point for its omission. It is still a perfectly usable form, all the truly vital information is included, but it is not fully complete.

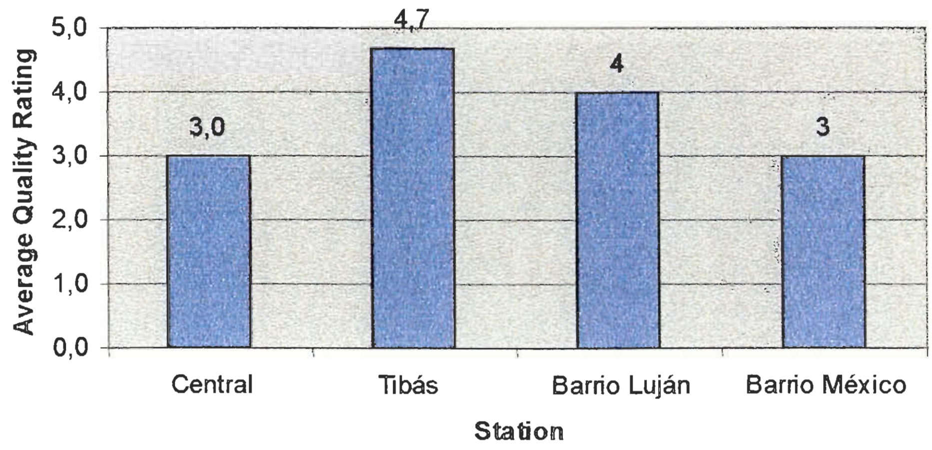
Estacion Central received straight 3's for their forms. It is important to note that this score was given due to a single common omission, the pressure of the water in the hydrant. This was neither caused by a defect in the form nor a error in the data collection process used by Los Bomberos of Estacion Central. Since Estacion Central is located in the heart of San Jose there is a large volume of traffic during the day which makes it both impractical and unsafe to bring the fire trucks to each hydrant to test it. Rather a small team goes out in one of the Bomberos' pickups and takes the location and other visible information about the hydrant. The Bomberos from Estacion Central will be returning to the hydrants during times when traffic is less (weekends and in the late evening) to hook up the hydrants to obtain the flow rate data.

B° Mexico received straight 3's for the same reason as Estacion Central. Their forms were fully completed except for the information about the flow rate and pressure. B° Mexico had already assigned their codes, and included a final number (2001) that designated the year in which the data was collected. Like Central, B° Mexico will be returning to the field to collect the flow and pressure data at a time when it is possible to take the fire trucks into the field.

B° Luján received straight 4's for their forms. They correctly filled out the header and the information about the water source, including the information about the flow rate and pressure. The only section they did not fill out was the "Codigo de toma de agua" section, the area where the unique code is assigned to each water source. This was because they were collecting all the water source data before they began to assign the codes.

With Tibas scoring a 4.7, B° Luján a 4 and Central and B° Mexico 3 (which when they obtain flow rates would be adjusted to ~5) it would appear that the quality of data being collected is both consistent, the same areas are being filled out by both stations, and of a high quality. See figure 7 on the next page for a comparison of the quality of data collected by the stations.

Figure 7: Data Quality



4.6.3 Data Longevity

Based on our interviews with the station chiefs we learned that the longevity of the data is also an important factor. As Walter Sanchun Arnaez (Barrio Luján) said, the information that they collect changes very fast. When people fix streets or repair buildings they often build around existing hydrants or even close valves that were suppose to be open. Data on hydrants is often obsolete after 3 to 6 months. This opinion was repeated by Jorge Murillo Araya (Central) who said that things such as building use and occupants change so fast that its hard to be sure if the data collected is right when they go to use it. He gave 3 years as the maximum time for which data could be considered reliable. Due to the fact that this opinion was repeated by high-ranking officials we determined that it was an important factor to consider when finalize the data collection procedure.

4.7 Los Bomberos' Current Data Collection Method vs GIS Collection Method

This section includes the comparison of the data collection methods that have been used in each district of San Jose with the methods that have been used in the collection of the data for the GIS. This is also based on the interviews conducted with station chiefs in four San Jose area stations (Estacion Central, Barrio Luján , Barrio Mexico and Pavas) on June 14. A detailed account of Los Bomberos' existing data collection procedure (Informacion Sobre Riesgo Peligroso form) is included in Section 2.1.1 of the Literature Review. The data collection method designed to aid in the implementation of the GIS has been split into separate forms (water sources, infrastructure, incidents, and stations) to account for the different layers that have to be included in the database. Meanwhile the Informacion Sobre Riesgo Peligroso form that have been used in the past by Los Bomberos was designed primarily for emergency response to areas that were thought to be high-risk for fire-related emergencies.

Organization & Design: The ISRP form included an area for the collector's name and the date the form was completed. The new forms contain a header for the collector's name, position within El Cuerpo de Bomberos, station, and area of district where data collection is taking place. The organization of the new forms is easier to follow because general information is separated from more specific data by using labels and boxes. The ISRP form was designed to collect information about potentially hazardous situations. This was principally comprised of infrastructure information, and included little water source information. The space that was provided for water sources was narrowed directly to hydrants. The new forms divide this information between the water source form and infrastructure form. By collecting this information separately each set of data can be entered into the GIS database to be used in its own layer, independent of one another. These sets of data can also be integrated in order to view several layers of information at once, allowing for a valuable feature of GIS to be utilized. The ISRP form accounted for the lack of a GIS by leaving space on the form for small maps to be drawn, illustrating both the building plans and the area surrounding the building. Physically drawing these maps will be unnecessary when the GIS is implemented and maps are available on the laptops within the fire trucks. Finally, the ISRP form had no way of labeling the water sources in order to easily find them on a map later. By giving each water source and building a code with the new data collection method, finding this data within the database is a much easier task.

Sharing data: Since the previous data collection method was restricted to each district, information was not shared between districts or O.C.O. This method also concentrated only on the hazardous risks that were obvious at the time; therefore Los Bomberos were lacking data about the remainder of the district. The method specifically designed for the GIS takes all of the water sources and significant infrastructure information into account. This information can be easily shared between districts and with O.C.O. once entered into the GIS database. A summary of this information is shown below in Table 5.

Table 5: Data Collection Procedure Comparison

Los Bomberos Previous Method	GIS Data Collection Procedure
Organization:	
Data collector's name and date	Data collector's name, position, station, and area code
General Info. combined with specific data	General Info. separate from specific data
Design:	
Mostly infrastructure info.	Water source & Infrastructure data separate
Little water source data	Better design for GIS database
Map directly on sheet	Layers can be accessed individually or together
Sharing data:	
Info. not shared between districts/stations	Info. to be shared with all stations and O.C.O.
Code:	
No codes given to buildings or water sources	Codes given to each water sources and buildings for easy reference
Data Coverage:	
Information includes data about potential hazardous risks	Information about water sources and buildings throughout district

4.7.1 Data Collection Method used by Pavas The Pavas fire fighters used an eight-man data collection team on one of their three fire engines to collect this data. This team consisted of a broad cross-section of the Los Bomberos found in the station; from the station chief to a twenty-one year old rookie. Included in this team was a driver, a supervisor, three fire fighters who connected the hoses and opened the hydrants, one who filled out the forms, and one who read the map and another who was taking notes in the cab. When they arrived at a hydrant the two firefighters on the back got off and opened the hydrant and let the water flow. By the time the truck had stopped the hydrant was closed and ready for the hose to be attached. At this point two Bomberos from the cab got out and helped attach the hose and read the gauges. Jarol Hidalgo, who rode with us, wrote down the information about the hydrant when we arrived and recorded the pressure readings as they were taken. The remaining three Bomberos either stayed in the truck or observed the procedure. During this time several of the Bomberos took their own notes for personal reference.

They had decided to collect all the hydrant information and then return to the station to locate them on the map and assign them codes according to the pre-determined method. This method was chosen so that each water source has a unique four-digit code that describes its location.

This system allowed many of Los Bomberos to participate in the collection of the data on water sources. While the collection could have been performed with fewer men, often as many as three or four of Los Bomberos were simply observing the process. The fact that all eight were present allowed all of them to observe the data being collected.

4.8 Cañas, Liberia and Nicoya

Based on our observations of the rural Bomberos stations we were able to compare their specific requirements and methods with those of the San Jose area Bomberos. One of the major differences between the two regions is their involvement with O.C.O. While the San Jose area stations receive basic emergency information from O.C.O., the rural stations do not receive any information from O.C.O. They receive the emergency calls directly from the caller and must use all their own information while responding to fires or other emergencies.

Los Bomberos from the Guanacaste Province expressed similar opinions about the performance of the paper form as their counterparts in San Jose. Javier Nolasco Guevara Gomez of Nicoya, Ronny Alvarado of Cañas and Tomas Morales of Liberia said the paper forms were both easy to use and understand. In addition Javier Nolasco Guevara Gomez said that the forms were complete.

Once again, the feedback from Los Bomberos in Nicoya, Liberia and Cañas was along the same lines as that of the San Jose area Bomberos. While they appreciated the ease of use of the paper form, they felt that in the end the Pocket PC would be the better data collection method. They recognized that the ease of transferring the data straight to the computer was a major benefit when it came to saving time and ensuring data quality.

From our interviews with the Bomberos in the Guanacaste Province, we learned that the longevity of the data is different in the rural areas then it is in the San Jose area. In general, the data is valid for a longer time in the rural areas due to the relatively low number of emergencies. The water source information, for example, would only change if another hydrant was added.

5.0 Conclusions and Recommendations

This chapter contains the conclusions we have come to and the recommendations we have made based on our project work.

5.1 Performance of the Form

Due to the high quality of the data collected we concluded that performance of the form was satisfactory. In addition, the reported ease of use allowed us to determine that the form reached both the goal of collecting accurate data as well as avoiding tedious work for Los Bomberos.

Based on our analysis of the forms, they were both complete and easy to use. The forms were serving their intended purpose of collecting the necessary data in a logical and easy to follow manner. The few corrections that could be made were not significant enough to warrant redistributing the forms because the amount of time the Bomberos have to collect the water data is short and seven districts of San Jose had already began the process of data collection.

5.2 Paper Form or Pocket PC

Based on Los Bomberos' current state of data collection, we concluded that it would be best for the stations that are currently collecting water source data to continue this process with the paper forms that are already in use. This conclusion was reached due to the fact that the stations currently collecting data on water sources are nearing the end of that collection phase. It would be a waste of time and energy to stop these stations and make them wait for the Pocket PC's.

We have also concluded that the Pocket PC's would be a worthwhile investment. The time saved in data entry and the ability to transfer the data files directly into a Microsoft Access database warrant the additional initial expense. Also, transferring the data straight to the database will reduce the possibility of data being misinterpreted during the data entry process. This will yield a more accurate database, which is the goal of Los Bomberos.

Based on the conclusions above, we have made several recommendations regarding the use of the paper form and the Pocket PCs:

1) The stations that are currently using the paper forms to collect data should continue using them.
2) Proceed with the data collection using paper forms in stations that are not yet collecting.
3) Purchase Pocket PCs (or their equivalent) as soon as possible for future data collection.
4) Once Pocket PCs (or their equivalent) are purchased, switch data collection method from paper forms to electronic collection.
5) Provide training in the use of the Pocket PC (or equivalent) so that the data collectors will fully understand how they work.
6) Stations should complete data collection using only one method for each data information layer. If a station has already started collecting the data using the paper form they should finish collecting with the paper form.
7) If possible (and since they haven't started collection yet), begin water source data collection using the Pocket PC in the rural areas, so that

they do not have to switch over from paper to electronic files in the middle of their data collection.

5.2.1 Purchasing Pocket PC

Based on our review of the Compaq iPAQ Pocket PC we have determined that this handheld device will meet the needs of Los Bomberos. Its price $500 as of last June places in on the lower end of the price scale for comparable devices. We recommend purchasing a Pocket PC (or equivalent) with a high processor speed (206 MHZ), and a high memory capacity (32+ MB of RAM). It should have a high contrast in the display screen so it can be easily viewed while working in the field. In addition it will need the capability to transfer files to a computer, either through USB or Infrared. Also, it should have a high battery life (8+ hours) so that it will not need to be recharged while it is being used in the field. Finally and most importantly it will need to have the capability to run Microsoft Excel, the program that runs the data collection form. As the Pocket PC we tested meets all of these requirements it would be an acceptable device to use to collect the necessary data.

5.3 GPS or Pin and Map System

This section contains our conclusions and results based on the analysis of the GPS and the Pin/ Map system. These conclusions and recommendations are based on the current state of affairs in the data collection process.

At this point can conclude that at this point both methods of locating the water sources are necessary. The GPS system of marking points is not precise enough to be used by Los Bomberos at this point. Therefore,, the pin system needs to be used so that Los Bomberos can visually locate the water sources until the GIS is in place. The pin system does not lend itself to easy translation into a GIS system and also causes inaccuracy when the pins fall out of the maps. Therefore, the GPS system should be used so the data can be easily transferred into the GIS. We conclude that by combining both of these collection methods Los Bomberos will have the information in a form they can presently understand as well as in a form that will be easily entered into the GIS. Once the GIS is fully operational there will be no need for the pin system as the GIS has the capability of displaying digital maps which would be as clear as the pin/ map system and easier to maintain.

From these conclusions we were able to make recommendations as to the use of the GPS and the Pin/ Map system:

8) Continue using the pin system to graphically locate the hydrants.
9) Calibrate the GPS so that it accurately reflects the actual point.
10) Use the GPS in conjuncture with the Pin system to locate the water source, until a digital map can be produced by the GIS.

5.4 Data Quality

From our analysis of the completed forms we were able to draw several conclusions about the quality of the data being collected.

The first conclusion was that the data being collected was for the most part uniform in completeness. Through reviews of the completed forms we concluded that there were some sections of the forms that were being consistently not filled out. However, were able to conclude that the absence of this data did not affect the quality of the data being collected. We determined that the blanks were either not very important to data collection (Header information) or information that could be better calculated in the station (flow). However due to the fact that Los Bomberos will still need to complete these sections later, we concluded that these areas should not be removed from the form. If these areas were removed from the form it would increase the chances that the data would be omitted during data entry.

In addition to uniformity, we concluded that the data collected by this form met the standard of quality Los Bomberos need for their GIS. We verified this from our observations of the fieldwork; interviews with the station chiefs, and reviewing completed forms. Through our observations of the fieldwork in Pavas, we concluded that Los Bomberos collecting the data both knew how to obtain the necessary data with out any additional training, and were intuitively able to record this information on the form correctly. In addition, by reviewing the completed forms we were able conclude that the important sections were being completed consistently. From our observations at each station, we concluded that the quality of data is ensured to be high because even though there is room for human error, the firefighters are dependant on this information to respond to emergencies where lives are at risk. In rural areas this is even more critical since Los

Bomberos in these areas receive no information from O.C.O. Therefore they are totally reliant on the data they collect which will motivate them to be more careful while collecting the data.

Because of the constantly changing nature of the data in metropolitan areas, we concluded that there would need to be periodic reviews of the collected data to ensure it was up-to-date and correct.

From our conclusions we have made several recommendations regarding the quality of the data being collected:

11) A brief initial training should be conducted for collection persons so that all of their questions are answered prior to data collection. The instructions for use of the forms, found in Appendix E can be used as a guide for this training and can be left with the data collectors for reference.

12) This training could be best administered by the designers of the forms, data collection administrators, or in the case of data on the water sources, by data collectors from stations that have already completed the data collection.

13) Stress the importance of completing information about the data collector on each form so the data collection person can be contacted if necessary.

14) Make sure data that cannot be collected in the field (flow) is calculated in the station and entered into the appropriate space on the form as

soon as possible. Be sure to specifically note on the form that this data needs to be collected at a later date.

15) After data collection has been completed in each area, the station chief should review the completed forms to ensure that all necessary data was included and Los Bomberos should return to the field and check 10% of the collected data to ensure accuracy.

16) To ensure the data is correct after the initial collection, a rotating schedule of recollecting the data should be set up so that every station has new up-to-date data on a regular basis, at least once every 3 years. Less frequent updates on data collection will be needed in the rural areas since data changes less often.

17) Data collected should be labeled with the date of collection; this will ensure Los Bomberos are aware of the age of the data.

18) If there is an emergency incident and data from the GIS is used to respond, this data should be checked after its use. For example if a hydrant is used, the flow and pressure should be measured and compared to the data in the GIS.

19) At each station, start entering data into Excel database within 2 weeks of finishing data collection in order to avoid misplacement of data. Complete all data entry of one data layer (such as water sources, or information about buildings) before starting data entry on the next layer to ensure all data is entered.

20) In agreement with the deadlines which have already been set, we recommend that data collection be completed by November 2001 so that transfer of data can be started once the hardware and software for the GIS are acquired.

21) Give a short briefing to newly hired staff working with the GIS regarding how the data collection procedure was designed and completed.

22) The consultants, who will coordinate GIS information between O.C.O. and the Dirección de Bomberos, should be permanent employees of INS in order to allow for smooth collaboration between the two organizations.

6.0 Conclusiones y Recomendaciones

Este capítulo contiene las conclusiones que nosotros hemos obtenido así como las recomendaciones que nosotros proponemos basados en nuestro trabajo.

6.1 Uso de la Formulario

Dada la alta calidad de los datos que se han recolectado con el uso de la formulario nosotros concluimos que esta cumple la función fundamental para la cual fue diseñada. Además los usuarios de la misma han reportado que es muy fácil utilizarla y que por lo tanto no solo permite obtener la información necesaria sino que además simplifica enormemente el trabajo de recolección para Los Bomberos.

Aunque se han reportado algunas pequeñas dificultades con su uso estas no parecen ser lo suficientemente importantes como para cambiar el diseño actual de la formulario. Tampoco se hace necesario recolectar nuevamente la información que ya ha sido obtenida con respecto a los datos de fuentes de agua en los siete distritos de San José en los cuales se ha comenzado este proceso de recolección de los datos.

6.2 Formulario Impresa o Formulario Electrónica

Ya que actualmente Los Bomberos' han iniciado le recolección de los datos de fuentes de agua a través del uso de la formulario impresa nosotros concluimos que es mejor continuar su uso en el caso de las estaciones en las cuales este proceso aun sé esta llevando a cabo. En vez de adoptar el uso de la formulario electrónica ya que al momento no se cuenta con el equipo PC de bolsillo. Esta conclusión se sacó debido al hecho de que en estas estaciones el proceso de recolección de información se encuentra casi al final.. Sería una pérdida de tiempo y energía detener este proceso hacerlos espera por el PC De bolsillo.

Nosotros también hemos concluido que el PC De bolsillo es una inversión que vale la pena. El tiempo que se ahorra en el traspaso de los datos recabados en formulario manual al la computadora así como la eliminación de errores potenciales durante este proceso parece justificar el costo de su adquisición. En este caso se hace una transferencia directa de los datos en formulario electrónica del PC de bolsillo a la base de datos creada con el programa de software Microsoft Acces Esto además de rendir un proceso más eficiente hace que la información almacenada en la base de datos sea más confiable. En base a lo anteriormente expuesto nosotros hemos hecho varias recomendaciones con respecto al uso de la formulario impresa y la formulario electrónica

1) Las estaciones que están actualmente usan la formulario impresa para coleccionar los datos de tomas de agua debe continuar usándola
2) Proceder con el uso de la formulario impresa en estaciones que aun no han empezado la recolección de tomas de agua.
3) Hacer la compra PCs de bolsillo (o su equivalente) lo más pronto posible para iniciar el uso de la formulario electrónica en la futura colección de los datos.
4) Una vez que el PCs de bolsillo (o su equivalente) se haya comprado implementar el uso de la formulario electrónica.

5) Proporcione el entrenamiento en el uso del PC de bolsillo (o equivalente) al personal que recabara los datos para que estos hagan un uso efectivo de la formulario electrónica.

6) Las estaciones deben completar colección de los datos u para cada capa de información ya sea con la formulario impresa o con la formulario electrónica pero nunca con una mezcla de los dos formularios Si una estación ha empezado ya coleccionando los datos usando la formulario impresa ellos deben terminar coleccionando datos con la misma.

7) Si es posible (y siempre y cuándo que ellos no hayan empezado la colección todavía), empezar a recabar la información relacionada con tomas de agua usando la formulario electrónica en las áreas rurales, para que ellos no tengan que cambiar de la formulario impresa a la formulario electrónica en medio del proceso de colección de los datos.

6.2.1 Compra PC De Bolsillo

Basados en nuestra revisión del iPAQ de Compaq PC De bolsillo nosotros hemos determinado que este dispositivo portátil satisfacer las necesidades de Los Bomberos. Su precio, a finales del mes de Junio de 2001 era de $500 Esto la hace una de las mas económicas en el mercado cuando se compara con el precio de otros dispositivos similares.

Nosotros recomendamos comprar un PC De bolsillo (o equivalente) con una velocidad del procesador alta (206 MHZ), y una capacidad de memoria alta (32+ MB de RAM). La pantalla del despliegue debe tener un alto contraste en para que pueda verse fácilmente mientras se trabaja en el campo. Además necesitará la capacidad para transferir los archivos a una computadora, ya sea a través de USB o rayos Infrarrojo. También, debe tener una vida de la batería alta (8+ horas) para que no necesítese recargado mientras está usándose en el campo. Finalmente, es muy importante que tenga ni la capacidad para operar Microsoft Excel, el programa que ha sido usado como base de la formulario electrónica para la colección de datos. El modelo de PC de bolsillo con el que hemos experimentado reúne todos estos requisitos. Es por eso que sería un dispositivo aceptable para usar en este proceso

6.3 GPS o Sistema de Mapas con Alfileres.

Esta sección contiene nuestras conclusiones y resultados basados en el análisis de GPS o Sistema de Mapas con alfileres. Estas conclusiones y recomendaciones son basadas en el estado actual de asuntos en el proceso de colección de datos.

A estas alturas se pueda concluir que ambos métodos de localizar las fuentes de agua en formulario grafica son necesarios. En este momento el sistema de GPS para localizar la posición exacta de las tomas de agua no es lo suficientemente preciso para ser usado en formulario confiable por Los Bomberos. Por consiguiente, el sistema de los mapas con alfiler necesita ser usado para que Los Bomberos puedan localizar las fuentes de agua visualmente hasta que el GPS esté sea calibrado.. El sistema del alfiler no se presta fácilmente a ser usado por el sistema GIS pues no es muy preciso y en casos los alfileres se desprenden de los mapas. Por consiguiente, el sistema de GPS debe usarse para que los datos puedan transferirse fácilmente al GIS. Nosotros concluimos que combinando los dos métodos Los Bomberos tendrán la información en una formulario ellos pueden entender presentemente así como en una formulario en que se entrará fácilmente en el GIS. Una vez los GPS sean totalmente operacionales no habrá necesidad de usar el sistema del alfiler ya que l GIS tiene la capacidad de desplegar mapas digitales que estarían tan claros como los mapas con alfiler y el sistema del GIS es más fácil de mantener.

De estas conclusiones nosotros podemos hacer las recomendaciones acerca del uso del GPS y el sistema de mapas con alfiler

8) Continuar usando el sistema del alfiler para localizar las bocas de agua gráficamente.
9) Calibrar el GPS para que refleje el punto real con precisión.
10) Usar el GPS en formulario conjunta con el sistema del Alfiler para localizar las fuentes de agua, hasta que un mapa digital pueda producirse por los GIS

6.4 Calidad de los Datos

De nuestro análisis de las formularios completadas nosotros pudimos derivar varias conclusiones sobre la calidad de los datos que se han reunido.

La primera conclusión es que la información que se ha reunido esta bastante completa. A través de las revisiones de las formularios completadas nosotros concluimos que en algunas secciones de las formularios no han llenado de formulario consistente. Sin embargo, se pudo concluir que la ausencia de estos datos no afectó la calidad de la información que se ha reunido. Nosotros determinamos que los espacios dejados en blanco no eran muy importantes (la información acerca del Título) o que la información faltante se podría calcularse en la estación (el flujo. Sin embargo debido al hecho que Los Bomberos todavía necesitarán completar estas secciones después, nosotros concluimos que estas áreas no deben quitarse de la formulario. Si estas áreas se eliminaran de la formulario se aumentaría las posibilidad que los datos se omitirían durante la entrada de los datos.

Además de que la información se ha completado en alto grado, nosotros concluimos que los datos recabados a través de esta formulario satisfacen la norma de calidad que Los Bomberos necesitan para su sistema GIS. Nosotros verificamos esto con nuestras observaciones del campo; con entrevistas con los jefes de la estación, y revisando las formularios ya completadas. A través de nuestras observaciones del campo en Pavas, nosotros concluimos que el personal de Bomberos que colecciono los datos no solo supo obtener los datos necesarios sin necesidad de entrenamiento adicional, si no que también pudo intuitivamente grabar esta información correctamente sobre la formulario. Además, después de revisar las formularios completadas nosotros podemos concluir que las secciones importantes han sido completadas de formulario consistente. De nuestras observaciones en cada estación, nosotros concluimos que se asegura la alta calidad de datos porque aunque a pesar de que siempre existe lugar para el error humano, los bomberos dependen directamente de la precisión de esta información para responder a emergencias dónde las vidas están en riesgo. En las áreas rurales esto es aun más crítico pues Los Bomberos en estas áreas no recábenla información de O.C.O. Por consiguiente ellos confían totalmente en los datos que ellos directamente coleccionan y esto los motiva a tener más cuidado mientras recogen los datos.

Debido a la naturaleza constantemente cambiante de los datos en las áreas metropolitanas, nosotros concluimos que allí se necesitaran hacer revisiones periódicas de los datos reunido para asegurarse que la información se tenga actualizada.

De nuestras conclusiones nosotros hemos hecho varias recomendaciones con respecto a la calidad de los datos que se han reunido:

11) Hace entrenamientos iniciales breves para el personal que a colección la información para que todas sus preguntas se contesten antes de iniciar a la colección de los datos. Las instrucciones para el uso de las formularios, que se encuentran en el Apéndice E pueden usarse como una guía para este entrenamiento y puede dejarse por los coleccionistas de los datos como la referencia.

12) Este entrenamiento podría ser llevado a cabo por los diseñadores de las formularios, administradores de colección de datos, o en el caso de datos en las fuentes de agua, por los coleccionistas de los datos de estaciones que ya han completado la colección de los datos.

13) Enfatizar la importancia de completar la información persona; sobre el coleccionista de los datos en cada formulario para que esta persona puede consultarse si necesario.

14) Asegurarse que los datos que no pueden coleccionarse en el campo (el flujo) sean calculados en la estación y llenar la formulario con esta información lo más pronto posible en el espacio apropiado. Asegurarse específicamente en la formulario que estos datos necesita ser coleccionado a una fecha más tardía.

15) Después de que la colección de los datos se ha completado en cada área, el jefe de la estación debe repasar las formularios completadas para asegurar que todos los datos necesarios están incluidos y Los Bomberos deben volver al campo y debe verificar 10% de los datos reunido para asegurar la exactitud.

16) Para asegurar que la información se actualice periódicamente después de la colección inicial, se deberá crear un itinerario para recoger la información en formulario periódica por lo menos una vez cada 3 años. Se necesitarán actualizaciones menos frecuentes en la colección de los datos en las áreas rurales ya que los cambios de los datos no ocurren muy a menudo.

17) Deben etiquetarse datos coleccionados con la fecha de colección; esto asegurará que Los Bomberos estén conscientes de la edad de los datos.

18) En el caso de una emergencia en la que los datos proporcionados por el GIS se usaran para responder, estos datos deben verificarse después de su uso. Por ejemplo si una boca de agua se usa, deben medirse el flujo y presión y deben compararse a los datos del GIS.

19) En cada estación, se deberá iniciar el proceso de entrada de datos a la computadora no mas tarde de 2 semanas después de terminada la colección

de los datos en campo para evitar la perdida de los mismos Complete toda la entrada de los datos de una capa de los datos (como las fuentes de agua, o información sobre los edificios) antes de empezar la entrada de los datos en la próxima capa para asegurar que todos los datos de la capa respectiva se hayan completos.

20) De acuerdo con las fechas limite que ya han sido fijadas, nosotros recomendamos que la colección de los datos se complete en el mes de Noviembre del ano 2001 para que la transferencia electrónica al GIS se inicie tan pronto como ---como el equipo y los programas de aplicación del GIS sean adquiridos.

21) Dar una sesión de información corta a personal recientemente contratado que trabaja con el GIS en lo que refiere al diseño del procedimiento de colección de datos.

22) Los consultores que coordinarán la información del GIS entre O.C.O. y el Dirección de Bomberos, deben ser empleados permanentes de INS para que se facilite a colaboración entre los dos organizaciones.

Appendix A

Agency Information-INS and Los Bomberos

In 1924 the Instituto Nacional de Seguros (INS) was created by Minister of the House Tomas Soley Guell, under President Ricardo Jimenez Oreamuno. This office set out to establish basic guidelines for the handling of accidents on the job, in the street, or at home. Today, INS contains eleven agencies, three offices, and twenty-one dispatch locations all across Costa Rica.

The Mission of INS is to provide a strong infrastructure for ensuring the security, socially and financially, of the community (INS Mission Statement, 2001). INS seeks to achieve this through continued modernization of its various divisions, which will result in an increased ability to provide for the public (Plan Estrategico Nacional, 2001). This modernization will improve the administrative, technical, and human aspects of INS's operation, thus making security services more easily and rapidly available for the Costa Rican population (INS Historia, 2001).

El Cuerpo de Bomberos de Costa Rica, the national fire department of Costa Rica, has been a division of the INS since 1925 (INS Historia, 2001). Before El Cuerpo de Bomberos came into existence, the country was extremely vulnerable to the dangers caused by fires. After numerous fire-related tragedies, the executive branch of the government approved the purchase of a fire pump from the United States on July 27, 1865, thus allowing the creation of the first fire department in San José. As fire-related problems grew in the early 1900´s, so did El Cuerpo de Bomberos. In 1914, the chiefs and fourteen firefighters resigned after receiving negative criticism from governmental officials. By 1917, the number of fire fighters dwindled to the point where El Cuerpo de Bomberos was forced to merge with the police department. Without a strong fire department, problems with arson grew.

Beginning in 1921, dishonest merchants who had financial problems began to burn their property in order to collect insurance money. The government, realizing this was a serious problem, passed the Law of Insurance on October 2, 1922 (INS Historia, 2001). . This law was intended to end the insurance fraud and devote money towards the purchase of new fire fighting equipment. Once again, the fire department was able to grow and expand. More equipment was purchased, more staff was hired, and fire trucks were acquired. In May of 1925, El Cuerpo de Bomberos became part of INS by national decree, for the protection of the people and their property from fires.

The goal of Los Bomberos is to continually improve its response abilities. This will allow them to meet the needs of the Costa Rican people as well as to meet the goals stated in the Plan Estrategico of INS.

The plan states that by 2005, the community will encounter a fire department:

- That is able to evaluate, prevent and mitigate the effects of disasters
- With personal of high quality, who have motivation and pride in their organization.
- With an image of serving and protecting the Costa Rican public.

Appendix A

- With technological advances in accordance with the time and the needs of the communities.
- That is comprised of the best fire fighters in Latin America.

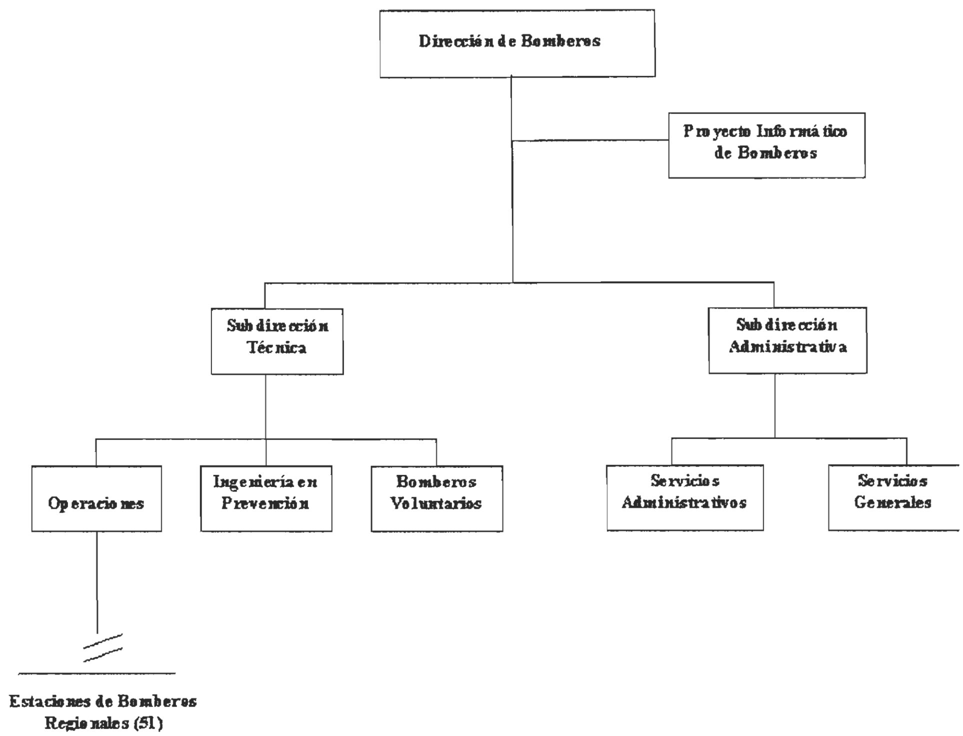
(Plan Estrategico Institucional,2001)Presently, the fire department comprises three hundred paid firefighters, one thousand volunteer firefighters, thirteen paramedics, two fire investigators, and a feet of fire engines and ambulances in fifty-one stations throughout the entire country (INS Misión, 2001).

The Direccion de Bomberos is divided into two major categories, the Subdirección Tecnia (Techincal Division) and the Subdirección Administrativa (Administrative Division). The Tecnia division is divided into three smaller divisions, Operacciones (Operations), Ingeniería en Prevencion (Engineering in Prevention), and Bomberos Voluntarios (Volunteer Firefighters). The Operaciónes division is where the Office of Operation Control (OCO) is located; this office is in charge of receiving emergency calls and dispatching the firefighters. This division is also responsible for the general operation of all 51 of the nation wide fire stations. Ingeniería is in charge of the fire prevention and education aspects of Los Bomberos' work. Don Héctor Chaves León (Jefe) and Esteban Ramos (Sub-Jefe) head this division. The Bomberos Voluntarios division is comprised of the volunteer members of Los Bomberos.The Subdirección Administrativa is divided into Servicios Administrativos (Administrative Services) and Servicios Generals

Appendix A

(General Services). Ana-Maria Ortega O., our liaison works in this Subdireccion.

All of these stations are run by an organized central administration, headed by the Director of Bomberos. The structure of El Cuerpo de Bomberos is shown below.



Appendix B

Winston-Salem

http://www.ci.winston-salem.nc.us/fire/infoproj/esripc.htm

http://www.ci.winston-salem.nc.us/fire/fire/infoproj/slidshow/

ESRI PRESENTATION PAPER

The following paper was presentated at the ESRI User Conference in San Diego, CA in July 1998 by Julia Conley and Tim Lesser of the INFO Project Team. It also represents the information provided to participants of the URISA Conference in Charlotte, N. C. in July 1998 by the INFO Project Team members in attendance. Note: This summary paper was complied and edited from three papers produced by our INFO project team members.

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CITY OF WINSTON-SALEM INTEGRATED NETWORK FIRE OPERATIONS WITH IT, GIS TO SUPPORT
E911 ROUTING AND IMAGING IN FIRE APPARATUS:

Abstract: The City of Winston-Salem's Integrated Network Fire Operations (I.N.F.O.) Project, funded through a matching funds TIIAP grant from the Department of Commerce, facilitates communication among all Fire Stations and provides critical information in graphical form to the fire fighters in emergency vehicles. ISDN technology provides the backbone for the network. The City has built a street centerline file utilizing Global Positioning Satellite (GPS) technology to provide the routing framework. GIS software utilizes the centerline network

and alarm location to define an optimal route. Other graphical information is also displayed, such as the locations of hydrants, railroads, streams, and schools. Additionally, the GIS software allows the firefighter to link via icons and touch screen interface to an imaging application in order to retrieve diagrams, floor plans and document imaging details on pre-fire survey information, physically challenged occupants, hazardous materials, and multiple address locations, such as apartment complexes. Before the City began the I.N.F.O. project, emergency vehicles stored paper pre-fire survey drawings in a binder for only their own home territory, due to space limitations. Document retrieval citywide is now automatic based upon the E911 dispatch address. This information will enable firefighters to improve decision making during an emergency.

INTRODUCTION

The Winston-Salem Fire Department includes 17 different Fire Stations serving a population of 170,921. The Fire Department is composed of 254 fire fighters and 12 support personnel, distributed over 106.5 square miles. Each station is occupied at all times and ready to respond to an emergency. Beyond their professional training, the ability of the Fire Department to save lives and minimize property damage is dependent on the quality and quantity of available information.

The fire fighter's ability to serve the public safety is significantly improved by timely access to the existing data. The likelihood that a fire fighter will save a life or avoid a catastrophe is determined by their response time which is measured in seconds. Technology can be used to bring all sources of existing information directly to the fire fighters at the emergency site in electronic form to improve their response time. In addition, existing computer technology can be used to improve the value of the information through graphical presentation and analysis tools. The benefits can be measured in saved lives, reduced property damage, and lower community insurance costs as a result of the ability to make faster and better decisions.

The goal of the Integrated Network Fire Operations (INFO) project is to provide critical information in graphical form to the fire fighters in the emergency vehicles. This reduces the time to respond and provides information that enables the fire fighters to improve decision making during an emergency. The project was implemented by the City of Winston-Salem to support the services of the Fire Department for the residents of Winston-Salem, NC and surrounding communities. A design and implementation team was composed of representatives from the City's Fire Department and the Information Services Department. The solution integrates several existing computer-related technologies. These include:

. Document Imaging . GIS . Optimized routing with a complete street centerline file . Computer Aided Dispatch . ISDN Networking . Compact Disk (CD-ROM) distribution . Mobile Data Computers (MDC)

FUNCTIONAL DESIGN

Overview

The INFO project changed the method for accessing and maintaining Fire Department information. Data and drawings are entered electronically. During an emergency, information is available in graphic form on the ruggedized PC in the vehicle, as compared to the prior combination of character data on a terminal, voice information over a radio, and paper documents in a notebook. When the fire alarm is initiated, the fire fighters proceed to their vehicles. The emergency location is sent by radio to the ruggedized MDC. The option of viewing a map defining the optimal route is immediately available. The capability exists to indicate the occurrence of a constraint such as a downed tree or power line and then to generate an alternate route. The fire fighter is able to zoom in on the emergency location and identify all available fire hydrants. Capacities of the fire hydrants can also be displayed. Any known hazardous materials in the area is displayed. Upon selection of the actual emergency location, any additional information on the property is indicated. Information such as floor plans, water or gas lines, and sprinkler systems can be selected through a link to an imaging component. All maps and grids display as graphical images. In the case of an extensive emergency, additional information is available on the surrounding areas. Analysis can be done to assist with decisions regarding evacuation areas.

Components

The 17 Fire Stations are connected to the City s existing fiber-based FDDI network through ISDN circuits. Each station is equipped with a PC to support image creation, office automation, and on-line access to the Internet through the City s existing T1 link. A PC server resides in the central Fire Administration Office, directly linked to the FDDI network.

Mounted in the emergency vehicle is a ruggedized MDC, which is equipped with WINMDT, GIS and imaging software. Graphical data including street and address locations and floor plans are available. The City's E911 Computer-Aided Dispatch (CAD) mainframe system identifies the closest available fire vehicle(s) for the incident type and location. Emergency dispatch information is transferred over radio frequencies to the ruggedized MDC in each fire vehicle dispatched to the incident. The CAD dispatch information received by the MDC includes the address location of the emergency site, details on the incident type and other responding units, and indicates whether prefire survey, hazardous material, physically challenged occupant, and/or multiple address information is available for the location. Dispatching information coordinated with all City Fire resources is available through the City's existing MDC system.

Appendix B

The Computer Aided Dispatch information passed to the GIS routing application is used to determine the shortest route to the emergency site, to identify the fire hydrant locations along with pertinent capacities, and to highlight the existence and characteristics of any hazardous materials. Building floor plans that include sprinkler locations, access points, and emergency exits are available as electronic images and may be retrieved. This allows the firefighter rapid access to very critical information during an emergency response

The City maintains a GIS environment utilizing ESRI's ARC/INFO and ArcView PC software. Multiple coverages representing a variety of GIS information reside in different servers in the City. Unique layers that are specific to the Fire Department are developed and maintained on the City's SUN Solaris GIS servers. The City's street centerline file was completed to provide a routeable network. Fire fighters at each Fire Station keep up-to-date information on their areas of responsibility. This includes the regular information from pre-fire survey inspections such as the location of fire hydrants and hazardous materials. All building and floor plans are drawn with Computer Aided Design (CAD) software into an imaging system and linked to the GIS routing application. The drawings and plans are maintained at the Fire Stations by the individuals responsible for collecting the information during their pre-incident analysis.

The network speed over radio frequencies is not adequate to distribute graphical data to a mobile environment. The solution is to provide copies of the data on CD-ROM, which is then loaded to the hard drive on the ruggedized laptop, which is a pentium PC with 32 megabytes of memory and a high density display device. The CDs are low cost to duplicate and can contain all of the relevant GIS data and images. The CDs are reproduced and distributed on a monthly basis to ensure current information. The GIS and image retrieval software resides on each PC. With this in place, the fire fighter enroute to the emergency site can obtain routing information, identify the location of hydrants or hazardous materials, and review building drawings upon demand in the vehicle.

GIS COMPONENT TO SUPPORT E911 ROUTING

The Geographic Information System (GIS) component of Winston-Salem's (I.N.F.O.) project provides optimal routing recommendations based on the address of the alarm sent to the mobile data computers (MDC) via radio. The objective is to reduce the time to respond to an incident and provide information that will enable firefighters to improve decision making during an emergency. In order to support the GIS routing application with all of its functionality, it was necessary for the City to develop additional GIS coverages. Utilizing Global Positioning Satellite (GPS) technology and existing mainframe street file information, the City has developed a street centerline coverage to provide the routing framework. Other GIS coverages developed to support this project include hydrants, fire demand zones (FDZs), physically challenged occupants, prefire surveys, hazardous material (Right To Know), multiple address locations, schools, and fire stations.

The GIS application generates and displays an optimal route based on information from the street centerline file, including speed limits, one-way streets, turning movements allowed, etc. Other graphical information may also be displayed, such as the locations of hydrants, prefire surveys, hazardous material, physically challenged occupants, multiple address locations, railroads, hydrography, FDZs, home territory, and schools. Additionally, the GIS software allows the firefighter to link, via icons and touch screen interface, to an imaging application. Through this interface the responder may retrieve diagrams, floor plans and document imaging details on multiple address locations such as apartment complexes, prefire survey information, physically challenged occupants, and hazardous materials. This allows the firefighter rapid access to very critical information during an emergency response.

Appendix B

The GIS routing component of Winston-Salem's I.N.F.O. project was developed using Microsoft Visual Basic 5.0 and MapObjects (Environmental Systems Research Institute, Inc., ESRI) software. It runs on ruggedized MDCs mounted in the fire vehicles. Some major highlights of the capabilities of this application include:

Recommends quickest route to the emergency site Provides text description of route Provides graphic pan/zoom capabilities to display route or part of route Identifies fire hydrant locations Highlights the presence of critical information within the vicinity of the emergency site, such as hazardous materials, prefire surveys, and physically challenged occupants Provides link to the imaging component Identifies multiple address locations Allows change to origin or destination of a route Provides the capability of closing and opening street segments from routing use, in case of temporary blockage, such as a tree down Allows selection of optional map layers to display, including FDZs, home territories, schools, hydrography, and fire stations Provides ability to select feature, such as hydrant, and view tabular data Allows routing directly to existing point addresses that match incident address for prefire, hazardous material, physically challenged, and multiple address coverages, eliminating the additional step of geocoding

GIS DATABASE DEVELOPMENT

The success of the GIS routing application depended on the development and availability of the necessary GIS coverages. The development of the database involved data collection from multiple sources, including paper maps, city and county mainframes and GIS. Other GIS coverages developed to support this project include hydrants, fire demand zones, physically challenged occupants, prefire surveys, hazardous material (Right To Know), multiple address locations, schools, and fire stations. Existing GIS coverages that were enhanced by the addition of attributes include hydrography and railroads.

Appendix B

The centerline is the most critical GIS coverage for this project. For the development of a routeable centerline, the Planning and CAD street files on two different mainframes provided tabular information on the street naming standards, block ranges, and location descriptions. The graphics only centerline and cadastral coverage maintained by the FC Assessor's office were also used as a reference during the building of this coverage. The City contracted with the Institute of Transportation and Research (ITRE) to use Global Positioning Satellite (GPS) technology to build the centerline coverage. ITRE collected attribute information (street name, block ranges, speed limits, etc.) and exact locations of all streets within the City. With joint City/County funding, the centerline coverage is being developed for the entire county.

The following coverages have been developed and utilized in the GIS and imaging applications. Each coverage has data attributes that can be displayed by the fire department via GIS item information table(s) or by an image(s) via the imaging application. Shown below are the GIS coverage (feature classes), development brief, and listings including but not limited to GIS or image data displayed within the complete application.

Centerline (GPS)

Network (arc)

Development Brief:
The centerline coverage continues to be updated and corrected for improved address matching for routing and maintenance of the other supporting coverages in this project. The goal is to minimize address street segment overlaps, duplications, and keep this coverage updated as new streets are built. The initial GPS data collection was done by ITRE. Information displayed by the GIS application includes:

street name, including direction and type left and right / to and from extended and exact segment address ranges speed limits (mph) street number of lanes street surface street classification over/under pass "elevations" closure status/closure expiration date street alias to and from impedance/turntable values to and from travel (one-way) streets school zones

Fire Demand Zones (poly)

Development Brief:
The fire demand zone (FDZ) coverage was initially developed for this project using screen digitizing with paper maps as reference. It continues to be updated/corrected as the fire department reviews the hardÄcopy hydrant maps plotted for each home territory cluster. The maps are encouraging the fire department to analyze more closely their territory and to correctly locate and edit FDZ lines. This process is critical because hydrants have a unique numbering scheme based on their assignment to FDZ polygons. Information displayed by the GIS application includes:

fire demand zone fire home territory cluster (sub divided areas within home territories) police beat

Fire Station Locations (point)

Development Brief:
Initially, the fire station address locations were parcel address matched to the cadastral coverage. Although the majority of the stations matched on the first run, others were address matched via fire department's feedback. This was due to the lack of address attribute information in the cadastral coverage. Since the fire station locations will be used in the majority of origin points for the GIS routing application, address matching to the GPS centerline was pertinent. These locations, when address matched, were positioned near the centerline

rather than within parcel polygons as before. Information displayed by the GIS application includes:

fire station number address CAD street identification number

Hazardous Material Locations (point)

Development Brief:
Hazardous material location address data was extracted from the CAD mainframe and address matched to the GPS centerline for the entire city. This hazardous material information is uploaded to CAD from Emergency Management for locations meeting Right To Know reporting requirements. Only attribute data will be displayed for hazardous material locations without a prefire survey. Locations are linked to the imaging application via an address attribute in the GIS point coverage. Coverage attribute information displayed by the image application includes:

company/complex name address emergency/alternate/business phone numbers fire location and cad street identification numbers right-to-know file number fire demand zone type & quantity of hazardous materials location of hazardous materials evacuation routes office-suite number jurisdiction

Hydrant Locations (point)

Development Brief:
Hydrant address data existed in CAD mainframe, but the addresses are not accurate to the exact spatial locations. Moreover, there were many instances where multiple hydrants had the same address, i.e. shopping centers, hospitals, etc. The address matching in this case would place several hydrants on top of one another, hence incorrectly. The solution was to create hard-copy maps for each fire home territory cluster (clusters being "sub-set" areas within a home territory) showing FDZ polygons. The fire department identified the hydrant

locations on the maps that were later digitized into the coverage. The unique hydrant number used in CAD requires the FDZ number in addition to the hydrant number within the specific FDZ. Using the same key in the coverage allows CAD hydrant information to be joined to the hydrant points via this unique hydrant number. Information displayed by the GIS application includes:

FDZ-hydrant identification number address public/private hydrant hydrant class (based on Gallons Per Minute - A,B,C) flowÄtest hydrant freeze (Y/N) hydrant in/out of service out of service expiration date description (special instructions/location)

Hydrography Network (arc)

Development Brief:
The hydrography coverage exists for the entire county. To improve utilization of this coverage, attribute items of name has been added. Flow-rate is to be added in the future. The fire department can identify a stream, river, or a water body and its flow-rate (when this data becomes available) in event of a chemical/hazardous material incident. For example, neighborhoods down stream of an incident can be alerted of the danger and/or evacuated if necessary. Furthermore, the fire department can be more proactive in setting up "barriers" to hinder the incident material flow down stream. Information displayed by the GIS application includes:

river, stream, creek name flow-rate

Multiple Address Locations (point)

Development Brief:
The multiple address location (MAL) coverage identifies locations without a prefire survey that have an overview diagram identifying the subaddress locations. These images of the entire layout of apartment complexes, mobile

home parks, and offices can be displayed to the fire department to locate subaddresses. For example, the GIS routing would only route to the "main" address point which is interpolated to the GPS centerline address ranges. Points of MAL's have this "main" address linked to the imaging application to display the layout of apartment and mobile home buildings and numbers, as well as floor plans of office buildings. Image information displayed by the image application includes:

complex name and code (apartment, mobile home, office building, etc...) address fire demand zone fire location identification number apartment number jurisdiction

Physically Challenged Locations (point)

Development Brief:
These point locations will be address matched from CAD generated addresses to the GPS centerline. Main address data for physically challenged will be matched to the points and "sub-addressed" data (apartment, suite, lot locations) will be handled and displayed in the imaging application. The floor plan of the physically challenged occupant's location would be displayed through the image. Image information displayed by the image application includes:

address name of person phone number ambulatory condition/description of physically challenged location within building floor plan diagram fire location identification number apartment number jurisdiction

Prefire Survey Locations (point)

Development Brief:
Prefire survey location address data was extracted from the CAD mainframe and address matched to the GPS centerline for the entire city. This process identified corrections needed to the centerline. Each prefire survey location links to the

imaging application via an address attribute in the GIS point coverage. Standardized color annotated details displayed by the imaging application includes:

company/complex name address fire vehicle(s) positions building best access / sprinkler / standpipe / hydrant positions building construction materials / dimensions / floor plan(s) fire demand zone fire location and cad street identification numbers hazardous material storage apartment number office-suite number jurisdiction

Railway Network (arc)

Development Brief:
Only railway graphics of the county existed (no attribute data attached). The name attribute was added and populated into the coverage to detail and identify the ownership of the networks. Information displayed by the GIS application includes:

railway company name

School Locations (point)

Development Brief:
School point locations were derived from address matching from the parcel (cadastral) coverage. Updates and/or corrections would be made when new schools are built and changes in name or address are determined. Information displayed by the GIS application includes:

school name address school code (high,middle,elementary,other) fire location identification number

IMAGING COMPONENT TO SUPPORT DIGITAL PRE-FIRE SURVEYS IN FIRE APPARATUS

Appendix B

The I.N.F.O. imaging system allows firefighters to view electronic documentation on a mobile data computer (MDC) in the fire apparatus. This information was previously accessed using paper and notebook binders. Now the Winston-Salem Fire Department uses a touch screen computer interface to access this information instantly.

This system utilizes several software components to create and maintain the information. The core application was written in Visual Basic 5.0 and comprises several ActiveX components. An off-the-shelf computer aided design package was used to redraw 1,384 pre-fire surveys electronically. These files were then printed to a universal image format. For retrieval, the TIF (Tagged Image File Format) filenames were imported into a database of Computer Aided Dispatch information. Each image was annotated with color to highlight trucks, hazards, water supplies, and service disconnects. This color annotation was critical to allow the firefighters to quickly and easily distinguish the information presented in the pre-fire survey drawings. Hazardous material (HazMat) information was also imported into the imaging database. This allowed a list of chemicals and their quantities to be displayed along with the pre-fire information. In addition to the primary information on the pre-fire surveys and in the HazMat database, the Fire Department can view physically challenged and multiple address drawings. An example of a multiple address document would be an apartment complex or a trailer park map submitted to the Fire Department. Through the use of state-of-the-art technology, the firefighters have been able to eliminate binders of paper documentation in fire trucks and improve their ability to access information during an emergency.

DOCUMENT MANAGEMENT ENVIRONMENT

The Fire Department maintains various types of documents to assist in the performance of their job. For any given location within the City, the following documentation may exist:

Appendix B

1. pre-fire survey drawing of a building and/or a preÄfire survey data sheet 2. hazardous material information 3. physically challenged evacuation plan 4. multiple address drawing

Copies of the paper documents were stored in the cab of each fire engine and organized alphabetically by company name in three-ring binders. The previous Mobile Data Terminal (MDT) would display a "Y" in the pre-fire (PF) field to indicate the existence of a pre-fire survey. Retrieval was done immediately after arriving at a location. To speed the process, the binders had colored index tabs and the documents were highlighted in color.

Personnel in each fire station are responsible for creating and maintaining their station's pre-fire surveys. Each firefighter studies their station's surveys to gain a better understanding of buildings in their home territory. This created a problem because the fire stations that are located in heavily populated urban areas must always have two engines waiting in the garage of the station. If one engine leaves the station on a call, another engine company from a less populated rural area will fill the vacant slot. This replacement engine company only had copies of pre-fire surveys for their home territory, but could potentially need to access information for the current home territory. Each fire engine required access to all pre-fire surveys, but, pre-fire surveys were created locally at each station so they varied dramatically. If a firefighter looked at a survey from another home territory which was drawn with different symbols and highlighted with different colors, he or she may not have been able to quickly understand the information presented.

The solution was to standardize the drawing tools used to create the drawings and then redraw them. This was necessary because all stations now have access to all pre-fire surveys.

IMAGING IMPLEMENTATION

Appendix B

Pre-fire survey drawings were standardized using Computer Aided Design software from The CAD Zone, which was installed at all 17 fire stations. The pre-fire survey form was redesigned and data entry macros were created. The General Order dictating pre-fire survey creation and maintenance policy was changed to reflect the new processes. Formal training classes were conducted and the Fire Department has redrawn 1,384 pre-fire surveys.

The CAD Zone software uses a proprietary file format (DW2) that can only be opened and viewed with its FIRE Zone drawing package. This software worked very well to redraw the pre-fire surveys, but would not have provided the firefighters with a quick and easy way of viewing the documents in an emergency situation. So, once the pre-fire surveys were redrawn, the Fire Department used two software packages to create standard black and white TIF files for viewing in the fire apparatus. Visionary Solutions' ImPrint printer driver for Windows 95 was used to create the TIF image files by simply printing each drawing. The Integrator from New Team Software was used to automate this process. Several macros were created using the Integrator's scripting language. Once completed, the Fire Department was able to automatically print an entire directory of DW2 files to TIF files.

The TIF pre-fire survey filenames were then imported into a Microsoft Access database along with information extracted from the City's Computer Aided Dispatch (CAD) database. Within the CAD database, each pre-fire survey has a five digit location identification. This LOCID was used to name the pre-fire survey drawings and automatically attach any CAD data without duplicate data entry. For example, Calvary Baptist Church's LOCID is 16919 and it has a two page pre-fire survey, so these files were named 16919001.DW2 and 16919002.DW2 when they were redrawn. This allowed the Fire Department to pull information from the CAD database and minimize the amount of labor required to create and maintain an imaging index. Automated processes were created using Microsoft Visual Basic that allowed the Fire Department to easily import flat-file data from the CAD database and verify the imaging database.

The software platform chosen was Microsoft Windows 95 operating system and the Microsoft Component Object Model for development of the imaging component of the I.N.F.O. application. A customized solution was nessessary because standard off-the-shelf imaging applications are not neccessarily usable through a touch screen interface. Also, the maximum amount of memory and highest processor speed available for a ruggedized mobile data computer are limited when compared to standard laptops. Since the MDC also would be running WinMDT (Windows based Mobile Data Terminal) and GIS routing software, a minimum memory foot print and processor requirement dictated that the City develop a custom solution with only the required functionality. A custom ActiveX imaging control was created to allow the firefighters to access the pre-fire database and images quickly and easily through a touch screen interface.

The ActiveX imaging control consists of several ActiveX controls and application extensions. The LeadTools Pro Express ActiveX control (OCX) is used to view and annotate the pre-fire survey images. The capability to annotate the black and white images in color was critical because this provided the firefighters with the ability to quickly distinguish key features on the drawing. For example, trucks are colored yellow, hazards are red, water supplies are blue, and service disconnects are orange. By using black and white images and highlighting with color, the Fire Department was able to reduce the amount of storage space for the image data from 7GB for color images to 400MB. This was of great importance because the images are being distributed on CD-Recordable media, which has a capacity of 650MB, and the MDC only has a 1.4GB hard disk drive. Changing CD-Rom disks during an emergency situation was not an option. Another component is the Microsoft DAO (Data Access Objects) 3.5 Object

Library application extension, which is used to search and retrieve data from the imaging database. By using these and other components, the City was able to effectively use the principles of Rapid Application Development to save time and money during the development of a custom ActiveX imaging control.

The MDC in the fire apparatus has a container application created using Microsoft Visual Basic. This container houses the GIS routing ActiveX control and the imaging ActiveX control. In addition, the MDC is also running WinMDT. WinMDT passes the address information via DDE (Dynamic Data Exchange) to the Visual Basic container application, which in turn initiates the GIS geocoder to create and then display a route. If the location has a pre-fire survey, then an imaging system button is enabled and the firefighter can view the pre-fire survey information by pressing this button. Once the firefighter does this, the GIS routing ActiveX control passes the incident address to the imaging ActiveX control and the pre-fire survey is automatically displayed. If several documents exist for the location, then the firefighter is presented with a list of documents from which to choose. For example, a location may have a pre-fire survey and HazMat data associated with it. This application enables automated retrieval of critical pre-fire information instantly so that the firefighters can make key decisions quicker and easier in-order to save lives.

IMAGING LESSONS LEARNED

We learned that our time was better spent examining the current document management environment and re-engineering it to exploit technology, rather than applying technology to automate an existing system. We also learned not to overlook details on the documents. We knew that the pre-fire surveys were an important piece in the overall solution, but the shape and color of the symbols on the documents were just as important in the design of the system.

CONCLUSION

Appendix B

Winston-Salem's endeavor to accomplish the ultimate levels of service and safety concerning fire response is being realized through the integration of technologies. The GIS component, as well as the dispatch interface to CAD and the imaging components of this project are critical in the dissemination of emergency response information in order to save lives. All components must function concurrently to enable fire personnel to access information for a more proactive response.

Fire related information as encompassed in the GIS component, such as the street centerline network, fire demand zones, fire station locations, hazardous material locations, hydrant locations, hydrography network, multiple address locations, physically challenged locations, prefire survey locations, railway network, and school locations is the core of the fire application. Hence, for the application to be more successful, the spatial and attribute accuracy of this information must be maintained. To enable fire fighters to possess quick access to the data with a "touch" is just one element of the emergency response situation. Maintaining data quality is another responsibility that can not be compromised.

Note: This summary paper for the ESRI Public Safety preconference workshop was compiled and edited by Julia Conley from three papers produced by our INFO project team members. The other coauthors include:

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Document Management / Imaging Specialist
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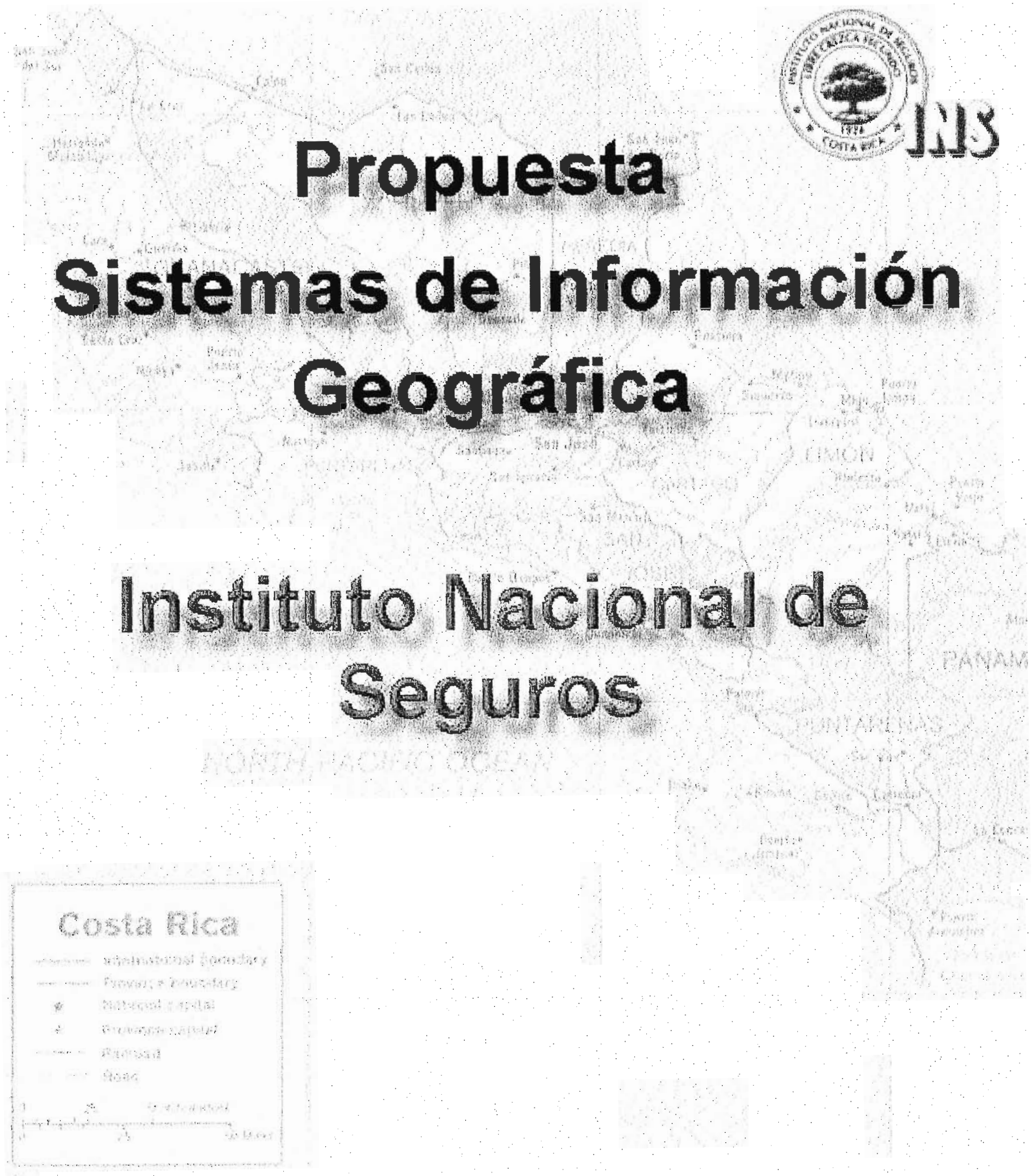
Winston-Salem, NC 27102

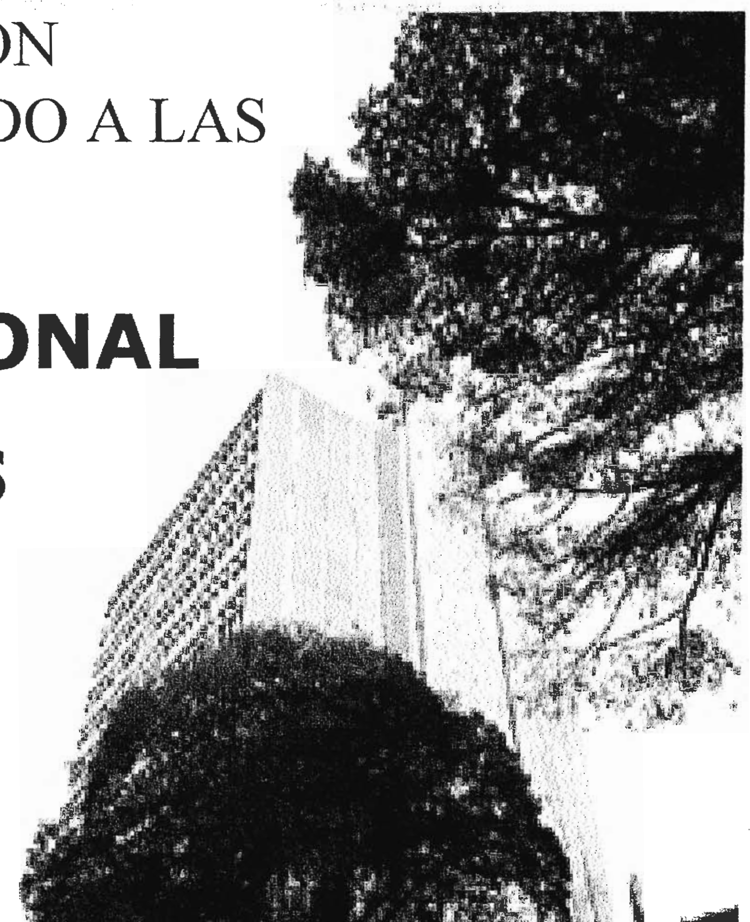
Propuesta Sistemas de Información Geográfica

Instituto Nacional de Seguros



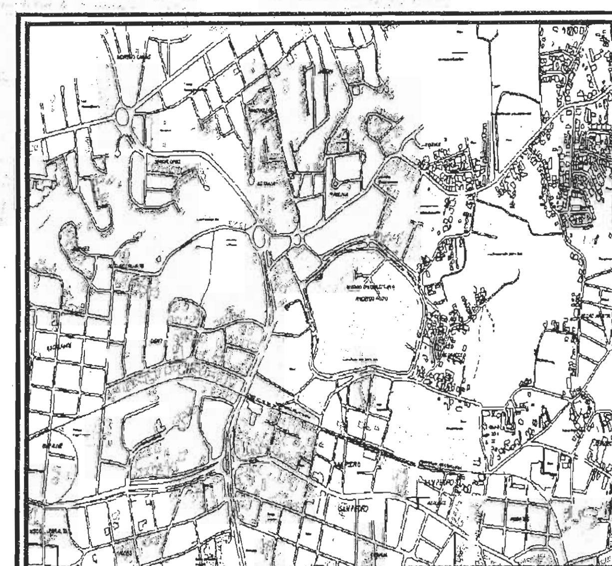
IMPLEMENTACIÓN Y DESARROLLO DE UN SISTEMA DE INFORMACIÓN GEOGRÁFICO (S.I.G.) APLICADO A LAS NECESIDADES DEL

INSTITUTO NACIONAL DE SEGUROS

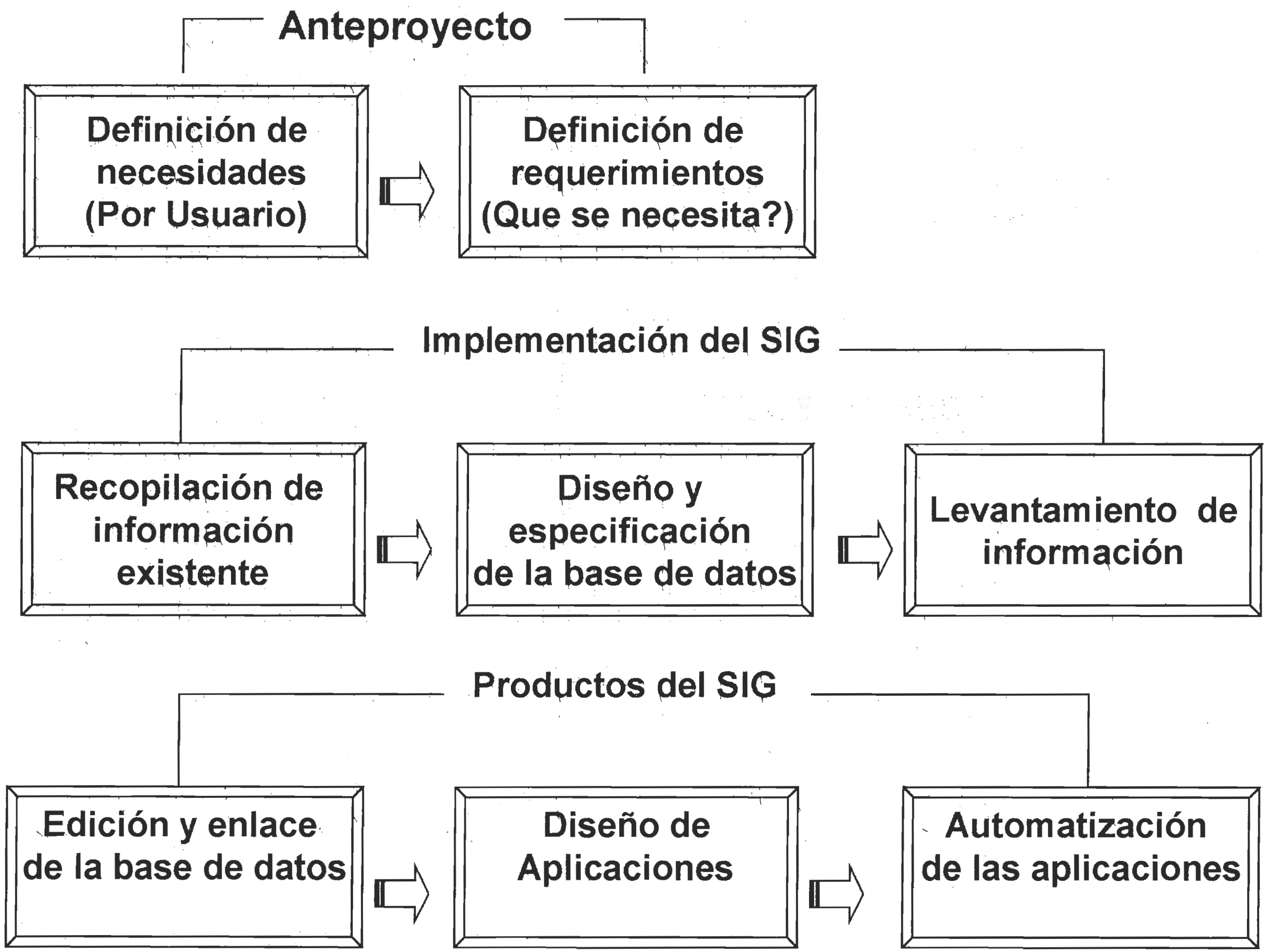


OBJETIVO GENERAL

Formular un Sistema de Información Geográfico que permita a la Institución integrar información de tipo geográfico con información de bases alfanuméricas, para una mayor capacidad de análisis en forma más rápida para la toma de decisiones.



DISEÑO DEL PROYECTO S.I.G - ETAPA I



NECESIDADES DEL USUARIO

- ❑ Integración de información geográfica, con bases de datos especificas existentes en Bomberos.

- ❑ Establecer estrategias que permitan la atención de emergencias en forma más oportuna y eficiente.

- ❑ SIG como canal de comunicación interdepartamental para facilitar la toma decisiones.

- ✓ Ubicar puntos de importancia para la atención de emergencias atendidas a través de OCO (N° 118).

NECESIDADES DEL USUARIO

- ✓ Mantener capas de información geográfica, con sus respectivas bases de datos(atributos asociados) para el análisis y generación de estadísticas.
- ✓ Ubicación de estaciones de bomberos asociado con sus respectivas bases de datos.
- ✓ Ubicación espacial de Fuentes de Aguas (hidrantes, pozos, tanques, piscinas) asociado con sus respectivas Bases de Datos.
- ✓ Planeación de rutas de acceso.
- ✓ Identificar rutas de transporte de materiales peligrosos.
- ✓ Identificación de áreas geográficas por tipo de incidentes.

PROPUESTA

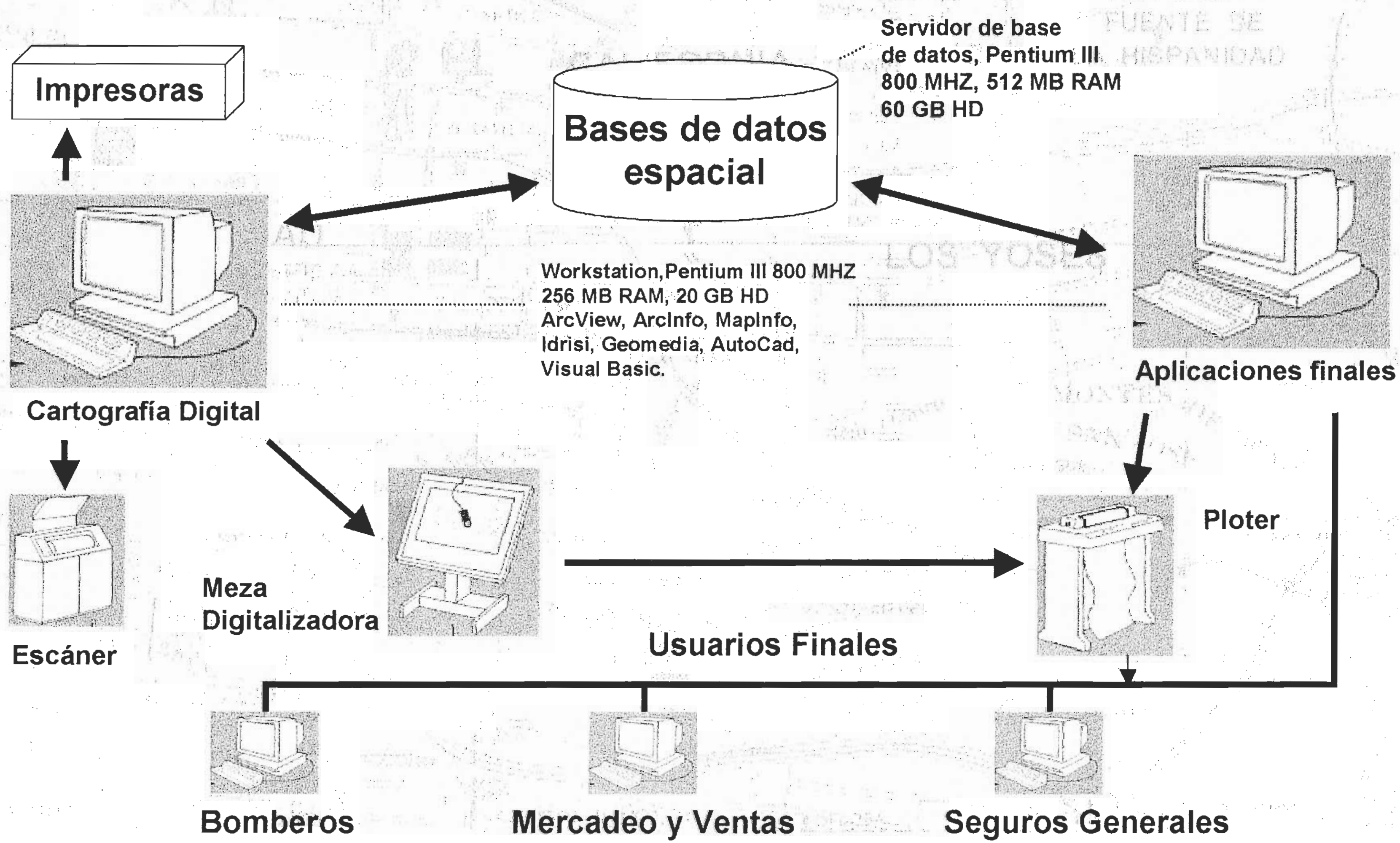
Recursos necesarios

- ⇨ Equipo de cómputo (HardWare)
- ⇨ Sistemas de Información (SoftWare)
- ⇨ Recurso Humano
- ⇨ Datos (Implementación del SIG)

PROPUESTA

Recursos necesarios

⇨ Equipo de cómputo (HardWare Recomendado)



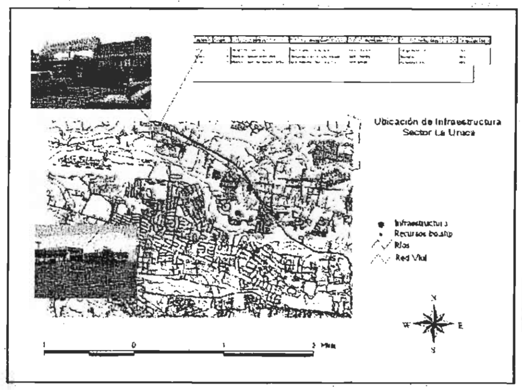
PROPUESTA

Recursos necesarios

⇨ Sistemas de Información (SoftWare recomendado)

(SIG Profesionales)

Programas SIG

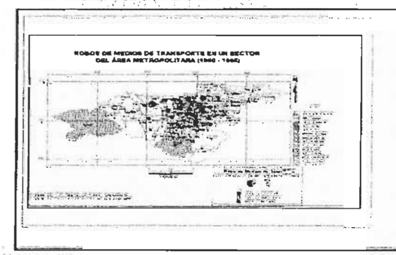


Arc View GIS (Este software esta diseñado para la administración y control de información espacial.

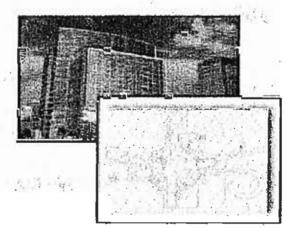
IDRISI SIG, tipo raster especializado en manejo de Imágenes Satélites

Otros

Visual Basic



Map Info



Auto Cad, programa especializado en diseño gráfico

Herramientas complementarias

PROPUESTA

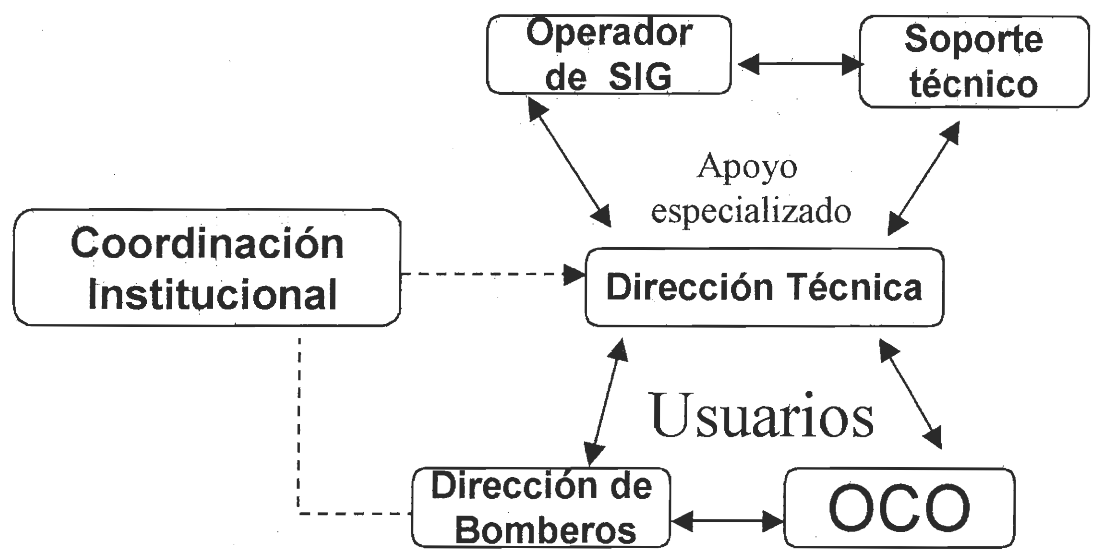
Recursos necesarios

⇨ Recurso Humano.

✓Director Técnico (tiempo completo)

✓Operador de SIG (tiempo completo)

✓Informática (Soporte Técnico)



PROPUESTA

Recursos necesarios

⇨ **Datos (Implementación del SIG).**

1. Recopilación de la información existente.

2. Diseño y especificación de la base de datos.
   2.1 Definición de capas geográficas.
   2.2 Requerimientos de datos.
   2.3 Migración de datos.

3. Levantamiento de la información geográfica.

4. Productos del SIG.

IMPLEMENTACIÓN DEL S.I.G.

Recopilación de información existente

Obtención de la base cartográfica (mapas digitales)

- ✓ Curvas de Nivel (Todo el país). 1:50.000, 1:10.00
- ✓ Red Vial (Todo el País). 1:50.000 1:10.000
- ✓ Hidrografía (Todo el País) 1:50.000 1:10:000
- ✓ Cuencas Hidrográficas (Todo el País) 1:50.000
- ✓ Hojas Cartográficas (Todo el País) 1:25.000
- ✓ Infraestructura (GAM) 1:10.000
- ✓ Líneas de Centro (GAM) 1:10.000

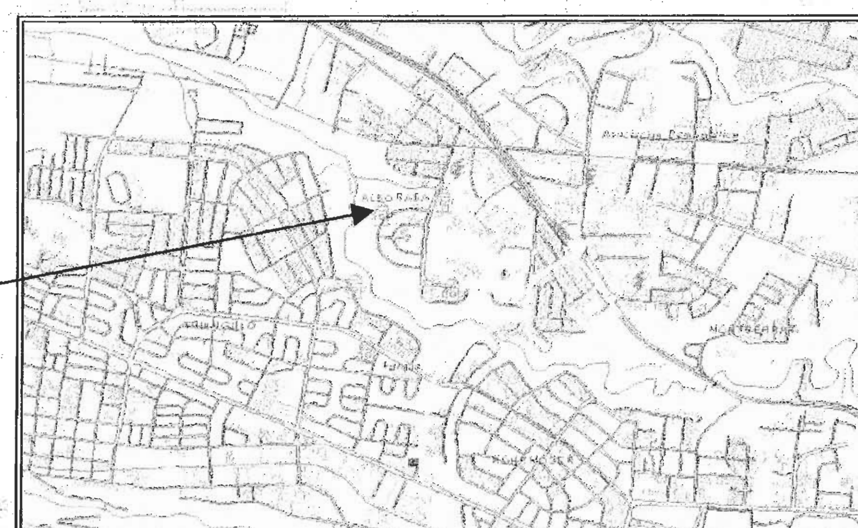
PROPUESTA

Recursos necesarios

⇨ **Datos.**

Requerimientos de Mapas - Definición de capas geográficas

- ✓ Estaciones.
- ✓ Incidentes.
- ✓ Infraestructura.
- ✓ Fuentes de Agua.



IMPLEMENTACIÓN DEL S.I.G.

Diseño y especificación de la BD

Requerimientos de datos

INFRAESTRUCTURA

Ubicación, dirección
tipo, número de pisos
actividad que realiza
accesos
salidas de emergencias
tipo de seguros
estación que corresponde su atención

ESTACIONES

Ubicación, dirección
clase
cobertura
descripción del edificio
clave
frecuencia
teléfono
número de bomberos permanentes
número de bomberos voluntarios

FUENTES DE AGUA

Ubicación, dirección
tipo privado, público
estado físico
capacidad
flujo
diámetro
Boquilla

INCIDENTES

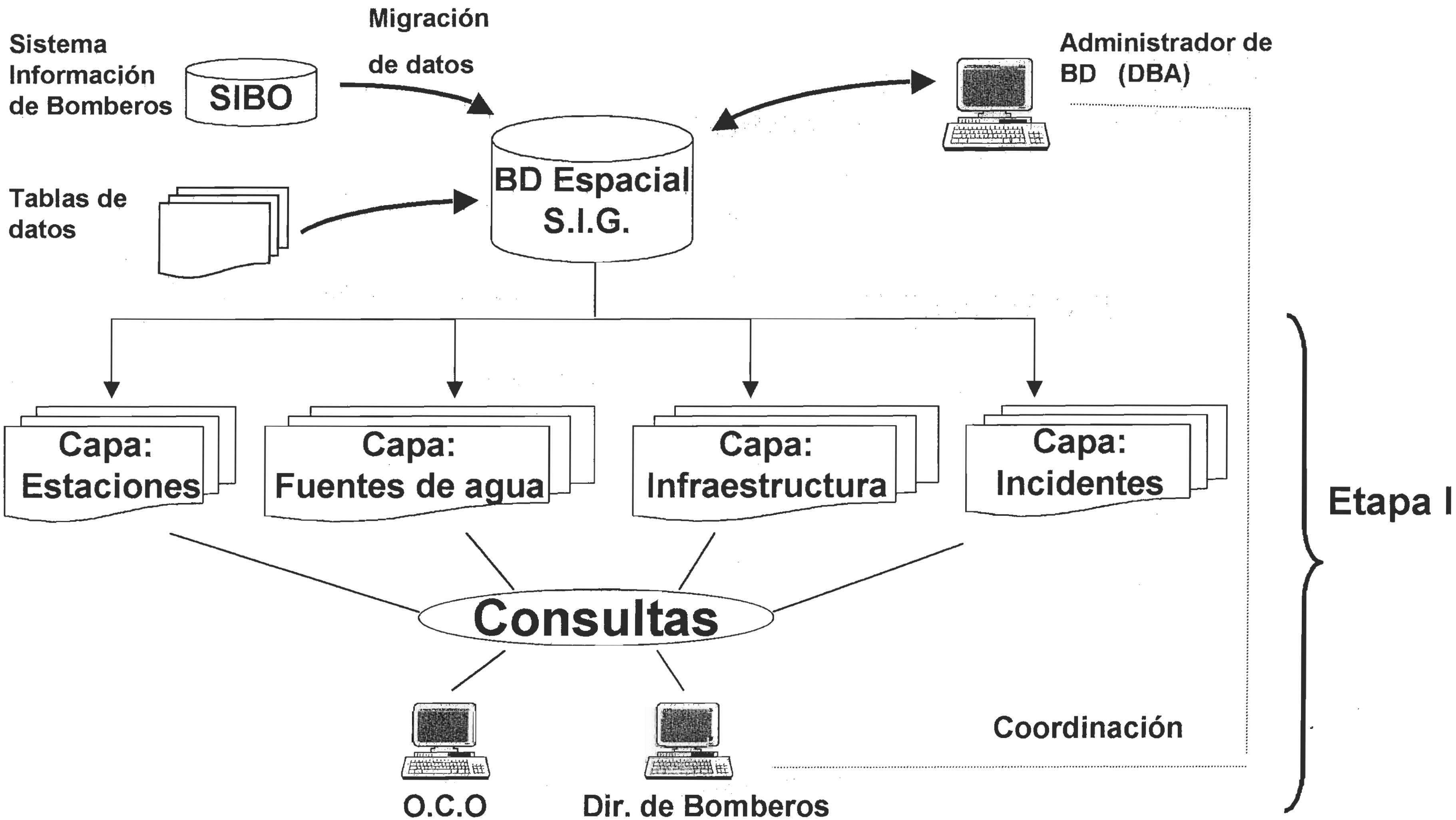
Ubicación
dirección
provincia
cantón
distrito
tipo de incidente
causa
estación que atendió

INFORMACIÓN COMPLEMENTARIA

Imágenes de fotografias digitales.

IMPLEMENTACION DEL S.I.G.

Diseño y especificación de la BD



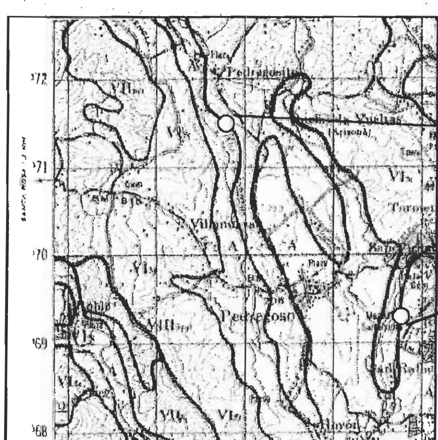
IMPLEMENTACION DEL S.I.G.

Levantamiento de la información geográfica

⇨ Levantamiento datos geográficos (Sistema convencional)

Generación de datos de coordenadas X, Y Lambert norte mediante la utilización de cartografía convencional (mapas y hojas cartográficas existente)

Trabajo de Campo.
Levantamiento de información directamente en el sitio, ubicación exacta por coordenadas de toda aquella información con que no se cuente con datos georreferenciados.

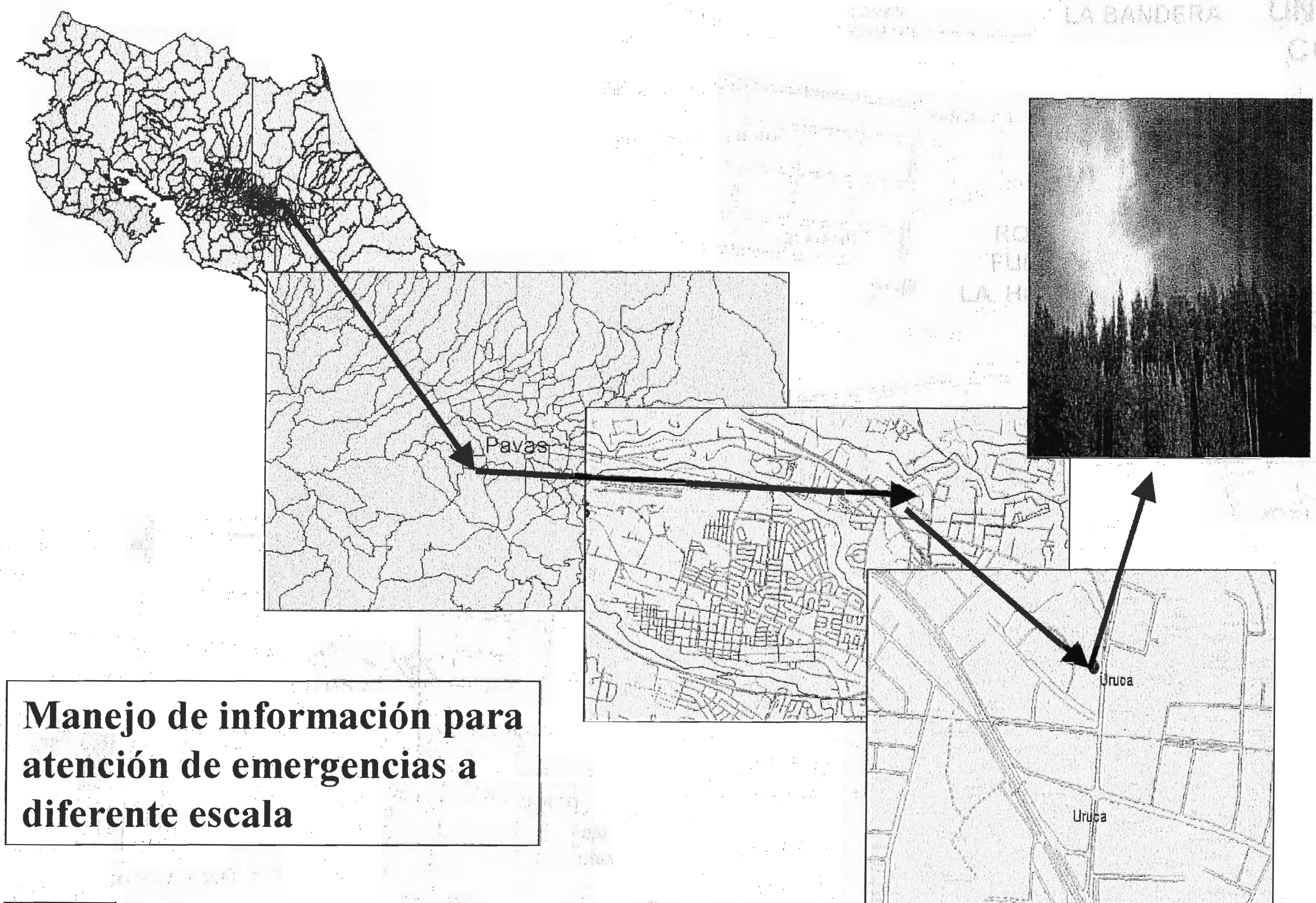


Identificador	Coordenada X Longitud	Coordenada Y Latitud
21	420350	283200
22	456220	287700

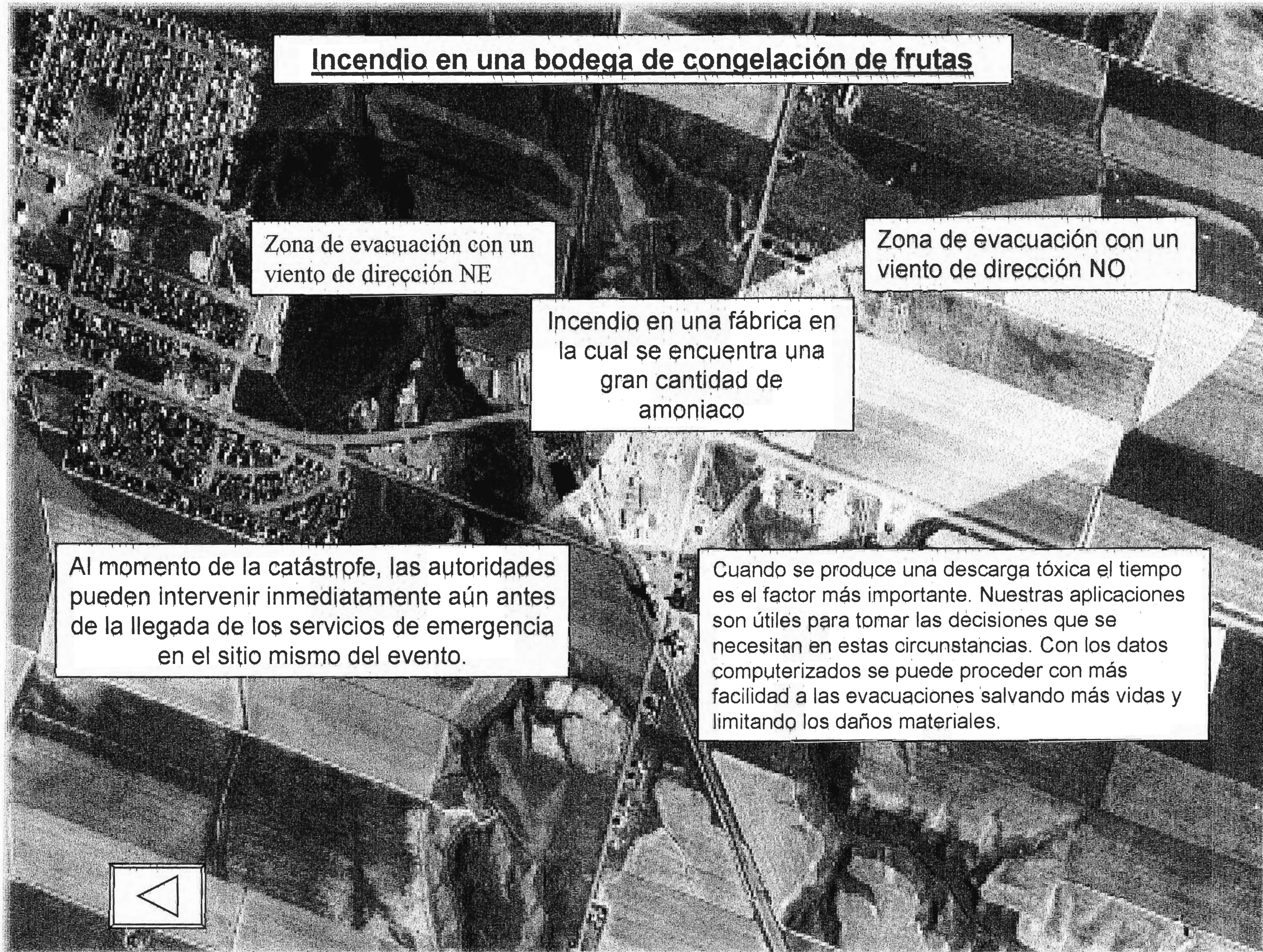
Calculo de coordenadas, utilizando sistema de coordenadas Lambert de las hojas cartográficas

IMPLEMENTACION DEL S.I.G.

Productos del SIG



Manejo de información para atención de emergencias a diferente escala


Incendio en una bodega de congelación de frutas
Zona de evacuación con un viento de dirección NE
Zona de evacuación con un viento de dirección NO
Incendio en una fábrica en la cual se encuentra una gran cantidad de amoniaco
Al momento de la catástrofe, las autoridades pueden intervenir inmediatamente aún antes de la llegada de los servicios de emergencia en el sitio mismo del evento.
Cuando se produce una descarga tóxica el tiempo es el factor más importante. Nuestras aplicaciones son útiles para tomar las decisiones que se necesitan en estas circunstancias. Con los datos computerizados se puede proceder con más facilidad a las evacuaciones salvando más vidas y limitando los daños materiales.

RESPONSABILIDADES DEL USUARIO

Facilitar los datos requeridos para el desarrollo del sistema

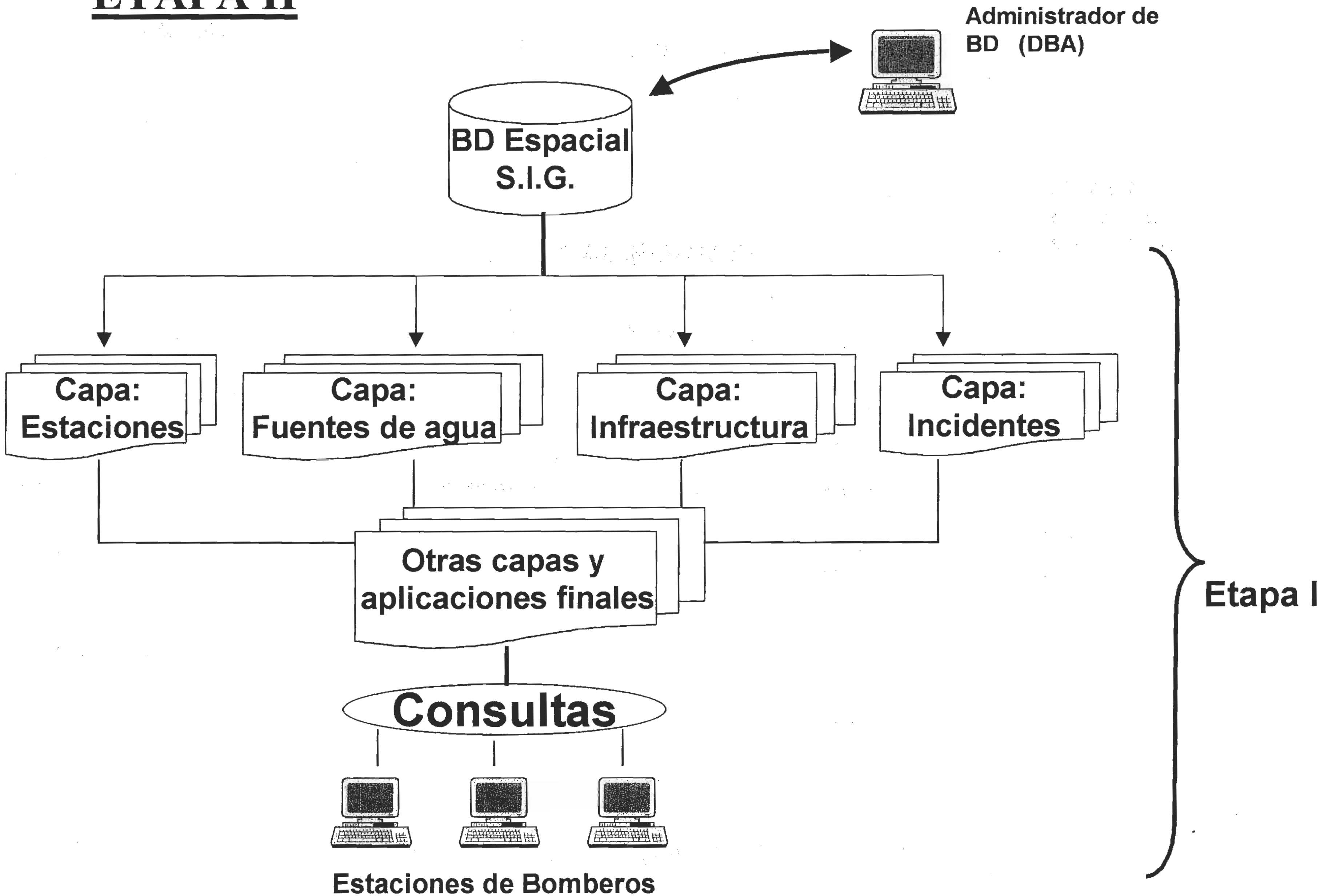
✓ Georreferenciación de datos (Coordenadas X,Y).

✓ Exportación de datos de SIBO.

✓ Generación de datos no existentes.

✓ Generación de información complementaria (Fotografía digital).

ETAPA II


Administrador de
BD (DBA)
BD Espacial
S.I.G.
Capa:
Estaciones
Capa:
Fuentes de agua
Capa:
Infraestructura
Capa:
Incidentes
Otras capas y
aplicaciones finales
Consultas
Estaciones de Bomberos
Etapa II

Appendix D Data Collection Forms (English)

&

Appendix E Data Collection Forms (Spanish)

El Cuerpo de Bomberos de Costa Rica
Formulario para Infraestructura
Nombre:______________________________
Puesto:______________________________
Estacion:______________________________
Area:______________________________

1) Location of Building:

X,Y Coordinates:__________ , __________**Building Code**:__________
Description of location:______________________________
____

Name of Building:______________________________
____
Primary Use: ______________________________
Telephone #:______________ E-mail:__________________
Station that responds to first alarm:_________

2) Building Information:

Number of floors:____(Include plans for each floor)
Evacuation Plans Yes ☐ No ☐
Year of Construction:_______
Physical state of building Good ☐ Regular ☐ Poor ☐

Principal construction material:

Wood ☐ Mixture ☐
Concrete ☐ Description:__________________
Metal ☐ __________________

Utilities:

Transformer bank Yes ☐ No ☐
Location:______________________________
Gas Yes ☐ No ☐ Location:__________________
Elevators Yes ☐ No ☐ Location:__________________

Dangers:

Structural Yes ☐ No ☐

Dangerous Chemicals Yes ☐ No ☐
Explosives Yes ☐ No ☐
Flammable Yes ☐ No ☐
Toxins/Venoms Yes ☐ No ☐
Radioactive Yes ☐ No ☐
Infectious Yes ☐ No ☐

Most Dangerous Chemicals	Amount	Location
__________	_____	__________
__________	_____	__________
__________	_____	__________

3) Building Access:

Access for firefighters Good ☐ Bad ☐
1- Width:__________mts. Location: __________________
2- Width:__________mts. Location: __________________
3- Width:__________mts. Location: __________________

Emergency Exits Yes ☐ No ☐
Number:__________
Condition Good ☐ Bad ☐

Security:

Barbwire/ Razor Wire Yes ☐ No☐
Electronic Security System Yes ☐ No☐
Guards Yes ☐ No☐
Dogs Yes ☐ No☐

El Cuerpo de Bomberos de Costa Rica
Formulario para Infraestructura

Name:
Position:
Station:
Area:

1) Location, Direction of Building: Building COde:

X,Y Coord.:
Address, Description:

Building Name:
Primary Use:
Phone #: E-Mail
Station that responds to first alarm:

2) Building information:

Numbero of floors (Include plans for each floor) Evacuation Plans Yes ☐ No ☐
Year of Construction:
Physical State of Building: Good ☐ Regular ☐ Poor ☐

Principal construction material:
Wood ☐ Mixture ☐ Description:
Concrete ☐
Metal ☐

Utilities:
Transformer bank: Yes ☐ No ☐
Loc
Gas Yes ☐ No ☐ Location:
Elevator Yes ☐ No ☐ Location:

Dangers:
Structural Yes ☐ No ☐

Dangerous Chemicals Yes ☐ No ☐
Explosivs Yes ☐ No ☐
Inflamable Yes ☐ No ☐
Tóxins / venom Yes ☐ No ☐
Radioactive Yes ☐ No ☐
Infectious Yes ☐ No ☐

Most important name	Ammount	Location

3) Building Access:

Access for Fire fighters
1- Width: mts. Location
2- Width: mts. Location
3- Width: mts. Location

Emergency Exits Yes ☐ No ☐
Number : Condition Good ☐ Poor ☐
Security:
Barbed wire Yes ☐ No ☐
Electronic Security System Yes ☐ No ☐
Guards Yes ☐ No ☐
Dogs Yes ☐ No ☐

El Cuerpo de Bomberos de Costa Rica
Formulario para Estaciones
Nombre:______________________________
Puesto:______________________________
Estación:______________________________
Área:______________________________

1) Location, Address of Station:

X, Y Coordinates:__________ , __________ **Station Code**:_______

Address:____

____

Coverage:____________________________

Radio Frequency:______________________

Phone Number:_____________________________

2) Description of Building:

Number of floors:__________(Include plans for each floor)

Year of construction:_______

Principal material of construction:_______________

Physical state of building:______________________

3) Personal:

Name of Chief:____

Name of Firefighters:	Position: (Include if they Are permanent or volunteers)	Home phone number

If you need more space attach an additional page.

Equipment: (For each category, if you need additional space include an extra page)

Fire Trucks: (Include Capabilities and Condition)

____
____
____
____

Hose: For each hose include size and length

______________________________ ________________________
______________________________ ________________________
______________________________ ________________________
______________________________ ________________________

Other Equipment (Portable Pumps, etc.): Include description

____
____
____
____

Firefighting Chemicals (Include amount and name):

____
____
____

Tanks:_______ (Volume)

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre:______________________________
Puesto:______________________________
Estacion:_____________________________
Area:________________________________

General Information

1) Location **Water source code:** ____-____-____

X,Y Coordinates ____________ , ___________

Description of Location____

____

____

2) Ownership

Public ☐
Private ☐

Contact Information:

Name:______________________________
Position:____________________________
Telephone #:_________________________
Postal Address:_______________________
E-mail:______________________________

Types of Sources

3) Hydrants

Connected to:
Public Line ☐ Tank ☐

Tank characteristics:
Above Ground ☐ Under Ground ☐ Aerial ☐
Volume (m^3) ____________________

Diameter of Mouth 2 ½" ☐ 4" ☐ 4 ½" ☐
Number of turns to obtain water ______

Physical state of hydrants

Excellent ☐ Good ☐ Regular ☐ Poor ☐

Excellent: Recently installed, excellent condition, fully functional. Does not need repairs
Good: Fully functional, but damaged from use.
Regular: Works, but needs repairs.
Poor: Needs replacement. Does not work.

Capacity

Flow (gpm)__________Pressure(psi):______(Static)______(Dynamic)__________

Indicate here if you need additional tools to obtain the water:

Hydrant key ☐ Pipe key ☐
Cube key ☐ Pry bar ☐
Additional Valve ☐

Location of tool:____

4) Visible or covered water

Visible ☐ Covered ☐ Volume-m^3 ______________

Pools ☐
Lakes ☐
Rivers ☐ Description:______________________________
Tanks ☐ ____
Subterranean Deposit ☐ ____

Access Conditions:

Method of obtaining the water:
Turbine ☐ Description:______________________________
Suction tube ☐ ____
Portable Pump ☐ ____

5) Other Notes (access problems, special conditions, dangers & risks, etc.) ______

____

____

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Name:
Position:
Station:
Area:

General Information

1) Location & Direction **Water source code**

X,Y Coordinats

Address:

2) Ownership

Public ☐
Private ☐

Contact Information

Name:
Pos
Ph
Address:
E-mail address:

Types of Sources

3) Hydrants

Connected to:

Public Pipe ☐ Tank ☐

Tank Characteristics:

Visibal ☐ Under ground☐ Aerial ☐

Volume (m^3

Diameter of largest mouth 2 ☐" ☐" 4☐½"

Number of turns to release the water

Physical state of the hydrants

Excelent ☐ Good ☐ Regular☐ Poor☐

Excelent: Recently installed, in excelent condition, and fully functional. Does not need repairs.
Good: Fully functional but worn by use.
Regular: Works, but needs repairs.
Poor: Needs replacement, does not work.

Capacity

Cuality (g Presure(psi): (Sta (Dyn

Indicate here if you require an additional tool to obtain the water.

Hydrant key ☐ Pipe key ☐
Cube Key ☐ Pry Bar ☐
Additional Valv☐

Location of to

4) Visible or covered water

Visible ☐ Covered ☐ Volume-m^3

Pools ☐
Lakes ☐
Rivers ☐
Tank ☐
Subterranean Deposite ☐

Description:

Access conditions:

Way to obtain the water(method of suction):

Turbine ☐
Suction tube ☐
Portabel Pump ☐

Description:

5) Other notes (access problems, special conditions, dangers and risks, etc.)

El Cuerpo de Bomberos de Costa Rica
Formulario para Infraestructura
Nombre:______________________
Puesto:______________________
Estacion:______________________
Area:______________________

1) Ubicación, dirección del Edificio:

X,Y Coordenadas:__________ , __________**Código de Estructura**:______
Dirección por señas:______________________________________
____

Nombre del edificio:______________________________________
Actividad que realiza: ______________________________________
Teléfono:________________ E-mail:____________
Estación que responde en primer alarma:__________

2) Información del Edificio:

Numero de pisos:____(Incluye planes por cada piso)
Planes de evacuación Si ☐ No ☐
Año de construcción:_______
Estado actual del edificio Bueno ☐ Regular ☐ Malo ☐

Material principal de construcción:
Madera ☐ Mixto ☐
Concreto ☐ Descripción:______________
Metal ☐ ______________

Servicios:
Banco de transformadores Si ☐ No ☐
Ubicación:______________________________
Gas Si ☐ No ☐ Ubicación:________________
Ascensor Si ☐ No ☐ Ubicación:________________

Peligros:
Estructurales Si ☐ No ☐

Químicos peligrosos Si ☐ No ☐
Explosivos Si ☐ No ☐
Inflamable Si ☐ No ☐
Tóxicos / venenosos Si ☐ No ☐
Radiológicos Si ☐ No ☐
Infecciosos Si ☐ No ☐

Nombres más importantes	Cantidad	Ubicación
________________	________	______________________
________________	________	______________________
________________	________	______________________
________________	________	______________________

3) Acceso del Edificio:

Acceso para Bomberos Bueno ☐ Malo ☐
1- Ancho:__________mts. Ubicación: ______________________
2- Ancho:__________mts. Ubicación: ______________________
3- Ancho:__________mts. Ubicación: ______________________

Salidas de emergencia Si ☐ No ☐
Cantidad:__________
Condición Buena ☐ Mala ☐

Seguridad:
Alambre de navaja Si ☐ No☐
Sistema de seguridad electrónico Si ☐ No☐
Guardas Si ☐ No☐
Perros Si ☐ No☐

El Cuerpo de Bomberos de Costa Rica
Formulario para Infraestructura

Nombre:
Puesto:
Estacion
Area:

1) Ubicación, dirección del Edificio: Código de Estructura:

X,Y Coordenadas:
Dirección por señas:

Nombre del edificio:
Actividad que realiza:
Teléfono: E-Mail
Estación que responde en primer alarma

2) Información del Edificio:

Numero de pisos: (Incluye planes por cada piso) Planes de evacuación Sí☐ No☐
Año de construcción:
Estado actual del edificio: Bueno☐ Regular☐ Malo☐

Material principal de construcción:
Madera ☐ Mixto ☐ Descripción:
Concreto ☐
Metal ☐

Servicios:
Banco de transformadores Sí☐ No☐
Ubic
Gas Sí☐ No ☐ Ubicacion
Ascensor Sí☐ No ☐ Ubicacion

Peligros:
Estructurales Sí☐ No☐

Químicos peligrosos Sí ☐ No ☐
Explosivos Sí ☐ No ☐
Inflamable Sí☐ No ☐
Tóxicos / venenosos Sí ☐ No ☐
Radiológicos Sí ☐ No ☐
Infecciosos Sí ☐ No ☐

Nombres más importantes	Cantidad	Ubicación

3) Acceso del Edificio:

Acceso para Bomberos
1- Ancho: mts. Ubicación
2- Ancho: mts. Ubicación
3- Ancho: mts. Ubicación

Salidas de emergencia Sí☐ No☐
Cantidad Condicion Buena ☐ Mala ☐
Seguridad:
Alambre de navaja ☐ Sí ☐No
Sistema de seguridad electrónico ☐ Sí ☐No
Guardas ☐ Sí ☐No
Perros ☐ Sí ☐No

El Cuerpo de Bomberos de Costa Rica
Formulario para Estaciones
Nombre:______________________________
Puesto:______________________________
Estación:______________________________
Área:______________________________

1) Ubicación, dirección del Estación:
Coordinas X,Y:____________ , __________ **Código de Estación:**_______
Dirección por señas:____
____
Cobertura:______________________________
Clave de radio:__________________________
Teléfono:______________________________

2) Descripción del Edificio:
Numero de pisos:__________(Incluye planes por cada piso)
Ano de construcción:_______
Material principal de construcción:_______________
Estado fiscal del edificio:______________________

3) Personal:
Nombre del Jefe:____

Nombres de los Bomberos:	Puesto: (Incluye sí ellos son permanentes o voluntarios)	Numero de teléfono en casa:

Si necesitas mas espacio incluye una hoja adicional.

Equipó: (Por cada categoría, si necesitas mas espacio incluye una hoja adicional)

Las Maquinas: (Incluye capabilidades y condición)
____
____
____
____

Manguera Suave: Por cada manguera incluye talle y (length)
_________________________ _________________________
_________________________ _________________________
_________________________ _________________________
_________________________ _________________________

Otro Equipo (Bombas portátil, etc.): Incluye descripción
____
____
____
____

Químicos contra incendios (Incluye volumen y nombre común):
____
____
____

Tanques:__________ (Volumen)

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre:________________________________

Puesto:________________________________

Estacion:______________________________

Area:__________________________________

Información General

1) Ubicación, dirección **Código de toma de agua** _____-_____-_____

X,Y Coordenadas ____________ , ___________

Dirección por señas ____

____

____

2) Propietario

Publico ☐

Privado ☐

Información del contacto:

Nombre:________________________________

Puesto:________________________________

Teléfono:______________________________

Apartado postal:________________________

Dirección de correo electrónico:_______________

Tipos de fuentes

3) Hidrantes

Conectado a:

Red publica ☐ Tanque ☐

Características del Tanque:

Superficial ☐ Subterráneo ☐ Aéreo ☐

Volumen (m^3) ___________________

Boca de mayor diámetro 2 ½" ☐ 4" ☐ 4 ½" ☐

Numero de vueltas para que salga agua ______

Estado físico de los hidrantes

Excelente ☐ Bueno ☐ Regular ☐ Malo ☐

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.

Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.

Regular: Es operable, pero necesita reparaciones.

Malo: Necesita un reemplazo, no puede usarse.

Capacidad

Caudal (gpm)________Presión(psi): (Estática)______(Dinámica)________

Indique aquí si se requieres accesorios adiciónales para extraer el agua:

Llave de hidrante ☐ Llave de cañería ☐

Llave de cubo ☐ Volante de válvula ☐

Válvula Adicional ☐

Disponible en:____

4) Agua superficial o cubierta

Superficial ☐ Cubierta ☐ Volumen-m^3 _______________

Piscinas ☐

Lagos ☐

Ríos ☐ Descripción:______________________________

Tanque ☐ ______________________________

Deposito subterráneo☐ ______________________________

Condiciones de Acceso:

Forma para la toma de agua (método de succión):

Turbina ☐ Descripción:______________________________

Tubo de succión ☐ ______________________________

Bomba portátil ☐ ______________________________

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)

____

____

El Cuerpo de Bomberos de Costa Rica
Formulario para Incidentes

Nombre:______________________
Puesto:______________________
Estacion:______________________
Area:______________________

1) Ubicación, dirección

X,Y Coordenadas ____________ , ____________
Dirección por señas ____
____
____

2) Propietario

Publico ☐
Privado ☐

Información del contacto:
Nombre:______________________________
Puesto:______________________________
Teléfono:______________________________
Apartado postal:______________________________
Dirección de correo electrónico:______________________

3) Tipo de incidente:

Incendio ☐
Tipo de Incendio________________
Accidente de Transito ☐
Eléctrico ☐
Resigue ☐

Descripción del incidente:____
____
____

4) Nombre de Estación(es) que responde ____________, ____________, ____________

5) Casualidades (Incluye descripción de heridos)
____
____
____
____
____

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre ______
Puesto: ______
Estacion ______
Area: ______

Información General

1) Ubicación, dirección **Código de toma de agua** ____ ____ - ____

X,Y Coordenadas ____ ____.

Dirección por seña ______

2) Propietario

Publico ☐
Privado ☐

Información del contacto

No ______
Pu ______
Te ______
Apartado p ______
Dirección de correo electrónico ______

Tipos de fuentes

3) Hidrantes

Conectado a:

Red publica ☐ Tanque ☐

Características del Tanque:

Superficia ☐ Subterrán ☐ Aére ☐

Volumen (n ______.

Boca de mayor diámetro 2 ½ ☐ 4 ☐ 4 ½ ☐

Numero de vueltas para que salga agu ______.

Estado físico de los hidrantes

Excelente ☐ Bueno ☐ Regula ☐ Mal ☐

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.
Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.
Regular: Es operable, pero necesita reparaciones.
Malo: Necesita un reemplazo, no puede usarse.

Capacidad

Caudal (g ______ Presión(psi): (Est ______ (Diná ______

Indique aquí si se requieres accesorios adiciónales para extraer el agua:

Llave de hidran ☐ Llave de cañer ☐
Llave de cubo ☐ Volante de válvula ☐
Válvula Adicion ☐

Disponible en ______

4) Agua superficial o cubierta

Superficial ☐ Cubierta ☐ Volumen-m ______

Piscinas ☐
Lagos ☐
Ríos ☐ Descripción: ______
Tanque ☐
Deposito subterráneo ☐

Condiciones de Acceso:

Forma para la toma de agua (método de succión):

Turbina ☐ Descrip ______
Tubo de succión ☐
Bomba portátil ☐

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)

______

Appendix F

Instrucciones para utilizar el Formulario de Fuentes de Agua

General: El objetivo de este formulario es brindar una ayuda en la recolección de datos de fuentes de agua. Fue diseñado para estandarizar la metodología y facilitar el acceso a la información importante.

Encabezado del Formulario: Esta sección fue diseñada para proveer información básica de los Bomberos quien está colectando los datos Como: nombre, estación, etc.

Información General: El objetivo de esta sección es obtener datos básicos e importantes de cada fuente de agua.

1) Coordenadas X,Y: La información se obtendrá por medio de GPS, escribe los datos en este espacio.

Ubicación/ Dirección: Use este espacio para indicar la ubicación y dirección exacta de la fuente de agua. Por ejemplo: 75 Metros Oeste de Taco Bell

Código de toma de Agua: En este espacio se asignara a cada fuente un código único.

Ejemplo: 1-5-3-2

Este es el código único para un hidrante en el tercer área del distrito de Pavas.

Los primero dos números, 1-5, designan la estación. (Pavas)

El tercer numero, 3, designa el área.

El cuarto numero, 2, designa la fuente específica

2) Propietario:

Indique aquí el propietario de la fuente de agua.

A) Si es publico, puede continuar a la sección por la fuente de agua.

B) Si es privado, puede completar la sección de la información del contacto.

3)Hidrantes: Si la fuente es una hidrante, complete esta sección.

Conectado a: Indique si el hidrante esta conectado a una red publica o un tanque

Si esta conectado a un tanque, complete el área debajo de la opción.

Appendix F

Boca de mayor diámetro: Indique aquí el diámetro de la las salidas del hidrante

Numero de vueltas para que salga agua: Escribe aquí él numero de vueltas necesarias para que salga el agua

Estado físico de los hidrantes: Indique aquí el estado físico del hidrante. Lea las definiciones. Y escoja la mejor opción.

Capacidad: Use este espacio para anotar las características del flujo y presión

Indique aquí si requiere accesorios adicionales para extraer el agua: Si necesitas un accesorio adicional escoja la accesorio y indique aquí, también indique donde puede obtener lo.

4) **Superficial o Cubierta:** Indique si la fuente es superficial o cubierta, incluye el volumen y tipo de fuente. Si necesario use el espacio a la derecha que corresponde a la descripción de la fuente.

Condiciones de Acceso: Escoja el método de succión y si es necesario describe el método de succión a utilizar en el espacio de la derecha

5) **Otras notas:** Escribe aquí toda aquella información que considere importante.

6) **Agregar Definiciones:**

1) **Tomas de agua superficiales:** Estés son tomas de agua que puede ver. Como piscinas, ríos, lagos etc.

2) **Tomas de agua subterráneas(cubierta):** Estés son tomas de agua que no puede ver. Como tanques o otros depósitos subterráneos.

3) **Tomas de agua aéreas:** Estés son tomas de agua elévate como una torre de agua.

Appendix I

Procedure for Collection of Water Source Data

1) Divide the fire zone into five areas.

The first step in preparing to collect the data about water sources is dividing the fire zone into five areas. These areas should be divided based on natural features or major roads. No matter what feature is used to divide the areas, the divisions should be clear so there is no confusion as to in which area a water source is located.

2) Locate the Water Sources and Collect the Data

There are two methods that can be used to complete this step depending on the needs of the specific station.

2.1 Total Data Collection

This method involves collecting all the data about the water sources in one pass. To collect the data in this method requires the presence of a pump truck to measure the pressure as well as enough Bomberos to man the truck.

This method is best used by stations that have both the time and manpower to devote these significant resources to data collecting.

2.2 Two Step Data Collection

This method involves collecting the data about the water sources in two distinct steps. The first step involves simply locating and cataloguing the water sources. As few as one or two Bomberos using any vehicle available can do this. They would locate the water sources, and record the location and visible data. The second step would involve bringing a pump truck out to these pre-catalogued sources and measuring the pressure.

This method is best used by station with limited man power or in areas where it would be prohibitively difficult stop a fire truck at each hydrant and record all the data (Such as in a major city)

In both cases while the water source is being catalogued the station and zone code should be recorded so that the assigning of individual codes can be easily completed.

3) Assign Codes and Locate the Sources on a Map

The next step in collecting the data on water sources is to assign unique codes to each water source. The labeling of the water sources should start in the most remote part of each area. The water sources should be numbered sequentially proceeding in a logical manner through the zone.

3.1 Pin & Map System

If the pin and map system is being used the water sources should be carefully located on the map of the fire zone, flags or paper tags should be used so each pin is labeled with the code assigned to the water source it makes. Labeling the pins ensures the proper data sheet is connected with the proper water source on the map.

3.2 GPS System

If the GPS is being used to locate the water sources the GPS location should be entered into the database along with the corresponding data.

Appendix I

Metodología para la Recolección de Información de Fuentes de Agua

1) Define las áreas

Este es el primer paso en la colección los datos de fuentes de agua. Define las áreas en la zona de la estación. Las áreas deben ser separados usando carreteras, ríos o otros cosas visibles.

2) Ubique los Fuentes de Agua y Recolecte los Datos

Hay dos métodos que puede usar para completar este paso, depende en la estación.

2.1 Método Uno:

En este método colectando todos los datos de las Fuentes de Agua son colectando en un paso. Para colectar los datos requiere una maquina a la fuente de agua y Bomberos suficiente para operar la maquina.

Este método debe ser usado en estaciones que tienen el tiempo, maquinas y Bomberos para completar este método.

2.2 Método Dos

En este método los datos de fuentes de agua son colectando en dos pasos diferentes. El primer paso es solamente ubicar las fuentes de agua y colectar los datos visibles. Este método puede ser completado con solamente uno o dos Bomberos.

El segundo parte de este método necesita una maquina para colectar los datos como flujo y calidad.

Este método debe ser usado en estaciones donde es tan dificil a traer una maquina a cada fuente de agua. Por ejemplo en una ciudad o otra área con mucho transito.

En los dos métodos es importante recordar el nombre de la estación y el código de la área para ayudar en el asignado de códigos únicos.

3) Asigne Códigos y Ubique los Fuentes en el Mapa

La próxima paso en la colección de datos es asignar un código único a cada fuente de agua. Empiece en el punto más lejano de la área y asigne un numero a cada toma de agua.

3.1 Sistema de Alfileres y Mapas

Si la sistema manual esta usando, los fuentes de agua debe ser ubicado en la mapa de la zona y banderas debe ser usado para marcar un código a cada fuente de agua. Las banderas con los códigos se aseguran que los formularios corresponden con la correcta fuente de agua.

Appendix I

3.2 Sistema GPS

Si el GPS esta usando para ubicar las fuentes de agua, la ubicación debe ser entrada en la base de datos con la información correspondiendo.

Appendix J

Meeting Minutes

Monday May 28, 2001 Central San Jose Fire Station

Purpose: Discuss tentative forms with fire chiefs of districts included in San Jose.

Attendees: Dagoberto Arias, Hector Chaves Leon, Walter Mora, Natalie Woodworth, Eric Kenney, Lisette Manrique and 5 station chiefs

Meeting Notes:

Discussed overall GIS plan

GIS scheme: Water Sources info & Infrastructure info need to be collected simultaneously to lead to database for complete GIS

Discussed changes for water sources form:

- Terminology—change 'Sector' to 'Area' due to miscommunication in fire language
- Tanks—include aerial tanks
- Additional Accessories—added additional valve category
- Private water—questions raised about permission to use private water. They plan on sending out a permission form to the owner using the contact information included on the data collection sheet.

Training:

- Training for the firefighters will be necessary for all data collectors to fully understand terminology and to use form most efficiently.

Appendix J

Thursday May 31, 2001 Central San Jose Fire Station

Purpose: Discuss further forms with more fire chiefs of districts included in San Jose.

Attendees: Hector Chaves Leon, Walter Mora, Natalie Woodworth, Eric Kenney, Lisette Manrique and 5 station chiefs

Meeting Notes:

Don Hector gave our power point presentation.

Explained each step in data collection (water sources) there were some questions over the methodology but after discussion between Don Hector and the chiefs the forms were distributed as is.

Maps and pins were given out to mark the location of the hydrants.

Decide to begin data collection in 7 greater San Jose area stations.

Appendix J

Wednesday June 6, 2001 Ana-Maria Ortega's Office: INS

Purpose: Discuss status of water source data collection.

Attendees: Esteban Ramos, Walter Mora, Ana Maria Ortega, Natalie Woodworth, Eric Kenney, 2 members of INS (IS) Head of the GIS project.

Meeting Notes:

The status of the data collection was discussed.

The INS staff members were brought up to date on the current plan as well as the time line. At this point 7 stations in the greater San Jose area are collecting their data on water sources. They have 15 days to do this.

There were some questions over the procedure observed in the Pavas fire district. The maps were not being marked as the water sources were recorded. It was decided to return to the Pavas district as well as the Barrio Mexico district to observe Los Bomberos for a second day. We will see how they coordinate the map points with the data sheets.

If the procedure is satisfactory the data collection will continue. However if the procedure is not satisfactory the collection will be halted in all 7 districts. We will then concentrate in one district in one area to ensure that the procedure is being followed correctly and that the points and sheets are being successfully coordinated.

Appendix J

Thursday June 7, 2001 Pavas fire station

Purpose: Discuss progress of water collection. GIS in general

Attendees: Pavas station chief, Ana Maria Ortega, Estaban Ramos, Walter Mora, Professor Salazar, Professor Elmes, Natalie Woodworth, Eric Kenney

Meeting Notes:

GPS: Talked about use of GPS to locate the water sources. It would eliminate the need for the maps. This would solve the problem of associating the pins on the maps with the individual data sheets. It would also be able to locate the hydrants as well as the access points for the other water sources more accurately then using descriptions. Los Bomberos have 4 GPS' that they are now planning to use in the city to locate the hydrants. The Pavas, Mexico, Lujon and Central stations will be using the GPS, the other 3 stations will stop data collection until collection with the GPS' has been tested (completed).

Forms: The Fuentes de Agua form is working fine. The problem exists in associating the proper form with the hydrant. Talked about putting a section in the Edificios form in case the building had a tank or other water source inside.

Appendix J

Interview: June 11, 2001

Office of Esteban Ramos 2:30 p.m.

Present:
Jose Conejo, Designed SIBO System
Esteban Ramos, Eric Kenney, Lisette Manrique, Natalie Woodworth

Questions:

1) What program did you use to write SIBO?
2) What methods were used to collect the data that is in SIBO?
3) Do you know of any problems that exist with SIBO? If so, what are they?
4) Who put the data into the program?
5) What program do you think should be used for the GIS database?
6) What properties should the new database have?
7) What should one keep in mind when designing a database?

1) Que programa usted usaba para escribir SIBO?
2) Que metodos fueron usando para colectar la informacion que esta en SIBO?
3) Sabe si hay algunas problemas con SIBO ahora? Y si cuales son?
4) Quien ponia los datos en el programa?
5) Que programa deberia usar para el base de datos del GIS?
6) Cuales calidades debe tener el nuevo baso de datos?
7) Que podemos tener en mente cuando estamos disenando un base de datos?

Notes: SIBO a DOS based program has problems interfacing with Windows.
Can transfer data from SIBO to Access

Programs to use: Access or Excel, Access is better
Data can be transferred from Palm Pilot (Excel) to PC (Excel) and then put into Access format.
Excel data must be in rows, not columns for Access to understand it.

For SIBO the Bomberos stations were given forms to fill out, these forms were collected and entered into SIBO

Data entered by OCO operators.

Appendix J

Minutes of Elite Interviews
Thursday June 14, 2001

Interview Question Format:

After explaining the differences between using GPS and pin method, being careful not to lead the interviewee toward either method:
1) Which would you prefer to record the location of water sources?

After explaining the capabilities of a Pocket PC and discussing with them the advantages and disadvantages of both the Pocket PC and the paper form:
2) What method seems better for collecting information in the field?

To probe for data on the old data collection method and the progress of the new data collection method:
3) How was the data that is now stored in SIBO collected?
Note: After asking this question, we learned that they did not rely on the data stored in SIBO, but their own files instead. We then made the rest of the questions apply to their own forms since that was the data collection method that they were aware of.

4) Did the firefighters use forms?
Were all the forms the same?
What information was contained in the form?
Note: This form is included in Appendix L.

5) Do you think that this method of collecting data provided you with results that you could trust?

6) What information is in the new form that is not currently in your file system?

7) How long is data good for before it becomes obsolete or unreliable?

8) Have you found any problems with the new data collection procedure? What are they?

9) Which method of data collection to you prefer? Why?

Tibas Henry Morales Alvarado

1) Felt like GPS currently isn't important for the station to respond to emergency

Realized on his own that GPS was important for use with GIS

Appendix J

Decided that both methods are important to use while collecting data now

2) Initial reaction was that the Pocket PC was complicated
Concluded that paper forms were simple, but Pocket PC is good alternative option

3) He did not know how the data in SIBO was collected, and informed us that the information that they use to respond to emergencies (other than the location and type of incident—which both come from OCO) was stored in files at the station. He then continued to explain to how the firefighters collected the information on those forms. He said that they did field work, visiting all potentially hazardous structures within their district, then recording the data on their data collection forms. Three copies of this form were filed, two in the station, and one in the fire truck.

4) Yes, they used forms to collect the data, which were all the same from station to station. This form included information about potentially hazardous structures, including: building name, location, contact info, haz-mats, structural dangers, building contents, nearby hydrants, security systems, company administering use of water, and building use. There were also 2 blank squares allowing for floor plans and a small map of the surrounding area to be drawn.

5) Henry Morales was not completely confident in the forms that they used because he felt like it was lacking detailed information about water sources. He had trust in most of the information that the collected but felt that there was data missing.

6) New information included all the specifics on the water sources data, except for the location and fact that it was a hydrant. In addition info on hidden or superficial water could also be included on the new form.

7) This data becomes obsolete after about 6 months for hydrants. No detailed explanation was given.

8) The current problems with the new form is that the dynamic pressure was not relevant to their collection, since when connected to the same pipelines the static pressure is the only thing they need to determine flow rate. Flow rate was not filled out on their forms either, because he said that they could calculate it later at the station.

9) The new method is better because the form is more explicit and has more detailed information bout water sources, which is necessary for optimal fire response.

Central Jorge Murillo Araya

1) Presently they are only using pins but he feels that both GPS and pins are important. Having coordinates is better for GIS.

2) Pocket PC is good because it passes the information without having to be re-entered. The paper on the other hand goes through several people before being finally entered into the database, causing more discrepancies. He is overall inclined to the Pocket PC especially since it has office uses outside of data collection and is faster in the end.

3) Same info provided about past data collection procedure as given by Henry Morales Alvarado from the Tibas station. He agreed that the same forms/sheets were used in data collection at the Central Station. He also stated that the information obtained from OCO included the type of incident, location of emergency, address, and station which should respond to the fire.

4) Same as before.

5) Jorge Murillo was hesitant to say that the information they currently had was "reliable," but was mostly opposed to stating this because of the frequent changes in the correct information. He agreed that when first collected the data was probably correct, but still lacked all the detail that he hoped to have for the best possible fire response.

6) As stated before, Jorge Murillo agreed that the important things included on the new form were the details on the water source information.

7) Data becomes obsolete fairly quickly. He felt that data would be accurate for 3 years at the most. Stated that things change so quickly, it's hard to believe that they are correct.

8) The current problems with the new form is they cannot collect the pressure and flow rate information because since they are in downtown San Jose it is impossible to bring the fire truck with them to collect data. They need to collect this information later, over the weekends or at night. The other comment he made was that the volume of tanks would not always be accurate, since some are filled with rain water, or used regularly, and the volume of water inside varies.

9) He also agreed that the new method is better because the form is more explicit and has more detailed information bout water sources, which is necessary for optimal fire response.

Barrio Lujon Walter Sanchun Arneaz

1) On the map it's easier to communicate where the location is by using the pins, but use of the GPS is also important.

Appendix J

2) Prefers Pocket PC because it is more practical and fast. Concerned about data transfer because many of the computers used in the stations don't have UBS ports.

3) The current data collection process works but the optimal choice would be to have the exact information they need when they arrive somewhere. If they have the info, OCO provides them with type of incident, type of structure, what traffic problems they might find, where it's occurring, what type of building it is, if there are victims, non-functional hydrants, or additional valves to reach water.

4) Same as above again.

5) Walter Sanchun Arneaz didn't say that the information they had was reliable because he felt that there was exact information they were lacking. He also felt they have other problems: They have limited resources for communication: often the radios don't work, perhaps cellular communication would help this. Concerned with hazardous material info and making construction info apply to structures typical of Costa Rica.

6) Obviously Walter Sanchun Arneaz agreed that the important things included on the new form were the details on the infrastructure form: hazardous materials, and structural material, as well as the more detailed info on the water source form.

7) Data is reliable for about 3 to 6 months. Reasons for unreliability: people build around them, when they fix the streets they close hydrant valves, cars crash into hydrants, etc.

8) The current problems with the new form is that they prefer the volume to be in gallons rather than cubic meters. He found the flow rate easy to find with the use of the fire truck. He was concerned about including the electricity info on the infrastructure form.

Appendix J

9) He also agreed that the new method is better because the form is contains more detail regarding water sources and additional risks.

Meeting Notes: June 25-27 Guanacaste Province

Ronny Alvarado Canas

Stated that the paper form was simple, but not "21st century." He preferred the Pocket PC for data collection. Was very excited overall about the GIS.
Used the same forms for previous data collection. Also have additional information for their area only about location of hydrants, just a map with some dots on it, representing hydrant location. No info about the hydrants is known.
Same differences between previously used forms and new data forms.
Main difference between info. in country compared to data in metropolitan areas: The stations outside of the immediate San Jose area do not get any information from O.C.O. because calls go directly to the station through 118. Fewer emergencies here-about 8-10 a month, and most are traffic related accidents. Feels data is good for a long time because things change so little out there. Data would only change if another hydrant/water source was added to the area.

Tomas Morales Liberia

Liked the paper form due to being accustomed to it, but felt that the Pocket PC would eventually be necessary and realized its advantages in entering data quickly.
Same sheets used in previous data collection, no further information acquired.

Javier Nolasco Guevara Gomez Nicoya

Stated that the form contained all the typical information that Los Bomberos would need for fire response. Liked the form on the Pocket PC and remarked that it was "Complete". Also liked the idea of the GIS as a whole; and said that the data about hydrants was very slow to change in the area. Filled out a form and said that it was easy to use.

Appendix K

Observation of Pavas Bomberos in the field: Water forms.

Monday June 4

1 Engine, 8 Bomberos, Walter Mora, Lisette Manrique, Natalie Woodworth, Eric Kenney

Jarol Hildago: Filled out the Water Data Forms.

- Only checked fire hydrants
- Worked in 2 sectors of area 1: ~ 10am to 2pm for 1st sector, ~3pm to? 2nd sector
- Hydrants were found, checked and assigned a number 1,2,3 etc. based on what order they were found
  - Makes sense, less time out in the field
  - Did start in furthest corner of zone 1
- Approx: 5 min/hydrant
  - By the time the truck stopped, the hydrant had already been opened and closed.
  - As soon as the hose was connected to the hydrant it was connected to the truck.
- Most hydrants ~27 of 30 in "Good" condition
- A few ~3 of 30 broken, need replacement…broken screw valves generally the major problem.
- Occasionally problems with access to private hydrants: ICE, but access was granted.
- Multiple source locations: mark as one when all connected to the same source special note indicating multiple hydrants: building complexes
- Pressure: only static recorded; dynamic too hard to check
- Flow rate not checked: formula to determine flow using pressure and area.
- X,Y coordinates NOT used
- Header NOT used.
- Generally the form was easy to use

Appendix K

- Map not marked in the field.... too unwieldy
- Several Bomberos took their own notes on each hydrant

Note: 15 days to complete their zone

All stations are doing this.

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre: Erik Quesada Ortiz
Puesto: B III
Estacion: Bo Lujan
Area:

Información General

1) Ubicación, dirección **Código de toma de agua** ___ - ___ - ___

X,Y Coordenadas ___ , ___ .

Dirección por señas: Avenida 15, calle 37
Restaurante Crepes

2) Propietario

Publico ☑
Privado ☐

Información del contacto

Nombre:
Puesto:
Teléfono
Apartado postal:
Dirección de correo electrónico:

Tipos de fuentes

3) Hidrantes

Conectado a:

Red publica ☑ Tanque ☐

Caracteristicas del Tanque:

Superficial ☐ Subterráneo ☐ Aéreo ☐

Volumen (m^3) ___ .

Boca de mayor diámetro 2 ½ ☐ 4 ☐ 4 ½ ☑

Numero de vueltas para que salga agua 1/2

Estado fisico de los hidrantes

Excelente ☑ Bueno ☐ Regular ☐ Malo ☐

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.
Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.
Regular: Es operable, pero necesita reparaciones.
Malo: Necesita un reemplazo, no puede usarse.

Capacidad

Caudal (gpm) 1215 Presión(psi): (Estática) 50 (Dinámica) 80

Indique aquí si se requieres accesorios adiciónales para extraer el agua:

Llave de hidrante ☑ Llave de cañería ☐
Llave de cubo ☐ Volante de válvula ☐
Válvula Adicional ☐

Disponible en M-27

4) Agua superficial o cubierta

Superficial ☐ Cubierta ☐ Volumen-m

Piscinas ☐
Lagos ☐
Ríos ☐
Tanque ☐
Deposito subterráneo ☐

Descripción:

Condiciones de Acceso:

Forma para la toma de agua (método de succión):

Turbina ☐
Tubo de succión ☐
Bomba portátil ☐

Descripción

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre: Erik Quesada Ortiz
Puesto: B III
Estacion: Bo Lujan
Area:

Información General

1) Ubicación, dirección **Código de toma de agua** [ ] [ ] - [ ]

X,Y Coordenadas [ ] [ ].

Dirección por señas: Avenida 9, calle 19
Panaderia La Selecta

2) Propietario

Publico ☑
Privado ☐

Información del contacto

Nombr
Puesto
Teléfo
Apartado post
Dirección de correo electrónico:

Tipos de fuentes

3) Hidrantes

Conectado a:

Red publica ☑ Tanque ☐

Características del Tanque:

Superficial ☐ Subterráneo ☐ Aéreo ☐

Volumen (m^3) [ ].

Boca de mayor diámetro 2 ½ ☑ 4 ☐ 4 ½" ☐

Numero de vueltas para que salga agu 2 .

Estado físico de los hidrantes

Excelente ☐ Bueno ☑ Regular ☐ Malo ☐

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.
Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.
Regular: Es operable, pero necesita reparaciones.
Malo: Necesita un reemplazo, no puede usarse.

Capacidad

Caudal (gpm 327 Presión(psi): (Estátic 35 (Dinámic 100

Indique aquí si se requieres accesorios adiciónales para extraer el agua:

Llave de hidrante ☑ Llave de cañería ☐
Llave de cubo ☐ Volante de válvu ☐
Válvula Adiciona ☐

Disponible en M-27

4) Agua superficial o cubierta

Superficial ☐ Cubierta ☑ Volumen-m^3 [ ]

Piscinas ☐
Lagos ☐
Ríos ☐ Descripción:
Tanque ☐
Deposito subterráneo ☐

Condiciones de Acceso:

Forma para la toma de agua (método de succión):

Turbina ☐ Descripción
Tubo de succión ☐
Bomba portátil ☐

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre: Michael Marin Herra
Puesto: Bombero III
Estacion: Barrio Mexico
Area:

Información General

1) Ubicación, dirección **Código de toma de agua** 3-1 1-2 2001

X,Y Coordenadas

Dirección por seña: Costado sur-este de la Pozuelo, frenta a FONT

2) Propietario

Publico ☑
Privado ☐

Información del contacto

Nombre:
Puesto:
Teléfono:
Apartado postal:
Dirección de correo electrónico:

Tipos de fuentes

3) Hidrantes

Conectado a:
Red publica ☑ Tanque ☐
Caracteristicas del Tanque:
Superficial ☐ Subterráneo ☐ Aéreo ☐
Volumen (m^3)

Boca de mayor diámetro 2 ½ ☐ 4 ☐ 4 ½" ☑
Numero de vueltas para que salga agua: 1/4

Estado físico de los hidrantes

Excelente ☑ Bueno ☐ Regular ☐ Malo ☐

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.
Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.
Regular: Es operable, pero necesita reparaciones.
Malo: Necesita un reemplazo, no puede usarse.

Capacidad

Caudal (gpm) Presión(psi): (Estática) (Dinámica)

Indique aqui si se requieres accesorios adiciónales para extraer el agua:
Llave de hidrante ☑ Llave de cañería ☐
Llave de cubo ☐ Volante de válvula ☐
Válvula Adicional ☐
Disponible en

4) Agua superficial o cubierta

Superficial ☐ Cubierta ☐ Volumen-m^3

Piscinas ☐
Lagos ☐
Ríos ☐ Descripción:
Tanque ☐
Deposito subterráneo ☐

Condiciones de Acceso:

Forma para la toma de agua (método de succión):
Turbina ☐ Descripción
Tubo de succión ☐
Bomba portátil ☐

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre: Michael Marin Herra
Puesto: Bombero III
Estacion: Barrio Mexico
Area:

Información General

1) Ubicación, dirección **Código de toma de agua** 1-1 1-2 -2001

X,Y Coordenadas ____ , ____ .

Dirección por seña: Costado norte de Envases COMECA, carretera a Heredia

2) Propietario
Publico ☑
Privado ☐

Información del contacto

Nombre:
Puesto:
Teléfono:
Apartado postal:
Dirección de correo electrónico:

Tipos de fuentes

3) Hidrantes
Conectado a:
Red publica ☑ Tanque ☐
Características del Tanque:
Superficial ☐ Subterráneo ☐ Aéreo ☐
Volumen (m^3) ____ .

Boca de mayor diámetro 2 ½ ☐ 4 ☐ 4 ½" ☑
Numero de vueltas para que salga agua 1/4 .

Estado físico de los hidrantes
Excelente ☑ Bueno ☐ Regular ☐ Malo ☐

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.
Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.
Regular: Es operable, pero necesita reparaciones.
Malo: Necesita un reemplazo, no puede usarse.

Capacidad
Caudal (gpm) ____ Presión(psi): (Estático) ____ (Dinámico) ____

Indique aquí si se requieres accesorios adiciónales para extraer el agua:
Llave de hidrante ☑ Llave de cañería ☐
Llave de cubo ☐ Volante de válvula ☐
Válvula Adicional ☐
Disponible en:

4) Agua superficial o cubierta
Superficial ☐ Cubierta ☐ Volumen-m^3

Piscinas ☐
Lagos ☐
Ríos ☐ Descripción:
Tanque ☐
Deposito subterráneo ☐

Condiciones de Acceso:
Forma para la toma de agua (método de succión):
Turbina ☐ Descripción
Tubo de succión ☐
Bomba portátil ☐

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)
Le falta una tapa de 2.5"

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre
Puesto:
Estacion
Area:

Información General

1) Ubicación, dirección **Código de toma de agua** 1-9 - -

X,Y Coordenadas ,

Dirección por seña Tibas, Linda Vista, de La Municipalidad 200 norte, 25 este

2) Propietario

Publico ☒
Privado ☐

Información del contacto

Nombre:
Puesto:
Teléfono:
Apartado postal
Dirección de correo electrónico:

Tipos de fuentes

3) Hidrantes

Conectado a:

Red publica ☒ Tanque ☐

Características del Tanque:

Superficial ☐ Subterráneo ☐ Aéreo ☐

Volumen (m^3)

Boca de mayor diámetro 2 ½ ☒ 4 ☐ 4 ½" ☐

Numero de vueltas para que salga agua 4

Estado físico de los hidrantes

Excelente ☐ Bueno ☒ Regular ☐ Malo ☐

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.
Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.
Regular: Es operable, pero necesita reparaciones.
Malo: Necesita un reemplazo, no puede usarse.

Capacidad

Caudal (gpm) Presión(psi): (Estática 30 (Dinámic 0

Indique aquí si se requieres accesorios adiciónales para extraer el agua:

Llave de hidrante ☒ Llave de cañería ☒
Llave de cubo ☐ Volante de válvula ☐
Válvula Adicional ☐

Disponible en

4) Agua superficial o cubierta

Superficial ☐ Cubierta ☐ Volumen-m

Piscinas ☐
Lagos ☐
Ríos ☐ Descripción:
Tanque ☐
Deposito subterráneo ☐

Condiciones de Acceso:

Forma para la toma de agua (método de succión):

Turbina ☐ Descripción
Tubo de succión ☐
Bomba portátil ☐

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)

Le falta tapa de 2 1/2, Mantenimiento Preventivo

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre
Puesto:
Estacion
Area:

Información General

1) Ubicación, dirección **Código de toma de agua** 1-9 0-3 -

X,Y Coordenadas

Dirección por seña: Tibas, Clinica Integral de Tibas, estado sur estadio Ricardo Saprissa

2) Propietario

Publico ☐
Privado ☒

Información del contacto

Nombre: Agustin Romero Romero
Puesto: Jefe de Mantenimiento
Teléfono: 292-23-91
Apartado postal
Dirección de correo electrónico:

Tipos de fuentes

3) Hidrantes

Conectado a:

Red publica ☐ Tanque ☒

Características del Tanque:

Superficial ☐ Subterráneo ☒ Aéreo ☐

Volumen (m^3)

Boca de mayor diámetro 2 ½ ☐ 4 ☐ 4 ½" ☐

Numero de vueltas para que salga agua

Estado físico de los hidrantes

Excelente ☐ Bueno ☐ Regular ☐ Malo ☐

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.
Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.
Regular: Es operable, pero necesita reparaciones.
Malo: Necesita un reemplazo, no puede usarse.

Capacidad

Caudal (gpm) Presión(psi): (Estático) (Dinámico)

Indique aquí si se requieres accesorios adiciónales para extraer el agua:

Llave de hidrante ☐ Llave de cañería ☐
Llave de cubo ☐ Volante de válvula ☐
Válvula Adicional ☐

Disponible en

4) Agua superficial o cubierta

Superficial ☐ Cubierta ☒ Volumen-m^3 34,718 gal

Piscinas ☐
Lagos ☐
Ríos ☐
Tanque ☒
Deposito subterráneo ☐

Descripción:

Condiciones de Acceso:

Forma para la toma de agua (método de succión):

Turbina ☐
Tubo de succión ☐
Bomba portátil ☐

Descripción: El tanque se encuentra en el Area de mantenimiento, el (aul) en horas no habiles no se puede utilizar

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)

Tiene caclura de entrado y salida al Costado norte. Las de salidas no cuenta con llave de cierro, al userla hay que apagar la Bomba contra incendio

El Cuerpo de Bomberos de Costa Rica
Formulario para Tomas de Agua

Nombre: Jorge A. Murillo Araya
Puesto: Bombero V
Estacion: Central
Area: 2

Información General

1) Ubicación, dirección **Código de toma de agua** 1-0 2 - 9

X,Y Coordenadas

Dirección por señas: Avenida 20 Calle 20

2) Propietario

Publico ☑
Privado ☐

Información del contacto

Nombr: A y A
Puesto:
Teléfon:
Apartado post:
Dirección de correo electrónico:

Tipos de fuentes

3) Hidrantes

Conectado a:

Red publica ☑ Tanque ☐

Características del Tanque:

Superficial ☐ Subterráneo ☐ Aéreo ☐

Volumen (m

Boca de mayor diámetro 2 ½ ☐ 4 ☐ 4 ½ ☑

Numero de vueltas para que salga agua

Estado físico de los hidrantes

Excelente ☐ Bueno ☐ Regular ☐ Malo ☑

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.
Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.
Regular: Es operable, pero necesita reparaciones.
Malo: Necesita un reemplazo, no puede usarse.

Capacidad

Caudal (gpm Presión(psi): (Estátic (Dinámi

Indique aquí si se requieres accesorios adiciónales para extraer el agua:

Llave de hidrante ☑ Llave de cañería ☐
Llave de cubo ☐ Volante de válvul ☐
Válvula Adicional ☐

Disponible en

4) Agua superficial o cubierta

Superficial ☐ Cubierta ☐ Volumen-m^3

Piscinas ☐
Lagos ☐
Ríos ☐ Descripción:
Tanque ☐
Deposito subterráneo ☐

Condiciones de Acceso:

Forma para la toma de agua (método de succión):

Turbina ☐ Descripció
Tubo de succión ☐
Bomba portátil ☐

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)

No se pudo medir presion y caudal

El Cuerpo de Bomberos de Costa Rica

Formulario para Tomas de Agua

Nombre: Jorge A. Murillo Araya

Puesto: Bombero V

Estacion: Central

Area: 2

Información General

1) Ubicación, dirección · **Código de toma de agua** 1-0 2 - 3

X,Y Coordenadas ____ , ____

Dirección por señas: Avenida 8 Calle 18

2) Propietario

Publico ☑

Privado ☐

Información del contacto

Nombre: A y A

Puesto:

Teléfono:

Apartado postal:

Dirección de correo electrónico:

Tipos de fuentes

3) Hidrantes

Conectado a:

Red publica ☑ Tanque ☐

Caracteristicas del Tanque:

Superficial ☐ Subterráneo ☐ Aéreo ☐

Volumen (m^3) ____

Boca de mayor diámetro 2 ½ ☐ 4 ☐ 4 ½ ☑

Numero de vueltas para que salga agua 3

Estado físico de los hidrantes

Excelente ☐ Bueno ☑ Regular ☐ Malo ☐

Excelente: Fue instalado recientemente, en una condición excelente, y su funcionamiento es completo. No necesita reparaciones.

Bueno: Su funcionamiento es completo, pero esta deteriorado por el uso.

Regular: Es operable, pero necesita reparaciones.

Malo: Necesita un reemplazo, no puede usarse.

Capacidad

Caudal (gpm) ____ Presión(psi): (Estático) ____ (Dinámico) ____

Indique aquí si se requieres accesorios adiciónales para extraer el agua:

Llave de hidrante ☑ Llave de cañería ☐

Llave de cubo ☐ Volante de válvula ☐

Válvula Adicional ☐

Disponible en:

4) Agua superficial o cubierta

Superficial ☐ Cubierta ☐ Volumen-m ____

Piscinas ☐

Lagos ☐

Ríos ☐ Descripción:

Tanque ☐

Deposito subterráneo ☐

Condiciones de Acceso:

Forma para la toma de agua (método de succión):

Turbina ☐ Descrip

Tubo de succión ☐

Bomba portátil ☐

5) Otras notas (problemas de acceso, condiciones especiales, peligros y riesgos, etc.)

No se pudo medir presion y caudal

INSTITUTO NACIONAL DE SEGUROS DIRECCION DE BOMBEROS Operaciones	INFORMACION SOBRE RIESGO PELIGROSO
PAG. de	Indice Alfabético
DIRECCION	NOMBRE DEL EDIFICIO

ROCIADORES ☐ SI/NO   PELIGROS A LA VIDA ☐ SI/NO   MATERIALES PELIGROSOS ☐ SI/NO

Nº. PISOS ☐   ESTACION: GPM:

PISO Nº ☐   NIVEL II DISPONIBILIDAD

Hecho por / fecha

CROQUIS DE UBICACION Nombre del Edificio:

1. CONTACTO TELEF
2. PELIGROS ESTRUC
3. CONTENIDO DEL EL
4. INFORMACION MAT
5. EXPOSICIONES
6. HIDRANTES
7. SISTEMAS DE PRO ORPORADO:
8. AYA QUE SUM NIS
9. OCUPACION:
10. CENTRO Y TIPO DE
11. ADICIONAL

Appendix N

BASIC POCKET PC INFO

Operating System   Windows® Powered Pocket PC

Processor   206 MHz Intel StrongARM 32 bit RISC Processor

Display Type   Color reflective thin film transistor (TFT) LCD

Touch Screen   Yes

Resolution   240 x 320

Pixel Pitch   .24 mm

Viewable Image Size   2.26 x 3.02 inches

RAM   32 MB

ROM   16 MB

Input Method   Handwriting recognition, soft keyboard, voice record, inking

Communications Port   Interface with USB / Serial connectivity that connects via serial or USB cable

Card Slot   optional expansion pack

Infrared Port   Yes (115 Kbps)

Speaker & Microphone   Yes

Audio Out Jack   Yes (3.5 mm Stereo)

Battery   950 mAh Lithium Polymer

Dimensions   5.11" x 3.28" x .62"

Weight   6.3 oz. including battery

Warranty   1-year limited

Appendix N

POCKET PC
POCKET EXCEL HELP:
TOPICS APPLICABLE TO USE WITH DATA COLLECTION FORMS

CONCEPTS
About Pocket Excel
Entering Data in Pocket Excel
Synchronizing Pocket Excel Workbooks
Workbook Conversion
On-device Conversion Changes

HOW TO
Create and open workbooks
Enter and locate data
- Go to a cell
- Enter a value or text in a cell
- Find or replace data

Edit and format data
- Edit cell contents
- Copy and paste
- Delete row or column
- Format numbers and text
- Insert symbols

Work with rows and columns
Work with workbooks and worksheets
- Modify or switch worksheets
- Adjust the view of a worksheet
- Save, rename, move, and delete workbooks
- Transfer a workbook via infared
- Send a workbook via e-mail

Change options

Appendix O

Instructions for Designing a Data Collection Procedure

1) **Determine exactly what information needs to be included in the form.**
   The first step is to determine exactly what information needs to be included in each form. Since Los Bomberos already have a detailed outline of what they need for their GIS, this step should be relatively easy. It is only a matter of refining the details.

2) **Design the form that includes space for all necessary information and is easy to use.**
   Second the form itself needs to be designed. The form should be written in such a way that the similar data is grouped so filling out the form will be as easy as possible. The options should be clearly defined, with explanations if subjective measurements are to be used. In addition there should be spaces to elaborate if it is necessary. The forms should also be as short as possible to make them seem less tedious to fill out, and to ensure accurate completion.

3) **Test form in the field and make any additional changes.**
   After the form is designed it should be taken into the field for a trial run. This run should be carefully observed and the people completing the form should be informally interviewed in order to determine the functionality of the form.

4) **Determine best procedure/ methods for use of form.**
   After the form has been tested the best way to use the form can be determined and final revisions can be made. Based on what worked in the test and what didn't, a procedure for the use of the form can be designed.

5) **Design instructions.**
   The final step is to design a sheet of instructions. They should be both clear and concise. Explain each section incase there are any question as to how the form should be filled out.

6) **Send form & instructions to stations.**
   After all these steps have been completed the forms and instructions can be sent to the stations for full-scale usage.

Appendix O

Instrucciones Para Designando la Metodología Para la Recolección de Datos

1) **Determine la Información Necesario.**
El primer paso es determinar la información que es necesario por cada formulario. Este paso debe ser fácil porque los Bomberos tienen la propuesta con la información necesaria.

2) **Designe el Formulario para Tener Espacio por Todo la Información Necesaria y Ser Fácil a Usar.**
El segundo paso es designar los formularios. El formulario debe ser escrito para combinar datos similares para que puede ser completado fácil. Define las opciones con explicaciones para ayudar el colector. Incluye espacios para explicar los datos sí es necesario.

3) **Pruebe los Formularios en el Campo y Haga Cambios sí es Necesario**
Después que el formulario esta designado debe traerlo al campo para probarlo. Hable con los colectores para ver si hay problemas con el formulario

4) **Determine la Mayor Metodología para Usar el Formulario.**
Por la información obtenido en el campo puede hacer una metodología explicando como usar el formulario.

5) **Designe Instrucciones.**
El paso final es designar las instrucciones. Ellos deben ser claros y cortos. Explica cada sección para responder a todos las preguntas.

6) **Mande los Formularios e Instrucciones a Cada Estación**
Después de paso cinco los formularios y instrucciones, puede mandarlos a las estaciones para usarlos.

Appendix P

Bomberos Group Logs

Week One

5/15 – Orientation to Agency. Arrive at INS at 9 AM. Meet with Esteban Ramos Gonzales, Ana Maria Ortega Ortega, and Don Hector Chavez León. Discuss project, what is expected of us, etc. Meet all other employees; spend rest of day with Esteban visiting Bomberos locations around San Jose. Gave project proposal to Ana Maria.

5/16 – Begin work on project. Given INS's proposal for GIS implementation by Ana Maria; it includes what they want in a GIS (software, hardware, etc.). Discussed questions to ask ICE about their GIS, Ministry of Health about Hazardous Materials, and our liaisons about the project. Translated all questions into Spanish. Plan to give presentation at 8 am on 5/17. Planned presentation. Met with Professors to discuss project goals, changes, etc.

5/17 - Presented proposal to Professors, Esteban Ramos, Ana Maria Ortega, and Don Hector Chavez at 8 am. Questions and comments for the next hour provided new insight into the aim of our project. We are to begin focusing on determining how to find the most important data that needs to go into the GIS, and make a form and a procedure that will allow the data to be collected easily. Water data is of foremost importance, and we will test the form we design to collect this data later on in Urban and rural areas. Revised some parts of proposal, met with professors to discuss clarifications on changes, gave presentation about first week to Professors, ICE, CICA, and Lankaster groups.

5/18 – Began work on form for collecting water data. Discussed necessary changes with Esteban, made some changes, and submitted a disc containing the form to Esteban for more corrections.

Week 2

25 May 2001

21/5 – Met with Esteban to discuss water form. Made two more revisions to it as advised to do by Esteban Ramos. Worked on translating building and infrastructure forms in down time.

22/5 – Lisette is sick and does not come to work with us. Eric and Natalie work on water from some more, add necessary details at the suggestion of Esteban (email contact info for private water sources, more detailed options for characteristics of water sources). Also met with Esteban, Ana Maria, and Walter Mora for about an hour to discuss form. Used some of the suggestions made in this meeting to change the organization of the form. Work on work plan for rest of week, and summary of the past week. Meet with Professors.

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23/5 – Continued to work on form and make changes whenever we can get a hold of Esteban to run stuff by him. Change organization by adding boxes around different part of the form, still trying to make it 2 pages or less. Make presentation for Thursday night, outline of final paper, plan final presentation for 29 June at 2 PM. Lisette is still sick.

24/5 – Lisette is better. Professors come to work with us. Travel to Santo Domingo and visit OCO, see SIBO (Bomberos info database) and dispatching process. Learn who to talk to about SIBO. Only a small amount of work is done on water form, since the trip took up most of the day. Get info on Bomberos' plans for next 3 years to add to lit review. Present Project (at night).

25/5 – Final revisions of water form made at the suggestions of Esteban and Don Hector Chavez. Discuss form with both men, separately and together. Look at maps of stations and districts in San Jose. Discuss future plans with Esteban. Print out final revision of form.

Week Three

1 June 2001

5/28 Monday –Esteban picked us up at 8 AM. He dropped us off at the Central Fire Station of San Jose at 9 AM for meeting with San Jose's fire chiefs. Met with Don Héctor Chaves León, and other chiefs for approximately an hour to discuss water sources data collection form. Scheduled another station chief meeting for Thursday morning at 9 AM. Returned to INS and updated water form with suggested revisions. Worked on completing Spanish version of Infrastructure data collection form. Finished working on Literature Review and Intro & passed them in.

5/29 Tuesday – Continued work on Water and Infrastructure forms, got them both revised by Don Héctor, and made revisions. Began work on Powerpoint presentation for Thursday's Station Chief meeting to explain use of water source form. Also made PowerPoint presentation for Thursday's weekly presentations for the WPI crew. Rewrote methodology section for Thursday.

5/30 Wednesday – Finalized both power point presentations. Finished methodology draft 1. Revised final report outline. We translated both forms from Spanish to English. Observed fire drill in INS building in the afternoon. Permanent firefighters did short drill on 3rd floor to show how the pump in the basement works in bringing water to pipes on each floor. Valves on these pipes allowed for access to the water. Being a timed fire drill, this was a good example for us to see how the firefighting process works. Talked to Esteban about data collection fieldwork—we will be doing collection with the help of Walter, and will later observe other firefighters using the forms.

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5/31 Thursday – Came to work with Professor Elmes at 8 AM, and went to Central Fire Station to give presentation on procedure for use of water form at 9 AM. Set up equipment & Don Héctor presented to the Fire Chiefs about the proper use of form. We received more feedback regarding the form, but it was mostly finalized. Maps of the fire districts were distributed to the chiefs of the San Jose districts to be used in collection of information on the water sources. We fixed the few things they wanted changed, and officially finalized the form. Received personal map of Pavas for our own use. Natalie went home sick :(... Francisco drove her home :)
Develop work plan for next week. Began to transfer forms from Word to Excel for use with Palm Pilot.

6/1 Friday – Work from home --> Continued attempt to transfer forms from Word to Excel.

Week Four

1 June 2001

6/04 Monday –Arrived at work at 8. At 9:30 left with Walter for the Pavas station. Arrived ~10 and picked up Jarol Hildago who would ride with us for the day. Followed the Pavas station fire engine and observed the collection of hydrant information. Asked questions and answered questions when something came up. The methodology is a bit different from the presentation, but it took only 5 min per hydrant. After a lunch break went back to the station and observed them until 3:30. (See notes for methodology and observations)

6/05 Tuesday – Lisette left today. She spent the morning working on our lit review while we were at work. Made instructions for the Fuentes de Agua form and translated it into Spanish. Designed an Excel spread sheet for cataloging the water sources. We fixed the methodology based on the information we obtained during our fieldwork at the Pavas station. We talked to Ana-Maria about ICE's GIS, there has been a meeting scheduled but she doesn't know when. Will check up on this later this week. Started writing conclusions based on what we have learned so far.

6/06 Wednesday – Made changes to the Literature Review and the Introduction. Talked to Walter and Esteban about the instructions and the Excel Sheet. Made corrections according to their comments. Met with Ana Maria, Esteban, Walter and two of the INS people in charge of the GIS project. We discussed the procedure being used in the field, the progress of the stations, and the time limits for each station. Brought the INS people up to date. (See notes for detailed explanation)

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6/07 Thursday – Returned to Pavas fire station. Prof. Salazar & Elmes came with us. Discussed the progress of the collection process and it was decided that a GPS would be of use in locating the hydrants. Discussed the effectiveness of the form briefly. Some suggestions were made about the layout of the Edificios form. Viewed the map and saw their current progress. 2 of 5 areas were completed and two sectors of a 3rd area. Returned to the office and worked on Palm Pilot version of Edificios form. Finished editing 2nd version of the Lit. Review. Translated the instructions into English. Finished translating the data collection forms (Palm Pilot Version) into English. Began work on instructions for the Edificios form.

6/08 Friday – Continued work on forms and instructions. Access version of Fuentes de Agua form and instructions for the Edificios form.

Week Five

15 June 2001

6/11 Monday – We met with Jose Conejo the designer of SIBO and he explained how we could transfer the Excel file in the Pocket PC to Access on the Laptop. Tried to get the connection between the Pocket PC and Laptop working but it wasn't working finally Ana Maria helped us get it going after some work. Worked on the methodology and the lit review. Began work on expected results section.

6/12 Tuesday – Talked to Don Hector and Walter about the inaccuracies in the GPS and what they were doing about it. Learned they're going to continue using the pins at least until they can resolve the accuracy problem with the GPS We continued work on enabling the transfer from the Excel (Pocket PC) file to the Access (Laptop) file. Revised the Methodology and the Lit review. Revised the outline based on changes made to the sections.

6/13 Wednesday – Wrote first draft of Data Presentation and Analysis. Met with Jose Conejo again to fix some problems with the Pocket PC version of our form. Learned how to transfer the Data Base files from the Pocket PC to the Laptop so it could be read in Access. Scheduled visits to 5 of the 7 San Jose area fire stations to get copies of the completed forms and talk with the Jefes.

6/14 Thursday – Visited 5 San Jose area fire stations, talked with the chiefs from B° Lujon, Central and Tibas. We obtained copies of the completed forms (10 from Tibas), discussed the form (strengths and weaknesses, over all satisfaction), GPS vs. Pins, and the Palm Pilot. The chief of B Lujon told us he could get us the forms by next week, we will follow that up early next week.

6/15 Friday – Worked on Results and Analysis began review of the completed forms. Revised the Methodology and Lit Review sections. The station chief from Central dropped off the 10 copies we requested.

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Week Six

22 June 2001

6/18 – Monday – Finished results and analysis section, analyzed the completed forms collected from each station and added graph explaining scores of stations' data collection performance. Worked further on conclusions and recommendations. Wrote literature review and methodology for personal and elite interviews.

6/19 – Tuesday – Began writing background of old data collection procedure, compared this procedure to the new procedure by examining forms. Finished conclusions and recommendations. Revised table of contents, tables, and figures. Revisions to introduction. Began writing executive summary. Requested more completed forms from the stations doing data collection.

6/20 – Wednesday – Wrote literature review for focus groups, form revisions, and data quality. Revisions to introduction and literature review. Wrote abstract, authorship page, and acknowledgements. Finished writing executive summary. Placed all revised sections of the project in one file. Began placing appendices in proper order. Translated forms to English to place in Appendices.

6/21 – Thursday – Revised methodology and results and analysis sections. Wrote section on the social impact of our project. Power Point presentation to professors and other groups.

6/22 – Friday – Finish revising results. Begin creating final PowerPoint presentation. Finalized instructions to complete manual. Work on lit review of pocket pc for data entry (stylus, keyboard, etc.). Inquire about Liberia travel details. Obtain final completed data collection forms and analyze them.

Week 7

6-25 to 6-27 Data Collection In Guanacaste:
From Monday to Wednesday we were in the Guanacaste Province to compare the rural fire stations with those of the San Jose area. We traveled to Nicoya, Canas and Liberia to interview the station chiefs about the forms and their preferences in data collection methods. We also created our final presentation.

6-28 Work At Home
We stayed home and worked on the final report. We made the suggested changes to the conclusions section, wrote the methodology, data results and analysis, and revised the conclusions based on the data we obtained during our trip to the 3 stations.

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6-29 INS
Worked on our final presentation, Esteban helped revise it for accuracy and grammar. Gave practice presentation to Prof. Salazar and Elmes. Worked on the final presentation based on recommendations, continued finalization of final report.

6-30 Work at Home
Finalized final presentation. Finalized final report, page numbering and final touches. Assembled the appendices and other sections into the correct order.

Bomberos Group-Week 2-Work Plan					
	Mon	Tues	Wed	Thrus	Fri
Work on Water form					
Work on Infrastructure form					
Work on Building form					
Discuss form with A.O. y E.R.					
Finish Water form					
Test water form					
Translate Infrastructure forms					
Edit First 3 chapters of Report					
Use GPS Equipment (?)					

Bomberos Revised Work Plan - Week 3										
Task	Lunes		Martes		Miercoles		Jueves		Viernes	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Visit central station										
Revise Water Form										
Resvise Building Form										
Talk to Liasons about Forms										
Finish Forms										
Create Power Point Presentation										
Present Procedure to Los Jefes										
Continue Revisions Based on Comments from Los Jefes										
Begin Field Work										

Bomberos Work Plan - Week 4										
Task	Lunes		Martes		Miercoles		Jueves		Viernes	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Began Field Work with Walter Mora in Pavas										
Attempt to use Palm Pilot in data collection										
Observe Los Bomberos using water form										

Bomberos Work Plan - Week 5										
Task	Lunes		Martes		Miercoles		Jueves		Viernes	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Begin working with GPS in field										
Test Palm Pilot in field										
Continue work on Instrctions/ Acess forms										
Begin writing results/ Conclusions/ Recommendations										

Bomberos Work Plan - Week 6

Task	Lunes		Martes		Miercoles		Jueves		Viernes	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Continue visiting Stations to Get Feed back on Forms/ GPS-Pin System/ PalmPilot										
Collect Completed Forms										
Review Completed Forms										
Continue Revising Project Parts/ Combine to Final Report format										

Bomberos Work Plan - Week 7

Task	Lunes		Martes		Miercoles		Jueves		Viernes		Sa.	Dom.
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM		
Go to Liberia to test water source form in rural area												
Analyze Liberia results and compare to urban results												
Return from Liberia to do dress rehearsal												
Continue writing report and including new Liberia results												
Revise, Revise, Revise												
Finish final PowerPoint presentation												
Practice final presentation for Monday												
Practice soccer for game												
Get killed in soccer game with Los Bomberos												

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