SIAM-2, C-4 Component

Environmental, Risk and Resource Management

Natural Resource Management

Geographic Information Systems Development Review

Prepared for

Ministry of Natural Resources, Environment and Meteorology

By

Peter Newsome, Matthew Elgin, James Atherton

On behalf of

BECA International Consultants Ltd

Report: GIS Development Review
Beca International Consultants Ltd.

Report

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By

Beca International Ltd

November 2005

Ministry of Natural Resource, Environment and Meteorology 13 December 2005
Private Bag
Apia
Samoa

Attention: Vitaua Peleiupu Fuatai

Dear Sir

Geographic Information Systems Development Review

Please find enclosed the GIS Development Review Report, the deliverable item for Tasks RM 1.1 and RM 1.2. In addition to the review of current GIS systems and practices in the Ministry it recommends a number of further development programmes to enhance the applications of GIS in the performance of the Ministries functions
Two key pathfinder projects have been recommended which it is proposed, subject to your agreement, be implemented by utilising the remainder of the professional advice time budget of the GIS specialists. These projects would comprise Task RM1.3 of the project. We would envisage these being commenced in early to mid February 2006 and being substantially complete within the year. Detailed timing and programming of subsequent visits can be agreed following your acceptance of the recommendations.

Following receipt of this report, it is understood you will take all necessary steps to implement the recommendations of the report, including staff and financial resourcing, and incorporate appropriate elements of the report in the Ministry's corporate plan.

Yours faithfully
Graeme Roberts
Manager, Planning

on behalf of
Beca International Ltd
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Revision History

Revision Nº	Prepared By	Description	Date
A	Peter Newsome, Matt Elgin	Draft circulated to James Atherton, Leo'o Polutea (MNREM) and Jude Kohlhase (PUMA) for comment.	2 Nov 2005
B	Peter Newsome, Matt Elgin, James Atherton	Final report	22 Nov 2005

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Action	Name	Signed	Date
Prepared by	Peter Newsome Landcare Research NZ Ltd		10 Nov 2005
Reviewed by	James Atherton		12 Nov 2005
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Approved by	Graeme Roberts, Beca International Ltd		13 Dec 2005
on behalf of	***Beca International Ltd***		

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Executive Summary

Project and Client

The Sustainable Management: Environmental Risk and Resource Management (Component C4) of the Second Infrastructure Asset Management Project (IDA Credit No. 3848-WS) requires the consultant (among other things) to train and support the MNREM to better manage and provide policy advice to government on natural resources using GIS.

This report comprises the main advisory document to the MNREM on its near-term GIS development options. It is compiled following a series of individual meetings during the project inception mission with key MNREM (and PUMA) staff and a day-long stakeholders workshop on 13 October 2005.

Strategy

It seems evident that a dual-path strategy is the best way forward from the present position. The GIS units in the Ministry have reached a certain level of technical competence and data development, but still need to cross a threshold of acceptance by the Ministry and outside agencies as a mainstream work tool. Striving to gain this acceptance should be the short-term objective via some convincing pathfinder projects and relationship development with potential clients. Meanwhile, on a longer term path, there are some data and institutional issues that can be worked on to better position GIS to serve the Ministry and Samoa in the mid term.

Conclusions and Recommendations

Stakeholder agencies and offices of MNREM/PUMA have a wide variety of data needs and applications. Some of these data layers have yet to be captured or created and most of the applications are yet to be realised

The MNREM has made significant advances in data capture and the development of a GIS capability. However, there remains some work in consolidating and augmenting data layers and in 'selling' GIS as an operational tool for users. We recommend a dual strategy of 'winning over' stakeholders whilst also investing effort in building a foundation of data layers from which to launch future applications.

We have identified three institutional issues within MNREM which, if successfully resolved, will release some unrealised GIS potential in the Ministry and beyond:

- Data access and pricing
- Utilisation of the Met Office Mapserver
- Integration of GIS units in MNREM

We have outlined the elements of an implementation plan that can be adopted as appropriate by the Ministry in its Corporate Plan:

- GIS software and hardware. We see no compelling reason to change, but counsel the Ministry to make full use of the resources available (some

valuable software remains to be installed many months after it was delivered). We also encourage the Ministry to maintain its GIS equipment to ensure that its capability remains undiminished over time.

- GIS Data Development. We list over 50 data layers for which there appears to be a demand and recommend a programme of work be formulated to capture or generate and document missing data, possibly in collaboration with stakeholders.
- We have delivered training in the theory of terrain modelling and in generating and using DEMs and their derivatives.
- We propose two pathfinder project for consideration and endorsement by MNREM and PUMA as showpiece applications of GIS to help win over new GIS clients:
    - MNREM Natural Resource Atlas
    - PUMA/MNREM Environmental Evaluation Tool
- We identify four other projects that we believe will return significant near-term gains to the Ministry:
    - MNREM Metadata Development
    - Disaster Management Office GIS Decision Support Tool
    - Global Map/ Global Spatial Data Infrastructure Grant Program
    - Orthorectification of IKONOS Imagery
- We recommend the MNREM open a dialogue with sister ministries with a view to providing GIS services to those ministries for whom GIS could realise some tangible benefit but for whom investment in GIS is not presently warranted.

1. Introduction

The Sustainable Management: Environmental Risk and Resource Management (Component C4) of the Second Infrastructure Asset Management Project (IDA Credit No. 3848-WS) requires the consultant (among other things) to train and support the MNREM to better manage and provide policy advice to government on natural resources using GIS.

This report comprises the main advisory document to the MNREM on its near-term GIS development options. It is compiled following a series of individual meetings during the project inception mission with key MNREM (and PUMA) staff and a day-long stakeholders workshop on 13 October 2005.

Appreciating the Ministry's wish, conveyed in the course of other components of the SIAM-2 project, to determine its own course of action, this report focuses its attention on perceived departmental needs and strategy options, issues that face the Ministry, and the elements required in an implementation plan for GIS development.

2. Departmental Needs Assessment

This section considers the role and functions of the component parts of the MNREM and associated agencies. It highlights some actual or potential applications of GIS and the data needs to undertake these applications. Some of these data layers already exist and are in use within the Ministry, while others remain to be captured.

2.1 MNREM Mapping

The MNREM Mapping section is the custodian of core spatial data to government and other agencies. As well as the capture and maintenance of core data, the section provides GIS services to policy arms of the Ministry, though their awareness and use of GIS is presently very low.

GIS Data Needs

The Mapping section is a provider rather than a consumer of data. Its GIS data needs are therefore dictated by its clients and their applications. Current data holdings as far as can be determined are listed and discussed in a coming section.

GIS applications

The Mapping Section has undertaken GIS applications for private, business, and government clients including:

- delineating closing lines across the mouth of bays to extend Samoan sovereignty over coastal waters under international law
- providing map material for village consultations on biodiversity protection by the Environment and Conservation Division, MNRE (with GEF funding)
- providing map material for Environment and Conservation Division studies on

watershed areas
- delineating National Park boundaries and subdivisions for Environment and Conservation Division
- digitizing new boundaries of land being transferred from government to villages

2.2 MNREM Terrestrial Biodiversity

The Terrestrial Biodiversity Section is concerned with the biodiversity of all island ecosystems. It undertakes monitoring of birds, bats, reptiles, and forest extent. The section also does some limited marine monitoring. Monitoring sites and techniques are not yet well standardised nor do they use GIS for storage and analysis.

National ecosystem mapping was carried out by SPREP and the East-West Center in 1991. The NZ Department of Conservation also did ecological surveys in Samoa of lowland forests (1991) and the Division of Environment and Conservation subsequently surveyed upland forests (date unkn). Forest cover mapping is also available for 1954, 1989, and most recently, with FAO funding, for 2004. There is potential to undertake GIS analyses of these data in conjunction with data on hazard and threat to assist the management of remaining areas of high indigenous biodiversity.

Public awareness and education is an obstacle to successful conservation of indigenous ecosystems. Incursions into indigenous forest for firewood is constant, and clearance of both forest and mangroves for agriculture and urban development continues. Many still regard these areas as a resource to be used without consideration of their other values. Hence, public awareness of their fragile state, and their contribution to a healthy island environment, needs to be raised through publicity and education. Two social structures are key to the success of any publicity/education campaign, schools (because children are both key to the future and a means of educating adults), and Pulunu'u with their village fono (because almost all remaining indigenous ecosystems are in customary ownership).

A biodiversity conservation programme is currently underway with a significant GIS component. With Australian government funding the DEC are surveying and mapping the distribution, abundance and threats to rare birds in Samoa, A MapInfo-based GIS system has been established at the DEC office at Vaiala to map and analyse the bird survey data. At the same time, all previous biodiversity data have been digitised and can now be mapped.

GIS Data Needs

The following data needs are inferred from discussions held outside the group workshop on which this report is primarily based.

Topographic base layers (roads, rivers, terrain, urban areas)

- Thematic layers
- Soils
- Geology
- Vegetation
- Land use
- Climate (rainfall, temperature, solar radiation)

- Species distribution
- Weed and pest distribution

GIS applications

This section has made limited use of GIS but could potentially use it for such studies as:

- Management and monitoring of ecosystem health
- Management and monitoring of invasive weeds and pests
- State of the environment reporting
- Monitoring of species distribution and abundance (birds, bats, etc.)

2.3 MNREM Watershed

This section was part of the Forestry Division until 3 years ago. Now its focus is more on whole ecosystems (from the source to the sea) rather than primarily forests. Its function is advocacy in respect of watershed management.

GIS Data Needs

The Watershed Section collects some data on water quality by ground survey. They also have a working relationship with Samoa Water Authority who do some water quality monitoring – work the Watershed section would like to see expanded. Their perceived data needs include:

- Topographic base layers (roads, rivers, terrain, urban areas)
- Surface water quality and quantity
- Catchment boundaries
- Infrastructure (e.g., culverts, stormwater networks, drains, etc.)
- Thematic layers
- Soils
- Geology
- Vegetation
- Land use
- Climate (rainfall, temperature, solar radiation)

GIS applications

Maps and map information are in everyday use by this section. Although their use of GIS has been limited to date, they foresee potential for this as a tool: for analysis and depiction of land use and vegetation change; for data management and storage; and as a medium for integrating data and disciplines in whole catchment studies. The section views the Vaisigano Catchment studies undertaken with FAO funding in the mid-1990s as a good example. They are also trying to promote the concept of watershed protection areas on customary land (e.g., in the Loimata o Apaula area).

2.4 MNREM Parks and Reserves

The Parks and Reserves Section have managed all the park lands in Samoa before the restructuring of the ministries in early 2005 and the move of the Forestry section to MNREM. We have been informed that since that time the Forestry section has assumed greater oversight of conservation lands with, perhaps, a corresponding shift in focus of the Parks section.

GIS Data Needs

The following data needs are inferred from discussions held outside the group workshop on which this report is primarily based.

- Topographic base layers (roads, rivers, terrain, buildings, urban areas)
- Thematic layers
- Soils
- Vegetation
- Land use
- Species distribution
- Weed and pest distribution

GIS applications

While not yet users of the GIS, Parks and Reserves can visualise uses for GIS in the management and publicity of the park network

2.5 MNREM Forestry

Forests, mainly indigenous forests, cover 105 000 ha or 37.2 percent of the country's total land area. In the 1990s, the rate of deforestation in Samoa was around 3000 ha or 2.1 percent per year. On the global scale, this is quite high. The main causes of deforestation and forest degradation are uncontrolled logging operations and conversion of forest lands to agriculture. Currently, this is the number one forest-related issue in Samoa.

The section also has an interest in the state of ecosystems outside reserves as a barometer of condition, trend and threat to the reserve system. The present reserve system is undergoing expansion from the original single national park (O Le Pupu-Pu'e) to include a park around Lake Lanoto'o, and some watershed management areas are also being considered.

A management plan is in place for the O Le Pupu-Pu'e National Park, and a management plan is in preparation for the whole reserve network. Samoa's ecosystems have suffered a slow decline in the face of shifting agriculture and development. Anecdotal accounts point to the incidence of drought and water shortages as evidence of the reduction in the ability of shrinking forests to regulate the hydrology of the islands. Such assertions fuel the debate for a mid-upper slope watershed management zone for both Upolu and Savaii. Other threats to environmental stability include exotic pests and weeds. Merremia vine (*Merremia peltata*) is of particular concern in successional vegetation and disturbed land.

Samoa has about 5000 ha of forest plantations. Plantation establishment began around 1974 with the planting of mahogany and Australian red cedar. Teak was also established during German colonial times. More than 90 percent of the plantation estate was destroyed by tropical cyclone Val in 1992. Samoa has banned the export of unprocessed logs. Commercial logging in natural forests on Upolu has also been banned. Samoa produces sawn wood for its domestic market. Other wood and paper products are imported. Much new forestry is now at the village level, where Forestry Officers provide the first 100 seedlings free and demonstrate planting and silviculture techniques to empower landowners to plant and manage their own small woodlots.

Stakeholders in the activities of the Forestry section include:

- EPC (in respect of renewable energy for electricity – coconut database)
- SWA (in respect of their interest in 5 catchment/watersheds)
- PUMA
- Land Owners (for whom they run an awareness programme)
- Logging companies (through their oversight/monitoring of the code of logging practice)
- Land Management Division and Mapping section, MNREM

GIS Data Needs

The following data needs were identified in the group workshop on which this report is primarily based:

- Topographic base layers (roads, rivers, contours, terrain, urban areas)
- Thematic layers
- Soils
- Geology
- Vegetation
- Forest class (current and historic)
- Land use
- Climate (rainfall, temperature, solar radiation)
- Species distribution
- Weed and pest distribution
- Cadastre

GIS applications

MNREM Forestry has a fully-functioning GIS (Samoa Forest Resource Information System, SamFRIS) built under an FAO funded project due to end in June 2005. The latest forest inventory survey in 2004 completes a time series of spatial forest layers for 1954, 1987 and 2004. Their perceived GIS applications include:

- Management and monitoring of the forest (and conservation) estate
- Administration of logging activities
- Identification and selection of new conservation estate
- Management and monitoring of community forestry schemes
- Management of weeds and pests in forests

2.6 MNREM Meteorological Office

The Meteorological Office undertakes weather station recording, daily forecasting, and modelling of extreme events such as storm track prediction, tsunami and storm surge inundation, and flood modelling. Extension activities are focussed on public education and preparedness to develop a capacity for communities to recognize and respond to emergencies when they occur.

The Met Office is the host site for a mapserver installed by SOPAC with EU funding. This presents both an opportunity and a challenge to the GIS community in Samoa because utilisation of the mapserver will result, on the one hand, in greater visibility of the spatial data and recognition of the MNREM's role as a national data custodian and, on the other hand, in a weakening of the MNREM's monopoly position as a gatekeeper and provider of spatial data.

GIS Data Needs

The following data needs are deduced from some insight into the role of the Met Office and a meeting prior to the GIS Development Workshop:

- Catchments
- DEM
- Streams & Rivers
- Roads
- Buildings and urban areas
- Coastline
- Bathymetry
- Storm tracks
- Earthquake origin and intensity
- Sea surface temperatures

GIS applications

The following GIS applications are deduced, with some insight into the role of the Met Office, from a meeting outside the GIS Development Workshop:

- Storm surge flood modelling
- Rainfall flood modelling
- Climate modelling
- Tsunami modelling
- Weather mapping
- Weather recording

2.7 PUMA Sustainable Development

PUMA (working under the Planning and Urban Management Act 2004) is responsible for the sustainable management, development and use of land resources for present and future generations. It operates under a planning board comprising 5 community representatives and representatives from the Ministries of Police, Finance, Women, Environment and Works. It has three sections:

- Strategic Planning (Sustainable Management Plans, Policies, codes and guidelines for various planning issues)
- Sustainable Development (Consents, Environmental Impact Assessments, Monitoring and Regulations)
- Urban Services (Markets)

Any activity or development requires a consent, including:

- Subdivision (Land Management Division, MNRE also involved)
- Building
- Land clearance
- Sand mining (Land Management Division, MNRE also involved)
- Reclamation (Land Management Division, MNRE also involved)

Each village has a Pulunu'u or mayor who acts as an intermediary between the people and central government. Every month there is a meeting of Pulunu'u, hosted by the Department of Internal Affairs. In this forum, government projects are explained (for promulgation to the people) and the concerns of, and issues for, villages are made known to central government. Many of the consents handled by the Sustainable Development section are vetted by Pulunu'u on behalf of their villages, because of their inevitable effect on the large area of customary land in

Samoa.

The transfer of PUMA, including its Sustainable Development Section, to the Ministry of Works, Transport and Infrastructure could place their function of environmental assessment in conflict with the Ministry's primary role of development. It is also considered that Sustainable Development's function of environmental monitoring is well away from the role of the MWTI. There is some speculation that subsequent restructuring may create a standalone planning and environmental monitoring agency.

GIS Data Needs

- Population (urban, rural, village, district)
- Utilities/Infrastructure
- Electricity supply
- Water supply
- Telephone
- Roading (inc bridges/fords, drainage/culverts, Asset Management database)
- Land parcels
- Land tenure/land use
- Hazards (erosion, flood, etc.)
- Buildings / developments
- Natural resources
- Forests
- Agriculture
- Soils
- Land stability
- Geology
- Hydrography
- Contours
- Rainfall
- Social
- Schools & hospitals/health centres
- Hazardous areas (chemicals, etc.)
- Heritage & cultural sites
- Consents database
- Civil aviation installations

GIS applications

PUMA use, or would like to use GIS as a tool in:

- evaluating consent applications
- assessing environmental impacts
- monitoring sustainable management plans
- supporting policy and decision-making

2.8 Disaster Management Office

Although most of the local responsibility during emergencies is the responsibility of village authorities, the DMO is responsible for:

- collaborating with stakeholders in promoting disaster risk reduction
- coordinating the development and implementation of preparedness

programmes
- coordinating response and recovery operations
- developing and implementing activities that will ensure a resilient Samoa
- saving lives and reducing damage to property
- Disseminating information during the response and recovery phases.

Stakeholders in the DMO comprise all urban, village and urban communities, businesses and government. The DMO works to build their capacity through awareness programmes and education and ensuring the continued flow of services during and after a disaster.

During an emergency, the authorities activate the National Coordination Centre, located in the Police Headquarters, Apia. The National Disaster Council determines priorities for response during an emergency. This council comprises the PM (as chair), all cabinet ministers, all ministry CEOs, the Red Cross, and the DMO (as secretariat). Disaster response is by agencies executing their normal functions such as, police/fire for rescue, PWD for roads, EPC for electricity, etc.

GIS Data Needs

Key to an effective disaster response are data layers of:

- community lifelines
- road networks
- electricity
- communications
- water, etc.
- buildings (inc. dwellings, businesses, churches, medical centres/hospitals, evacuation centres, schools, relief depots, etc.)
- vulnerable and hazardous areas
- floodable areas & areas subject to inundation
- oil storage installations
- industrial sites
- reclamations
- erosion-prone areas

GIS applications

The Disaster Management Office considers GIS to be key to its effectiveness in all four phases of disaster management, namely: mitigation, preparedness, response, and recovery. The DMO would like to acquire some basic resources for use during emergencies, such as communications equipment, shelters, generators, tools and equipment, food and water to sustain the NCC during times of crisis. Clearly, an installed GIS capacity to visualise situations, produce maps and analyse information would be an immense advantage, and not only during times of crisis.

2.9 Other Agencies

GIS, quite evidently has application to agencies other than MNREM/PUMA. Such agencies may elect to maintain their own GIS or contract these services in from another provider. In either event they will inevitably need reputable spatial data.

We are aware that SamoaTel has been running GIS for two years, and Samoa

Water Authority also has a MapInfo/ArcView system. The Department of Statistics in the Ministry of Finance has also developed a MapInfo based GIS system to plan statistical surveys and to map statistics findings. Similarly, the Ministry of Works, Transport and Infrastructure has a MapInfo GIS system for all public works assets, including roads, bridges and culverts. Electric Power Corporation of Samoa (EPC) presently uses accounting software to maintain their inventory of assets, but would like to move to a GIS-based asset management package. These and other infrastructure/utilities agencies will have a need for good quality, well-attributed data (such as road edges or centrelines, imagery and cadastre) that MNREM could provide.

Collaborative opportunities probably also lie with other ministries, including:

- Ministry of Agriculture and Fisheries (in respect to agricultural development, plant and animal health, management of the EEZ, etc.)
- Ministry of Commerce, Industry and Labour (in respect to (mainly rural) economic development studies, etc.)
- Ministry of Communication and Information Technology (in respect to IT standards and policy)
- Ministry of Finance (in respect to population, land agricultural and forestry statistics, and statistical analyses/mapping)
- Ministry of Health (in respect to public health applications, e.g., disease transmission, drinking and lagoon water contamination from septic tanks, etc.)
- Ministry of Police, Prisons and Fire Services (in respect to general mapping, emergency management, fire hazard modelling, etc.)
- Ministry of Works Transport and Infrastructure (other than PUMA) (in respect to management and maintenance of roading and infrastructure)

3. GIS Development Strategy

To the extent that is possible, this strategy and the implementation plan that follows build on and enhance that which already exists in the MNREM and PUMA. It endeavours to be flexible rather than prescriptive. Instead of defining a fixed programme of work, it identifies issues for consideration and uptake by the Ministry through processes and at a pace that can be tailored to fit within the MNREM corporate plan.

3.1 Current State

Currently, there is no definitive GIS Strategy in either the MNREM or PUMA. However, there are some effective, often unwritten, procedures and methods for data management that have been put in place by the leaders of the respective GIS units.

The success of the three main GIS units, now resident in the MNREM, is both a strength and a weakness. On the one hand, the Ministry has inherited the leadership and inspiration of three effective GIS units and, on the other, the Ministry faces problems inherent in managing separate groups working in the same discipline, in

particular those of disconnected data management, and lack of synergy resulting from low levels of coordination and collaboration.

A proposed implementation plan cannot ignore the fact that the MNREM is an experienced user of GIS. Instead, the proposed strategy will look at ways to draw together the threads of experience and GIS skills in the MNREM and to enhance the recognition of spatial tools so that GIS may one day become a tool accessible to all people working on problems with a spatial component.

3.2 Alternative Strategies

Organisations install Geographic Information Systems either to extend services with new products, or to streamline existing services. In the process of implementation, organisations must cross a threshold in systems installation, staffing and training, and data acquisition before they can begin to be productive. There is a dilemma here in finding a balance between building a long-term, 'perfect' system (at enormous cost in time and resources) and assembling a short-term, still incomplete, 'functional' system (at modest cost in time and resources). The 'perfect' system is clearly the point that all GIS units want to reach, but sometimes managers and users become impatient and withdraw their support for an implementation strategy that invests all its energy invisibly building the foundations of a perfect GIS. The reciprocal situation arises with an implementation that becomes productive too soon by sacrificing quality, with the attendant risk of disappointing the managers and users on whom they depend for support.

The conventional solution to this dilemma is the dual-track development strategy whereby after a preliminary requirement analysis and core design, a short-term development track implements immediate data capture and applications, while a long-term development track continues the detailed analysis and design and data capture. The short-term results are obtained by sacrificing detail and accuracy to gain recognition and support while the long-term results are achieved slowly by infilling and improving data and building strong applications. Such a strategy does not dismiss the benefits of detailed planning and implementation, but development of such a detailed data base takes a great deal of time and money, and the system in the meantime is not very useful. It is widely believed that low accuracy data can support around 80–90 percent of initial applications for a fraction of the outlay that will ultimately be invested building the mature system.

3.3 Recommended Strategy

It seems evident that the best strategy from the present position is dual-path. The GIS units in the Ministry have reached a certain level of technical competence and data development, but still need to cross a threshold of acceptance by the Ministry and outside agencies as a mainstream work tool. Striving to gain this acceptance should be the short-term objective via some convincing pathfinder projects and relationship development with potential clients. Meanwhile, on a longer term path, there are some data and institutional issues that can be worked on to better position GIS to serve the Ministry and Samoa in the mid term.

4. Institutional Issues

4.1 Data access and pricing policy

The Mapping Section's access and pricing policy for electronic data is considered restrictive by some stakeholders, a barrier to GIS development in Samoa, and a factor that limits application of GIS in nationally and locally important issues.

The Ministry may elect to consider alternative access and pricing policies such as:

- Cost recovery for public good agencies – data charge for private good agencies
- Data maintenance partnerships with external agencies
- Providing standard data products at nominal fixed prices (with acknowledgement of source)

The key to success in this area is to strike a balance between revenue generation from data sales and uptake of GIS layers:

- An unreasonable price will attract no (or few) data sales, and potential clients will either avoid using spatial data or capture it themselves, resulting in multiple dissimilar, uncontrolled, copies of the same data
- A high price will attract some sales but no repeat customers, and clients will still capture supplementary data themselves
- A reasonable price will attract repeat customers, prepared to pay a nominal fee for access to authoritative data layers they neither have to capture nor maintain themselves

4.2 Utilisation of the Meteorological Office Mapserver

In the near term, web delivery of data and GIS maps via the Mapserver installed at the Met office is a practical proposition. We understand that at the present time the Mapserver is functional but scarcely used.

Clearly there are positive and negative implications for the MNREM if the Mapserver was utilised to its full potential, including:

- Improved uptake and usage of nationally important spatial data
- More widespread recognition of MNREM (and other data contributors) among Mapserver users, both national and international
- Loss of potential revenue from data sales and GIS services
- Potentially reduced control over GIS applications and possibly compromised quality of spatial analyses

Ultimately, it may become a choice between charting a course as a low-value data and map vendor (the current path) and a course as a value-added GIS services agency. This alternative path has less emphasis on warehousing raw data and more emphasis on value-added GIS services. The alternative path is clearly the greater challenge, with the potential for a greater gain, but neither course would compromise the Ministry's role as a custodian of core spatial data for national mapping,

environmental management, and disaster management.

4.3 Integration of GIS Units within MNREM

MNREM faces a challenge integrating the respective GIS capabilities of the present Mapping Section with that of SamFRIS and the Meteorological Office. There are both positive and negative outcomes from co-location and integration of these GIS units:

- Each unit presently has its own history, identity and sense of purpose that are valued by their respective staff and clients. It is important that these values are not ignored and lost in any merging of units
- Each unit has hardware and software, staff and expertise that, if pooled, will enhance the capabilities of the whole
- Each unit has a traditional and potential 'client-base' that must not be alienated in any restructuring or this will further compromise adoption of GIS as a tool within the Ministry and outside agencies

5. Implementation Plan

5.1 System Configuration

GIS software

We recommend no change to the present concentration on MapInfo, Vertical Mapper, and ERDAS Imagine Essential. Staff exhibit varying competencies in this software but most seem comfortable with the concentration on this suite of software. Furthermore, these software seem to be performing their present roles satisfactorily, so we see no immediate justifiable case for change.

The single copy of ArcGIS ArcInfo 9.1 is a useful and powerful complementary product that provides additional function in such things as map preparation and spatial analysis.

We would recommend that, where possible, the Ministry maintains these software (perhaps just to the latest 'whole-number revision level) to take advantage of recent developments and improvements in function. MapInfo is presently at Version 9, Vertical Mapper is presently at Version 3, ERDAS Imagine is presently at Version 8.7, and ArcGIS is at Version 9.1.

GIS Hardware

We would recommend that, where possible, the Ministry maintains an appropriate standard of hardware in the GIS units to allow for their efficient operation. The minimum specification for a desktop MapInfo GIS computer is a Pentium 4, 1.6GHz CPU, with 256 MB RAM, 40GB Hard Drive and 17" monitor. It would be preferable that all machines exceed this specification in every aspect.

5.2 GIS Data Development

An examination of data needs by departmental section compared with data holdings notified in interviews and workshop sessions reveals the following:

DataLayer	Data Needs (by division)									Holding
	Map[1]	BioDiv	W'shed	Parks	Forest	Met	DMO	PUMA	Other	
Airfields/airports	✓	✓			✓	✓	✓	✓	✓	?
Bathymetry	✓		✓			✓	✓			(SOPAC?)
Building (inc type) polygons	✓						✓	✓	✓	?
Building points	✓						✓	✓		✓
Built-up areas	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Climate – Rainfall		✓	✓		✓	✓				
Climate – Solar Radiation		✓			✓	✓				
Climate – Temperature		✓			✓	✓				
Coastline	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Communication sites	✓						✓		✓	
Consents (building, subdivision, development, mining, etc.)								✓		
Conservation areas	✓	✓	✓	✓	✓			✓		✓ (SamFRIS)
Emergency centres (fire, police, medical, refuges, CD, Red Cross, etc.)	✓						✓			?
Ecosystems	✓	✓	✓	✓	✓				✓	✓
Environments	✓	✓	✓	✓	✓				✓	
Fauna – species		✓	✓	✓	✓					✓
Forest class – current	✓	✓	✓	✓	✓					✓
Forest class – historic		✓			✓					✓
Forest plot monitor sites		✓			✓					✓ (SamFRIS)
Geology	✓	✓	✓		✓	✓		✓		✓ (Met)

[1] The Mapping Section, while not an end user of spatial information, is custodian of core data layers necessary for work by client agencies and for future topographic mapping. It has therefore been accorded with 'needs' appropriate for the discharge of these functions.

DataLayer	Data Needs (by division)									Holding
	Map[1]	BioDiv	W'shed	Parks	Forest	Met	DMO	PUMA	Other	
Hazards – Coastal Erosion	✓						✓	✓	✓	✓
Hazards – Flood	✓		✓	✓	✓	✓	✓	✓	✓	✓
Hazards – Industrial							✓	✓		
Hazards – Landslide	✓		✓		✓	✓	✓	✓	✓	?
Heritage/Cultural sites	✓			✓	✓		✓	✓	✓	
Imagery – Colour photo	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Imagery – Multispectral	✓	✓	✓		✓		✓	✓	✓	✓ [2]
Land cover	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓?
Land Parcels	✓			✓	✓		✓	✓	✓	? [3]
Land tenure	✓	✓	✓	✓	✓			✓	✓	✓?
Land use	✓	✓	✓					✓	✓	
Land Use Capability	✓							✓	✓	✓
Logging concessions					✓					✓
Meteorology – rf/temp station						✓				?
Meteorology – Weather stations						✓				
Pest Distribution		✓			✓					
Population by census district	✓								✓	✓
Population by census unit	✓						✓	✓	✓	✓
Power lines	✓						✓		✓	?
Reclamations	✓		✓				✓	✓		
Rivers/streams	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Roading – centrelines	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Roading – edgelines								✓	✓	
Roading – Bridges	✓		✓				✓	✓	✓	✓
Roading – Fords	✓		✓				✓	✓	✓	?
SMP extents								✓		
Soil Attributes	✓	✓	✓		✓				✓	✓
Soil Unit	✓	✓	✓		✓				✓	✓

[2] Requires Orthorectification before it is available for use
[3] Incomplete. Requires editing and updating by Land Registry division

DataLayer	Data Needs (by division)									Holding
	Map[1]	BioDiv	W'shed	Parks	Forest	Met	DMO	PUMA	Other	
Stormwater drains			✓					✓	✓	✓(Atherton)
Stream flow rate			✓					✓	✓	
Telephone lines	✓						✓		✓	?
Terrain – Contours	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Terrain – Digital Elevation Model	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Vegetation	✓	✓	✓	✓	✓				✓	?
Water quality – Bores	✓		✓					✓	✓	
Water quality – Lagoon	✓		✓					✓	✓	
Water quality – Stream/river/lakes	✓		✓					✓	✓	
Water supply	✓		✓		✓		✓	✓	✓	
Weed Distribution		✓			✓					?

It is clear that a collaborative data-capture programme by all MNREM/PUMA GIS units could make useful progress in filling the gaps identified above, and thereby make spatial information systems more attractive to client divisions and external agencies.

The majority of the layers listed above were also been identified by SPREP, in a UNEP-funded project to define a State of the Environment Database for Samoa. We have not been able to determine whether this comprehensive database definition was ever transformed into reality but suggest that enquiries be made of:

- SPREP
- The Pacific Environment and Natural Resource Information Centre (PENRIC)
- UNEP
- Dept of Statistics (because a subsequent ADB project RETA 555 "Environment Statistics" is reputed to have developed from the original project

Base Data Development

Some attention could be paid to the completeness and structure of the digital topographic database. Dissimilar features presently in the same layer, such as roads and bridges, could usefully be separated.

The degree of attribution (description) of features could be intensified for some layers. For example, roads could be described by name, surface, hierarchy, etc. Stakeholder agencies. MWTI in the foregoing example, could be approached to assist with this process in exchange for a shared licence to use the upgraded layer(s).

The buildings database, reportedly compiled by SOPAC under the Pacific Cities Programme could be reconciled with the building polygons from the 1:50 000 digital topographic database and updated as an improved layer for mapping and management (especially disaster management).

Similarly, bathymetric information, captured from navigational charts and bathymetric scanners would provide a valuable resource for such applications as general

mapping, marine environmental studies and modeling Tsunami run-up.

SIAM-2 Component C5 is implementing a programme to digitally capture and manage land parcels (cadastre) and land registry information. Elements of these data are keenly sought by stakeholder agencies with interests in planning, infrastructure and resource management. A detailed land tenure layer would be another useful derivative from this work programme.

Participants at the workshop mentioned issues with version control on some base datasets. Establishing metadata, and procedures for the updating and maintenance of key datasets would be helpful in standardizing the data being used by the ministries.

Thematic Data Development

There is immense scope to work with stakeholders within, and outside, the MNREM/PUMA, to develop thematic data layers suitable for applications in; Biodiversity Conservation, Climate Modelling, Disaster Management, Health, Infrastructure Management, Planning, Resource Management, and Policy. Thematic data development identified in a workshop of MNREM/PUMA stakeholders on 13 October 2005 included:

Biodiversity conservation themes

Conservation areas
Forest monitoring sites
Logging concessions
Weed distributions
Pest distributions
River/stream flows
Water quality (freshwater & marine)

Disaster themes

Emergency centres
Hazards (inc industrial)

Planning themes

Consents
Hazards (inc. landslide)
Heritage/cultural sites
Reclamations
SMP locations/extents
Census data

Climate themes

Rainfall surfaces
Temperature surfaces
Solar radiation surfaces
Potential evapotranspiration surfaces

Infrastructure themes

Power generation and supply
Roading (inc management tools)
Telephone networks
Water supply networks
Stormwater drainage system

Resource themes

Geology
Land cover
Land use
Vegetation

5.3 Priority Applications for Near-term Development

A key to successful development of GIS is the acknowledgement, acceptance, and uptake of GIS products by stakeholders inside MNREM/PUMA. Accordingly, we have identified the following ‘pathfinder’ project applications that are both useful and demonstrate the utility of GIS. We offer these projects to the MNREM/PUMA for their

consideration and endorsement as deliverables under SIAM-2 Component C4. Extended descriptions of Projects 1 and 2 are presented as Appendices 1 and 2.

Project 0. Samoa Digital Elevation Model (completed October 2005)

During the GIS Development Workshop held on 13 October it was evident that the level of understanding of DEMs and their potential uses was rudimentary among most GIS practitioners and non-existent among users. Furthermore, it appeared that MNREM/PUMA had never generated a DEM from elevation contour data. Accordingly, the SIAM-2 Component C4 team prepared a short training course for GIS operators covering the theory of terrain models and the practice of generating a DEM and its derivatives. The course was delivered by Matthew Elgin on 18 October 2005 and attended by representatives from the Mapping Section, SamFRIS, the Met Office and PUMA. Attendees received a set of written notes and each GIS unit received a CD containing national copies of the layers produced (the DEM, and Aspect, Slope, and Hillshade layers).

Project 1. MNREM Natural Resource Atlas

MNREM has a significant collection of data that is not appreciated by potential users and not well understood by its custodians. We propose to boost understanding of the data collection by reviewing data structures and documentation, identifying a programme of work to upgrade shortcomings and to undertake any such upgrades that are necessary for the following mapping. We propose to compile a series of 'showcase' maps that, together, will form a Natural Resource Atlas of Samoa that could be used to inform stakeholder agencies of the range of data and quality of presentation available through the Ministry's GIS.

We expect the project primarily to involve staff from the Mapping Section and SamFRIS GIS units, although other units could be included at the Ministry's discretion. We envisage the resourcing required being approximately 15 days consultant time and 30 days MNREM time plus plotting consumables of perhaps 2 rolls of high-quality paper and ink. Collaboration with another agency with similar needs, such as the Statistics Department could be considered

Project 2. PUMA/MNREM Environmental Evaluation Tool

While there is a respectable suite of GIS layers available for environmental evaluation, and GIS skills to undertake such analyses, repetitive tasks such as consent evaluation are usually tackled as a series of one-off jobs with consequent inefficiency and temptation to skip any spatial analysis unless it is explicitly required.

We propose to encapsulate the common GIS analyses used in resource consents (and other applications if justified) in a customised MapInfo workspace so that spatial environmental evaluation and reporting can be done routinely and efficiently.

We expect the project primarily to involve staff from the PUMA and Mapping Section GIS units primarily, although other units could be included at the Ministry's discretion. Involvement of key 'users' including (but not necessarily restricted to) Fetolai'i Alama, would be critical to the successful uptake of the project. We envisage the resourcing required being approximately 25 days consultant time and 20 days PUMA/MNREM time.

Other applications

The two projects above are proposed for delivery as part of SIAM-2 Component C4. In addition, we suggest the MNREM consider the following for near-term implementation as resources allow:

- **MNREM Metadata Development.** Build on the creditable foundation provided by the SPREP-developed Samoa Metadata Catalogue by capturing metadata for all core data layers in sufficient detail not only for data discovery, but also for data documentation. These data should, ideally, be published (on the Met Office Mapserver, for example), be downloadable as ISO 19115-compliant .xml files, and should accompany all data deliveries to client agencies. Samoa has already captured a significant amount of GIS data, but its existence, custodian and nature are not widely known. Published metadata are the key to effective management and application of spatial information.

- **Disaster Management Office GIS Decision Support Tool.** This would be similar to, and probably based on, the Environmental Evaluation Tool above. During and after a disaster, the DMO must provide advice with a high degree of confidence within very confined timeframes. Spatial visualisation, irrespective of the value added by spatial analyses, enhances confidence and timeliness in the advice given. This facility could be enabled on both desktop PCs (staffed by GIS specialists) and mobile PCs (operated by DMO staff).

- **Global Map/Global Spatial Data Infrastructure Grant Programme.** The MNREM Mapping Section has enlisted with the Environmental Systems Research Institute (ESRI) in the above programme. ESRI has provided GIS analytical and publishing software and training (valued at US$50,000). In return, the grantee (MNREM) undertakes to capture and publish, on the Web, national GIS layers (and metadata) of nominal scale of 1 000 000 or better. This scheme is documented on the following website http://www.esri.com/industries/sustainable_dev/grants/description.htm. To date, the software has not been installed by MNREM and nor has any move been made to fulfil the Ministry's obligations under the agreement. The Met Office Mapserver provides an alternative medium for publication of generalised spatial layers required under this programme.

- **Orthorectification of IKONOS Imagery.** SOPAC has provided the MNREM with national, unrectified, multispectral imagery from the IKONOS sensor. This requires orthorectification to the map grid (using a DEM such as that produced in Project 0, above) before it can be used. This is not a trivial process, but it is well understood and documented. We have advised the MNREM to seek SOPAC's guidance in the first instance. Alternatively, the SIAM-2 Component C4 Team has expertise that could assist the Ministry, but the scope of the current project would probably not provide the funding to support this activity.

5.4 Organisational Development

Data access and pricing

This is clearly a contentious issue for stakeholder agencies, the majority of whom

feel that existing policies should be considerably relaxed. As discussed in an earlier section, it is an issue that requires resolution by the MNREM in consultation with stakeholders.

GIS Unit Integration

There is a compelling case for integration of the three GIS units in MNREM to optimise usage of equipment and realise the synergies of their respective skill sets. This has the potential to deliver significant gains if handled well, but significant losses if handled poorly. Key success factors include:

- assigning a technically capable, energetic, visionary leader for GIS in MNREM
- thinking 'merger' not 'takeover' if combining units
- valuing the different skills and backgrounds of the combined team
- managing client relationships as well as staff relationships during any integration
- considering office location to achieve the best:
    - facilities for work
    - proximity to clients
    - proximity to support services
    - security of data and service during normal times and times of crisis

Alternatively, one could point to the advantages of keeping the three GIS units separate to concentrate on their three separate mandates. In this case, careful consideration should be given as to how the three units can better collaborate, share data and develop and manage nationally significant data layers for the benefit of Samoa. A GIS Coordinator could be appointed with responsibility for integrating the GIS activities of the various GIS units and guiding GIS development throughout the MNREM and influencing its successful uptake by other agencies.

Meteorological Office Mapserver

The Mapserver installed by SOPAC in the Met Office is an underused asset in the Ministry. It is viewed by some as a threat to the data monopoly of the MNREM and by others as the medium for free exchange of spatial information within the global community. In reality it can be either or a combination of the two, but it should not be sidelined from the GIS development plans of the Ministry. Viewed positively, it could become the 'shop window' through which users can gain a glimpse of the capabilities of the Ministry (and the wider Samoan GIS community) in terms of spatial data, GIS analyses and related activities. We recommend the MNREM factor the Mapserver into its development plans for GIS.

Staffing and Training

Generally, the staff of the MNREM and PUMA have adequate technical training and background for GIS analysts and operators. Most have attended university and studied GIS and related disciplines such as IT. However, the existing staff lack a strong understanding of how GIS can be applied to potential natural resource, disaster and planning applications. Targeted training for both the GIS staff and potential GIS users could enhance the opportunities for using GIS with MNREM.

As the various GIS groups within MNREM begin to work together it is possible there will be further opportunities for sharing knowledge, and the Samoa GIS User Group could help with the exchange of knowledge, both in technical skills and application of

GIS.

The proposed projects outlined above will also assist in building skills in new areas including cartography, image interpretation and MapBasic scripting. These skills will be relevant to other applications of GIS technology.

The University of the South Pacific will be providing distance learning courses in GIS, geomatics and remote sensing from 2006. These courses will open up many new opportunities for GIS training and skills development throughout the Pacific, including Samoa.

Client Relationships

Samoa has covered significant ground in terms of GIS capability and data. The proliferation of GIS units in several agencies of government and business is a sign of the healthy interest in GIS as a planning, management and business tool. In the natural course of events, one might expect that in a decade or two GIS will be as commonplace as spreadsheeting in the various arms of government and business, but at present it is possible this growth is outstripping demand and the capabilities of existing data and staff resources. The market for GIS services in Samoa, while growing, is not large at present and could easily be served by fewer GIS providers with well-developed data and skills and a market-aware client-provider-partnership approach.

In this environment, the MNREM could promote itself as the main GIS provider to a number of agencies of central government agencies, including:

- Ministry of Agriculture and Fisheries (in respect to agricultural development, plant and animal health, management of the EEZ, etc.)
- Ministry of Commerce, Industry and Labour (in respect to (mainly rural) economic development studies, etc.)
- Ministry of Communication and Information Technology (in respect to IT standards and policy)
- Ministry of Finance (in respect to population, land, agricultural and forestry statistics, and statistical analyses/mapping)
- Ministry of Health (in respect to public health applications, e.g., disease transmission, drinking and lagoon water contamination from septic tanks, urban runoff and agriculture, etc.)
- Ministry of Police, Prisons and Fire Services (in respect to general mapping, emergency management, fire hazard modelling, etc.)
- Ministry of Works Transport and Infrastructure (other than PUMA) (in respect to the management and maintenance of roading and infrastructure)

6. Conclusions

Stakeholder agencies and offices of MNREM/PUMA have a wide variety of data needs and applications. Some of these data layers have yet to be captured or created and most of the applications are yet to be realised

The MNREM has made significant advances in data capture and the development of

a GIS capability. However, there remains some work in consolidating and augmenting data layers and in 'selling' GIS as an operational tool for users. We recommend a dual strategy of 'winning over' stakeholders whilst also investing effort in building a foundation of data layers from which to launch future applications.

We have identified three institutional issues within MNREM that, if successfully resolved, will release some unrealised GIS potential in the Ministry and beyond:

- Data access and pricing
- Utilisation of the Met Office Mapserver
- Integration of GIS units in MNREM

We have outlined the elements of an implementation plan that can be adopted as appropriate by the Ministry in its Corporate Plan:

- GIS software and hardware. We see no compelling reason to change, but counsel the Ministry to fully utilise the resources available (some valuable software remains to be installed many months after it was delivered). We also encourage the Ministry to maintain its GIS equipment to ensure its capability remains undiminished over time.
- GIS Data Development. We list over 50 data layers for which there appears to be a demand, and recommend a programme of work be formulated to capture or generate and document such data, possibly in collaboration with stakeholders.
- We have delivered training in the theory of terrain modelling and in generating and using DEMs and their derivatives.
- We propose two pathfinder project for consideration and endorsement by MNREM and PUMA as showpiece applications of GIS to help win over new GIS clients:
    - MNREM Natural Resource Atlas
    - PUMA/MNREM Environmental Evaluation Tool
- We identify four other projects that we believe will return significant near-term gains to the Ministry:
    - MNREM Metadata Development
    - Disaster Management Office GIS Decision Support Tool
    - Global Map/Global Spatial Data Infrastructure Grant Programme
    - Orthorectification of IKONOS Imagery
- We recommend the MNREM open a dialogue with sister ministries with a view to providing GIS services to those ministries for whom GIS could realise some tangible benefit but for whom investment in GIS is not presently warranted.

7. Acknowledgements

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Telesia Sila
Larissa Toelupe

Appendix 1 Project 1 – MNREM Natural Resource Atlas

MNREM has a significant collection of data that is not appreciated by potential users and not well understood by its custodians. We propose to enhance understanding of the data collection by reviewing data structures and documentation, identifying a programme of work to upgrade shortcomings and to undertake any such upgrades that are necessary for the following mapping.

We propose to compile a series of 'showcase' maps to form a Natural Resource Atlas of Samoa that could be used to inform stakeholder agencies of the range of data and quality of presentation available through the Ministry's GIS. Preparation of this atlas will also be a mechanism for developing the cartographic skills and standards employed by the GIS units.

Functionality

The atlas would involve the collation and verification of existing layers as well as potentially the generation or capture of new geographic layers. The use of MNREM's multi-spectral IKONOS satellite imagery to create new layers for the atlas may also be possible once this has been orthorectified.

Through training and mentoring, skills in cartographic production and data manipulation will be enhanced.

The production of the atlas would be assisted through the development of MapBasic tools to generate workspaces for the atlas. The development of standard workspace layout templates would also assist in developing standards for the cartographic outputs produced by MNREM.

As originally envisaged, the output of this project would be (as below) computer plotted maps produced in limited numbers on-demand and primarily as a marketing tool. If desired, however, corporate sponsorship could be sought for a small print run of bound copies for sale and distribution to schools, etc.

Outputs

The output from this project would be:

- A set of A3 or A2 sized maps.
- Refined MapInfo layers.
- MapBasic scripts for the creation of layouts.
- MapInfo Workspaces for the atlas.

Resourcing

We expect the project primarily to involve staff from the Mapping Section and SamFRIS GIS units, although other units could be included at the Ministry's discretion. We envisage approximately 15 days consultant time and 30 days MNREM time plus plotting consumables of perhaps 2 rolls of high-quality paper and ink.

We are informed that the Department of Statistics has expressed an interest in compiling an atlas of statistical information. If true, then collaboration could deliver and enhanced outcome for less effort for both agencies.

Appendix 2 Project 2 – Environmental Monitoring Tool

While there is a respectable suite of GIS layers available for environmental evaluation, and GIS skills to undertake such analyses, repetitive tasks such as consent evaluation are usually tackled as a series of one-off jobs with consequent inefficiency and temptation to skip any spatial analysis unless it is explicitly required.

PUMA staff commonly need to view, query and analyse environmental layers within the GIS to assess impacts of proposed developments. A simple, user-friendly tool could assist non-GIS experts in production of maps and to view the most appropriate data to analyse a potential development.

We propose to encapsulate the common GIS analyses used in resource consents (and other applications if justified) in a customised MapInfo workspace so that spatial environmental evaluation and reporting can be done routinely and efficiently.

Functionality

The proposed tool would open a workspace of base datasets and use MapBasic to create a custom interface of buttons and menus that allowed a user to alter the visible environmental layers present on the map. Potential layers for assessment would include:

- Coastal Erosion
- Soil
- Vegetation
- Catchment Areas
- Easements
- Marine Reserves
- Policy Implications
- Cultural, Heritage and Archaeological Sites
- Satellite Imagery and Aerial Photography

The tool would include some search functionality built upon existing layers such as roads, localities and grid co-ordinates. Each layer would have its attributes and thematic details defined.

Using customised query and search functions the user could identify potential downslope and downstream effects from the development. For example, an automated process to query a catchment layer could find in which catchment the proposed development would be occurring. A query of the catchments could then identify potential effects from stormwater discharges at the coastal outfall, and whether the catchment drains to sensitive areas such as mangroves, marine reserve or conservation areas.

The tool could also generate site-specific layers as required. These might include noise contours and viewshed calculations for a proposed site. The site-specific layers would also be menu or button driven using MapBasic scripting.

Once complete, the user could produce an A4 or A3 map. The production of the map would also be automated using defined layout templates and scripts.

Outputs

The outputs from this project would be:

- New, updated or reclassified data for environmental evaluation.

- A set of MapBasic tools as outlined above and MapInfo layouts to support the toolset.

Resourcing

We expect the project primarily to involve staff from the PUMA and Mapping Section GIS units, although other units could be included at the Ministry's discretion. Involvement of key 'users' including (but not necessarily restricted to) Fetolai'i Alama, would be critical to the successful uptake of the project. We envisage the resourcing required being approximately 25 days consultant time and 20 days PUMA/MNREM time.