Bureau of Public Health
Executive Summary

Student Consultant: Brandon Clark Loughery
Community Partner: Pearl Marumoto, Chief of Public Health Planning and Development

I. Background Information

The Ministry of Health (MOH) is charged with building a "Healthy Palau in Healthful Environment." It accomplishes this vision by following its mission statement:

The Ministry of Health shall take positive actions to:

- *Attain healthful environment,*
- *Promote health and social welfare,*
- *Protect family health and safety, and*
- *Provide health care services throughout the Republic of Palau.*

The consultant worked exclusively in the Bureau of Public Health with the Emergency Health Program. According to the 2008 - 2013 strategic plan, the following mission statement guides the Bureau of Public Health:

The Bureau of Public Health is committed to ensuring that all members of our community have access to the resources, education, knowledge, and services needed to help them in reaching the highest possible level of health.

Geospatial Information Systems (GIS) supports the strategic directions of the Bureau of Public Health in the following ways:

- GIS manages data to better prioritize decisions
- GIS maximizes data and resources of BPH to ensure efficiency and alignment with the Bureau vision and priorities

II. Consulting Tasks

The consultant performed four main tasks:

- **Established baseline GIS data** – The Bureau of Pubic Health had maps provided by the Ministry of Resources and Development that were spatially inaccurate and not useful for mapping for emergency planning operations. Before this time, it was impossible to develop a GIS mapping tool for the Emergency Health Program because layer files would not line up correctly and the Bureau of Public Health would have to rely on other agencies to create maps.

  The consultant used ArcGIS 9.3 mapping software manufactured by ESRI, Inc., to spatially adjust the base data.

- **Developed hazard planning and emergency response maps** – There are no street names or addresses in Palau, so prior to this summer, the Emergency Health Program relied on estimating the location of certain populations for emergency response mapping. The Director of Planning and Development wished to have a system to make efficient decisions based on accurate map data in order to direct limited resources to populations in need.

The consultant used a GPS receiver to map the locations of homebound hospital patients, emergency relief shelters, and HAZMAT locations to provide base layers to be used for planning.

- **Documented GIS procedures and presentation materials** – Staff members relied on complicated GIS tutorials and users manuals to find information about basic operation and functions of the ArcGIS mapping software. Looking up information in the manuals was time-consuming and frustrating in order to complete basic mapping functions.

  The consultant carefully documented his procedures in a step-by-step format in order to ensure on-going sustainability for GIS activities.

- **Created a 3D analyst model for future projects** – The Emergency Health Program has limited mapping software extensions, which makes more advanced spatial analysis impossible. 3D models may serve as useful tools in the future for emergency planning.

  The consultant used the ArcGIS 3D Analyst extension on his personal computer to build a sample model for Public Health. The purpose of this model is to provide an example for future GIS emergency health activities.

III. Outcomes and Recommendations

The following are the most important outcomes from the consulting tasks (See full report for all of the outcomes):

- **Accurate and reliable baseline geographic data** – Map data collected from PALARIS and other agencies was organized and spatially adjusted using ArcView GIS software to ensure map layers lined up with each other properly.

- **Location of Homebound Patients** - Homebound residents are hospital patients who, whether through age or disability, are not able to visit the Palau National Hospital. The consultant and the coordinating staff member used GPS receivers to capture the exact location of a patient's residence.

- **Emergency Shelter, Dispensary, and Fuel Storage Locations** – Emergency shelters are facilities such as public buildings, schools, hotels, etc. that can be converted to shelters in the event of emergencies or natural disasters. Dispensaries are satellite locations of the hospital. One of the essential components of disaster mitigation is the anticipation of hazardous material (HAZMAT) emergencies. All locations are imperative to national emergency health planning.

- **GIS Desktop Reference Manual** – The reference manual serves as a step-by-step guide for the GIS work completed.

Three of the most important recommendations are listed below (See the full report for all of the ten recommendations):

- **Obtain at least two licenses for ArcView 9.3 GIS software as well as desktop PCs to support the program** – In order to continue the work begun by the consultant, it is necessary to have the proper tools in place. The tools include hardware, software, and software extensions to keep the mapping activities supported.

- **Provide training to at least two Bureau of Public Health employees –** The coordinating staff members are familiar with ArcGIS functionality and interface, but in order for the program to be sustainable, more staff members should be trained on basic software applications.

- **Regularly communicate with other bureaus and agencies to update data as it is available –** Relationship building between other bureaus and agencies is paramount in order to obtain and the most current data.

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Brandon received his Master of Arts Management degree from the Heinz College at Carnegie Mellon University in May 2009.

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I.   Preface

The staff and administration of the Ministry of Health (MOH) are responsible not only for providing clinical and preventative services to the Republic of Palau, but also for monitoring and evaluating the effects and impacts of those services. The use of geospatial information systems (GIS) is one of the tools identified by the Ministry of Health, specifically, in the Bureau of Public Health, to create maps to help the management team make better health policy decisions.

According to ESRI, Inc. the world's leading geospatial software specialists, a GIS is a "geo-database", which is a data management software system that stores datasets that represent features on the earth's surface. These datasets can be thought of as map "layers" that share geographic relationships with each other. The layers are made up of points and lines that create what are known as "shapefiles" or polygons representing different geographic features and showing various spatial relationships. An example can be found in **Figure I**, below:

FIGURE I: An Illustration of Layer Files (Environmental Systems Research Institute, Inc. 2007)
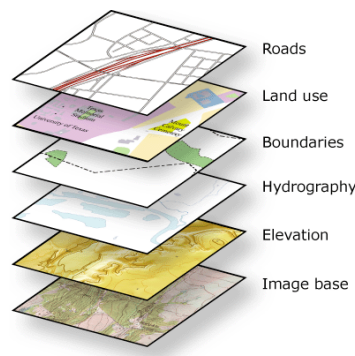
The Bureau of Public Health (BPH) has been attempting to launch a sustainable means of recording and storing geographic data for the past couple of years. A limited version of ESRI's ArcGIS mapping software was purchased with one license to be shared between the two cooperating staff members. Both staff members understand the basics of how the software operates, but some assistance from the consultant is needed to launch the software into a fully operational system.

The implementation of a GIS complements the MOH's mission to "protect family health and safety" as well as supports the Bureau of Public Health's mission to provide "access to the resources, education, knowledge, and services needed to help [community members] in reaching the highest possible level of health". The intent of this project is to build sustainable GIS base layers for use in the Bureau of Public Health's Emergency Health Program. It is the community partner's wish to use this project as a model that can be implemented in other divisions and programs within the Bureau of Public Health.

The consultant will provide a set of map documents and data sets from which future maps can be built, a reference guide detailing the creation and editing of the map files for future projects, software training and presentation materials, and additional map models for use in grant writing in order to obtain more funding for GIS activities. All of these activities are reliant on the continued support of coordinating staff members, the community partner, and other participating departments at the MOH. The consultant will also be available to advise how to best organize the nascent, Public Health Information System - a program under the Office of Planning and Development. It will be a clearinghouse for all data management activities and technology support for the Public Health. The following context analysis describes in further detail the organizational climate and the effects that a GIS will have on the mission of the Ministry of Health and the greater community.

II. About the Organization

Organization

The Ministry of Health (MOH) is charged with building a "Healthy Palau in Healthful Environment." It accomplishes this vision by following its mission statement:

The Ministry of Health shall take positive actions to:

- *Attain healthful environment,*
- *Promote health and social welfare,*
- *Protect family health and safety, and*
- *Provide health care services throughout the Republic of Palau.*

The MOH is subdivided into two bureaus, the Bureau of Hospital and Clinical Services (BHCS) and the Bureau of Public Health Services (BPHS). The BHCS provides emergency and special services while the BPHS provides both primary and preventative services.

The consultant is working exclusively in the Bureau of Public Health. According to the 2008 - 2013 strategic plan, the following mission statement guides the Bureau of Public Health:

The Bureau of Public Health is committed to ensuring that all members of our community have access to the resources, education, knowledge, and services needed to help them in reaching the highest possible level of health.

The Bureau defines public health as being "physical health, peace of mind, spirituality, social relationships, and strong family ties. It is everyday life in our community." The Bureau approaches public health from a multi-layered perspective by identifying four "pillars" or components of public health: Individual Health, Environmental (External Factors) Health, Behavioral Health, and Community Health. These pillars address eight thematic areas: Creating Healthy Workplaces, Obesity, Alcohol Abuse, Tobacco Use, Injury/Violence, Depression, Emerging and Re-emerging Infections, and Immunization. The Bureau of Public Health provides primary care, risk and disease prevention, health and wellness promotion, and rehabilitation/healing/recovery services while addressing the eight thematic areas and the four pillars of public health.

The task of the student consultant was to work with Bureau of Public Health officials to implement a functional, sustainable geospatial information system (GIS) in order to better serve the planning and evaluation needs for the Bureau of Public Health. The Bureau seeks to use GIS technology to answer the following emergency response questions:

- Where are the incidents or outbreaks in relation to vulnerable populations (human, animal, plant) and critical infrastructure (utilities, roads, medical, waste facilities)
- Where are the victims relative to the locations of emergency and health resources (hospitals, shelters, emergency response units)?
- Where can first responders and equipment be strategically and safely staged and mobilized?

Prior to this time, emergency planners and public health officials relied solely on logbooks and spreadsheets to make spatial assumptions and plans. An active GIS program will allow staff members to view data in a new way that reveals relationships, patterns, and trends in the form of maps, reports, and charts. The Bureau of Public Health currently owns one license to ArcGIS, a leading mapping software program. Two Public Health staff members, the Database Support

Specialist and the Exercise Coordinator for the Emergency Health Program, were the coordinating staff members for this project.

The impact of this project will enable to the Bureau to use the GIS to touch each of the pillars of public health as well as complement the implementation of strategic objectives highlighted in the strategic plan.

The implementation of a GIS as a monitoring and evaluation tool will satisfy two of the six strategic directions of the organization: the need to be a data driven, and the need to increase efficiency and align programs with the Bureau's vision and priorities. A working, sustainable GIS will allow the Bureau of Public Health to use this data management technology to fulfill its mission as well as the mission for the Ministry of Health.

Current GIS Environment

There are currently a number of GIS initiatives taking place in the Pacific. One initiative, in particular, that involves the MOH's Emergency Health Program is the Pacific EMPRINTS ("Emergency Management, Preparedness and Response Information Network and Training Services") association. This training program is part of the Pacific Global Health Conference held in Honolulu, Hawaii and includes a special GIS component – organized by the ESRI, Inc. "ESRI products are a 'de facto' standard in the GIS market with one-third of the global market share" (NIIT, Inc. 2005). The Ministry of Health recognizes the need for health professionals, first responders, and planners to be current on the latest public health tools and techniques and therefore sponsored one of the coordinating staff members to receive emergency health GIS training at the conference.

The conference was funded by a grant from the US Health and Human Services, Office of the Assistant Secretary for Preparedness. Multiple partners came together for this event including experts from the University of Hawaii and the Pacific Disaster Center with the purpose of continuing GIS and emergency preparedness education and enhancing preparedness and response to public health threats.

The World Health Organization (WHO) is also encouraging the use of computerized mapping programs to reveal trends and interdependencies that would not be initially apparent in a tabular or paper-based format.

In 2001, the WHO implemented a pilot GIS project to identify pockets of leprosy in the Western Pacific Region, specifically in Cambodia and Vietnam. Like the MOH in Palau, the WHO wished to accomplish two basic tasks, 1. The accurate recording of each health facility in the country, the second is the recording of relevant baseline data for each health facility including:

- The location of the health facilities,
- number of registered cases,
- number of new cases detected annually, and
- type of leprosy treatment available. (World Health Organization 2009)

The WHO GIS pilot project was very successful in identifying at-need populations within the Pacific Region. One sustainable feature of GIS for the MOH is that Palau already has a geospatial data clearinghouse that continually collects, edits, and manages GIS data. PALARIS (Palau Automated Land and Resources Information Systems) is an agency under the direction of the Ministry of Resources and Development.

The use of mapping technology to report and investigate health care and emergency data is growing in the Pacific. Palau is one of the first independent Micronesian countries to embrace geospatial technologies as an important public health tool. The infrastructure, support, and

knowledge base is already in place, but some guidance, organization, and training is still necessary to implement a functioning mapping system within the Bureau of Public Health.

Facilities

The Bureau of Public Health Services is located on the Belau (Palau) National Hospital campus. Several programs have satellite offices, such as the Community Advocacy Program (CAP), which is approximately a 10-minute drive from the main complex. An additional MOH office is located in the Capitol Building, which is approximately an hour drive away.

There are also ten satellite medical dispensaries, or "community health centers", that provide medical services away from the main hospital. These dispensaries are of great importance to the population as they are instrumental in providing essential services in remote parts of the country as well as in emergency situations. The dispensaries are spread throughout the country and act as remote locations for the main hospital campus. An older map of the major dispensaries can be found in **Appendix I** at the end of this report. Four of the dispensaries are equipped as "super dispensaries" because a doctor or nurse visits each one regularly. There is a dispensary in the Northern, Eastern, Western, and Southern tips of the islands. Other dispensaries can be found in Kayangel, Ngaraard, Anguar, Sonsorol, Hatohobei, and Pulo Anna.

At each location, vital statistics such as total number of patients, total repeat visits, operations, deaths, referrals, etc. are all recorded. Other recorded information includes laboratory activity, reportable diseases, acute illnesses, chronic illnesses, injuries, and accidents. These statistics are recorded in Excel spreadsheets and databases. This data can be easily linked to the map location with help of GIS to show spatial trends with the summary statistics.

Bureau of Public Health Organizational Structure

The Bureau of Public Health is divided into five main divisions:
- Division of Environmental Health
- Division of Primary & Preventive Care
- Division of Oral Health
- Division of Behavioral Health
- Division of Planning and Development

Overarching programs support the five divisions, these programs include:
- Emergency Health Program
- Public Health Data and Statistics
- Social & Spiritual Health Program
- Public Health Information Systems
- Community Advocacy Program

More detailed descriptions of each division and program can be found in **Appendix II**.

Emergency Health Program

While the Bureau of Public Health contains many programs, the primary beneficiaries of the work done throughout the ten weeks was the Emergency Health Program (EHP) located in the Division of Planning and Development, which is managed by the community partner, Pearl Marumoto. An organizational overview of the Bureau of Public Health as it fits into the Ministry of Health is located below in **Figure II**.

FIGURE II: Organizational Overview of Planning & Development Office
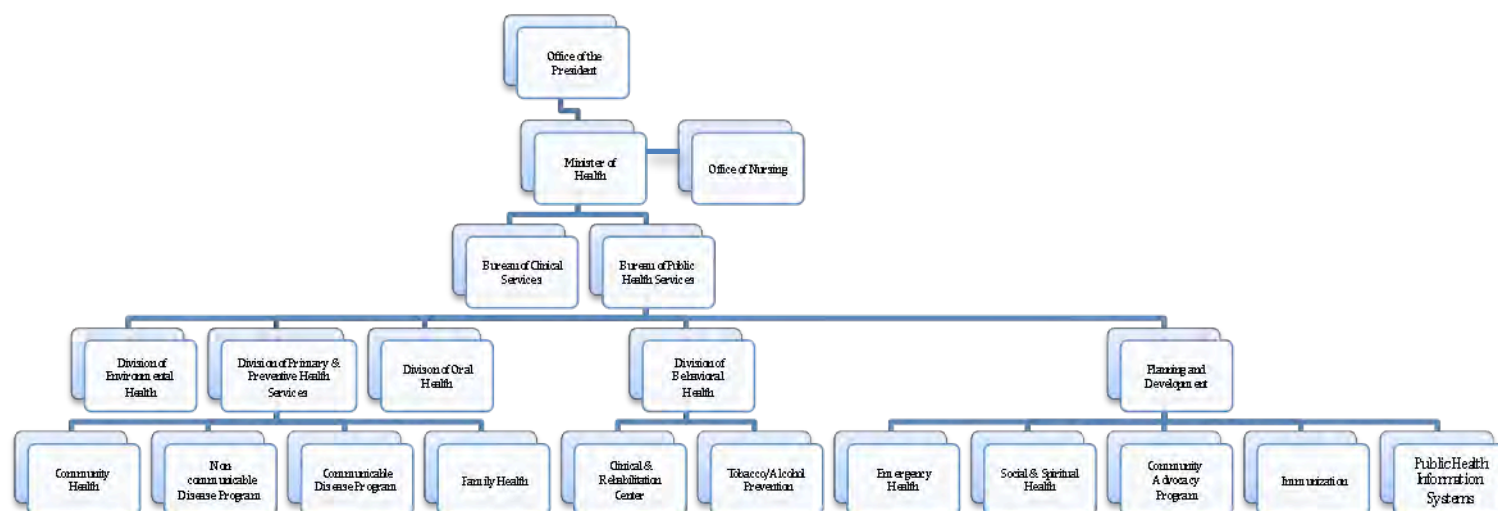
The EHP was originally created in the aftermath of the September 11, 2001 terrorist attacks on the United States. A grant by the Center for Disease Control (CDC) established the Emergency Health Program as a way to prepare for a potential bio-terrorism attack on Palau. The purpose for the EHP is to provide planning, training, injury mitigation, and inter-agency relationship building to prepare the government and the citizens of Palau in the event of an emergency. The GIS project will allow maps to be drawn to assist an activity under the Emergency Health Program called the Emergency Operation Center (EOC). The EOC is only active during emergency situations when a designated Incident Commander (IC) activates it. The IC and a group of assigned specialists assemble depending on the type of emergency in order to mitigate the situation.

Six staff members are employed under the EHP, an Administrator, a Public Information Officer, a Database Specialist, an Administrative Manager, a Preparedness Training and Exercise Coordinator, and an Administrative Assistant. The Database Specialist and the Preparedness Training and Exercise Coordinator are the coordinating staff members who will receive the consultant's resultant training and reference guide materials. Data collection, management, and analysis will be the primary responsibilities of staff under this department after the consultant leaves.

The creation of geospatial mapping system aligns perfectly with the program components. GIS will help the Emergency Health Program in planning and training activities by:

1. Equipping the Bureau's ability to be prepared for an emergency

2. Educating first responders, health officials, and emergency personnel on the location of patients, shelters, dispensaries, and hazardous materials

3. Improving the cohesion of key stakeholders, such as the Office of Nursing, the Bureau of Statistics, epidemiologists, public health officials, etc., in emergency planning

Reliable map data and accompanying layer files is paramount for effective planning and disaster management practices. Current data and planning methodologies will emergency personnel staff to determine the appropriate protocol during emergency situations and assign resources accordingly.

Staff

Approximately 380 people work at the Ministry of Health, of those staff members, 170 work for the Bureau of Public Health. A break down of staff-member titles can be found in **Appendix II**. Since the Public Health Information System (PHIS) is not fully operational at this time, coordinating staff members for the GIS project are paid through the Emergency Health Program. The Database Support Specialist and the Emergency Exercise and Preparedness Coordinator are two of the six staff members of the Emergency Health Program. They assist the program in planning and implementing emergency operations protocol as well as developing new methods for disaster and disease mitigation. Both staff members are trained in the fundamentals of ArcGIS, ESRI's main GIS mapping application.

In the long-term, PHIS staff members will be the main beneficiaries of the GIS products. It is the hope of the community partner that the training and succession planning that accompany this project will provide other staff members with the opportunity to learn more about the capabilities and features of GIS in order to further integrate the reporting features into other program areas.

Technical Environment

There are approximately 180 computers in the MOH, 150 workstations in Clinical Services and approximately 30 in Public Health. Additionally, there are approximately 350 user email accounts that are managed through the Health Information System of the MOH. The email accounts can be accessed on Microsoft Office Outlook Web Access client. There are nine wireless access points throughout the campus as well as eight servers: two for x-ray, one for paging doctors, one shared file system that includes email, the website, etc., one Domain Name System server, one Public Health server, one firewall, and one backup.

Internet connectivity is limited within the Bureau of Public Health because BPH shares bandwidth with the rest of the MOH hospital campus. The satellite communication system is also heavily affected by moisture and rain in the path of the signal, which occurs frequently in this climate. Internet and email communications can also be very difficult when large x-ray images are being sent via email from the radiology department to doctors for review. From time to time, the electricity shuts off for varying lengths of time. The hospital employs back up generators and the BPH is equipped with non-commercial use PC battery backups that can provide approximately 40 minutes of extra power to properly save and shut down a computer.

Theoretically, the Health Information System (HIS) Department should be the entity that orders, stocks, and repairs hardware, software and technical equipment. In actuality, there are only three staff members working for HIS and the demand for service and support is more than the current capacity can handle. The lack of capacity in the HIS department places strain on the other departments and programs, such that many times, department heads and program directors will order their own hardware and software. Since each program in the BPH makes technology decisions at the program level by purchasing the majority of software and hardware, most of the

equipment and programs are current. Unfortunately, the de-centralization of technology acquisition and management has caused a "silo effect" with the data and the activities of each department and program. It is the hope of the community partner, to transform the newly formed Public Health Information System into a self-sufficient technology and data management entity for the Bureau of Public Health. It is her vision to turn PHIS into a program under the Department of Planning and Development that will serve the technology and data management needs for the Bureau. PHIS will work together with the current HIS, but will not be under its jurisdiction.

PHIS will be the program where the GIS software and activities will exist for the Bureau of Public Health. The GIS software currently used is ArcMap 9.1, which is two versions old. One issue that will be addressed in the succession plan is that PHIS does not own any additional extensions or licenses for GIS, which can limit the depth of analysis that can be conducted. With these limitations in mind, it is important to create deliverables that can be used on an older system.

Technical Management

Currently Health Information Systems (HIS) provides the technical maintenance for the data, software, and hardware of both bureaus (Clinical Services and Public Health Services) under the supervision of the MOH. While HIS is involved with the management of data for programs such as Immunization, which is located under the Bureau of Public Health, an attempt is being made to institute a Public Health Information System (PHIS), which would be a completely separate "sister" department to HIS. PHIS would perform all of the technical support, maintenance and data management needs for the entire Bureau of Public Health, while communicating and sharing information with HIS, which would still be the main technical support department for the Bureau of Clinical Services.

One obstacle impeding the development of PHIS is grant money for the program's operating expenses. It is the intent of the Chief of Planning and Development to use this GIS project as well as the scheduled strategic technology planning workshop to garner more grant support and hospital administration buy-in to augment the PHIS services in order to streamline BPH activities.

Technology Planning

The community partner recognized the need for technology planning to ensure that vital organizational, human resource, and technological needs are being met, so she scheduled a BPH strategic technology-planning workshop for the week of June 29 – July 3, 2009. The consultant helped to facilitate the session by assisting the various departments in creating logic models for the use of technology in their day-to-day responsibilities (The logic model can be found in the **Appendix VII**). The end-result of this process will give the Director of Public Health as well as the Minister of Health a better idea of the current needs of the Bureau of Public Health so that the appropriate resources are assembled.

At this time, the community partner as Chief of Planning and Development for the BPH, apportions funding for staff members who are in need of system or hardware upgrades. Funding for the identified needs comes from the operating budgets of individual programs. Assistance from outside of the Bureau of Public Health, normally Health Information Systems (HIS), is required for technology issues that cannot be resolved by staff members alone. The formulation of a strategic technology plan is still underway and will include members from all divisions and programs within the BPH in order to align needs with technology solutions while satisfying the strategic direction and mission of the Bureau of Public Health.

Internal and External Communication

One of the challenges being faced by the MOH is the management of sensitive patient information across many administrative departments. Patient information is stored on multiple databases throughout the various departments in MOH.

External:

Routine external communication with outside stakeholders is usually done face-to-face, over the phone, or via email. Most business communication in the Bureau of Public Health is done through telephone or email.

Employees also attend off-island conferences, such as GIS training workshops in Hawaii, to discuss health issues and risks, and the MOH cooperates with other south Pacific islands to share information.

Social marketing is the main channel of communication with the greater public. Much of the marketing messages come from the Community Advocacy Program (CAP), which publishes a variety of pamphlets, posters, billboards and newsletters about health risks in order to better educate the public about primary services and disease prevention.

Internal:

MOH and Bureau of Public Health employees mainly communicate through face-to-face interaction or by phone calls. Email is used less frequently probably due to the fact that the Internet and Intranet is not reliable. Regularly scheduled face-to-face meetings are important for the inter-departmental issues.

BPH employees have mobile phones, which they use to contact each other, because it is imperative because of the remote nature of some of the programs such as CAP. Patient information is shared both in paper form and electronic form (in the form of MS Excel datasheets). The Internet is slow because of the limited amount of bandwidth and server space for the volume of computers in the MOH.

Information Management

The Bureau of Public Health manages their information on a variety of Microsoft Office applications as well as other databases.

Primary Health Information System (HIS) is the central database located in the main hospital campus. This database is intended to hold and manage all patient information required by the hospital. Data is entered by transcribing information from a paper forms, called a Patient Encounter Form, which is filled out with every visit a patient makes to the hospital. The information on these forms is shared by many different departments and is coded by the patient's hospital number, which serves as a primary identifier for the database.

Additional independent databases and templates are other means of storing information in the BPH. Many of these programs are stored on a main server, but are not directly synced. For example, the Immunization Department uses FoxPro, which is stored on the HIS server.

One strength of GIS is that it is applicable to many, if not all departments and can interpret many types of data in various forms. Information can be entered into ArcGIS as a .txt, .csv, database table, or an MS Excel Sheet. This will be a viable component of PHIS because of GIS compatibility is not necessarily dependent on the other systems working together.

III.   Scope of Work

Task 1: Establish baseline GIS data

One of the strategic directions of the Bureau of Health is to "Prioritize decisions based on data." In order to make better decisions, standardized and reliable data collection and reporting systems must be in place. The Bureau of Public Health at the MOH has invested in a GIS system and has already gone to the expense of training the database support specialist at GIS mapping workshops in Hawaii. While there is already some expertise in GIS by the BPH staff, the staff does not currently have the capacity to import and customize map files from Palau Automated Land and Resources Information Systems "PALARIS" and customize them for the MOH. This task is paramount, because the BPH staff needs help in establishing a methodology for importing, customizing, and augmenting map files.

Establishing a strong set of baseline GIS maps is a crucial activity that creates a foundation from which all other map layers are built. If consistent, reliable baseline map data is not in place, a GIS cannot function properly. Once baseline layers are created and the process is documented, the staff can easily replicate any activity for future needs. The completion of this activity will be the impetus for using the information on hand as an additional decision-making tool for disaster relief, planning and public policy analysis.

Expected Outcomes

The consultant will use editing tools within the ArcGIS 9.3 software to edit existing maps from the Palau Automated Land and Resources Information Systems "PALARIS", which is housed in the Ministry of Resources and Development. The first step will be to obtain the current county boundaries and road files from PALARIS. The database support specialist at the Bureau of Public Health has already begun the editing process, but he needs assistance from the consultant to finish the process and to clearly document the procedure for future adjustments.

As of this time, anchor points for Koror have already been collected. They will serve as points of reference from which satellite map images and other layers (such as roads) can be adjusted. The process of adjusting maps based on spatial location is known as "georeferencing". The next step (completed by the consultant) is the comparing of existing layers, such as the outlines of the islands, or roads to the newly adjusted map. The consultant will use the Koror (main island) map and supporting documentation to teach the two staff members the process so that future maps can be updated. The database support specialist and the exercise coordinator for the Emergency Response Program will use the documentation for the Koror (main island) map to conduct the same type of georeferencing and editing for the larger island (Babeldoab).

Approach	Expected Outcomes	Measurement	Baseline Measurement
1. Use ArcMap 9.3 Editor to spatially adjust shapefile features	Accurate and reliable baseline geographic data	Results will be evaluated by completed, adjusted map layers	Distorted satellite pictures are being used to approximate the locations of various features.
2. Collect waypoints using a portable GPS receiver	Points of reference for map adjustment and geo-referencing	Waypoints will be collected simultaneously with two devices to ensure fidelity.	Features are assigned on maps using clip art points in MS Word.

Additional Impacts

The successful completion of the first consulting task is necessary for any of the GIS implementation to work. Not only will this outcome produce a robust foundation for future mapping activities for the Planning and Development Department, if successful, this information can be influential in the development of the Public Health Information System. This outcome will help establish additional evaluation tools for staff members to make better-informed decisions.

Feasibility

This is the most feasible task for the summer. The spatial adjustment and editing process should take approximately 5 – 7 business days to complete. The partner understands that without complete and accurate baseline data, no further GIS work can continue. The requisite steps taken to adjust and implement the baseline data will be recorded in a report format in case additional efforts need to be taken after the consultant leaves. The required resources are available with the consultant's ArcGIS 9.3 software package, but future analysis will be able to be conducted on the software version and licenses currently operated by the Office of Planning and Development.

Task 2: Develop hazard planning and emergency response maps

One of the services provided to the public by the Bureau of Public Health is risk and disease prevention. This service informs the public when outbreaks or emergencies occur and then takes appropriate measures to mitigate disaster so that morbidity and mortality will be reduced in the aftermath of such events. The Emergency Operations Center (EOC) is a compendium of health care officials and disaster relief experts who work together to provide emergency relief services to the public. The EOC can only be activated through a mandate by the Incident Commander and will only be dissolved once expert services are no longer needed. The assembly of EOC members changes based on the emergency situation at hand. It is through the EOC that the greatest GIS project will best be utilized.

One way that the MOH can benefit from a GIS in emergency situations is by identifying at-need groups, such as the elderly, who are in need of specialized services or medicines. Should an emergency situation occur, the EOC will very easily be able to query the at-risk population and provide detailed reports as to the demographic make up and the medical service needs of the given population. The vital patient information will be stored in a database that is currently under construction and will be linked by primary key fields to points on the map. Similarly, dispensaries and emergency shelter locations (e.g. hotels and schools) will be recorded in spreadsheets along with information such as occupant capacity that will be uniquely joined to a map location. By mapping dispensing sites and shelters, the EOC can more easily locate and assign the population to appropriate dispensing sites or shelters in the case of an emergency. Layers can also be mapped to indicate the spread of infections or contagious diseases throughout the country such as Dengue Fever.

Expected Outcomes

Hazard planning and emergency response maps will more accurately locate at-risk or high need populations in order to provide efficient and thorough service in emergency situations. The solution for this objective is to locate and document medical supply dispensaries as well as shelters in order to more efficiently serve the population. Another outcome that is spurred by the use of GIS software is a new, more standardized way for tracking homebound patients. As

of now, patient name and hospital numbers are kept on a mix of paper-based logbooks or Excel spreadsheets. The nurses also do not have an efficient way to show when a patient moves or expires. If a patient moves, they just remove the patient name and number off of the list; there is no method for recording dates served or a comment field with the patient's name.

As a response to this problem, the database support specialist will design a database to store the patient information. He will also design a query to gather updated homebound data on a quarterly basis. It will then become the database support specialist's responsibility to coordinate with the nurses to collect new address locations and to remove patients that no long require homebound services.

A homebound data base system will allow the nurses to generate quarterly reports without burdening the nurses with the trouble of finding a way to sustain the needs of a GIS system. This portion of the GIS project will provide the initial base layer. The format used for recording names and coordinates will be used by the database support specialist to craft a database for the nurses. He will be responsible for training the nurses to generate quarterly reports and the consultant will be responsible for recording the requisite steps for collecting, recording, storing, and reporting patient data with a GIS.

Approach	Expected Outcomes	Measurement	Baseline Measurement
1. Collect HAZMAT waypoints using a portable GPS receiver	Accurate and reliable baseline geographic data for gas stations, oil reserves, toxic locations, etc.	Results will be evaluated by a complete geocoded HAZMAT map layer	There is no current baseline measurement for this approach
2. Collect homebound patient waypoints using a portable GPS receiver	Location coordinates that match patient's hospital ID with residence.	Waypoints will be collected simultaneously with two devices to ensure fidelity. A new database to track the continual changing of homebound locations (to be completed by the database support specialist).	There is no current map of homebound patients. Due to the absence of addresses, nurses must know the houses of patients. At the present time, patient's names and numbers are recorded on paper and in Excel spreadsheets.

Additional Impacts

Use of a GPS receiver is the main approach to collecting location of HAZMAT facilities and homebound patients because addresses do not exist in Palau. If a natural disaster or a HAZMAT emergency occurred at this time, there would be no formalized way to identify the location of homebound patients. This absence of location data and the absence of a reliable data management system to store address and HAZMAT material locations conflicts with one of the components of the MOH's mission, which is to "protect family health and safety". If an act of terrorism or a natural disaster were to occur, the MOH would not have readily available maps from which to organize efficient rescue efforts.

Due to the unavailability of address data, the only way to measure spatial location is through some mechanism of measuring latitude and longitude (i.e. collecting with a global positioning system (GPS)). The initial process of collecting and matching homebound patients names and addresses will expedite and facilitate future emergency medical service operations. Beginning with homebound patients provides an easily manageable sample set to model future, more comprehensive address mapping methods. It is the hope of the Bureau of Public Health to

create a sustainable GIS system with homebound patients so that the mapping activities can be translated to other at-need communities.

Prior to this time, HAZMAT mapping resulted in a map with estimated the location of hazardous facilities and then designated them by inserting clip art features in Microsoft Word. This project will better equip decision makers and emergency response personnel by providing precision map documents will improve information management as well as emergency staff efficiency by creating a basis for future longitudinal studies. The HAZMAT and emergency response maps will also aid in the procurement of additional funding and will ultimately facilitate future technology planning and disaster response efforts.

Feasibility

Data collection and mapping methodology is similar to the collection of baseline data as discussed in the first objective. This objective is purposely limited in scope to mapping HAZMAT facilities, EOC shelters, dispensaries, and homebound patients because of the time constraint of ten weeks. In initial meetings with the community partner, it was determined that these GIS objectives were of the highest priority and therefore, would comprise the scope of the mapping project. Collecting coordinate data falls not only within the consultant's skill set, but also the skill set of the database support specialist in the Emergency Response Program. Both the database support specialist and the exercise coordinator for the Emergency Response Program have prior GIS training. This will facilitate any additional training that the consultant provides as well as provides resources for other staff members as GIS capabilities expand throughout the Bureau of Public Health.

Task 3: Document GIS procedures and presentation materials

The resultant products of the ten-week GIS consulting project will be a unifying factor for the Bureau of Public Health's Planning and Development Department. The GIS activities that are occurring over the next ten weeks are part of a broader strategy of the Public Health Information System. The community partner wishes to see the successful implementation of GIS in other program areas and divisions within the Bureau of Public Health to ensure that program activities prioritize decisions based on data. One of the tactics associated with that strategy is to create a tool that supports the activities of the Office of Planning and Development and that falls within the jurisdiction of Public Health Information System Activities. In an effort to better plan for technology integration within the Bureau of Public Health, the community partner has asked to consultant to participate in a week-long strategic technology planning process in June. Documentation and presentation materials will create a communication and succession plan to ensure that the work completed this summer continues to develop.

Expected Outcomes

The content for a GIS manual and presentation materials will be in response for the need for continued development and training after the consultant leaves. The end deliverable should be a desktop reference guide and tutorial that can be used to train future users. The approach of involving multiple stakeholders will allow greater buy-in and sustainability.

Approach	Expected Outcomes	Measurement	Baseline Measurement
1. Attend and participate in Public Health Information Systems (PHIS) strategic planning meetings.	Program objectives, strategies, and tactics for future development.	A written deliverable that is accessible to general users, but advanced enough to serve as a tool for present GIS users.	Currently there is no strategic plan component for PHIS.
2. Involve staff members of the PHIS who will be end-users of the software by holding regular development meetings.	Staff suggestions and buy-in for current mapping and planning processes	Same as above.	Same as above.

Additional Impacts

This reporting strategy will be a capstone deliverable that synthesizes the disaster planning fieldwork, the strategic planning, and succession planning. Currently the Emergency Planning program is building capacity with GIS as a viable activity under that program. This plan will also enable staff without prior GIS training to use basic mapping features while allowing more advanced users to build upon the current data. This document will also facilitate internal communications, as GIS mapping is a new component of the strategic direction for the program. The strategic technology planning process will also serve as a road map to guide the implementation and on-going maintenance of technology and information system use throughout the Bureau of Public Health. This plan will serve as an evaluation tool to garner future financial support and management buy-in for future technology-related initiatives.

Feasibility

The documentation and succession-planning component of this summer consultation project is the culmination of the work done at the Bureau of Public Health. The community partner is passionate about the system and materials presented during the ten weeks becoming a model program for other programs within the Bureau of Public Health. In order for it to be a success, requisite time should be allocated in order for stakeholders to be involved at all levels of the project. The documentation process will be the passkey for future work and expansion on the program.

Task 4: Create 3-D analyst model for future projects

One major obstacle in the expansion of programming and acquisition of new technology is funding. As of 2006, approximately 43% of the MOH's operating expenses are acquired from the U.S. Federal grants. Without Federal support, the Bureau of Public Health would be severely restricted. Currently, the Public Health Information System is functioning with no budget. It receives support by providing services to other programs under the Office of Planning and Development. As a way to attract future funding and garner the interest of key decision makers at the MOH, the consultant will build a demonstration project to show more features of the mapping software and how it can be further applied to the needs and mission of the Bureau of Public Health and other departments within the MOH. The consultant will use the ArcScene three-dimensional analyst to build a model 3-D map of Koror, Palau as an example of future GIS applications. This simulation will be useful for illustrating flood plains during typhoons as well as the impact of toxic waste spills on the environment. While the Bureau of Public Health does not currently own the 3-D extension for the ArcGIS software, the consultant can save the

resultant file as a .wav movie or as a .jpeg file in order for grant writers to show how 3-D analysis can be used in disaster planning and emergency recovery situations. The community partner plans to use this deliverable as a means to advocate for continued funding and GIS program expansion activities.

Expected Outcomes

The consultant will use principles from Will Gorr and Kristen Kurland's *GIS for Health* tutorial, published by ESRI Press, to construct 3D representations of Koror based on topographical maps obtained from Palau Automated Land and Resources Information Systems (PALARIS).

Approach	Expected Outcomes	Measurement	Baseline Measurement
1. Complete the ArcGIS 3D Analyst Tutorial from *GIS for Health*, Gorr & Kurland, 2007	An examination of the 3D Analyst extension for ArcGIS.	Proficiency in displaying and analyzing topographical data.	There are no 3-D Analysis materials because PHIS does not own the 3-D extension. 2-D maps are the only current base-line measurement.
2. Contact Palau Automated Land and Resources Information Systems (PALARIS) to obtain topographical maps of Koror	Create TIN from contours and drape EOC layers of TIN features. Create 3D scenes and set observer and target locations for EOC operations in Koror.	Creation of a functional .wav file of a 3D simulation. Creation of TIN features from contour map of Koror.	Only a 2-D topographical map is available. It is not even known if a digitized topographical map exists.

Additional Impacts

The products of this objective will be used to for the sole purpose of examining additional ArcGIS functions that the Bureau of Public Health could utilize in the future. This kind of technology would also be helpful for acquiring additional funding. Exploring alternative ways to demonstrate data will also facilitate future technology planning processes and information collection and planning processes.

Feasibility

This objective is the lowest priority of the proposed projects for the summer. It is feasible, but should not be attempted until the baseline data and other reporting features have been collected and analyzed. This task fits the consultant's skill set and will provide a new vantage point from which to view existing data. This activity will not be sustained after the consultant leaves until additional funding can be secured. This is merely a mechanism by which the community partner can acquire additional funding.

IV. Outcomes and Recommendations

Task 1. Establish baseline GIS data

Outcomes

The consultant worked with multiple bureaus and agencies including the Office of Planning and Statistics and the Palau Automated Land and Resources Information Systems (PALARIS), an agency under the direction of the Ministry of Resources and Development, as well as departments within the Ministry of Health to gather population data, previously created maps, and resources to make new maps.

The outcomes of this task are:

- **Accurate and reliable baseline geographic data**– Map data collected from PALARIS was organized and spatially adjusted using ArcView GIS software to ensure map layers lined up with each other properly. Geographic data was also assigned a projection and coordinate plane (if not previously designated).

- **Complete Palau census data**– A meeting with the Office of Planning and Statistics yielded access by the Bureau of Public Health to all population and housing data including tables for 1995, 2000, and 2005 for official use. The Office of Planning and Statistics is responsible for the collection, production, and distribution of the statistics is the Republic of Palau. Access to this data was an unexpected, but ideal outcome to the data collection activities.

- **Complete map data information from PALARIS**– Several meetings with agency analysts resulted in the collection of all available shapefile data including political boundaries, conservations zones, transportation layers, biological layers, hydrology layers, cultural and tourism data, and topographical layers for Koror, Peleliu, and Anguar. The sharing of this data is imperative to the success of any GIS initiatives by the Bureau of Public Health.

- **Coordinating staff's new knowledge** - The coordinating staff members from Emergency Health are now connected to the Office of Planning and Statistics and PALARIS. Also, the staff has used the information and the base layers to develop methods for collecting and editing geographical data for future projects.

Prior to Implementation

Before the establishment of baseline data:

- **Incomplete data sets** - The Bureau of Public Health did not have complete sets of geographic data including infrastructure maps

- **Inaccessible data** - Population and housing data was not easily accessible from the Office of Planning and Statistics

- **Inaccurate maps** - Maps created for planning and reports were not always geographically accurate

- **Lack of methodology** - There was no methodology for gathering and editing data

Capacity Not Yet Reached

The current capacity for the stated task was completed for hamlets and road layers, however additional layers such as buildings and conservation zones are still in need of spatial adjustment. The layers yet to be adjusted are not priority layers, but may be used at some point in the future.

The Bureau of Health now has all of the current map files and data currently available from PALARIS, so the BPH staff does not need to download any additional files.

Effect on Mission

The successful aggregation of data from various agencies allows officials in the Bureau of Public Health easy access to data for planning and policy analysis. The prioritization of decisions based on data is one of the main strategic directions of the Bureau of Health as stated in the 2008 Strategic Plan.

Sustainability of Outcome

The acquisition and editing of baseline data is sustainable within the Bureau of Public Health because:

- **Relationship Development** – The coordinating staff members have established relationships with members of other agencies who can provide access to data when updates are needed. For instance, Palau will conduct the next population and housing census in 2010. The Office of Planning and Statistics has already promised to make the data easily available to the Office of Emergency Health. Several contacts have been made at PALARIS, the nation's GIS clearinghouse and data will be easily updated.

- **Staff Training** – The coordinating staff members have been trained in georeferencing and editing activities and will be able to train additional technicians as funding becomes available.

- **Public Health Information Systems** – PHIS is a newly formed office in the Bureau of Public Health that will serve as an IT support and data management department.

Risks to Sustainability

Although much consideration has been given to the sustainability of this project, there are several risks that may threaten the sustainability of this task within Public Health.

Lack of Funding for GIS Initiatives

Description: A fully functional GIS requires both a high degree user expertise as well as costly software. Software updates and user training requires on-going financial support on behalf of the Ministry of Health administration. In a time of economic uncertainty, GIS may be one of the first programs to be truncated.

Mitigation: It is imperative that two or more staff members be trained on the basic functionality of GIS so that maps may be created to support the data-driven initiatives of the Bureau of Public Health. The bare essential instructions on how to import data and create map documents is included in the attached GIS desktop reference manual; it will allow even a novice computer-user to make basic map documents for reporting.

Dissolution of Existing Relationships

Description: Perhaps the most important outcome of the GIS project is the formation of cross-departmental relationships. The symbiotic relationships between agencies and how data is collected, managed, and shared is important for the continuation of a GIS program. The Bureau of Public Health depends on the cooperation of many different agents both outside and inside the Ministry of Health.

Mitigation: In order to maintain effective lines of communication, it is recommended that an employee from the Public Health Information Systems Department, where the GIS data will soon live, become a point of contact for Public

Information Officers from each cooperating program or agency. It is also important for the designated PHIS employee to schedule regular meetings with stakeholders to demonstrate the uses and outcomes of GIS for public health activities as well as collect updated map data.

New Uses of Technology:

The consultant and cooperating staff members could only envision new ways for using technology to aggregating and editing baseline data by parties outside of the Ministry of Health. The Bureau of Land and Surveys should consider uploading shapefiles and map data to an online database such as the U.S. Census has done for geographical features collected by the United States Geological Survey (www.census.gov). Similarly, the Office of Planning and Statistics should consider formatting the population and housing figures in a .txt and .xls format to allow easy downloading for other agencies, currently the information is in .pdf format.

Recommendation 1: Provide training to at least two Bureau of Public Health employees

After the consultant leaves, it is suggested that the coordinating staff members receive additional training

Steps for completion:

1. *Investigate up-coming workshops in the Pacific*: Many health care organizations in the South Pacific use GIS including the World Health Organization, the Pacific Disaster Center, etc.

2. *Secure funding for at least one employee to attend:* It is important that at least one employee receives more advanced training in order to return to the Bureau of Public Health to instruct and inform other staff members.

Resources Needed: In order to satisfied, there should be enough computers for each trainee to use. Software must be up-to-date in order for the training session to have the most impact for the staff member. Funding for technology upgrades, conference fees, and transportation are also required for the implementation of this recommendation to be successful.

Recommendation 2: Continue spatially adjusting, other layers, such as the building layer, to be used in future GIS activities

Steps to completion:

1. *Refer to the GIS Reference Manual*: The GIS Reference Manual contains sections on spatial adjustment and editing procedures for map files. It contains a step-by-step guide for modifying and saving changes in ArcGIS.

2. *Conduct Editing*: Spatially adjust and edit the desired documents and save any changes.

Resources Needed: All resources for this recommendation are available. All available map data has been obtained from PALARIS and Public Health staff members have access to editing components in ArcGIS.

Recommendation 3: Regularly communicate with other Bureaus and Agencies to update data as it is available

Steps to completion:

3. *Set up regular meetings with other agencies*: Currently, the Bureau of Public Health has the most current map and population data, but mapping and data collection is a continuous process and should be updated.

4. *Continue building relationships external parties*: Organizations such as the Pacific Disaster Center and the Pacific Island Health Officers Association hold valuable information and resources that can be shared.

5. *Build high-quality maps for policy use*: Using local information, from sources such as A(H1N1) Encounter Forms, to create useful maps that other agencies can use will help maintain strong inter-agency relationships.

Resources Needed: Successful communication and data sharing relies on healthy relationships with managers and assistants from other agencies. Agency websites can also serve as a place to begin with investigating new resources.

Task 2: Develop hazard planning and emergency response maps

Outcomes

The consultant worked primarily with coordinating staff members from the Emergency Health Program within the Bureau of Public Health. The purpose of the Emergency Health Program is to coordinate efforts to save lives through emergency preparedness, response, and prevention for all people in the Republic of Palau. The main outcomes from the second task were as follows:

- **Location of Homebound Patients** - Homebound residents are hospital patients who, whether through age or disability, are not able to visit the Palau National Hospital. The consultant and the coordinating staff member worked with the Office of Nursing to visit patients with the Homebound Program nurses. At each residence, a coordinate was recorded to add to a spreadsheet of names. The Office of Nursing did not have a means of recording homebound patients, so the Emergency Health Database Specialist designed and is creating a database to store patient information to sustain the GIS effort. It has been determined that the Database Specialist will be responsible for updating the Homebound Registry database with new coordinates every three months.

- **Emergency Shelter Locations** – Emergency shelters are facilities such as public buildings, schools, hotels, etc. that can be converted to shelters in the event of emergencies or natural disasters. The list of locations was already pre-determined by the Emergency Health Program. The consultant and the Database Specialist collected the location of the shelters in order to more efficiently apportion the population should an emergency arise.

- **Locations of Dispensaries** – Dispensaries are satellite locations of the hospital. It is imperative the Bureau of Public Health map the exact location of the dispensaries for the emergency planning process.

- **Locations of Fuel Storage Containers**– One of the essential components of disaster mitigation is the anticipation of hazardous material (HAZMAT) emergencies. According to a 2004 HAZMAT Proposal, one of the capacity needs is HAZMAT planning and mitigation. The consultant and coordinating staff member began collecting

points in Malakal, a hamlet in Koror with a high level of bulk oil storage facilities. From the collected points, buffer zones can be created to show the potential impact of an explosion or spill to surrounding residents and structures.

Prior to Implementation

Before developing the data for hazard and emergency planning maps:

- **No Maps of Homebound Patients** – There are no home addresses in Palau and the roads are not marked. The nurses rely on memory and word of mouth to keep track of homebound patients in the various states and hamlets in Palau. For an emergency rescue operation, the ability to assist the disabled was difficult, if not impossible. Prior to the implementation of this project, there was not an organized way to keep track of the patients requiring home assistance.

- **No visual representation of shelters** – PALARIS is currently taking great steps to survey and draw all of the buildings on the island. Unfortunately they do not provide much detail in the map data regarding what each structure represents. Prior to the mapping of emergency shelters, planners had to rely on memory and static paper maps to determine where at-risk populations should seek assistance.

- **Current map of dispensaries did not exist** – Some of the satellite dispensaries were recently built so their location is not always on printed materials or on maps.

- **No layer file for HAZMAT locations** – The HAZMAT map created for the 2004 proposal was created using a picture file map (.jpg) and clip art images in MS Word to represent hazardous locations. There is no robust way to examine the impact of a catastrophe on vulnerable populations.

Capacity Not Yet Reached

The spread of the A(H1N1) "Swine Flu" to Palau has usurped the availability of some Emergency Health staff members. Much was accomplished to begin the methodologies for emergency planning, but there is much to be completed in order to have rigorous plans in place.

- **Not all homebound patients have been mapped** – Accessibility to the outer islands of Peleliu and Anguar is limited, so the final points to be collected for the Homebound program will be from those locations. The GIS Desktop Reference Guide details the step-by-step process of collecting and mapping those points.

- **Capacity constraints and contact information for shelters needs completed** – One major advantage to using GIS is that it functions much in the same way that a relational database works. Each layer can store multiple fields of information about an object, Emergency Health workers can fill in missing data like building capacity, point-of-contact name, etc. for each shelter location to ensure that effective and efficient decisions are being made.

- **Collecting HAZMAT locations is labor-intensive** – There was only enough time to capture toxic materials locations from the hamlet of Malakal in Koror. Planning and collecting data points is a very time and labor-intensive process and the remaining hamlets and states in Koror and Babeldoab need collected and added to the current hazard map.

Effect on Mission

Collecting homebound data will allow for disaster planning that allocates the appropriate amount of resources to the at-need population based on where they live. These resources can include medicine, food, and other materials, per the situation. HAZMAT mapping allows for policy makers to make wise decisions on how to protect vulnerable populations in emergency situations.

Sustainability of Outcome

The continued use and development of GIS for emergency planning is feasible because:

- **The consultant worked with other staff members to collect all field data**–The database support specialist scheduled and participated in the data collection, so he is familiar with the established methodology in order to continue future data collection.

- **The coordinating staff members understand how the software works**–Both coordinating staff members have received previous GIS training for ArcView 9.1. They are comfortable proposing new GIS initiatives for future projects.

- **The Homebound Registry is being designed with long-term sustainability in mind**– The initial assessment for the homebound mapping project revealed a need for a small database to monitor the patient activity. There was no way to see when a patient entered homebound status or when a patient moved or passed away. In response to this need, the database support specialist created a "Homebound Registry" so that the nurses could monitor the patients as well as provide data for the database support specialist to upload into ArcGIS. It has been determined that homebound shapefiles will be updated every three months.

Risks to Sustainability

While sustainability for emergency and hazard mapping activities has been considered, there are still external factors that could threaten the sustainability of the project

Data collection for homebound patients could lapse

Description: The Homebound Registry has been designed with the intent of capturing homebound patient information. There may come a time when the database no longer serves the nurses' needs. Also the database support specialist may not be able to commit to update the homebound map every six months.

Mitigation: One way to mitigate changes that occur over time is to hold an annual GIS evaluation process within PHIS. Evaluation of current operating processes may lead to more efficient data collection methods especially if the database specialist is no longer able to update the maps.

Shelter locations may become outdated

Description: The ephemeral nature of business is such that shelter locations may change over time without updates being made to the map data.

Mitigation: One way to ensure map data is updated is to schedule annual meetings with PALARIS to obtain any new shapefiles that may have been created. Additionally, the GIS point person at PHIS should update the shelter list and points annually.

New Uses of Technology:

Effort is already underway to finish the Homebound Registry for the Office of Nursing. Ideally, the homebound patient information could be stored on a shared server infrastructure so that multiple parties could share information. Strategic planning for Public Health Information Systems is already underway to determine the best way to share data among multiple stakeholders in Public Health.

Recommendation 1: Continue homebound, hazard, and shelter mapping

One of the major activities of the GIS implementation was arranging times and days to complete the mapping field work. Homebound mapping was limited to the Koror and Babeldoab. Tracking homebound patients in Peleliu and Anguar has not yet been completed, but would be a good addition to the already collected data. Also, hazard mapping should continue from Malakal to the rest of the country.

Steps to completion:

1. Prioritize and create a timeline for data point collection
2. Coordinate data collection times with the appropriate parties (i.e. Office of Nursing)
3. Secure transportation and driver, if need be, to mapping sites
4. Upload updated map data

Resources Needed: The GIS staff will need to coordinate with the Office of Nursing to collect homebound points. The staff will require transportation, fuel, and a GPS receiver to collect the data points.

Recommendation 2: Use data from epidemiology to map other enzootic diseases, especially those that affect specific population groups (e.g. age, language barrier, ect.)

ESRI's ArcGIS is not only a visually appealing mapping software system, it is one of the most powerful statistical analysis tools for policy analysis. The World Health Organization (WHO) conducted a GIS study in 2001 to identify pockets of leprosy in the Western Pacific Region. Similarly, the Bureau of Public Health could use GIS to track the spread of A(H1N1) or Dengue Fever. Furthermore, data from the Immunization program could be used to examine the immunization rate of children per hamlet or state.

Steps to completion:

1. Obtain epidemiological data and format data in excel to join to hamlet layers
2. Import census information into map shapefiles in order to calculate rates

Resources Needed: GIS staff members need epidemiologists to provide accurate and timely data and the census bureau to provide the population data.

Recommendation 3: Forge relationships with other emergency planning or public health agencies

The only way to move closer to the Ministry of Health's vision of a "healthy Palau in a healthful environment" is if multiple agencies work as a team and share data. Disaster mitigation agencies like the Pacific Disaster Center would be an excellent place to start to share data or methodologies. Large organizations such as the World Health Organization also use GIS for decision-making, which can provide some ideas or useful tips when designing GIS projects for Palau.

Steps to completion:

1. Assign a staff member of PHIS to become a public information officer to maintain contacts with other agencies and who feels comfortable researching and discussing technology initiatives for public health.

2. Maintain relationships by sharing data, findings, and GIS practices with others.

Resources Needed: In order to create and maintain effective and productive relationships with other agencies, PHIS staff time is required. Internet and email access are also paramount because most research will be directed through that channel.

Task 3: Document GIS procedures and presentation materials

Outcomes

The following were outcomes of this task:

- **GIS Desktop Reference Manual** – The reference manual is meant to serve as a step-by-step guide for the GIS work completed this summer by the consultant. It is not meant to serve as a replacement for actual training, but is intended to serve as an additional resource for staff training and development.

- **Introduction to GIS PowerPoint presentation** – Oftentimes it will be necessary for the informative presentations to be given for fundraising or other activities where GIS may be pertinent. The consultant will leave a template behind for the Public Health staff to use as they wish for presentations involving the explanation of GIS. Slides will be modified based on the audience.

Prior to Implementation

Before documenting GIS procedures and developing the presentation materials:

- **No simple reference manual**– The manuals and tutorials used by the Bureau of Public Health were publications that staff members received at conferences. The material was either too advanced or not applicable to public health in Palau. The manual serves as excellent documentation for the consultant's technical work.

- **No materials to support the use of GIS** –The use of GIS in the Ministry of Health is limited to the Bureau of Public Health, which that in mind, much of the administration and staff will need to be educated on what GIS is, why it is used for public health, and what it can currently do.

Capacity Not Yet Reached

Creation of the manual and presentation are one-time deliverables that require no further elaboration.

Effect on Mission

The creation of the desktop reference manual has no significant effect on the mission other than to support Bureau of Public Health internal processes.

Sustainability of Outcome

The reference manual and presentation materials are sustainable and relevant such that the Bureau of Public Health conducts GIS activities under the scope of the documented work and the reference manual and materials are not misplaced.

Risks to Sustainability

While sustainability for the creation of a reference guide has been considered, it is still that external factors could threaten the sustainability of the GIS project.

> #### The reference manual could be misplaced
>
> > *Description*: One of the only reasons that the manual and materials would not be sustainable is because the files could be accidentally lost, deleted, or misplaced.
> >
> > *Mitigation*: In is advisable to make multiple back-up copies of not only the reference manual, but of the entire GIS file tree.
>
> #### A software upgrade may make the manual obsolete
>
> > *Description*: The current ArcView product that the Bureau of Public Health uses is 9.2, but 9.3 is the most current version. The manual is formatted and written based on the 9.3 framework.
> >
> > *Mitigation*: One way to keep the manual and presentation materials from becoming obsolete is to make periodic adjustments to them as changes are deemed necessary.

New Uses of Technology:

The consultant has not yet identified any additional uses of technology for the creation of GIS materials.

Recommendation 1: Use the GIS reference manual as a guide for training staff members

> #### Steps to completion:
>
> 1. Assemble interested staff members
> 2. Copy shapefiles and map documents onto trainees computers
> 3. Use reference manual as tutorial
>
> **Resources Needed:** Staff expertise in GIS is required for the on-going training with the staff member training.

Task 4. Create 3-D analyst model for future projects

Outcomes

The intent of creating a 3-D analyst model was to provide the community partner with a demonstration project to illustrate additional features of the ArcGIS software. The model could potentially serve as an instrument to advocate for further funding and GIS program expansion activities. The following were outcomes of this task:

- **A three-dimensional rendering of Koror** – The three-dimensional rendering of Koror shows the island as a TIN (triangulated irregular network) image. TIN uses the elevation data of two-dimensional topographic lines as input to draw the 3D image. This map image does not include major infrastructure like roads or buildings, nor does it include geological or biological features.

- **A introduction tutorial for using the ArcGIS 3D Analyst extension** – The tutorial was adapts the mapping principles for 3D Analyst found in Kristen Kurland and Will Gorr's tutorial, "GIS for Health" (ESRI Press, 2007). It provides introductory techniques of importing and creating 3D data in ArcGIS.

Prior to Implementation

Before creating this task:

- **There were no 3-D models for Public Health** – Prior to this time, only two dimensional map documents were being used for analysis.

Capacity Not Yet Reached

The purpose of the final task was to provide a demo and overview of the 3D component to GIS. With that in mind, there are several ways that capacity could be reached:

- **Integrate HAZMAT landmark to 3D map** – One feature that 3D models can demonstrate is the effect of a toxic spill on the population and environment. The location of toxic sites could be added to the 3D model to provide emergency planners with an additional perspective for emergency planning.

- **Assign height attributes to buildings and structures** – Adding height to buildings throughout Palau (even if it is estimated) will allow the software to render a 3D buildings as well as elevation. This information could be important to estimate the effects of a toxic spill, flood, or explosion.

Effect on Mission

Since the outcome was only a model, the current demonstration has no observable effect on the mission. If, in the future, 3D analysis could be conducted, it could have a positive effect on the mission by aligning resources to create a robust planning tool.

Sustainability of Outcome

Three-dimensional analysis is a long-term goal (greater than one year from now) for the Emergency Health program, but two tools have been put in place to aid in the long-term sustainability of this task:

- **3D Analyst Tutorial is available** – The tutorial serves as an introduction to the 3D Analyst extension of ArcGIS. It demonstrates how to display topography and transportation data in 3D. It is designed in a step-by-step way to allow novice users to create their own 3D simulations.

- **Contour raster data has been collected** – PALARIS provided contour data (data showing elevation) for Koror, Babeldoab, Peliliu, and Anguar. Whenever the extension is purchased, the data will already be available for use.

Risks to Sustainability

- **The Bureau of Public Health does not own the ArcGIS Analyst extension for 3D modeling**

  Description: The ArcGIS software package is a costly investment for any organization and it only includes base extensions or components. Additional components like 3D Analyst require additional licenses, which cost extra.

  Mitigation: The Bureau of Public Health should wait to purchase 3D Analyst extension from ESRI only if the Emergency Health Program is prepared to use the extension enough to warrant the cost. Perhaps other agencies like PALARIS would be able to create the same types of 3D modeling for a nominal fee. Also, there may be grant money available from organizations like the Center for Disease Control or the United States Department of Homeland Security that would cover the cost of the extension.

New Uses of Technology:

The use of a 3D Analyst extension in itself is a new use of technology for a planning team. The consultant and coordinating staff members feel that this extension can be one of the long-term projects for Emergency Health GIS activities.

Recommendation 1: Obtain the 3-D Analyst extension for ArcView

Steps to completion:

1. Finish collecting HAZMAT and shelter locations throughout Palau

2. Design a report, detailing the uses and expected outcomes of 3D modeling for public health

3. Use the report to obtain grant money to update ArcGIS software, including extensions

Resources Needed:

- **Completed HAZMAT and Shelter Data** – This data is needed to make the 3D Analyst fully functional and useful.

- **Funding** – The ArcGIS software and hardware upgrades require capital to bring the Emergency Health program up-to-date.

- **Staff Knowledge** – Emergency Health GIS expertise is needed when extra extensions such as 3D Analyst are used for health policy analysis.

Recommendation 2: Create additional 3-D models for HAZMAT planning

Steps to completion:

1. Obtain the 3D Analyst extension from ESRI

2. Train Emergency Health GIS users on the features of the 3D extension

3. Use the data gathered in task 2, listed above, and drape the features over a 3D map of the study area

Resources Needed:

- **ArcGIS 3D Analyst Extension** – This extension is required for 3D modeling, as highlighted above.

- **Emergency Health Data** – HAZMAT, shelter, homebound, and other emergency health data is needed for the effective and complete creation of a 3D model.

Additional Recommendation

Additional Recommendation 1: Obtain at least two licenses for ArcView 9.3 GIS software as well as desktop PCs to support the program

The consultant recommends continuing to use GIS software developed by ESRI, Inc. Although free or low cost options mapping applications are available, ESRI develops some of the most advanced geospatial software technology. There are three main reasons why ESRI would be a good match for the Bureau of Public Health:

1. **Consumer Support** – ESRI is a global leader in geospatial technology with approximately one third of the global market share. It is the same system that the U.S. Geological Survey uses as well as the same platform PALARIS uses. ESRI maintains strong partnerships in the Pacific, including the Pacific EMPRINTS (Emergency Management and Response Information Network and Training Services) at the University of Hawaii, which provides workshops and training modules throughout Micronesia with ESRI products.

2. **Current Program** – The Bureau of Public Health already owns one copy of ArcView GIS on an Emergency Health laptop. More than two staff members are already familiar with the interface and are able to create map documents. Implementing a new system would be time-consuming and costly.

3. **Used currently in Palau** – As mentioned above, PALARIS uses ESRI products and is the primary purveyor of map data in Palau. Data sharing and data collection will be easier if both organizations use the same GIS application.

Resources Needed: The Bureau of Public Health needs financial support to purchase the computers, software, updates and extensions for ArcGIS.

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John Livengood, Pacific Disaster Center

Homebound Nursing Program Staff

Palau Automated Land and Resources Information Systems (PALARIS) Staff

Office of Planning and Statistics Staff

Ministry of Health Family

About the Consultant

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APPENDIX I: Map of Satellite Medical Dispensaries

APPENDIX II: Summary of Public Health Divisions and Programs

Division or Program	Purpose/Mission	Division/Program Components	Employees
Division of Environmental Health	To help protect the health of residents of Palau through providing leadership in empowering communities to create, build, and maintain healthy settings.	1. Ensuring healthy community environments through routine household inspections and remediation 2. Provide guidance on pollution and hazard control 3. Consumer protection through inspection of service establishments 4. Ensure food safety 5. Ensure water quality 6. Work with communities to reduce vectors and vector borne diseases 7. Provide leadership in international health quarantines 8. Maintain capacity to respond to emerging issues, emergencies and disasters	(FT 20) Chief, Environmental Health Officer, Statistics Specialist, Computer Operator, PCEHDP Specialist, 5 Sanitarians, 8 Sanitation Technicians, Administrative Officer, Administrative Assistant
Division of Primary & Preventive Health	To provide routine preventative medical care as well some non-routine treatments for illnesses. This program is also responsible for supervising the remote dispensaries.	1. Family Health Program 2. Primary and Community Health Program 3. Non-Communicable Disease Program 4. Communicable Disease Unit 5. Cancer Prevention & Control Program 6. HIV/STD Program	Family Health (FT 15); Primary and Community Health (Board of 10) and (FT 5); Non-Communicable Disease (FT 8): Communicable Disease (FT 8 Nurses, 1 Physician); Cancer Prevention (FT 3); HIV/STD (FT 10)
Division of Behavioral Health	To provide evidence-based therapy methods for patients experiencing problems such as alcohol and drug abuse.	Unavailable at this time.	Unavailable at this time.
Division of Oral Health	To improve the oral health status of the community through education and making adequate oral health services accessible.	Community Based Dentistry – Provides Dental Public Health Services	Unavailable at this time.
Emergency Health Program	Coordinates efforts to save lives through emergency preparedness and response, and injury prevention for all people in the Republic of Palau	1. Increase readiness levels on emergency preparedness 2. Increase levels of education on emergency preparedness 3. Improve cohesion of all partners and/or key stakeholders to increase quality of preparedness	(FT 6) Administrator, Public Information Officer, Database Specialist, Administrative Manager, Preparedness Training and Exercise Coordinator, Administrative Assistant
Public Health Data and Statistics	To collect and disseminate data regarding public health in Palau, and to act as a statistical and methodological resource for departments and individuals within the Ministry of Health.	1. Improves data collection, verification, and dissemination 2. Assists with data analysis for various registries, logbooks, and data systems 3. Acts as a data/statistical resource for the MOH 4. Generates "Annual Public Health Profile and Ministry of Health Facts and Figures publication"	No designated full-time staff. Epidemiologist (Cancer funded) Statistical Technician II (DEH funded) RDSS Technician (HIVSTI funded) Statistician (Family health funded)
Social & Spiritual Health Program	To promote the importance of social ties to overall well-being. This program is recognizes the fact that good health is not just "curing and preventing illness," but it encompasses a more holistic wellness to an individual and the community.	Unavailable at this time.	Unavailable at this time.
Public Health Information Systems	To produce accurate, reliable, and timely information that supports health policies and data-driven decisions for the Ministry of Health and the Community. Health information data is supported by a team of trustworthy personnel to protect the integrity and confidentiality of the information.	**IT Development and Maintenance** – PHIS will serve the data management needs of the Bureau of Public Health by developing, implementing, and maintaining a centralized information system for the Bureau of Public Health Services. **Data and Information Management** – PHIS will use technology tools to ensure that data collection, recording, and reporting is accurate and reliable. **Human Resources** – PHIS will promote a positive working environment through the support of a	Not yet determined by BPH.

| | | highly qualified and trustworthy team. This team is tasked with the responsibility of upholding the system's policies and supporting the technology initiatives of the BPH.

Planning – PHIS staff will conduct strategic technology planning on a regular basis to ensure goals and objectives are being met as well as prepare for future opportunities and mitigate potential challenges.

Communication - PHIS will establish communication protocols, procedures, and guidelines for internal data collection and management as well as collaborate with other agencies to disseminate important public health information. | |
|---|---|---|---|
| **Community Advocacy Program** | To facilitate behavioral change through the dissemination of information. The program serves as a thread that binds the other programs and divisions together and presents a unified voice to the public. | 1. Social Marketing
2. Health Promotion
3. Health Education
4. Research and Evaluation | (FT 4) |

APPENDIX III: Project Timeline

Updated: June 23, 2009

Date	Tentative Tasks
Week 1 (5/25/09 - 5/29/09)	Orientation; Edit Base Maps (Koror)
Week 2 (6/1/09 - 6/5/09)	Meeting with Homebound Nurses; Tech Inventory; Context Analysis
Week 3 (6/8/09 - 6/12/09)	Tues-Thur, Homebound waypoint collection
Week 4 (6/15/09 - 6/19/09)	Homebound Mapping; Hamlet Adjustment
Week 5 (6/22/09 - 6/26/09)	Homebound Documentation, Strategic Planning Prep
Week 6 (6/29/09 - 7/3/09)	Strategic Planning (PHIS), 3-D Analyst
Week 7 (7/6/09 - 7/10/09)	Hazard Mapping and Babeldoab; Finish layer mapping
Week 8 (7/13/09 - 7/17/09)	Documentation (Manual); Training
Week 9 (7/20/09 - 7/24/09)	Documentation Cont'd
Week 10 (7/27/09 - 7/31/09)	Final Report; Final Succession Plan

Appendix IV: Example of a Satellite "Super" Dispensary

Southern Community Health Center

The photo above is the entrance to the Southern Community Health Center located on Peleliu, an island that is approximately a 45-minute boat ride from the Palau (Belau) National Hospital. It was completed in 2002 and serves the primary health care needs of the local residents as well as residents of the Island of Anguar and the Southwest Islands. It is regularly visited by a doctor, which is why it is one of the four designated "Super Dispensaries".

## Appendix V: Hardware and Software Recommendations

The consultant recommends purchasing ArcView from ESRI, Inc. Some of the key feature and system requirements are listed below.

System Requirements	Minimum	Recommended
Platform	PC-Intel	PC-Intel
Operating System	Windows Vista (Ultimate, Enterprise, Business, Home Premium), Windows 2000, or Windows XP (Home Edition and Professional)	Windows XP Professional
Memory	1 GB RAM	2 GB RAM or higher
Processor	1.6 GHz	2 GHz or higher
Processor	Intel Core Duo, Pentium 4, or Xeon Processors	Intel Core 2 Duo
Display Properties	24 bit color depth	32 bit color depth
Resolution	1024 x 768 recommended or higher	1280 x 800 Resolution

The following extensions are available at an extra cost. The consultant suggests purchasing the ArcGIS 3D Analyst.

Appendix VI: Selected Map Examples

The example below represents the location of homebound patients in Koror. Koror is divided into 15 hamlets, which are symbolized by color.

HAZMAT Locations: Malakal, Koror
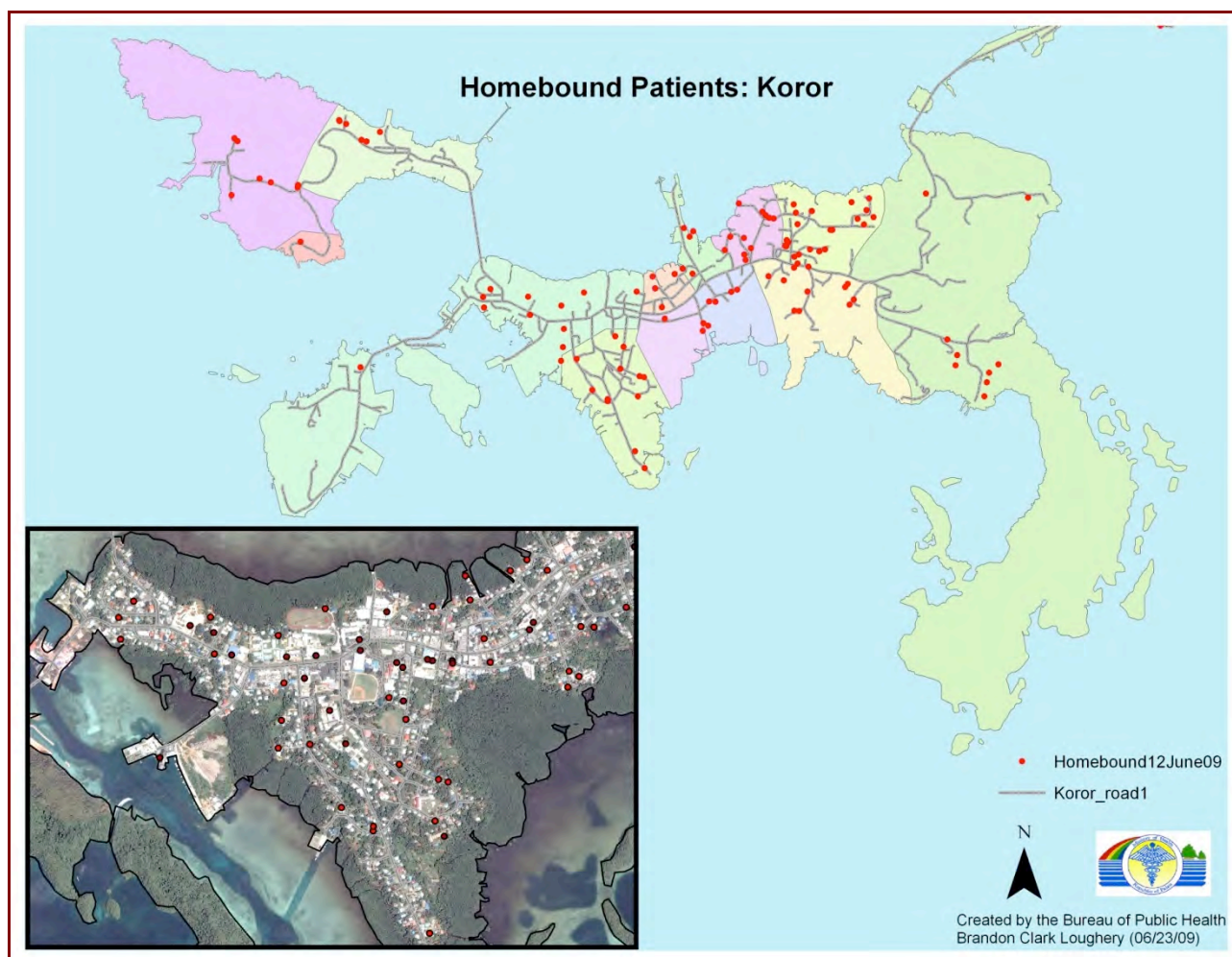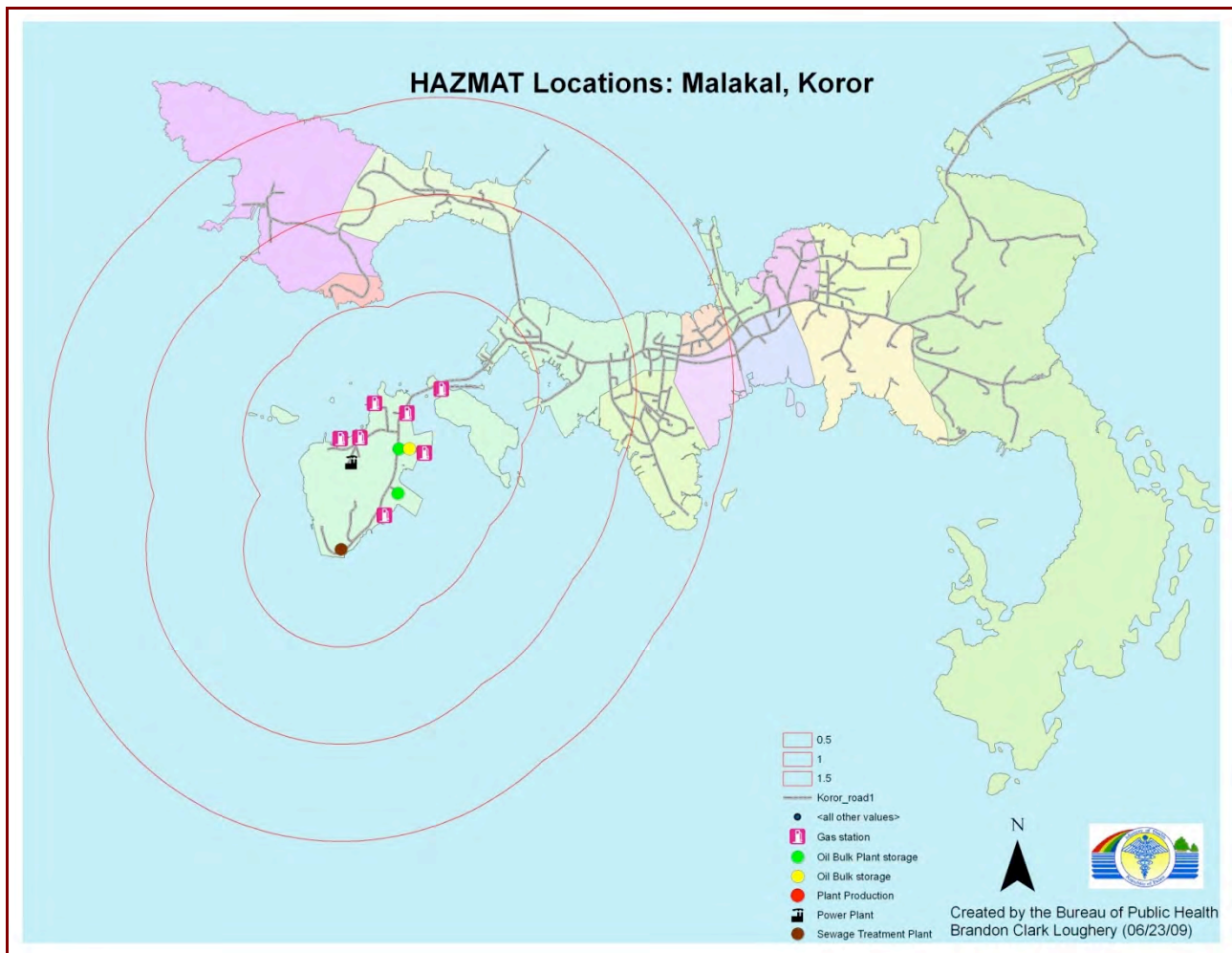
The example above illustrates how GIS can be used for spatial analysis. Only HAZMAT locations in Malakal, Koror were recorded due to time constraints. The buffer regions around the toxic locations represent intervals of 0.5, 1.0, and 1.5 miles. The distances were picked arbitrarily and only serve as an example for future analysis.

Emergency Shelters, Koror
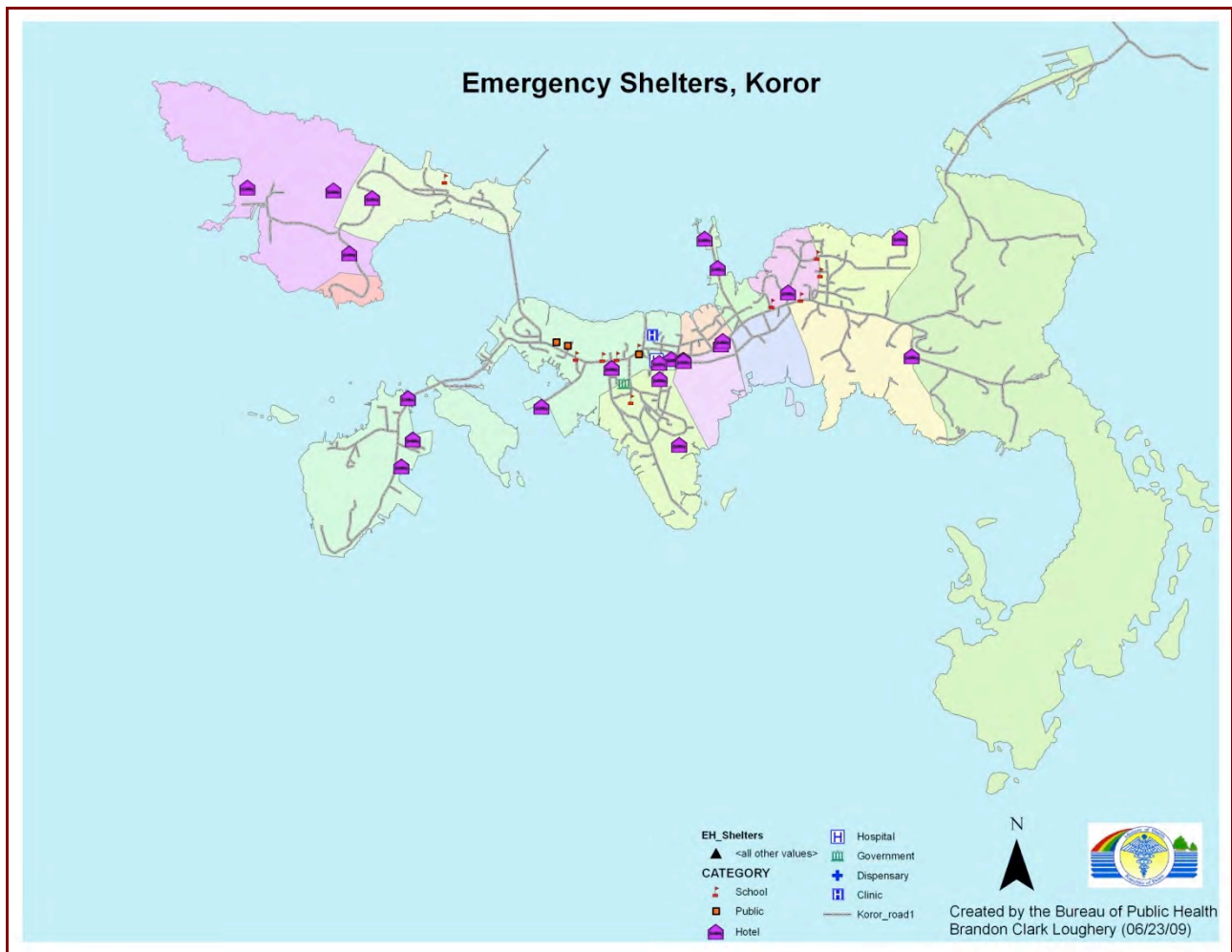
The example above illustrates emergency shelter locations in Koror. These locations are determined by the Emergency Health Program and are symbolized according to their use (e.g. school, dispensary, clinic, etc.).

Below is an example of a 3D model of the Island of Peleliu. Models such as this can be used in the future for more extensive analysis.
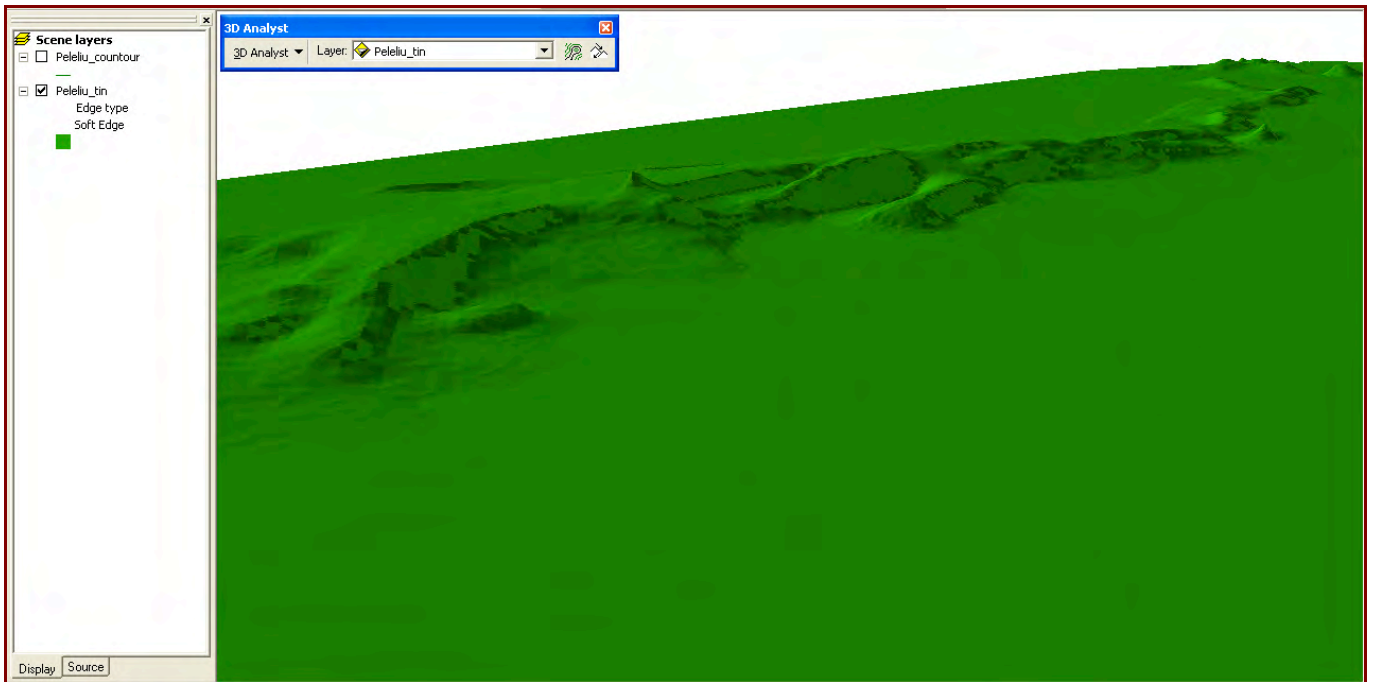
Appendix VII: Technology Planning Logic Model

Bureau of Public Health
Public Health Information Systems (PHIS) Logic Model

Planned Work (We can control) — Intended Results (We cannot control)

Inputs

(What we invest)
Staff
Volunteers
Time
Money
Research
Materials
Equipment
Technology
Partnerships
Consumers

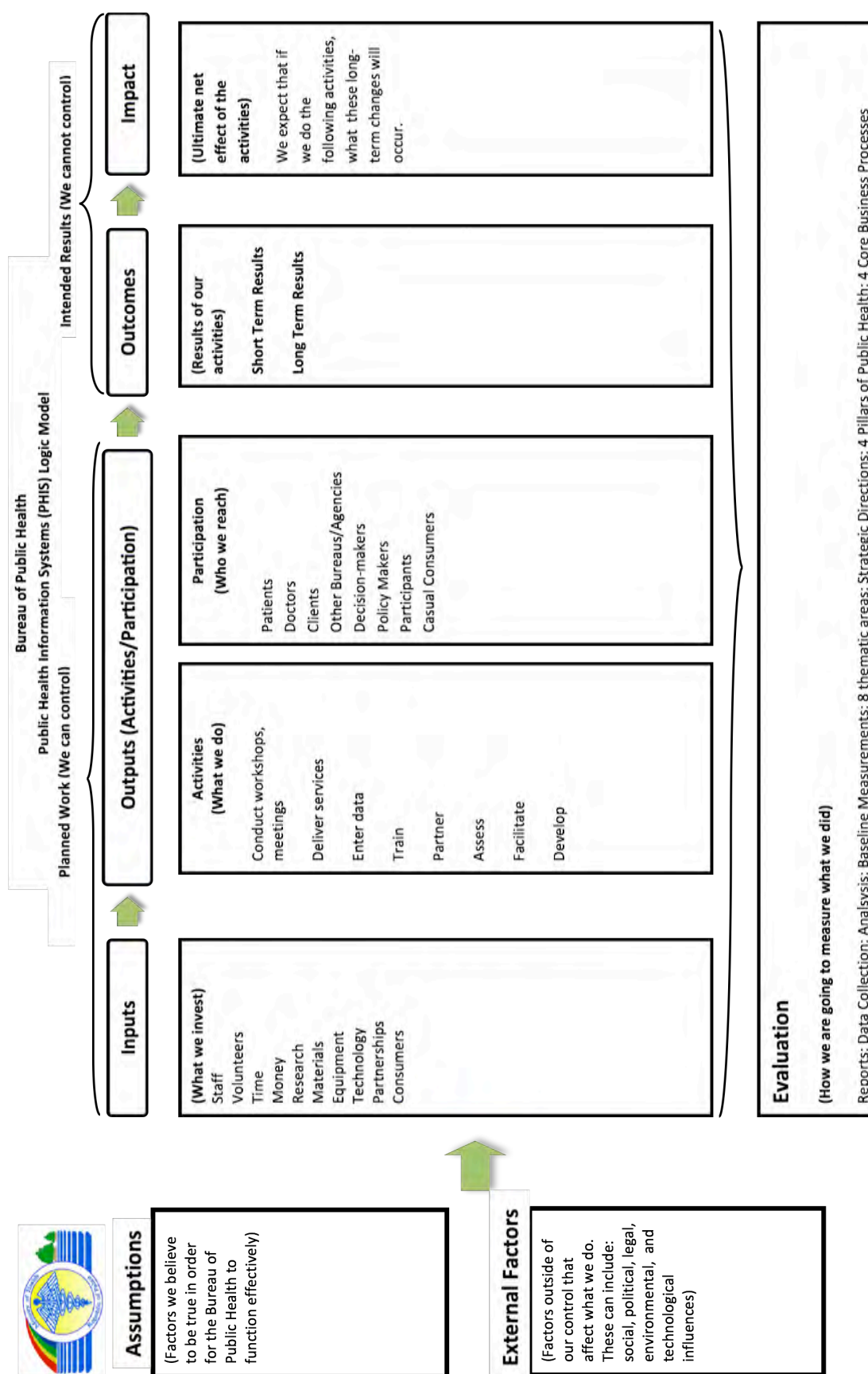## Outputs (Activities/Participation)

Activities
(What we do)

Conduct workshops, meetings

Deliver services

Enter data

Train

Partner

Assess

Facilitate

Develop

Participation
(Who we reach)

Patients
Doctors
Clients
Other Bureaus/Agencies
Decision-makers
Policy Makers
Participants
Casual Consumers

Outcomes

(Results of our activities)

Short Term Results

Long Term Results

Impact

(Ultimate net effect of the activities)

We expect that if we do the following activities, what these long-term changes will occur.

Evaluation

(How we are going to measure what we did)

Reports: Data Collection; Analsysis; Baseline Measurements; 8 thematic areas: Strategic Directions; 4 Pillars of Public Health; 4 Core Business Processes

Assumptions

(Factors we believe to be true in order for the Bureau of Public Health to function effectively)

External Factors

(Factors outside of our control that affect what we do. These can include: social, political, legal, environmental, and technological influences)

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